Archeogastropoda, Mesogastropoda and Stratigraphy of the Ripley Owl Creek, and Prairie Bluff Formations

GEOLOGICAL SURVEY PROFESSIONAL PAPER 331-A

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By NORMAN F. SOHL

LATE CRETACEOUS GASTROPODS IN TENNESSEE AND MISSISSIPPI

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In this report, 48 genera and 94 named and 33 unnamed species are discussed and diagnosed; 4 genera are new; 3 new subgenera are proposed, and 21 species and 2 subspecies are described as new

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By Norman F. Sohl

ABSTRACT

The present paper is the first of a proposed two-part treatment of the Late Cretaceous (Maestrichtian) gastropod faunas of the Ripley, Owl Creek, and Prairie Bluff formations of southern Tennessee and northern Mississippi. In this part of the Mississippi embayment both the Ripley and the Owl Creek and Prairie Bluff formations present similar patterns of sedimentation. During the entire span of time represented by these formations, sand (clastic sediment) predominates in the northern areas and chalk (carbonate) predominates in the southern areas. At various times the demarkation line of the sedimentary provinces shifted back and forth, as exemplified by the southern shift during middle Ripley time owing to the great influx from the north of the sands which formed the McNairy sand member. Thus, laterally, one finds a series of interfingerings of different lithologic types.

The Ripley formation is thickest in the northern areas of outcrop, where in the vicinity of the Tennessee-Mississippi State line it is close to 350 feet thick. The formation thins southward until near the Alabama-Mississippi State line it is only about 60 feet thick. In northern Mississippi the formation can be divided into five units, which are, from oldest to youngest, transitional clay, Coon Creek tongue, McNairy sand member, sand of the upper part of the Ripley, and the Keownville limestone member (new name).

The base of the Ripley is gradational downward to the Demopolis chalk through a dominantly clayey unit termed the transitional clay. In Tennessee and northernmost Mississippi, this clay unit lies entirely within the *Exogyra cancellata* zone, but south of southern Tippah County the transitional clay lies in part above that zone. This clay, along with the rest of the formation, grades into sandy chalk in Noxubee County, Miss. Upward, the clay becomes increasingly sandy and grades into the highly fossiliferous sand units of the Coon Creek tongue. The Coon Creek varies in age along the outcrop belt. At the type locality on Coon Creek, Tenn., the sand contains *Exogyra cancellata* Stephenson; but in Mississippi a few miles south of the State line, the member lies entirely above that zone. The sand of the Coon Creek tongue grades upward through thinner bedded lighter colored sand and clay beds into the varicolored crossbedded McNairy sand member. The McNairy represents a blanket deposit of shallow-water irregularly bedded sand that spread out from the head of the Mississippi embayment south to Union County, Miss. Its maximum southward extent was probably reached in middle Ripley time. The McNairy sand member bears few fossil invertebrates. Locally, massive but lenticular clay units contain abundant plant material. Deep water fossiliferous sand beds of the upper part of the Ripley formation overlie the McNairy in Mississippi and are in turn followed by a sequence of fossiliferous *Sphenodiscus*- and echinoid-bearing limestone strata of the Keownville member, which extend as far south as Chickasaw County. In the southern counties (Pontotoc County to Kemper County), the McNairy sand member is absent, and the greater part of the Ripley cannot be divided. In Noxubee County, Miss., the whole formation grades into the chalk facies. The unconformity at the top of the Ripley varies locally in magnitude. In some places the Keownville limestone member appears to be entirely eroded off, and the overlying Prairie Bluff chalk rests on sand of the middle part of the Ripley.

The Owl Creek formation consists of dark fossiliferous sand 30-40 feet thick. In Hardeman County, Tenn., the formation is overlapped by the Midway group; but southward along the outcrop belt, it can be traced until it interfingers with the Prairie Bluff chalk in Pontotoc County, Miss. The Prairie Bluff chalk reaches a maximum thickness of about 70 feet and is recognizable from southernmost Tippah County, Miss., to Bullock County, Ala., where it interfingers with the Providence sand of the Chattahoochee River region. The unconformity at the base of the overlying sand and limestone of the Midway group is marked almost everywhere by a zone of reworked Cretaceous fossils. The relations of these formations are graphically represented on plate 1, which presents columnar sections spaced north-south along the outcrop belt in Mississippi. A separate section is devoted to the measured stratigraphic sections of the individual collecting localities.

The bulk of the report consists of the section on systematic palenontology. Short discussions on terminology, method of description, state of preservation, and method of collecting are followed by the systematic part. Forty-eight genera of Archeogastropoda and Mesogastropoda are diagnosed and discussed. Of the 48 genera recognized, four are new: *Dircella*, *Lemniscolittorina*, *Tintorium* and *Graciliala*. In addition, three new subgenera are proposed: *Calliomphalus* (*Planolateralus*), *Arrhoges* (*Latiala*), and *Mathilda* (*Echinimathilda*). In all, 94 species and 3 varieties are named, and 33 additional descriptions are included of material too poorly represented or preserved to warrant attachment of a specific name. Twenty-one species and two varieties are described as new, and numerous reassignments are made.

Occurrence and abundance data are presented on a chart keyed geographically and stratigraphically.

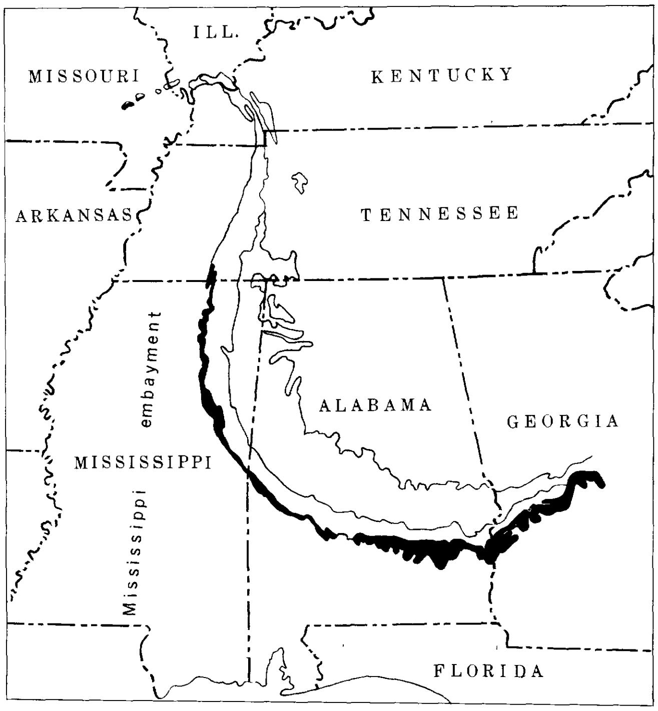

FIGURE 1.—Sketch map of the Upper Cretaceous outcrop belt in the Southeastern States. Shaded parts equivalent to the Owl Creek formation; inner line is the edge of the coastal plain sediments; middle line is the base of the Demopolis chalk.

INTRODUCTION

SCOPE, PURPOSE, AND HISTORY OF THE REPORT

The invertebrate fauna of the Ripley, Owl Creek, and Prairie Bluff formations of northern Mississippi and southern Tennessee is one of the largest and most diversified fossil assemblages to be found in strata of Late Cretaceous age anywhere in the world. Species of the phyla Protoza, Porifera, Coelenterata, Bryozoa, Brachiopoda, Annelida, Mollusca, Arthropoda, Echinodermata, and Vertebrata have been described in this fauna. Of them all, the Mollusca comprise the greatest percentage of the macroinvertebrates, both in number of species and in number of individuals. With the exception of those found in the Prairie Bluff chalk, the mollusks are extremely well preserved, and many retain their original pattern of coloration. Considering the preservation and the relative ease of recovery, it is amazing that so much of the fauna has remained undescribed.

The area of outcrop discussed in this report (fig. 1) is a critical one, being between the East and West Gulf Coastal Plain sections of outcrops of Cretaceous rocks in what is termed the Mississippi embayment. Further knowledge of the Cretaceous fauna of this northern part of the embayment should greatly aid in determining the relationships of the faunas of the whole gulf coast and in correlation with the Upper Cretaceous sections of the Atlantic Coastal Plain province.

With these factors in mind, an investigation of the gastropod fauna of the *Exogyra costata* zone, as represented by the Ripley, Owl Creek, and Prairie Bluff formations, was undertaken. The fieldwork, consisting of the collecting of fossils and the measurement of stratigraphic sections, began in the summer of 1950 while the author was a student at the University of Illinois. Fieldwork continued through parts of the summers of 1951, 1952, and 1953. When time permitted, shorter excursions were also taken. Preparation and identification of the material collected and journeys to the Academy of Natural Sciences of Philadelphia and the U.S. National Museum for comparison of the type specimens at those institutions culminated in a dissertation submitted as partial fulfillment of requirements for the degree of doctor of philosophy at the University of Illinois in 1954. In that same year the author joined the the U.S. Geological Survey, where work continued on the project. Additional fieldwork consisted of a short trip to Mississippi in April 1955 with L. W. Stephenson. The remainder of the time has been spent in integrating the many collections made by the Survey in this area since 1889 with those made by the author.

The report on this work is divided into two parts, of which the present volume is part one. Part 1 deals with the general geologic setting and the stratigraphy of the three formations, and includes descriptions of species of the prosobranch orders Archeogastropoda and Mesogastropoda. Part 2 will deal with paleoecology, the relationship of the described gastropod fauna to those of other areas, and descriptions of the species and genera of the prosobranch order Neogastropoda and the superorder Opisthobranchiata. These discussions will be inserted in part 2, as the new species of neogastropods and opisthobranchs, will have been described and their names introduced, which will facilitate the paleoecological discussion as well as the faunal comparisons.

ACKNOWLEDGMENTS

In undertaking a project of this sort, one must depend heavily on the aid of fellow workers and on the institutions with which they are affiliated. Drs. Harold Rehder and J. P. E. Morrison, of the U.S. National Museum, have given freely of their time and advice on taxonomic problems. Dr. H. G. Richards aided in making available T. A. Conrad's Cretaceous type specimens from Mississippi in the collections of the Academy of Natural Sciences of Philadelphia. Dr. Bernhard Kummel, formerly of the University of Illinois, now of Harvard University, it due thanks not only for suggesting the problem and supervision of the early stages of the work but for his continued interest and encouragement. Thanks are also due 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 collecting and studying of the material. Among my colleagues of the U.S. Geological Survey, special thanks are due L. W. Stephenson, the late J. B. Reeside, Jr., and E. L. Yochelson for their interest and advice in preparation of the manuscript and for critically reading the manuscript.

GEOMORPHIC SETTING

The area of southern Tennessee and northeastern Mississippi under consideration here is classed as part of the Mississippi embayment in the Gulf Coastal Plain (Stephenson, 1926). The three Upper Cretaceous formations, the Ripley, the Owl Creek, and the Prairie Bluff, crop out in an arcuate or crescent-shaped pattern (fig. 1) that crosses this region and Alabama to Georgia in the east and northward through Tennessee and Kentucky to Illinois at the head of the embayment. These formations are overlapped by Paleocene rocks at the head of the embayment but crop out in Missouri.

Physiographically these three units are noteworthy. The sands of the Ripley formation especially the McNairy sand member, hold up hills which have a relief of up to 250 feet in northern Mississippi. This physiographic district has been called the Pontotoc Hills or Pontotoc Ridge since before the time of Hilgard (1860). Locally, other names have been applied, such as the Tippah Hills and Buncombe Hills. The ridge proper includes sands of the Ripley and Owl Creek formations and a part of the Clayton formation of Paleocene age. Its eastern margin forms a rather highly scalloped cuesta, one unit of the complex system of belted cuestas of the Gulf Coastal Plain. This geomorphic feature stands in decided contrast to the low Black Prairie district (Lowe, 1919, p. 30), which lies directly to the east and is underlain by the chalk of the Selma group. As one looks to the west over these low flat "prairies," the Pontotoc Hills rise steeply from the lowlands, and the cuesta face affords many of the better exposures of the lower part of the Ripley. West of the Pontotoc Hills lies an area known as the Flatwoods district. The Flatwoods district, like the Black Prairie belt, is an area of low relief and is formed on the Porters Creek clay of Paleocene age.

In southern Tennessee, the Pontotoc Hills have a breadth of almost 25 miles, but in Mississippi they taper along with the thinning of the sands of the Ripley formation and finally become indistinguishable from the Black Prairie Belt in Noxubee County. The Pontotoc Ridge forms an important divide for the drainage systems of the region and many of the important streams head in these rugged hills of northern Mississippi (fig. 5). The Hatchie River heads in northeastern Union County, Miss., and flows northwestward to the Mississippi River. Numerous other smaller streams flow southeastward to the Tombigbee River, which discharges into the Gulf of Mexico. The Tallahatchie River flows west and southwest, eventually joining the Mississippi River. Thus the Pontotoc Ridge forms the major divide between the Tombigbee and Mississippi Rivers drainage area.

Structurally the three formations form the upper part of the great wedge of Upper Cretaceous sedimentary rocks that dip embaymentward and gulfward as a monocline. Exclusive of minor local variation, the Cretaceous strata possess a rather uniform regional dip of approximately 30 feet per mile. No faults of large displacement occur, but several flexures that produce reverse dips have been noted (Stephenson and Monroe 1940, p. 34, 74; Priddy, 1943, p. 20, fig. 3). In places faults of small displacement are present and are more common near the Alabama State line, which is close to the fault belt mapped by Monroe (1955) in Sumter County, Ala.

HISTORICAL REVIEW

Although the systematic work on the paleontology of the Ripley, Owl Creek, and Prairie Bluff formations of Mississippi is small in proportion to that done on fossils from other parts of the Atlantic and Gulf Coastal Plain much information has none the less accumulated since the early 1800's. The list of contributors to its stratigraphy and paleontology reads much as an honor roll of the early Coastal Plain geologists. Morton, Gabb, Conrad, Tuomey, Hilgard, Harris, Stephenson, and many others have all added significantly to the geologic and paleontologic knowledge of the region.

Attention was first drawn to the Cretaceous sequence in Mississippi by Morton (1834, p. 22), who cited diagnostic Cretaceous fossils as occurring in northern Mississippi. Aside from incomplete and understandably faulty maps by Marcou (1853) and Lieber (1854), little was known of the geology of this area until the first of the official State reports by Wailes in 1854. Wailes gave a brief account of the Cretaceous strata. This first report was soon followed by reports of a similar nature but of superior quality in 1857 by Harper and in 1860 by Hilgard. The latter report was by far the best and most complete and shows Hilgard to have been an astute observer. Hilgard's division of the Cretaceous of the area (figs. 2, 3) is still to a large extent broadly applicable today. His Ripley group is now divided into the Ripley and Owl Creek formations and the uppermost beds of "bored" limestone are now classed as Paleocene in age. The more recent reports on the general geology of Mississippi by Crider (1906) and Lowe (1915, 1919, 1925), even though having the advantage of much additional information have failed to eclipse Hilgard's work.

Similar work was progressing in adjoining States. Safford provided an excellent work on the "Geology of Tennessee," which appeared in 1869. Tuomey, as state geologist of Alabama, was actively engaged in Cretaceous investigations as early as 1847. His investigations were followed by those of Smith, Langdon, and Johnson whose work culminated in 1894 with the publication of the definitive "Coastal Plain of Alabama."

The early reports were of a general nature, with emphasis mostly on economics and soils and were accompanied by accounts of stratigraphy of variable quality. Frequently, as in Hilgards report, fossil lists were cited, but little attempt was made to incorporate them into the stratigraphy. Subdivisions of the column were based on lithologic characteristics, which in turn gave rise to a disparity in the use of formation names (fig. 2).

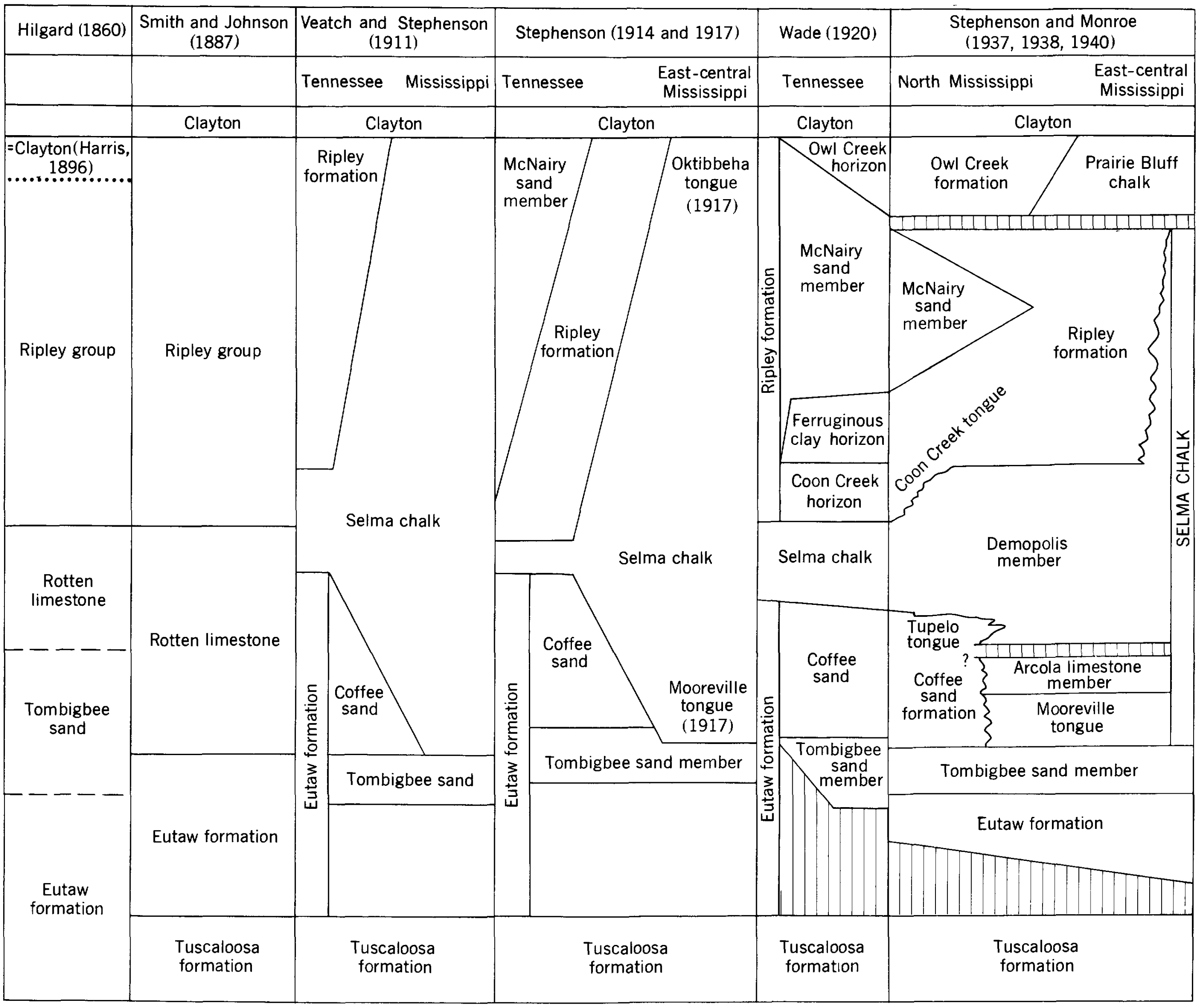

FIGURE 2.—Summary of the past correlation of the Upper Cretaceous rocks of Tennessee and Mississippi. (See fig. 3 for correlation used in this paper.)

Paleontologists, however, had not been neglecting the fossils, and contributions to the Cretaceous paleontology, although generally of a minor nature and purely descriptive, began to accumulate. Morton in 1834 described internal molds from what is now recognized as the Prairie Bluff chalk in Alabama. Tuomey (1854) added many new species to these from the chalk beds of Mississippi and Alabama. Tuomey's contribution however is essentially valueless for his descriptions are inadequate and unaccompanied by illustrations. In addition the names are based primarily on internal molds, the types of which have been lost and the type localities are unknown. The type specimens may have been lost during the Civil War, as Harris (1896, p. 7) stated that the Tuscaloosa cabinets of Tuomey were destroyed by fire.

That a number of Tuomey's Mississippi specimens probably came from the Eutaw formation at Plymouth Bluff in Lowndes County is shown by Hilgard, who stated (1860, p. 74):

> At Plymouth Bluff we find one of the best and most characteristic exposures of the Tombigbee Sand Group . . . . It was early visited and its fossils collected, by Dr. William Spillman, of Columbus, who possesses a fine collection of its fossils: a number of these have been studied and named by Tuomey.

In spite of the nebulous validity of Tuomey's species, the names are perpetuated by many authors and have even been applied to specimens of a considerably different age as far away as New Jersey (Weller, 1907).

Conrad (1858) described a collection of fossils made by the same Dr. Spillman from the classic locality on Owl Creek in Tippah County, Miss., and gives an admirable account of their startling state of preservation. A great debt is due Dr. Spillman for his energy in collecting, for although he did not himself publish and was not a paleontologist, he provided the impetus for the early study of the Cretaceous paleontology of Mississippi which no one else at the time could give. As Hilgard (1860, p. 84) stated:

> In the spring of 1856, I explored the territory, and collected the fossils of the Ripley Group from the town of Pontotoc to the Tennessee line, and in autumn of the same year, its southern portion, from Pontotoc to Houston. Upon my information regarding these localities Dr. William Spillman, of Columbus, (whose splendid collection of fossils from the lower stages of the Cretaceous has already been mentioned), visited the Owl

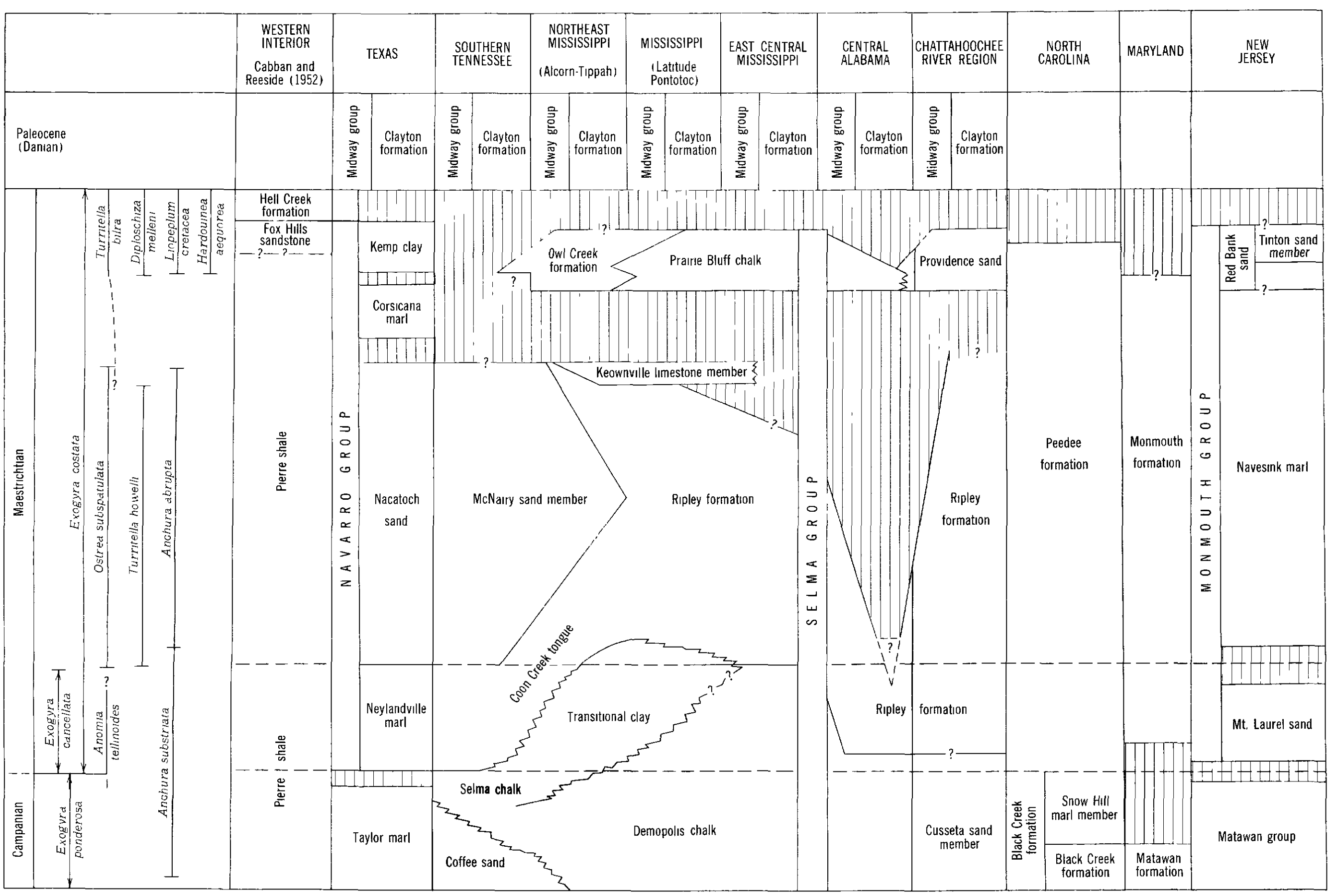

FIGURE 3.—Correlation of the Upper Cretaceous rocks of the *Exogyra costata* zone of the Atlantic and Gulf Coastal Plains (modified from Stephenson and others, 1942).

Creek locality in November 1856, and brought back a fine collection of its fossils; which he subsequently submitted to Mr. Conrad for description, there being then no prospect of anything being done with the collections of the Geological Survey. Great credit is due to Dr. S. for the energy and enthusiasm with which he has for years pursued, during his leisure hours, the study of the Cretaceous formation, of Mississippi.

Conrad's description of 56 new species from Owl Creek marks a milestone in the Cretaceous paleontology of Mississippi, as it was the first major illustrated work on the subject. Unfortunately the type specimens originally in the collections of the Academy of Natural Sciences of Philadelphia are no longer available and have evidently been lost. Fortunately the type locality is known, and the illustrations are of sufficient quality to identify most of the species from topotype material. In 1860, Conrad published another paper dealing with additional Cretaceous species from Tippah County, Miss., and Eufaula, Ala. Subsequent authors for the most part have assumed that the Mississippi specimens dealt with are from the Owl Creek locality; but as indicated below, I believe a number to be from the Ripley formation. Fortunately the types of many of these 1860 species are preserved in Philadelphia. The only locality given for the Mississippi specimens is Tippah County. It seems reasonable that if Conrad knew the specimens to have come from Owl Creek he would have so stated, as he did in 1858. The same holds true for Dr. Spillman, who had sent the specimens to Conrad. A comparison of the preserved type specimens with collections from northern Mississippi shows the following species described by Conrad to be restricted to the Ripley formation: *Turbonilla* (*Chemnitzia*) *spillmani* (=*Dircella*), *Turbonilla* (*Chemitzia*) *corona* (=*Trobus*), *Athleta leioderma* (=*Liopeplum*), *Morea cancellaria*, *Anchura abrupta*, *Pyrifusus subdensatus*, *Fusus tippanus* (=*Hercorhyncus*), *Strepsidura ripleyana* (=*Stantonella*), *Trigonia thoracia* Morton of Conrad, *Astarte crenulirata* (=*Veteric ardia*), *Cassidulus subquadratus* (=*Hardouinia mortonis* (Michelin)).

The latter species is common in the Keownville limestone member, the others for the most part are present in the lower part of the Ripley. In addition the specimen of *Pugnellus densatus* figured by Conrad (1860, pl. 46, fig. 31) is more typical of the size exhibited by the specimens from the Ripley than the larger average size attained by the specimens from the Owl Creek formation. *Thylacus cretaceus* Conrad is known from only a few specimens from the Owl Creek formation, but numerous specimens have been collected from the Ripley. Most of the remainder of Conrad's Tippah County species are either long-ranging, or their identification is tenuous.

It is evident from Hilgard (1860, p. 84) that Spillman knew of numerous localities besides Owl Creek, and it is most likely that Conrad's specimens came from several localities. A glance at figure 4 indicates that the primary collecting area for fossils from the Ripley in the area north, east and south of Molino no longer lies entirely within Tippah County and some specimens may have come from what is now Union County.

Gabb (1860) published two papers on Tertiary and Cretaceous fossils: the first included species from the Ripley and Prairie Bluff formations of Alabama and their New Jersey equivalents; the second contained some species from a sequence in Tennessee which Gabb assigned to the Ripley, but which actually belongs in the Paleocene (Harris, 1896).

In spite of these announcements of the remarkably well-preserved Cretaceous fossils of this area, publications virtually ceased. Perhaps this was brought on by a period of inactivity during the Civil War. It was not until 1909, almost 50 years later, that the next paleontologic contribution dealing directly with Mississippi fossils appeared, when Slocum described six species of echinoids. Although Mississippi was neglected, except for minor contributions (Stephenson and Monroe, 1940, p. 21–26), work of monographic proportions was being done on faunas of equivalent and near equivalent age in other areas, and the results appeared in rapid sequence in New Jersey (Whitfield 1885, Weller, 1907), Maryland (Gardner, 1916), and North Carolina (Stephenson, 1923). Of more immediate bearing on the Cretaceous of Mississippi and Tennessee were papers on stratigraphic subdivision, correlation, and paleontologic zonation, such as that of Stephenson (1914), in which the *Exogyra* zones were defined. From this date Stephenson has contributed much to the stratigraphy and paleontology of the area. In Tennessee, Wade contributed short papers on the stratigraphy (1917, 1920). In 1926 a milestone was reached when Wade completed a monograph on the Ripley fauna of Coon Creek, McNairy County, Tenn. This monograph described an astoundingly well preserved fauna from the *Exogyra cancellata* zone, most of which was new and included many genera hitherto unknown in the Cretaceous. This monograph has served as a reference point for subsequent work on the Campanian-Maestrichtian paleontology of the gulf coast. By 1940, knowledge of the Late Cretaceous stratigraphy of Mississippi had reached a plateau and with slight modification is essentially unchanged to the present. With minor modification the classification used here is an outgrowth of that used by Stephenson and Monroe in 1937, 1938 and 1940. Other papers that are most useful and applicable to the paleontology of the *Exogyra costata* zone in the Mississippi embayment have been Stephenson's 1941 monograph on the Navarro fauna of Texas and his 1955 paper on the Owl Creek formation of Missouri. In recent years the Mississippi Geological Survey has issued county reports each of which includes a geologic map and short summaries of geology by formations. Such bulletins have appeared on Tippah (Conant, 1941), Union (Conant, 1942), Clay (Bergquist, 1943), Pontotoc (Priddy, 1943) and Lee Counties (Vestal, 1946).

Thus knowledge of the late Upper Cretaceous stratigraphy and paleontology of the Mississippi embayment has gradually accumulated. With the exception of Wade's monograph (1926) on the Coon Creek fauna of Tennessee, it has been necessary to view the Ripley and Owl Creek faunas in the light of work on other areas, much of which is outdated. To fill this gap in our knowledge at least partly is one purpose of this report.

STRATIGRAPHY

The areas of exposure of the Ripley, Owl Creek and Prairie Bluff formations exhibit moderately high relief for an area in the Gulf Coastal Plain region. However, the hills are highly overgrown by vegetation, the sediments are commonly deeply weathered and exposures here as in most other parts of the coastal plain are small and poor. The best exposures are in streambanks, where they are kept fresh by frequent washing, and in manmade cuts and excavations along roads and railroads, where weathering and overgrowth by vegetation soon obscure the fresh surface. Complete sections of even a member of the formations are few. Plate 1, which represents the relationships of the various formations in this area of the Mississippi embayment, is therefore compiled from composite sections spaced along the strike of the outcrop belt from the Mississippi-Tennessee State line to Kemper County, Miss. The individual composite sections were compiled from traverses across the outcrop belt at right angles to the strike of the beds. In all, several hundred stratigraphic sections were measured in this area between 1950 and 1955. Measurements were made by conventional hand-level and tape methods. As there was essentially no topographic map coverage of the area when the work was in progress, the sections were tied together with the aid of an altimeter. Recently several Survey and Tennessee Valley Authority quadrangle maps have appeared

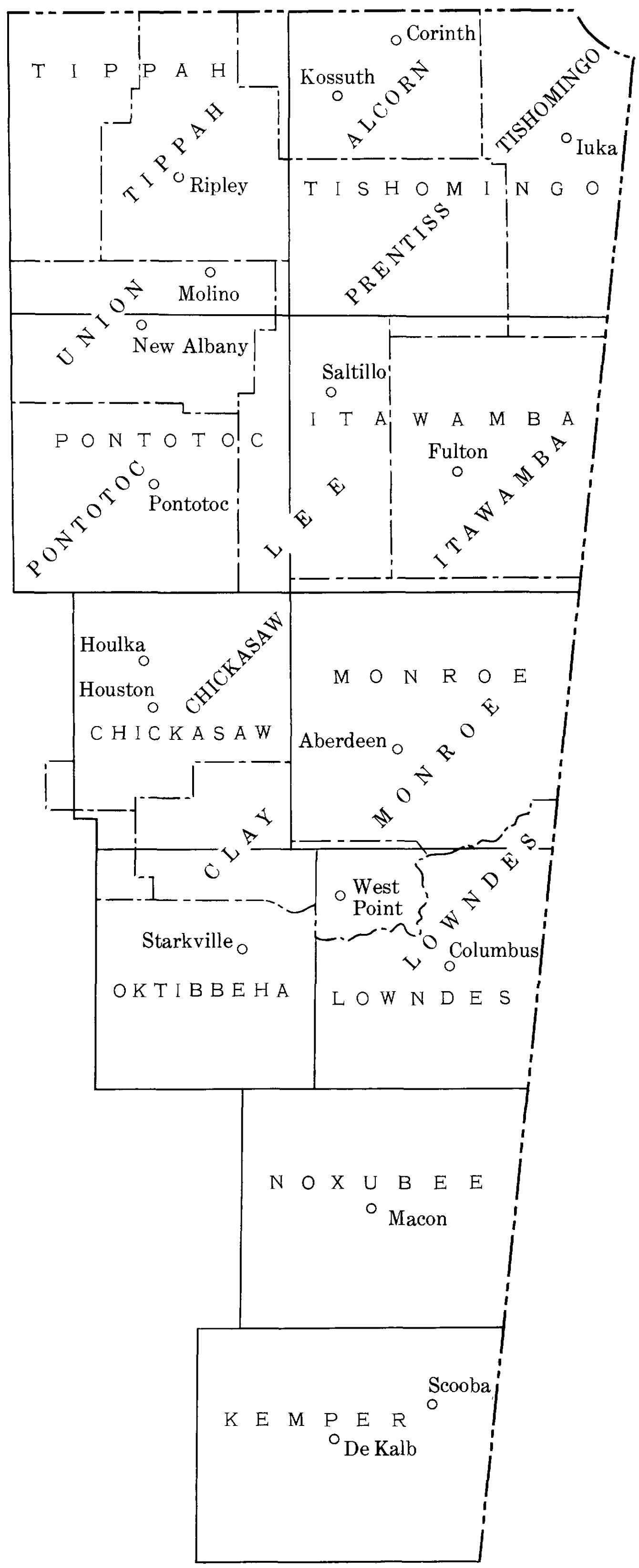

FIGURE 4.—Map showing the county boundaries in northeastern Mississippi in 1860 (solid lines) and those of the present (broken lines).

that cover parts of the area involved and have afforded a check for the interpretations previously made.

With a few exceptions, stratigraphic sections of the fossiliferous localities have been placed together in a separate section but are referred to by locality number in the following stratigraphic discussion.

ZONATION

The three formations here under discussion, the Ripley, the Owl Creek, and the Prairie Bluff, in Mississippi and Tennessee conveniently form the major part of a larger subdivision or zone. This zone, the *Exogyra costata* zone (fig. 3), can be traced and delimited on the Coastal Plain from Mexico to New Jersey (Stephenson, 1914 and 1933). Within the Coastal Plain this major zone can be subdivided into several subzones, some of which have been indicated on fig. 3. *Exogyra cancellata* Stephenson and *Anomia tellinoides* (Morton) have for many years been recognized as distinctive of the lower part of the *E. costata* zone (Stephenson, 1933). *Ostrea subspatulata* Forbes, and its analog in Texas, *Ostrea owenana* Stephenson, have been recorded from the part of the Ripley and its equivalents above the *E. cancellata* zone from Texas to the Carolinas. Many other species are restricted to these units, but their distribution is provincial, such as *Turritella howelli* Harbison, known from the Ripley formation of Mississippi to Georgia. The most widespread species in the Prairie Bluff chalk and equivalents are *Turritella bilira* Stephenson, which is known from Texas to Georgia, and *Liopeplum cretacea* Conrad, which occurs in the sand facies (Owl Creek and Providence) from Mississippi to Maryland. Other species, such as *Diploschiza melleni* Stephenson and *Hardouinia aequorea* (Morton), are also stratigraphically restricted to these upper beds but occur only in the chalk facies (Prairie Bluff).

Compared with the European time scale both deposits of Campanian and Maestrichtian age appear to be represented. The boundary between these two European stages cannot be exactly determined, but according to Cobban and Reeside (1952) it occurs in the western interior of the United States at the base of the *Baculites baculus* zone. For reasons stated in the following discussion of the Ripley formation, this places the boundary close to the base of the Ripley.

How much of the Maestrichtian is represented in Mississippi is debateable and will be discussed in detail in a section in part 2 on faunal comparisons. In any event, the unconformity at the top of the Owl Creek and Prairie Bluff formations represents a hiatus sufficient for the considerable faunal change represented by the contrast between faunas of the Owl Creek and the Clayton formation of Paleocene (=Danian age, which occur immediately above the latest Cretaceous sedimentary rocks in the Mississippi embayment.

SEQUENCE OF DEPOSITION

The sediments of the *Exogyra costata* zone record several fluctuations in the seas of the Mississippi embayment region. In part, these fluctuations appear to be incomplete sedimentary cycles.

Throughout the period of time represented, sand is more common in the northern part of the area, toward the head of the embayment; and calcareous sediment dominates in the south in east-central Mississippi. This is true near the base of the *E. costata* zone (fig. 3 and pl. 1) where the upper part of the impure Demopolis chalk grades northward along the strike into clay of the transition zone in northern Mississippi, and these in turn grade into sand of the Coon Creek tongue in Tennessee. The faunal assemblages of these units indicate that the water was not deep, but it must have been rather quiet, as crossbedding is rare and the fossils are well preserved and show little or no effects of wear and transportation. The sand of the Coon Creek tongue grades upward into shallow-water sediment of the McNairy sand member. During the time of deposition of the middle and upper parts of the Ripley formation, these sand units spread as a thick blanket extending from the head of the Mississippi embayment in Illinois south into Union County. These sand units of the McNairy are thin bedded and show many structures, such as crossbedding and scour and fill, that are indicative of reworking by waves and currents. The general sparcity of invertebrates may be due in part to such reworking and wear. In parts of the McNairy sand member massively bedded lenticular clay units which contain abundant plant debris are common. The clay probably accumulated in quiet waters, perhaps that of coastal lagoons, as has been postulated by Berry (1925, p. 4).

The shallow-water origin of the McNairy sand member is in distinct contrast with the underlying and overlying deeper water sand units of the Ripley formation, which possess more massive bedding and a high organic and carbonate content and which, with the exception of the transition zone, generally lack crossbedding. To the south, the McNairy pinches out into the sand of the Ripley in Union County, but the shallow-water nature of the crossbedded and thin sand and clay units of the middle part of the Ripley of Pontotoc County indicate that shallow-water conditions prevailed farther to the south. These sand beds, where followed along the strike, gradually change to more highly micaceous and finer grained sediment, as typified by the calcareous silt units of the Ripley of Chickasaw and Clay Counties, Miss. In turn the silt increases in carbonate content until in Noxubee County they become silty and sandy impure chalk.

Following the deposition of the Ripley formation, the embayment sea evidently withdrew from the area. How far it withdrew is difficult to ascertain, as in the subsurface the distinction between Ripley and younger sediments cannot be drawn with certainty On the outcrop the erosion interval as represented by the unconformity at the top of the Ripley, is widespread, extending from Texas to Georgia. The differences between the faunas of the Ripley and Owl Creek formations are not so marked that one would assume this hiatus to be of major proportions, but it was significant enough for the development of numerous new species and the introduction of different genera from other areas. The variation in thickness of the Ripley ascribed by Stephenson and Monroe (1940, p. 257) as proportional to the amount of erosion in post-Ripley times could equally well be, at least in part, accounted for by differing rates of sedimentation. It is difficult to believe that erosion alone would account for the thickness variation of the Ripley from 300+ feet in the north to 50 feet in east-central Mississippi. It does appear reasonable that, where an abundance of coarse clastic material is available for deposition, sediment will be thicker there than in areas where deposition is dominantly of a chemical or organic type.

In later Cretaceous time the seas again transgressed northward in the embayment, reaching at least as far north as Missouri. Like the Ripley formation, sand deposition, represented by the Owl Creek formation, dominated in the north and chalk deposition, as typified by the Prairie Bluff chalk dominated the more southerly counties. This interval was rather short lived, as even in the sand facies thicknesses are small. After deposition of the Owl Creek and Prairie Bluff, the sea again left the embayment, and the Cretaceous deposits were subjected to erosion. The sea, according to Stephenson (1941, p. 32, 33), retreated at this time to the edge of the continental shelf, and the post-Cretaceous erosion lasted long enough to produce a striking change in the fauna, with only a few of the old species retained when the sea returned. Stephenson and others (1942) allowed part of the Maestrichtian and all the Danian for this interval. As data on the foraminifera of the Midway group become available, evidence continues to accumulate indicating that, as Scott (1934) thought, the Midway is of Danian age; but it is Paleocene not Cretaceous as he believed. As now known, the hiatus between the Cretaceous and Paleocene represents only a part of the Maestrichtian and perhaps some of the earliest Paleocene. Monroe (1953, p. 13) believed that the physical evidence does not bear out a long period of erosion. He believes the youngest Cretaceous beds cropping out are of about the same age across the Gulf Coastal Plain, an area over which one would expect some pronounced differential erosion if exposed for such a period of time. Stephenson (1941, p. 321–23) believed such a difference exists between Texas, where the Kemp clay and Escondido formation are represented by many hundreds of feet of sedimentary material, and the rest of the Coastal Plain where usually only 100 feet or less represent such rocks. A reevaluation of the faunal evidence will be included in the discussion of the faunal relationships.

The Midway sea carried far up the embayment and in some areas, as in Missouri and Arkansas, the Cretaceous is completely overlapped. The basal units of the Clayton formation of the Midway group contain abundant reworked Cretaceous materials in Mississippi, Tennessee, and Missouri. Many of the fossils are so fragile that they could not have been transported far but may have been incorporated in the Clayton in blocks of sand from the Owl Creek formation broken from bordering cliffs or ripped up from the bottom.

The Midway sea was the last sea to inundate the upper part of the Mississippi embayment, and since that time the area has been subjected to subaerial erosion.

RIPLEY FORMATION

Conrad (1858, p. 324) informally proposed that the strata cropping out on Owl Creek in the vicinity of Ripley, Tippah County, Miss., might well be called the Ripley group because of their distinctive fauna. These fossils he correlated with the Senonian stage of d'Orbigny. It remained for Hilgard (1860, p. 83) to more formally designate and ascribe limits to the Ripley sequence. Hilgard considered all beds between the top of the "Rotten limestone" and the base of the overlying Tertiary as belonging to his Ripley group (See fig. 2). The base as defined by Hilgard has remained essentially as he placed it and was recognized by him in some places to be transitional. However the upper limits have changed considerably. Upon both paleontologic grounds and physical evidence, in the form of an unconformity, Harris (1896, p. 18) showed that the upper or "bored" limestone of Hilgard exposed in the vicinity of Ripley were actually Eocene (=Paleocene) in age. The use of Ripley formation in the sense of Hilgard continued for a period of 40 years after Harris' discovery, but the formation was divided into a number of zones and members (Stephenson, 1914, and Wade, 1917). Later Stephenson and Monroe (1937, p. 808) divided the Ripley of Hilgard into two formations, the Ripley and the Owl Creek, by proving the existence of a wide spread unconformity at the base of the Owl Creek formation. As defined at present (fig. 3), the Ripley formation lies within the *Exogyra costata* zone and in northern Mississippi and southern Tennessee includes some slightly older (*E. cancellata* zone) strata than it does to the south. Southward the boundary falls within a transitional clay zone, and the base of the Ripley formation is chosen arbitrarily at the top of the *E. cancellata* zone (Stephenson and Monroe, 1940, pl. 1a).

The name Ripley is applied to beds of similar age and lithologic composition as far east as Georgia but northward in Illinois and Missouri it has been supplanted by McNairy sand (Stephenson, 1955; Grohskopf, 1955). In southern Tennessee and northern Mississippi the Ripley crops out in a band 20–25 miles wide which trends a few degrees west of directly south. Southward in Mississippi, the outcrop band thins to 2 miles or less in Noxubee County and changes in trend to a southeasterly strike. The thickness of the formation varies in proportion to the width of the outcrop belt. In the northern areas at the Kentucky-Tennessee State line, the formation is only 100–200 feet thick, but it thickens in southern Tennessee to an estimated 400 feet. Whitlach (1940, p. 44) stated that the formation is 600 feet thick here, but this estimate appears excessive and includes the Owl Creek formation and probably a few feet of the lower part of the Clayton formation. In Tippah and Union Counties, where the McNairy sand member thins, the Ripley formation probably does not exceed 360 feet in thickness. Southeastward along the outcrop belt, the sand units of the Ripley become finer grained, more silty, clayey, and calcareous until in Noxubee County they grade to an impure sandy chalk which is only 50–70 feet thick.

On the outcrop in northern Mississippi, the Ripley formation can be divided to five units; these are from younger to older:

5. Keownville limestone member
4. Sand units of the upper part of the Ripley
3. McNairy sand member
2. Coon Creek tongue
1. Transitional clay

Downdip these divisions cannot be recognized in wells because the character of the sediments changes. In general the formation does not seem to thicken appreciably downdip along with the lithologic change. K. E. Born (1935, p. 260, fig. 3) showed the Ripley, including the Owl Creek, to consist predominantly of sand and to be near 1,000 feet thick near the Tennessee-Mississippi State line, thinning northward to the Kentucky line to 300 feet. Stearns and Armstrong (1955, figs. 13, 14) give evidence indicating K. E. Born's thicknesses are highly excessive and that the whole Cretaceous series in the subsurface of southern Tennessee does not much exceed 1,000 feet. That part of the 1,000 feet which includes part of the Selma and all the Ripley and Owl Creek formations, ranges between 500 and 700 feet thick (Stearns and Armstrong, 1955, table 1).

As on the outcrop, the formation becomes less sandy, finer grained, and more calcareous southward in the subsurface material of the embayment. McGlothlin (1944, p. 45) summarized the occurrence of the Ripley formation in the subsurface of Mississippi:

> The Navarro-Selma (=post *E. cancellata* Ripley and Owl Creek) contains more chalk and marl than the Taylor-Selma. Generally, in the north part of the state it can be subdivided into the Ripley and Prairie Bluff. At the north part of its outcrop belt, in the northeast part of the state the Ripley is predominantly sandy but grades downdip and toward the south, into calcareous shales and chalks. The thickness of the Navarro-Selma ranges from approximately 100 feet in the Tinsley field (Yazoo County) to 450 feet in Wayne County. The Prairie Bluff, which consists of calcareous shale and chalk has a thickness of 25 to 50 feet.

As noted above, the thickness of the formations as given by McGlothlin are in harmony with those of the area of outcrop.

The correlation of the Ripley formation given in figure 3 is modified from Stephenson and others (1942). In the western interior section, Cobban and Reeside (1952) placed the Campanian-Maestrichtian boundary at the base of the *Baculites baculus* zone, which corresponds to the base of the Mobridge member of the Pierre shale. They indicate the base of the Navarro group to be equivalent to the base of the DeGrey member (=base of *Baculites compressus* zone). In Texas the Campanian-Maestrichtian boundary as thus interpreted would fall at about the top of the Nacatoch sand. Such an interpretation is at variance with present knowledge. According to Cobban (written communication, 1956), *Baculites baculus* Meek and Hayden finds an analog in the gulf coast in *B. undatus* Stephenson, and the associated *B. claviformis* Stephenson is a synonym of *B. grandis* Hall and Meek, which occurs with *B. baculus* from central

Wyoming south. Stephenson (1941) cited the presence of *B. claviformis* in both the Neylandville marl and the Nacatoch sand of Texas, a range duplicated by the species in Tennessee and Mississippi. *B. undatus* is questionably present in the Neylandville and ranges through the Nacatoch. On the basis of these two forms then, the corresponding base of the Maestrichtian would be at the base of the Neylandville marl. An alternative would be to assume that the baculite species differ as to their ranges between the western interior and the gulf coast. This latter interpretation finds support in that the western interior species are restricted to a rather thin unit, the Mobridge member, while they range through several hundred feet in the Texas and Mississippi sections.

Exogyra costata Say has been reported from one locality in the Pierre shale of the western interior (Reeside, 1929, p. 271) below the *B. baculus* zone, but in the gulf region it does not range below *B. claviformis*. Owing to its very limited occurrence it is questionable how much faith can be placed in the range of the *Exogyra* in the interior.

On the generic level there is both conflict and substantiation of the position of the boundary in a comparison of ranges. *Placenticeras* in Texas occurs with *B. claviformis* in the Neylandville marl. In the interior, *Placenticeras* occurs below the *B. baculus* zone. On the other hand, the lowest ranges of *Discoscaphites* and *Sphenodiscus* relative to the first occurrence of *B. claviformis* (=*B. grandis*) appears to be similar in the two regions. Numerous other comparative ranges have been given by Stephenson and Reeside (1938).

The conflicting evidence of the cephalopod ranges may be resolved in the future by a comprehensive study of the gulf coast cephalopod species. At present the best that can be done is to place the boundary on the basis of existing knowledge and accept it as tentative. The evidence points to the placement of the Maestrictian-Campanian boundary at least at the base of the Nacatoch sand and perhaps as low as the base of the Neylandville marl.

Correlation with the rest of the gulf coast is based primarily on the occurrence of *Exogyra costata* and *E. cancellata*. Numerous other species of mollusks can be used for correlation, and these will be discussed in detail in the discussion of the fauna.

TRANSITIONAL CLAY

The base of the Ripley formation at all points of exposure in southern Tennessee and northern Mississippi is transitional with the underlying Demopolis chalk of the Selma group. The transitional zone separating these two formations consists primarily of clays which become increasingly arenaceous and argillaceous upward as they grade into sand of the Ripley and increasingly calcareous downward as they grade into the Demopolis chalk. The term "transitional clay" was applied to this zone by Conant (1941, p. 20), who included the whole unit in the Ripley. The clay varies in thickness but is generally less than 50 feet. In southern Tennessee the transitional clay lies within the lower part of the *E. cancellata* zone, but in Mississippi the unit rises stratigraphically, so that in part it lies above that zone (fig. 3; pl. 1). Near the Alabama border in southern Oktibbeha, Noxubee, and Kemper Counties, Miss., there is an impure upper phase of the Demopolis chalk present immediately below the Ripley formation. This marly chalk does not appear to be the same type of unit as the transitional clay of the north, and the transitional clay unit is believed to have graded here to silty chalk and chalky sand much like the rest of the Ripley.

Few good exposures of the transitional clay occur in southern Tennessee. In low roadcuts along Tennessee State Route 22, 2.2 miles east of Enville (*A* on pl. 2), Chester County, Tenn., the upper part of the clay is poorly exposed. Here greenish-gray micaceous sandy clay crops out in the roadside drainage ditch in which Stephenson (field notes) found *E. cancellata* in 1929. This locality is about 3.5 miles northeast of the classic Coon Creek locality and is probably very close to the contact with the Coon Creek tongue of the Ripley formation. Farther to the south in McNairy County, Tenn., Whitlach (1940, p. 171) noted a section exposed in roadcuts on Tennessee State Route 57, 2.5 miles west of Stantonville (*B* on fig. 5), which exposed 45 feet of clayey "marl" that becomes increasingly glauconitic upward and contains an oyster assemblage. This unit is overlain by 35 feet of greenish- to bluish-gray clay with many very fragile molluscan fossils. When visited by the author in 1953, this outcrop had become much weathered, but the lowest part appears to belong to the transitional clay, and the upper part, to the lower part of the Coon Creek tongue.

Exposures of the clay are much better in Mississippi and can easily be traced through the northern counties. In general the upper part is better exposed than the lower part because it crops out at the base of the east-facing steep slope of the Pontotoc Ridge. In Alcorn County, Miss., in the vicinity of Corinth, a number of railroad cuts expose various parts of the clay. At "Blue Cut" 4.5 miles north of Corinth on the Gulf, Mobile, and Ohio Railroad (*C* on pl. 2), just north of the State line, impure Demopolis chalk bearing *E. cancellata* and *Anomia tellinoides* occurrs. Stephenson and Monroe (1940, p. 141) report sands of the Ripley formation to be present in the upper part of the hill here. Similar exposures on the Southern Railway exhibit the full transition (section 1, pl. 1). At 2.75 miles northwest of Corinth (*D* on pl. 2), a repetition of the "Blue Cut" section appears; exposures of lower parts of the section in cuts 0.7–1 mile southeast of Wenasoga (*E* on pl. 2) exhibit about 15 feet of typical transitional clay with *E. cancellata*; and in a railroad cut 0.75 mile northwest of Wenasoga (loc. 2), the Coon Creek tongue is exposed. The upper contact is well exposed to 0.8–0.9 mile south of the crossroads at the center of Kossuth on the northfacing slope of Hancock Hill (SE¼SW¼ sec. 35, T. 2 S., R. 6 E.). Here Stephenson and Monroe (1940, p. 142) measured a 73-foot section which contained *Exogyra cancellata* in sand of the lower part of the section, overlain by sand of the Coon Creek tongue.

South-southwest through Alcorn and Prentiss Counties, poor small exposures of the transitional gray clay occur paralleling the trend of the Pontotoc Hills. Stephenson and Monroe (1940, p. 138, 139) noted several outcrops in the vicinity of Blackland and Geeville in Prentiss County which they assigned to the Selma chalk but which appear to be part of the transitional clay unit.

The best exposures of the lower part of the transitional clay in the State occur on and near Mississippi State Route 30 between Geeville and Graham. The upper impure chalk of the Demopolis chalk containing *E. cancellata* is exposed in a roadcut 0.5 mile southwest of Geeville at the base of Geeville Mountain (NE¼SE¼ sec. 7, T. 6 S., R. 6 E.) in Prentiss County. About 2.7 miles east of the latter and 0.25–0.5 mile north of the road on the east-facing bluff of Tishomingo Creek (NE¼SW¼ sec. 24, T. 6 S., R. 5 E.) in extreme eastern Union County, the following and perhaps most complete section of the unit is exhibited (*F* on pl. 2).

This locality has been known since the time of Hilgard (1860, p. 78) and shows that the transitional clay rises stratigraphically, as *Exogyra cancellata* is present in the lower part of the section, but this ostreid is absent in the upper part of the bluff. The contact between the Ripley and Demopolis from this point south is arbitrarily chosen at the upper limit of the occurrence of *E. cancellata*, because no consistent lithologic basis for separation appears to exist where the beds are transitional.

Similar exposures occur south through Union County, Miss. Two miles east of Blue Springs roadcuts

Section of the transitional clay unit of the Ripley formation at Kennedy's Bluff on Tishomingo Creek

	Feet
Quaternary:	
Recent:	
4. Residuum, clayey weathered sand to top of hill	10.0
Cretaceous:	
Upper Cretaceous:	
Selma group:	
Ripley formation—transitional clay:	
3. Clay, buff to reddish-brown, somewhat weathered; exposed intermittently on slope above bluff; less weathered gray clay exposed in a few small gullies	22.0
2. Clay, like unit one, but slightly more micaceous and sandy (upper part of bluff proper)	13.0
Demopolis chalk—transitional clay:	
1. Clay, dark-gray; fine-grained sand present in variable amounts; fossiliferous, with *Exogyra cancellata* Stephenson and other oysters of the typical chalk assemblage	25.0

on the east-facing slope of Browns Creek Valley (*G* on pl. 2; section 17 on pl. 1) reveal weathered sand near the top of "Red Hill" which appears to have been derived from the lower part of the Ripley formation. This sand is underlain by 64 feet of gray clay of the transitional unit and at the base of the slope grades into chalkier sediment which contains *Exogyra cancellata* Stephenson. Bald spots typical of the Selma group occur immediately to the east on the prairies. From this point south the transition zone begins to thin. Priddy (1943, p. 17) and Conant (1942, p. 21) noted the presence of about 44 feet of transitional clay along the Union-Pontotoc County line road 1.3 miles east of Sherman (*H* on pl. 2) which represents nearly the total thickness of the unit.

The best exposures of this interval in Pontotoc County are along Mississippi State Route 6 from just east of the Pontotoc-Lee County line to about 4 miles into Pontotoc County. A roadcut exposure (*I* on pl. 2) near the county line (SE¼SE¼ sec. 1, T. 10 S., R. 4 E.) exhibits 20–25 feet of blue-gray silty chalky clay which weathers tan. This is in the upper part of the *Exogyra cancellata* zone. *Anomia tellinoides* Morton is absent here and supports the argument that *A. tellinoides* and *E. cancellata* have overlapping ranges with the *Anomia* extending lower than but not as high as the *Exogyra*. On Route 6 0.75 mile to the west (SW¼SW¼ sec. 1, T. 10 S., R. 4 E.) another roadcut exhibits typical transitional clay about 12 feet thick which lies above the *E. cancellata* zone (*J* on pl. 2) and is much sandier and more micaceous than the preceding roadcut. For the next 2.2

miles west, the land is low, and the road runs mostly on the flood plains of several small streams. Highly fossiliferous clay of the transition zone (probably lowermost Ripley) crops out in a roadcut on the east-facing slope of Muddy Creek about 1.2 miles west of Furrs (loc. 34 section 26, pl. 1). The clay exposed here is very similar in both lithology and faunal content to that at Wenasoga in Alcorn County (loc. 2) and occurs at about the same stratigraphic position. In southern Pontotoc County the clay appears to thin, as Priddy (1943, p. 17) recorded only 24.6 feet of clay occurring at the base of the Pontotoc Ridge escarpment east of Troy (loc. 33) which is immediately overlain by limestone in the lower part of the Ripley formation.

In Chickasaw County the transitional zone retains its position and crops out at the western edge of the Black Prairie Belt, but in general the exposures are very poor. *Exogyra cancellata* is present at a number of localities but occurs for the most part in typical Demopolis chalk. The lack of this species in sediment which lithologically might be called transitional clay may indicate that the zone occurs almost entirely above the *E. cancellata* zone. Lithologically the clay units are similar to those in the north, and their whole thickness is believed to be present on the east-facing slope of Long Creek Valley about 3 miles west of Buena Vista (*K* on pl. 2; see section on p. 21). About 43 feet of transition-type beds crops out at the base of the slope and on the flood plain, with typical impure blue-gray sandy chalk of the upper part of the Demopolis that forms the bed of Long Creek. Overlying the clayey sediment is highly silty sand of the Ripley formation. The general lack of fossils in this part of the section in Chickasaw County increases the difficulty of delimiting the unit, but for the most part it appears to lie above the *E. cancellata* zone.

The character and thickness of the transitional clay is obscure in Clay County, Miss. Exposures are poor and weathered. Bergquist (1943, p. 32–34) published a section including some of the transitional beds as they crop out in roadcuts about 6 miles northwest of Abbott in the northern part of the county (*W* on pl. 2) (NE¼ sec. 2, T. 16 S., R. 4 E.). He cited 71 feet of silt, clay and silty clay occurring in the roadcuts and underlain by the impure part of the Demopolis chalk. These clay and silt beds belong to the Ripley formation, and if distinguishable at all, the transitional zone is much more silty than to the north.

In Oktibbeha County, Miss., no outcrops of the transitional clay appear to be present. The contact between the Demopolis chalk and Ripley formation is still gradational, but the typical clayey lithology is no longer present. At locality 88 in the southern part of the county, the sandy chalks, of the upper part of the Demopolis bearing *Exogyra cancellata*, are overlain by calcareous to chalky silty sand and sandy limestone of the Ripley formation.

This sandy impure to "marly" upper part of the Demopolis chalk, as exhibited in the foregoing section, has been named the Bluffport marl member by W. H. Monroe (1956).

COON CREEK TONGUE

Wade (1917a, p. 74) recognized two divisions of the Ripley formation below the McNairy sand member of southern Tennessee—a "Ferruginous clay horizon" immediately below the McNairy and a "Coon Creek horizon" immediately above the Selma chalk. These two "horizons" were later lumped by Wade (1926, p. 7) into the Coon Creek tongue. Wade stated that the Coon Creek tongue thinned northward but was recognizable at the Kentucky line and that the ferruginous clay merged to the north into the McNairy. Whitlach (1940, p. 49) misinterpreted this statement and assumed Wade to mean the whole of the Coon Creek was lost northward. The ferruginous clay appears to be merely a transition zone between the typical Coon Creek tongue and the McNairy sand member and as treated here is included in the latter, from which it becomes indistinguishable both to the north and to the south.

As at the type locality on Coon Creek, the Coon Creek tongue is typified by massive dark- to bluish-gray micaceous glauconitic calcareous fossiliferous silty sand beds which the older authors called "marls." Locally clay, lighter colored sand, and minor beds of limestone are present. The lower part of the unit is gradational to the transitional clay, and thin interbeds of sand and sandy clay abound. Similarly at the top of the tongue, generally unfossiliferous, noncalcareous thin-bedded sand again becomes common.

In Mississippi south of the Union-Pontotoc County line, the Coon Creek tongue is indistinguishable from the remainder of the Ripley formation not only because the McNairy sand member has pinched out but because the typical massive fossiliferous dark sand of the type locality is no longer represented.

In Pontotoc County the transitional clay and lower limestone and sand beds of the Ripley occur at the same stratigraphic position as the sand of the Coon Creek farther north.

The best and greatest number of fossiliferous localities of the Ripley formation in Mississippi occur in the Coon Creek tongue, and our knowledge of its fauna far exceeds that of the other parts of the formation. Optimum conditions for the development of a diversified molluscan fauna were present during Coon Creek time. However, the development of this fauna occurred at different levels in different places. In Tennessee at the type locality on Coon Creek in McNairy County, the fauna represents a population developing earlier than that in Mississippi, as is indicated by the presence of *Exogyra cancellata* Stephenson and *Anomia tellinoides* Morton. In Mississippi the Coon Creek faunas lack these two species and lie above the *E. cancellata* zone, but the populations are dominated by direct descendents of the species from the type locality. From Tennessee to Mississippi the Coon Creek fauna appears to have developed under similar ecologic conditions and is a relatively shallow-water assemblage. Two distinct fossiliferous levels appear to be present in the Cook Creek tongue in northern Mississippi. The first occurs only slightly above the transitional clay and has a close affinity to the type from Coon Creek. Although it lacks *Exogyra cancellata*, it does bear such species as *Lemniscolittorina berryi* (Wade) and *Anchura substriata* Wade, which are absent at the second level. In addition *Caesticorbula crassiplica* Gabb is very abundant at some localities. Such a fauna is recongnizable at localities 2 and 22 and in roadcuts on Mississippi State Route 4, 2–2.5 miles east of the Dry Run Bridge in Prentiss County. The greater number of fossiliferous localities, however, lie at a higher stratigraphic position and maintain a rather uniform position relative to the McNairy sand member. Almost all are found just below the transition between the Coon Creek and McNairy. This level is characterized in many places by the concentration of crab remains at certain levels and also by the presence of *Anchura abrupta* Conrad. Localities 6, 15, 17, 18, 20, and 23 are all typical of this level as well as are the exposures at the base of the slopes along the Hatchie and Dry Run Valleys in southern Tippah County and western Prentiss County.

The Coon Creek tongue probably does not exceed 60 feet in thickness in northern McNairy County, Tenn. At the type locality on Coon Creek (see section on "Locality 1"), 27 feet of typical blue-gray fossiliferous sand crops out in the bed and banks of the creek. Coon Creek flows onto the broad flood plain of White Oak Creek, which is underlain by transitional clay (*A* on pl. 2). To the west of the creek near the old Dave Weeks place and to the top of the hill, gullies expose about 30 feet of thin-bedded sand with clay stringers and laminae typical of the transitional zone between the McNairy and Coon Creek. The interval between the flood plain of White Oak Creek and the lowest sand bed recognized in the McNairy allows a thickness of only about 80 feet for the sand of the Coon Creek, but it is not known if the Coon Creek occupies the whole interval.

Both at this locality and at many of the other localities in the Ripley formation to the south the sand beds are locally indurated to sandstone that forms concretionary masses of various sizes up to several feet in diameter. At Coon Creek these concretions form in zones at a uniform elevation (pl. 3, fig. 1). Because of their resistant nature, the concretions cap small falls in several places in the base of the creek. Such concretions appear to form in the Coon Creek tongue only at the fossiliferous localities. At some localities where the concretions were removed the surrounding nonindurated "marls" showed a concentration of fossils as an aura. When broken or sectioned the concretions appear abundantly fossiliferous (pl. 4, fig. 4) with the concentration continuing into the center, but no tendency for a uniform orientation or concentric layering was noted. Away from the concretions the abundance of fossils in the nonindurated sand is less, and the concretions thus appear to be points of concentration. The mechanics of the concentration are unkonwn. Concentration by wave action is possible, but the fragile fossils are unbroken, a fact negating excessive movement before burial. Storm rolling again is a possibility, but no layering effect has been noted, and violent movement would surely have broken many of the fossils. Synchroneity of formation is indicated by the uniformity of the levels at which the concretions occur, but assignment of a definite origin must await further investigation.

Southward from the type locality, the Coon Creek tongue thickens and the McNairy sand member thins. The corresponding stratigraphic rise of the top of the Coon Creek is in part offset by the accompanying rise of its base (fig. 3 and pl. 1). Although the base of the Coon Creek tongue lies well within the *Exogyra cancellata* zone in Tennessee in all but the northernmost part of Mississippi, the base of the member lies above that zone. The transitional clay in these areas is present in the corresponding stratigraphic interval of the *E. cancellata* zone.

Roadcuts on U.S. Route 15 (Tennessee State Route 64), 4.2 miles east of Selmer in McNairy County (*L* on pl. 2), reveal the upper part of the Coon Creek tongue and a part of the transitional zone. Fifteen feet of typical blue-gray sand with fragile fossils, similar in lithology and faunal content to the type section on Coon Creek, is overlain by reddish-brown weathered sand of the McNairy. Concretions are present near the base of the exposure, and the great abundance of *Caesticorbula crassiplica* (Gabb) is very reminiscent of Coon Creek. The owner of the adjoining property states a well drilled at a point 5 feet below road level penetrated 23 additional feet of the Coon Creek. Additional exposures of the transitional zone between the Coon Creek and McNairy are present in roadcuts in the next 1.5 miles to the west and in the surrounding hill slopes.

In northern Tippah County the Coon Creek tongue is estimated to be 40 feet thick and consists of yellow to blue-gray sand and sandy clay. The sand beds generally have a high mica content, with the darker sand having the higher glauconite and carbonate content. Even the most highly fossiliferous sand beds, however, seldom exceed a 10 percent calcium carbonate (C.C.E.) content. The lower clayey parts of the member immediately above the transitional clay crop out at locality 2 in railroad cuts immediately northwest of Wenasoga. As previously noted, Stephenson and Monroe (1940, p. 142) measured a section south of Kossuth in Alcorn County where the contact between the Coon Creek tongue and the transitional clay was exposed. The Coon Creek at this locality contained *Exogyra cancellata* and is the most southerly occurrence of the species in this member. Nearby, the upper part of the Coon Creek tongue is exposed on the north-facing slope of Tarebreeches Creek Valley (SW¼SE¼ sec. 8, T. 2 S., R. 6 E.), 1 mile south of Theo, Alcorn County (*M* on pl. 2). At this locality, 44 feet of clay and thin-bedded clayey to silty sand of the Coon Creek grades upward to 33 feet of varicolored silty sand and ferruginous crenulate sandstone ledges of the McNairy sand member.

Numerous other exposures of the Coon Creek tongue are near the Tippah-Prentiss County line. The bed of Dry Run is cut in the transitional clay, but roadcuts on Mississippi State Route 4 in the hills to the east exhibit fossiliferous sands of the Coon Creek. (See pl. 1.) South of Route 4 along the valley walls of both Dry Run and Hatchie River, the upper part of the Coon Creek is well exposed and grades up through the laminated sand and clay beds of the transition zone into the McNairy sand member. The hills bordering these valleys are capped by ferruginous sandstone ledges of the McNairy.

The best exposures of the highly fossiliferous dark galuconitic sand units of the Coon Creek tongue are to be seen in the highly dissected area of southern Tippah County and northern Union County (fig. 5). The hills in the vicinity of Dumas are over 650 feet in elevation and are capped by the McNairy sand member, by the Keownville limestone member, or in a few places by an outlier of the Owl Creek formation. The valleys formed by the headwaters and tributaries of the Hatchie and Tallahatchie Rivers flow at an elevation of about 300 feet offering a relief of more than 300 feet. The Coon Creek tongue crops out in the lower slopes of the hills and in the beds of many of the streams. This area between Keownville, Union County, and Dumas, Tippah County, offers the best collecting of Ripley fossils in Mississippi. Generally the fossils occur a few feet below the McNairy sand member. (See sections on "Localities 6, 15, 17, 19, 20, and 23".)

Along Mississippi State Route 30, a composite section (pl. 1, col. 12) indicates that the Coon Creek tongue is probably only about 60 feet thick in northeastern Union County. This estimate varies somewhat, dependant on where the Coon Creek and McNairy boundary is placed. In southern Union County and Pontotoc County, the Coon Creek tongue is impossible to distinguish. With the exception of the Keownville limestone member, the Ripley formation in this area and to the south is treated as undifferentiated. (See pl. 1.)

The sediments of the Coon Creek tongue, in contrast to the dominant carbonates of the Demopolis chalk, represent a time of clastic deposition but in water deeper than that in which the McNairy sand member accumulated. The massive bedding of some of the fossiliferous sand units as well as the general lack of wear of the fossils seems indicative of quiet-water sedimentation. The upper part of the Coon Creek with its thinner bedding and common cross-bedded structures indicates a shallowing of water just before the great influx of the clastic sediment that formed the McNairy.

McNAIRY SAND MEMBER

Stephenson (1914, p. 17, 18) originally proposed the McNairy sand as a member of the Ripley formation and distinguished it as follows:

> In the vicinity of the Tennessee State line and northward into Tennessee all but the basal beds of the formation (Ripley) appear to merge along the strike into shallow water equivalents consisting of irregularly bedded, largely nonglauconitic sands and subordinate clays, probably in part of marine, in part of estuarine, and in part of fresh water origin. Their lithologic dissimilarity to the typical material of the Ripley formation seems to justify the use of a member name to designate them, and the name McNairy sand member, derived from McNairy County, Tennessee is proposed. The type section of this member is exposed in a cut of the Southern Railway 1¼ miles west of Cypress

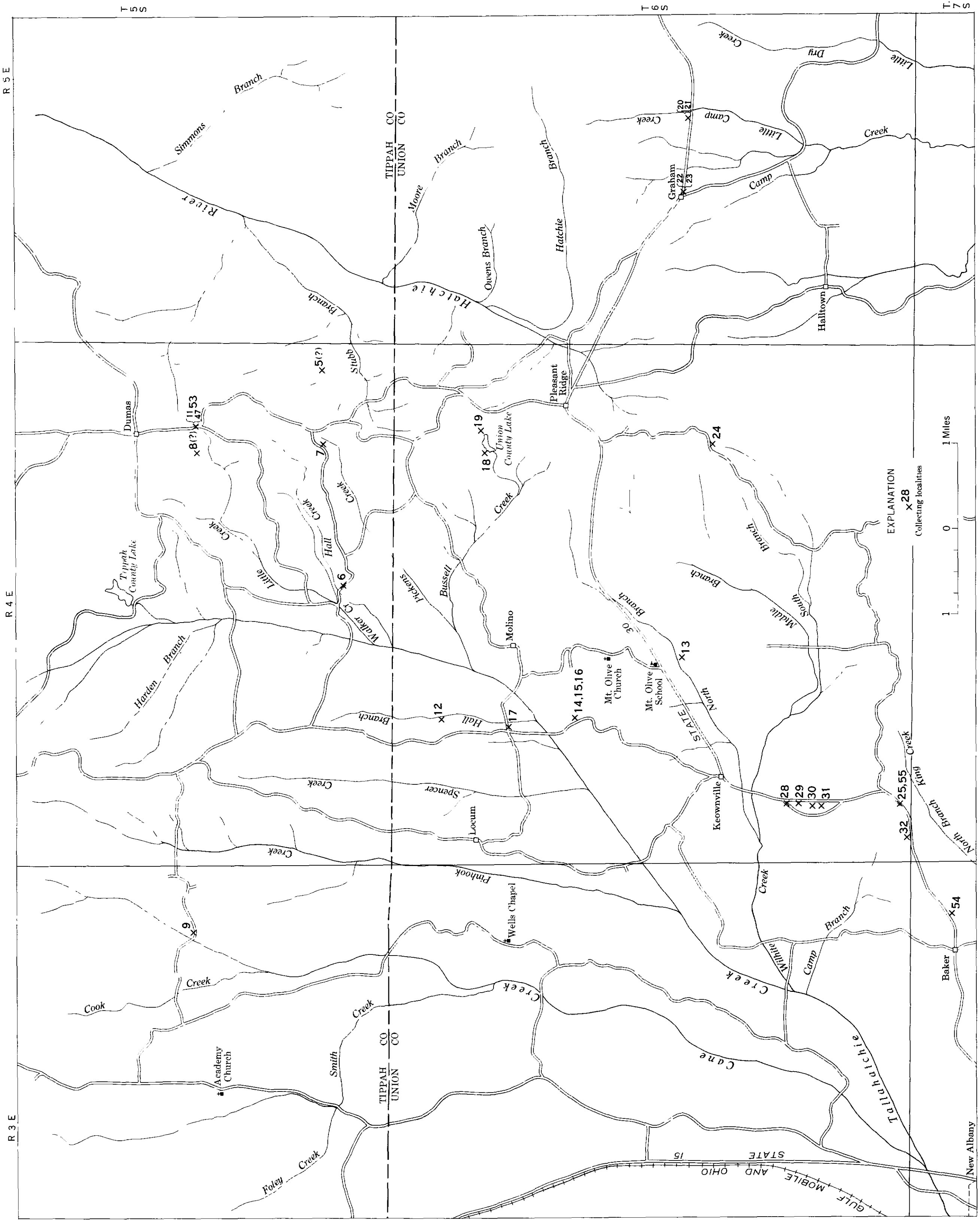

FIGURE 5.—Sketch map of parts of Tippah and Union Counties, Miss., showing collecting localities in the Ripley, Owl Creek, and Prairie Bluff formations.

Station in this county, where the railroad passes a ridge known as "Big Hill" * * * A section of this cut is given below:

	Feet
6. Yellowish sandy loam, grading down into reddish argillaceous, rather coarse sand with irregular iron crusts along base	6
5. Coarse, loose crossbedded varicolored sand with scattered small white clay films and pellets and with irregular sandy iron concretions in upper 2 ft	17–24
4. Coarse corrugated ferruginous sandstone presenting many parallel cavities, round to irregular in cross section, of all diameters up to a foot or more, the cavities all pointing northeast and southwest. Pockets of varicolored sand occur intermixed with the ironstone masses	3–10
3. Massive, loose, fine micaceous sand, pale yellowish green in upper part and blotched and streaked with purple in the lower part	20
2. Irregular layer of ferruginous sandstone	1–3
1. Pale-yellowish-green, loose- finely micaceous sand with numerous thick laminae of white and drab clay; toward the western end of the cut short relatively thick lenses of black, carbonaceous clay reaching a maximum thickness of 8 or 10 ft. The black clay contains a few imperfectly preserved leaf remains	25–30

The type section quoted above contains all the major characteristic sedimentary types of the McNairy sand member.

To the north in Tennessee the member thickens but then thins in Kentucky, Illinois, and Missouri. In these areas the McNairy has been raised to formation rank (Stephenson, 1955, p. 98; Grohskopf, 1955, p. 20), as the other members of the Ripley are impossible to distinguish or are absent.

In southern Tennessee and northern Mississippi, the McNairy sand member is typically composed, in the lower part, of thin-bedded sand and clay strata with thin ferruginous plates, which are transitional to the Coon Creek tongue. Upward the units become thicker bedded, and lenticular masses of massive carbonaceous clay are common. Locally the sand is consolidated to corrugated ferruginous sandstone ledges that range in thickness from less than 1 inch to as much as 10 feet, as in the type section. (See pl. 4, fig. a.) These ironstone masses do not hold a constant position within a given exposure but rise and fall through a given sand unit. They appear to have formed where local concentration of iron oxides has been sufficient to cement the sand. This has led to the highly irregular commonly honeycombed shapes that the ledges assume. (See Stephenson and Monroe, 1940, figs. 41, 42.) The sand units, especially where indurated, are quite resistant and form the major support for the high ridge of hills that compose most of the Pontotoc Ridge. Where weathered, the sand is generally vivid brownish red, and the resistant ferruginous ledges remain as a residuum covering the slopes of the hills.

The unindurated sand beds vary from fine to very coarse grained and from white to greenish and purplish, all of which weather red. A little glauconite is present, and mica is abundant. Near a quarry just west of the Alcorn County line and south of U.S. Highway 72 in Tippah County (*N* on pl. 2), occur exposed beds of thin layers, less than 2 inches thick, composed predominantly of biotite and interbedded medium-grained yellow micaceous sand. The bedding of most of the sand is irregular, with crossbedding, scour and fill structures, and general lenticularity of beds being common.

The dark, carbonaceous clay units of the lower and middle parts of the McNairy sand member are well exposed in the vicinity of Selmer in McNairy County. In a quarry south of that town (*O* on pl. 2) the clay occurs in thin layers interbedded with laminae of silt and silty sand. One crab claw of the genus *Avitelmessus* was collected here. More massive lenticular clay masses are seen in roadcuts on the east-trending highways in both McNairy and Alcorn Counties. In general there is much plant material in these clay beds, but usually it is fragmentary. Berry (1925) wrote a monograph on a Ripley flora which was collected from the McNairy sand member. Marcasite is also quite common in the clay, which is not surprising in view of its carbonaceous nature.

Invertebrate fossil remains aside from the crab claw mentioned above, are rare. Stephenson and Monroe (1940, p. 184) noted the occurrence of mollusk imprints in the ferruginous sandstone of northern Mississippi. Besides such prints, only borings attributed to *Halymenites major* Lesquereaux are common, but these are sufficient to indicate the marine nature of the sand.

The clay, sand, and sandstone units are best exposed in roadcuts on Tennessee State Route 57 in southern McNairy County and along U.S. Highway 72 in northern Alcorn and Tippah Counties Miss. Composite sections measured along these highways (pl. 1, col. 2) indicate that the McNairy sand member probably does not exceed 250 feet in thickness. Whitlach (1940, p. 49) states the total section of the Ripley formation, most of which is McNairy, is about 600 feet thick in southern Tennessee but this estimate appears excessive. Stephenson and Monroe (1940, p. 178) estimated the McNairy of northern Mississippi to be 225–240 feet thick, which is closer to the estimate given here.

Southward in Mississippi the McNairy sand member thins and finally feathers out in Union County.

Both Stephenson and Monroe (1940, pl. 1a) and Conant (1942, pl. 1) mapped the southernmost outcrop of the sand as occurring about 3 miles south of Pleasant Ridge School (fig. 5). However, evidence does exist for the possible presence of sands typical of the McNairy in southern Union County in the vicinity of Blue Springs, where coarse red crossbedded sand and thin-bedded clay, much like the lower part of the McNairy of the north, crop out along secondary roads (Stephenson and Monroe, 1940, p. 190).

SAND UNITS OF THE UPPER PART OF THE RIPLEY FORMATION

As here defined, the sand units of the upper part of the Ripley formation consist of massive- to thin-bedded fossiliferous sand and sandstone lying between the McNairy sand member and the Keownville limestone member of the Ripley formation. These sand beds and the overlying limestone units below the Owl Creek formation have generally been lumped together in the literature as an upper marine tongue of the Ripley. These units are not present in Tennessee, because they grade into the McNairy sand member south of the State line. Southward in Pontotoc County they become indistinguishable from the sand of the middle and lower parts of the Ripley where the McNairy is absent.

The most northerly exposure of the sand of the upper part of the Ripley is in a roadcut on the north-facing slope of Jonesboro Creek (*Q* on pl. 2), 1.5 miles south of U. S. Highway 72 in Tippah County (SE¼ sec. 2, T. 2. S., R. 4 E.), where about 14 feet of clayey, weathered dark sand with poor fossil imprints overlies 13 feet of sand with ferruginous sandstone ledges typical of the McNairy. This sand of the upper part of the Ripley is in turn unconformably overlain by 18 feet of gray clayey micaceous calcareous sand of the Owl Creek formation that contains poor pelecypod prints.

Of special interest at this outcrop is the absence of the Keownville limestone member. From this point south the sand units of the upper part of the Ripley formation thicken as the McNairy sand member thins, but exposures are poor and scattered. The sand weathers down to rounded hill slopes where it is not capped by the limestone of the Keownville member. In southern Tippah County and northern Union County, the strata of the upper part of the Ripley are composed of blue-gray fossiliferous sand similar to that of the Coon Creek tongue. The best exposure of this unit is at locality 29 (pl. 1, col. 12), where a maximum of 120 feet of blue-gray to yellow fossiliferous sand and sandstone is overlain by about 50 feet of alternating echinoid-bearing limestone and sand of the Keownville member. This locality was visited when the roadcut was new, but at other localities this sand weathers rapidly to a buff or drab-grayish, then oxidizes to red, and loses much of its fossil content.

The fauna of the sand units is very similar to that of the Coon Creek tongue, but when well represented the remainder of the fauna differs from it by containing a greater abundance of corals and a number of new genera and some different species of mollusks. *Ostrea subspatulata* Forbes, common to the Ripley of Alabama and Georgia, was found at locality 12, and is the first unquestionable occurrence of the species in Mississippi.

Southward the sand becomes siltier and is indistinguishable from that of the lower part of the Ripley formation where the McNairy sand member is absent.

KEOWNVILLE LIMESTONE MEMBER

The uppermost member of the Ripley formation is named herein the Keownville limestone member. The name is derived from the small settlement of Keownville in Union County, Miss., in the vicinity of which are the most characteristic exposures of the member. The member is generally less than 100 feet thick and consists of yellowish-brown sandy limestone beds which are no more than 5 feet thick that are interbedded with yellow to dark-blue-gray fossiliferous sand units. In some places the indurated beds of the member become so sandy that they might more properly be called a highly calcareous sandstone. In contrast to the sandstone beds in the upper part of the immediately underlying part of the Ripley, they are coarser grained, sideritic, and less micaceous. In addition to the distinctive lithology, the member possesses a unique faunal content. Many of the mollusks are of the same species as those in the beds below and in the Owl Creek formation above, but the assemblage differs. New and undescribed species of a large *Spondylus* and a large *Ostrea* (*Arctostrea*) occur in the member. These two species have been found in great abundance at locality 31, where they appear to form a low moundlike structure simulating a biohermal growth structure although this could not be deffnitely proved in the small exposures available. Large trigonids are very common in the Keownville member as well as *Idonearca littlei* (Gabb) and several large species of *Pachycardium* and *Veniella*. Gastropods, with the exception of the turritellids, are uncommon, but a few new species have been found (table 1). Of the cephalopods, large specimens of *Sphenodiscus* are common. The most striking feature of the limestone fauna, however, is the abundance of echinoids of the species *Hardouinia mortonis* (Michelin) and *H. micrococcus* (Gabb). The presence in abundance of the echinoids in these limestone beds has given rise locally to the name of "star rock." That the environment represented by these limy sedimentary deposits provided optimum conditions for the development of the gregarious echinoids is amply shown by the similar assemblage to be found in the basal part of the Providence sand of the Chattahoochee River region of Georgia and Alabama in rocks of a similar lithologic character (Veatch and Stephenson, 1911, p. 179).

The type section of this member is in roadcuts on the new Mississippi State Route 30, 1.4–2.1 miles south of Keownville, Union County, Miss., on the north-facing slope of Willhite Creek Valley and parallel to Daniel Creek, a north-flowing tributary of Willhite Creek, in the E½ sec. 31, T. 6 S., R. 4 E. (See "Localities 29–31".) At this point, 47 feet of yellow-brown sandy sideritic fossiliferous limestone in beds 1–3 feet thick alternate with yellow to gray micaceous fossiliferous layers of sand and represents the full thickness of the Keownville limestone member. These beds are uncomformably overlain by 8.5 feet of fossiliferous sand and clay of the Prairie Bluff chalk containing phosphatic molds of mollusks and *Diploschiza melleni* Stephenson. Below the limestone sequence of the Keownville member lies about 120 feet of the dark fossiliferous sand and sandstone beds of the upper part of the Ripley formation.

Both Stephenson and Monroe (1940, p. 187) and Conant (1941, p. 24) stated that about 10 feet of sand in the upper part of the Ripley formation is present on the east slope of Muddy Creek valley 1.5 miles south of the Tennessee State line (NE¼ sec. 26, T. 1 S., R. 4 E.) and have mapped it as forming the bed of Muddy Creek. A very instructive section just south of U.S. Route 72 in northern Tippah County (NW¼ sec. 35, T. 1 S., R. 4 E.) yielded information that the upper part of the Ripley is entirely absent this far north in the State. Here (*R* on pl. 2 and pl. 1, col. 2), about 10 feet of the McNairy sand member with ferruginous layers is unconformably overlain by about 4 feet of brownish, iron-stained silty micaceous semi-indurated fossiliferous sand which bears the impressions of *Trigonia angulicostata* Gabb, *Trobus buboanus* Stephenson, and other mollusks diagnostic of an Owl Creek age. About 1.5 miles south of this locality, (*Q* on fig. 5) in a roadcut north of Jonesboro Creek, the first sand bed of the upper part of the Ripley was seen, but the Keownville limestone member was absent. To the north of these localities, the sand beds mentioned by Stephenson and Monroe and by Conant probably belong to the Owl Creek formation.

The northernmost undoubted exposures of the Keownville limestone member appear about 12 miles south of the Tennessee State line in roadcuts at the base of the south-facing slope of Walnut Creek (see section on "Locality 42"), where 2 feet of the typical echinoid-bearing limestone is unconformably overlain by 25 feet of the Owl Creek formation.

In central Tippah County the Keownville limestone member is thin and appears to be restricted to a few limestone ledges. Southward into southern Tippah County, the member thickens as does the rest of the upper part of the Ripley formation, and in the vicinity of Dumas the limestone reaches a maximum of about 80 feet thick (loc. 11, pl. 1, col. 8). In this highly dissected area the limestones beds of this member cap most of the hills between Dumas and Cane Creek, 6 miles to the east, and south through Union County. The limestone beds crop out on the steeper valley walls throughout much of this area. Stephenson and Monroe (1940, p. 186, 187) and Conant (1941, p. 24) listed a considerable number of the exposures, which abound in the region. In northern Union County, exposures of this limestone in the vicinity of Baker and Keownville have been known for many years (Hilgard, 1860, p. 91). Many such limestone beds develop cavernous weathering and give rise to such local names as "The Caves." At locality 32 in the vicinity of the type section, Stephenson and Monroe (1940, p. 194) recorded about 40 feet of the member with one limestone bed in which a cavern 5 feet high and 15–20 feet wide was weathered.

The limestone beds continue to crop out on the hill slopes at the top of the Ripley formation through southern Union County, south through Pontotoc County, and into Chickasaw County, but the unit again thins, so that only one or two limestone ledges are present at a given locality. In part this may be due to the poorer outcrops to the south.

In Pontotoc County the Keownville limestone member retains its faunal and lithologic distinctiveness, but as the sections given for localities 35, 37, and 38 indicate, the thickness has decreased considerably. In some localities, Priddy (1943, p. 24) noted that the Keownville is absent in Pontotoc County, but it may locally reach a maximum of 18 feet. Priddy interpreted this irregularity and total absence to be indicative of the erosion interval which followed deposition of the Ripley. In view of the thinness of the unit in this area, local absence caused by solution of the limestone cannot be overlooked because, as it was pointed out above that solution cavities are common.

The southernmost outcrop of this member is in the latitude of Houston, in Chickasaw County, where the upper part of the Ripley is thin and erratic, in keeping with the thinning of the whole formation. As in Pontotoc County, the limestone is absent locally. What exposures are present indicate that the limestone is siltier than that to the north and the lithologic change is accompanied by a corresponding change in the fauna, with the loss of the most distinctive element, the echinoids.

An interesting sequence involving the Keownville limestone member occurs east of Houston in roadcuts on old Mississippi State Route 8. The highway here traverses the outcrop belt of the Ripley formation normal to the strike and affords a series of roadcuts on the dip slope of the Keownville that exhibit its downdip changes. The first exposure (*K* on pl. 2), 3 miles west of Buena Vista, reveals a full sequence of the Ripley formation underlain by the Demopolis chalk and overlain by the Prairie Bluff chalk. At this locality the uppermost beds of the Ripley are sand, and any trace of limestone is missing. A mile farther west, at locality 39, 15 feet of limestone occurs at the top of the Ripley is unconformably overlain by the Prairie Bluff chalk. On the same highway 2 miles south-southeast of Houston, at locality 68, 16 feet of nodular calcareous sandstone and sand similar to that of the Keownville limestone member to the north crops out in the valley walls of Houlka Creek. This is perhaps an indication of the increasing calcareous content of the member in the downdip direction. The absence of the limestone bed at the easternmost outcrop may be due to nondeposition, solution of the limestone, or pre-Prairie Bluff erosion. Very possibly it is represented by a silty facies equivalent to the limestone beds farther west.

South of Houston no exposures of limestone typical of the Keownville have been noted, and the limestone is probably represented by chalky silt in Clay County.

RIPLEY FORMATION SOUTH OF UNION COUNTY

From the Pontotoc County–Union County line south along the arcuate belt of outcrop, the Ripley formation between the transitional clay at its base and the Keownville member at its top becomes indivisible. The McNairy sand member is absent here, and only local subdivisions can be made. In general the coarser sand size characteristic of outcrops in Ripley of the northern counties gradually gives way to fine-grained sand and silt, with the sand and silt in turn becoming increasingly chalky to the south until they become almost indistinguishable from the Prairie Bluff above and the impure Demopolis chalk below. Thus in Stephenson and Monroe (1940) and in most publications prior to that date (fig. 2), the Ripley formation of Noxubee and Kemper Counties was actually included in discussions of the Selma group as an impure upper phase. However, Monroe's (1941, 1955) work in Alabama has shown that the Ripley formation can be distinguished and mapped separately from the rest of the Selma group. In general the base of the unit coincides rather well with the top of the *Exogyra cancellata* zone.

In Pontotoc County the Ripley formation, according to Priddy (1943, p. 16), nowhere exceeds 250 feet and is generally considerably less. Immediately above the transitional clay at its base is a sequence of light-colored sandy silty fossiliferous limestone strata that is interbedded with sand and silt through a thickness of 50 feet or less. These limestone beds crop out in the valley walls of numerous creeks in the county and on the east-facing slope of the Pontotoc Hills overlooking the lowlands underlain by the Selma group in the Black Prairie Belt in the vicinity of Troy. The limestone beds are fossiliferous and bear an assemblage typical of the lower part of the Ripley, but it is not so well diversified as that of the sand beds of the lower part of the Ripley formation farther north. This is partly due to the difficulty of recovery of specimens, for they do not break out of the limestone beds and must be identified from weathered surfaces. These lower limestone strata mark the lower part of the Ripley through Pontotoc County, but they disappear a few miles south of Troy in the southeastern part of the county.

The middle part of the Ripley formation of Priddy (1943) actually includes the equivalents of the McNairy sand member and sand beds of the upper part of the Ripley of Union County and occupies that part of the formation between the lower limestone beds of the Ripley and the upper limestone beds of the Keownville member. The middle part of the Ripley is composed predominantly of unfossiliferous sand that in a few places gives rise to a calcareous sandstone. At a few localities, as in the low banks of Bob Miller Creek just north of the bridge of Mississippi State Route 6, 3 miles east of Pontotoc, about 4 feet of blue-gray fossiliferous sand, containing a typical oyster assemblage and poor prints of other bivalves, overlies the lower limestone bed. One mile to the west the only fossil found in the upper part of these sand beds was *Halymenites major* Lesquereux. The roadcuts at the latter locality (see section on "Locality 38") provided exposures of about

50 feet of sand beds overlain by the Keownville limestone member of the Ripley. The sand beds are in part lenticular, crossbedded and yellow to greenish near the top, and darker near the base. No bentonite was noted here, but elsewhere a layer of bentonite immediatly underlies the Keownville limestone member and is mined locally (Priddy, 1943, p. 22). On the basis of the presence or absence of this bentonite, Priddy has demonstrated the presence of an unconformity at the base of the Keownville. More study is needed to indicate the magnitude of the hiatus, but locally it appears to cut out a considerable part of the sand beds of the middle part of the Ripley.

In Chickasaw County several sections exposed in cuts along old Mississippi Route 8 between Houston and Buena Vista expose almost the complete thickness of the Ripley formation. Three miles west of Buena Vista the following section is exposed:

Demopolis chalk, Ripley formation, and Prairie Bluff chalk measured in roadcuts on old Mississippi State Highway 8, on east-facing slope of Longs Creek Valley, 3 miles east of Buena Vista, Chickasaw County, Miss. (S½ sec. 4, T. 14 S., R. 4 E.)

	Feet
Age indeterminate:	
10. Residual red sands grading to soil at top of hill	22
Prairie Bluff chalk:	
9. Sand, gray, silty, glauconitic and chalky in part; *Gryphaea mutabilis* Morton, *Diploschiza melleni* Stephenson and *Hardouinia aequorea* (Morton)	8
Ripley formation:	
8. Sand, light-gray, fine-grained, glauconitic and very micaceous	9
7. Sand, gray, fine-grained, very silty and micaceous; weathers brown; locally semi-indurated	16.8
6. Silt, gray to buff, sandy with thin micaceous clay laminae	2.2
5. Silt, light-brown, sandy, very micaceous and crossbedded	15.5
4. Silt, light-gray to buff; clayey and slightly plastic with a few rounded grains of quartz sand and disseminated mica flakes	9.9
Ripley formation—transitional clay:	
3. Clay, gray, micaceous and weathered; crops out intermittently in drainage ditch north of road	20.0
2. Clay, gray, silty, micaceous, mottled by iron staining	5.5
Demopolis chalk—upper impure phase:	
1. Clay, gray, sandy, micaceous (weathered chalk?), intermittently exposed in cuts on the flood plain; grades down into consolidated blue-gray sandy chalks in bed of Long Creek	18

The Ripley formation at this locality is slightly less than 80 feet thick and is composed predominantly of silt and sand that is finer grained than that to the north. Another section on the highway about 1 mile to the west (see section on "Locality 30") shows a downdip thickening of the formation to more than 80 feet, and the silt and sand beds increase in carbonate and fossil content.

The silty composition of the Ripley formation continues into Clay County, where Stephenson and Monroe (1940, p. 200) have estimated the formation to have a maximum thickness of 140 feet in the northern part of the county. Only about 100 feet is present in southern Clay County, according to Bergquist (1943, p. 32). Exposures of the Ripley formation are incomplete and poor in the county, and for the most part the sand units are heavily weathered, and the topography of lesser relief than to the north. Nowhere in the county is there evidence of the Keownville limestone member, and the Ripley consists of interbedded clay and silt in the lower part with silt units predominating in the middle part and grading near the top of the formation to medium- and fine-grained white to tan highly micaceous and silty sand beds that weather a reddish brown (pl. 1, col. 39, 42, 43). Where fossiliferous, the fossils, with the exception of the oysters, are weathered to a fragile chalky material. No fossiliferous "marls" of dark color typical of the Ripley in the northern counties have been found this far south.

An almost complete section can be pieced together from two exposures in the northern part of the county. In a roadcut and in gullies 3 miles northeast of Montpelier (SW¼ sec. 29, T. 15 N., R. 4 E.), 18 feet of sandy blue-gray fossiliferous chalk and clay of the Prairie Bluff overlies about 50 feet of unfossiliferous sand and silt units of the Ripley formation. Three miles south-southeast of this locality, at the edge of the belt of outcrop of the Ripley overlooking the valley of Underwood Creek 6 miles northwest of Abbot, a section displays 95 feet of clay, silt, sand, and chalky sediment of the lower part of the Ripley and transitional zone. When visited in 1951 the section was evidently more weathered than when visited by Bergquist (1943, p. 32), as the sediment appeared much less clayey than he indicated.

Good exposures of the Ripley formation are rare in Oktibbeha County also. The outcrop belt has narrowed considerably—to less than 2 miles in places. From intermittent outcrops 4.8 miles north-northeast of Starkville (sec. 11, T. 19 N., R. 14 E.), Stephenson and Monroe (1940, p. 202) noted 70 feet of sand and sandstone cropping out on valley slopes above the Demopolis chalk (pl. 1, col. 46). A more exact measurement can be made 6.8 miles south-southeast of Starkville (see section on "Locality 88"), where a full thickness of the Ripley formation is exposed on the north-facing slope of Catalpa Creek Valley. Here 49 feet of dull gray silty micaceous glauconitic sand and sandstone of the Ripley formation is underlain by bluish silty micaceous sandy fossiliferous Demopolis(?) chalk that contains *Exogyra cancellata*. Overlying the Ripley is 12 feet of typical silty Prairie Bluff chalk that contains an abundance of phosphatic molds and *Diploschiza melleni* Stephenson.

In Noxubee County the Ripley continues its narrow band of outcrop and becomes increasingly calcaerous until in the vicinity of Macon it is essentially an impure sandy chalk. Stephenson and Monroe (1940, p. 203) noted 45 feet of gray chalky micaceous sand with *Exogyra costata* Say cropping out 5.5 miles northwest of Macon (*S* on pl. 2); this probably represents nearly the whole of the Ripley as it is known in this area. In roadcuts on U.S. Highway 45, 4.5–5 miles south of Macon (see section on "Locality 91"), about 55 feet of sandy and silty blue-gray chalk, containing an oyster assemblage typical of the chalk, is conformably underlain by impure Demopolis chalk, bearing *E. cancellata*, and is unconformably overlain by 18 feet of Prairie Bluff chalk with *Diploschiza melleni* and numerous internal phosphatic molds of mollusks. The medial 55 feet of chalk belongs to the Ripley formation, but it was assigned by Stephenson and Monroe to the upper impure phase of the Demopolis chalk.

Similar relations are to be seen in a similar exposure on the southern slopes of Wahalak Creek Valley (see section on "Locality 94") 6 miles north of Scooba where 55 to 60 feet of silty and sandy blue-gray chalk of the Ripley is exposed in contact with the Demopolis chalk below and the Prairie Bluff chalk above. The relations here are somewhat clouded by the suggestion of faulting. Faults involving these beds become much more common a short distance to the east in Sumter County, Ala., where Monroe (1955) reported the Ripley to range from 35 to 125 feet with variation in thickness due to structural effects during deposition.

OWL CREEK FORMATION

The Owl Creek formation although long recognized as a distinctive unit has until recently been considered a part of the Ripley formation. Hilgard (1860, p. 85) called attention to the "Owl Creek Marl" and its well-preserved fossils and included it within his Ripley Group, which at the time also included the overlying "bored limestone" of Clayton age and all underlying strata younger than the Selma. In addition, he (1860, p. 88) furnished the first measured section of the type locality on Owl Creek, 3 miles northeast of Ripley, Tippah County. (See section on "Locality 46.") Conrad (1858) described 56 new species of invertebrates from the type locality and suggested the name Ripley group be applied to such beds. Later authors (Veatch and Stephenson, 1911, for example) followed this usage until Wade in 1917 (p. 74) formally designated all strata above the McNairy sand as the Owl Creek horizon, and still later (1920, p. 52; 1926, p. 9) first called it a member and then a tongue. However, Wade included some of the marine upper part of the Ripley within his Owl Creek. Although the fauna from Owl Creek has always been recognized as having many elements distinct from the typical Ripley fauna, it was not until Stephenson and Monroe in 1937 (p. 806) cited evidence of an important and wide spread unconformity at the base of the unit that the Owl Creek was accepted as a formation.

The Owl Creek formation lies within the bounds of the *Exogyra costata* zone and is unconformably overlain by the Clayton formation of Paleocene age and lies with unconformity on the Ripley formation. The magnitude of the unconformity at its base is incompletely known and is evidently variable, for in some areas the Owl Creek is in contact with rather thick sequences of beds of late Ripley age such as the Keownville limestone member, but in places such as Pontotoc County that member is very thin or even absent. In northernmost Mississippi and southern Tennessee, the Owl Creek is, at its base, in contact with the McNairy sand member. In most areas the Clayton formation has at its base a limestone, which is generally in contact with the Owl Creek. This limestone bears an abundant fauna of Cretaceous species reworked from the Owl Creek formation. In some places, reworked Owl Creek fossils occur in a reworked marl typical of the Owl Creek below this limestone. (See section on "Locality 40.")

Geographically the Owl Creek has a restricted occurrence in comparison to the Ripley formation and may be considered as a northern facies of the Prarie Bluff chalk, with which it merges to the south. Northward in Tennessee it is overlapped by the Midway group near Hornsby in Hardeman County, about 18 miles north of the State border. The Owl Creek formation is absent at the head of the Mississippi embayment in Illinois but is present in Missouri (Matthes, 1933, p. 1003), and its fauna has been described (Stephenson, 1955). Its subsurface extent is poorly known, but has been traced in Missouri (Grohskopf, 1955), where it is quite thin. In the subsurface of Tennessee the sand units of the Owl Creek are generally included with the undifferentiated Ripley (Born, K. E., 1935; Stearns and Armstrong, 1955).

Outside the embayment area the Owl Creek formation is correlated (fig. 3) with the Prairie Bluff chalk of Mississippi and Alabama and with the Providence sand of Georgia. In Texas the restricted range of the molluscan species *Eoancilla acutula* Stephenson, *Turritella bilira* Stephenson, and *Napulus octoliratus* (Conrad) indicate that at least part of the Owl Creek is equivalent to the Kemp clay. Stephenson and Monroe (1940, p. 229, 248) and Stephenson (1941, p. 25 and Stephenson and others, 1942) correlated the formation with the Corsicana marl.

The Owl Creek formation consists most characteristically of dark silty sand and subordinate amounts of clay, which are glauconitic, micaceous, and highly fossiliferous. In thickness the formation only locally exceeds 40 feet and is thickest in the southern area of its outcrop, where it merges into the Prairie Bluff chalk. Whitlach (1940, p. 50) indicates the thickness of the Owl Creek "tongue" to be 168 feet at the Tennessee-Mississippi State line but does not state how his estimate was derived. In my opinion, based upon observed thicknesses on the outcrop belt, the estimate appears highly excessive.

Exposures of the formation are generally poor, and its sand beds give rise to no separate and distinct physiographic expression but follow the same trend as sand beds of the Ripley formation.

Knowledge of the Owl Creek formation in Tennessee is scanty, for outcrops are poor and obscured by the overlap of the Midway group. In Hardeman County the sands of the Owl Creek crop out on the east-facing slope of Muddy Creek valley. Perhaps the most informative exposure of the formation in the county is on the east-facing slope of Muddy Creek valley in roadcuts of Tennessee State Route 57. (See section for loc. 40.) Here 17 feet of dark clayey unfossiliferous sand of the Owl Creek is overlain by sand, clay, and limestone units of the Clayton formation. Because at the type locality (loc. 46) in Tippah County the basal limestone of the Clayton immediately overlies sand of the Owl Creek, the contact at other localities has in the past been placed at the base of the limestone. However at locality 40 in Hardeman County, the basal unit of the Clayton consists of 5 feet of "marl" reworked from the Owl Creek that underlies the lowest limestone of the Clayton. Whitlach (1940, p. 169) placed the contact at the base of the limestone. A large and well-preserved fauna collected from this unit yielded many species from the Owl Creek (see lists of fauna in table of distribution "locality 40") but in addition also contained *Calyptrophorus velatus* (Conrad), *Venericardia planicosta* Lamarck, *Mazzalina impressa* (Gabb), and other species indicative of the Paleocene. Aside from the intermixing of the fossils, numerous pitted to smooth and well-rounded silty pebbles are common and are up to 3 inches in diameter. The pits, where present, may be borings. The outer layer of the pebbles is generally darker than the interior (phosphatized?). The sand beds contain an abundance of disseminated fragments of wood and plant debris with pockets of coarser sand and glauconite concentration. In many places stringers and pockets of well-rounded fossil fragments, stained green on the surface, occur interbedded with well-preserved shells. All these minor features indicate that the material has been reworked. The presence of well-preserved delicate shells, such as *Pterocerella*, with its thin expanded outer lip digitations, could not have been transported far and perhaps were derived from some blocks of the Owl Creek which were dropped into the Clayton sea from a nearby bluff.

The Trims Mill locality in Hardeman County, Tennessee, mentioned by Wade (1926, p. 9) is just slightly to the south of this locality and bears a similar relationship to the Clayton formation, and the fauna he notes as Owl Creek is also reworked. Similar exposures can be noted along this bluff down to the latitude of Walnut in Tippah Cunty where a repetition of the locality 40 section is exposed in cuts of U.S. Highway 72. Thus, care must be taken in picking the Cretaceous and Paleocene boundary in this region as it is not always at the base of the Clayton formation.

Numerous small, fossiliferous exposures are known throughout Tippah County, Miss. (fig. 6), but only at Yancey Hill (loc. 43) does the Owl Creek formation appear to be more than 30 feet thick. In northern Mississippi, outcrops in and south of U. S. Highway 72 west of Walnut, Tippah County (*R* on pl. 2, and fig. 6), expose weathered silty fossiliferous sands of the Owl Creek immediately overlying the McNairy sand member of the Ripley formation. But about 1.5 miles south on Jonesboro Creek (*Q* on pl. 2), the Owl Creek is in contact with sands of the upper part of the Ripley. At 9.5 miles south on Walnut Creek, the Owl Creek overlies the echinoid-bearing units of the Keownville limestone member (loc. 42; see fig. 6). This latter relation holds constant for as far south as the Owl Creek is recognizable. The upper contact is well displayed at a number of localities. From the vicinity of Chalybeate Springs (loc. 41) south to Union County, the overlying Clayton formation of Paleocene age commonly has a basal limestone overlain by glauconitic sand with *Ostrea pulaskensis* Harris and other diagnostic species from the Clayton. Locally, as at locality 45, north of Providence School in Tippah County, the basal limestone is absent. This

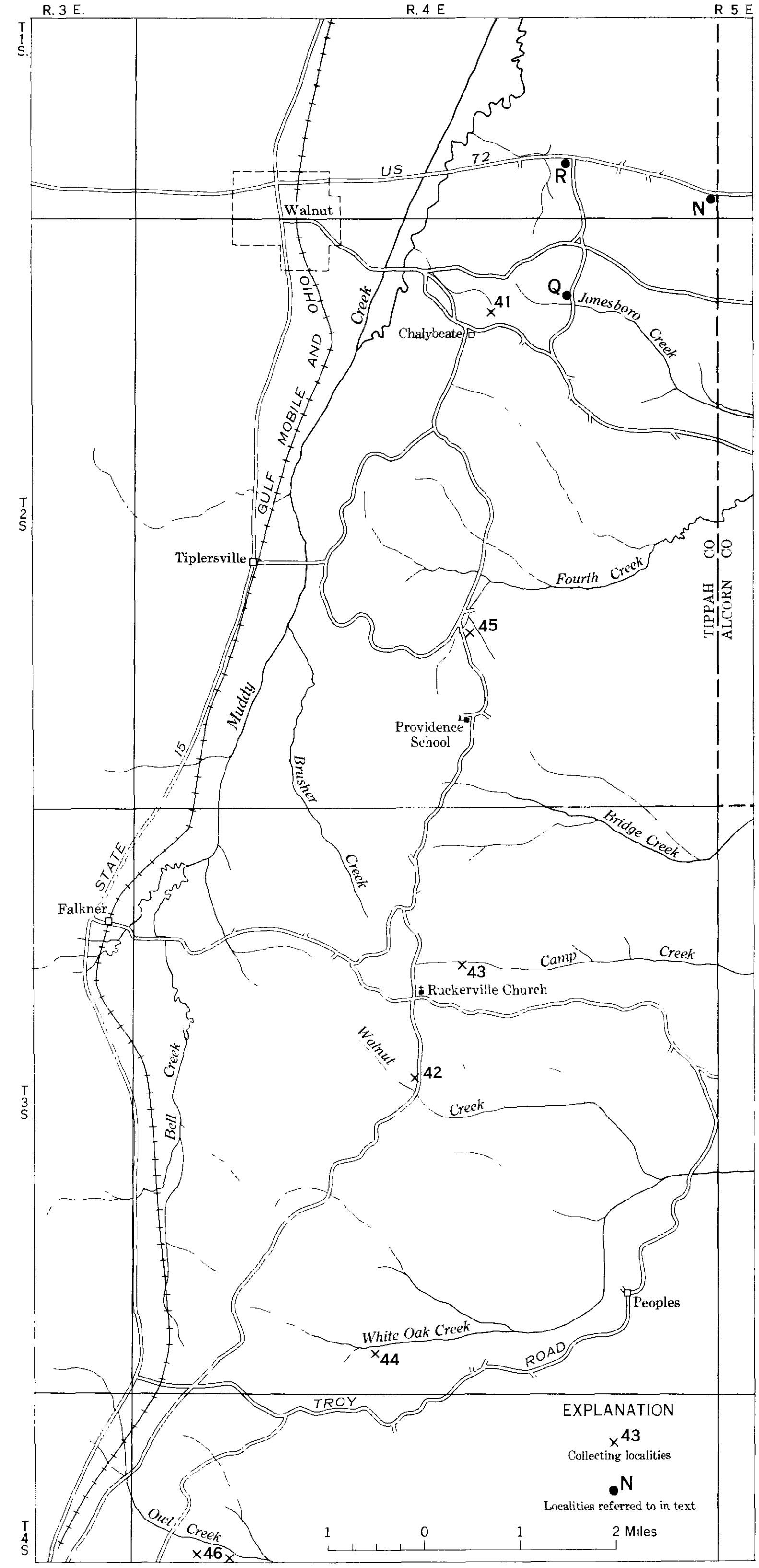

FIGURE 6.—Sketch map of the primary collecting localities from the Owl Creek formation in Tippah County, Miss.

could be interpreted as lenticularity of the limestone, but more probably the absence of the limestone is due to solution. Support for the latter view is seen in many places in the form of residual clay with small limestone pebbles at the contact of the Owl Creek and Clayton formations. Farther south, where the limestone overlies the Prairie Bluff chalk, the limestone contains an abundance of reworked Cretaceous fossils.

The first evidence of intertonguing of the Owl Creek formation with the Prairie Bluff chalk may occur at locality 11, 0.8 mile south of Dumas, where a few feet of silty calcareous brownish sand containing an abundance of phosphatic molds overlies about 7 feet of typical blue-gray "marl" of the Owl Creek formation (pl. 1, col. 8). From this point south the formation becomes increasingly less "marly" and turns to a poorly fossiliferous brown, calcareous sand.

Through most of southern Tippah County and northern Union County, it is difficult to determine what part of this interval represents the Owl Creek and what part belongs to the Prairie Bluff chalk. The outcrops weather rapidly, and as the Prairie Bluff is very sandy the two formations greatly resemble each other and are very difficult to distinguish lithologically. The presence of phosphatic molds is typical of the Prarie Bluff, and the presence of a few specimens of *Diplochiza melleni* Stephenson, a form restricted to the chalk facies, also aids in distinction.

In exposures in roadcuts of Mississippi State Route 30 on the crest of the ridge from about 2.5 to 5 miles east-northeast of New Albany in Union County, the northern sandy facies of the Prairie Bluff chalk may be seen in contact with the Keownville limestone member of the Ripley formation (loc. 54, 55). The southernmost exposures of the Owl Creek formation that retain their typical composition of blue-gray silty sand occur in the vicinity of New Albany and are well exposed in roadcuts of Mississippi State Route 15 about 4.4 miles north of New Albany city limits (SE½NE¼ sec. 16, T. 6 S., R. 3 E.). Stephenson and Monroe (1940, p. 236–238) cited the presence of glauconitic sands of the Owl Creek (loc. 51) above the sandy limestone and sand beds of the Prairie Bluff and below the sand beds of the Clayton formation in three railroad cuts of the St. Louis and San Francisco Railroad between New Albany and Wallerville. When visited by the author in 1950, these cuts were highly weathered and overgrown, obscuring the relations. South of New Albany, on Mississippi State Route 15 on the north-facing slope of King Creek Valley (loc. 50), 18 feet of fossiliferous chalky sand of the Owl Creek is overlain by basal limestone of the Clayton containing reworked Cretaceous fossils such as *Bullopsis cretacea* Conrad and other typical Cretaceous genera as *Drilluta*, *Anchura*, *Liopeplum*, *Discoscaphites*, and *Baculites*. The most southerly report of the Owl Creek formation is in Pontotoc County where Priddy (1943) treated the upper sandy part of the Prairie Bluff chalk as the Owl Creek "facies" and reports a maximum thickness of 45 feet. The Owl Creek is not recognizable at all outcrops where the contact between the Cretaceous and Paleocene is exposed (see section on "Locality 57") and is so similar to the overlying sand of the Clayton formation that where the basal limestone is not present the contact is difficult to distinguish. One mile south of Pontotoc in a cut of the Gulf Mobile and Ohio Railroad (see section on "Locality 60") Stephenson and Monroe (1940, p. 224) cited a section that includes 25 feet of sand that they ascribe to the Owl Creek, unconformably overlain by sand of the Clayton with reworked Cretaceous fossils. Southward, poor exposures of sandy material assigned to the Owl Creek occur in roadcuts of Mississippi State Route 15, 2 miles south of Pontotoc and just south of Chiwapa Creek, but in the southern part of the county even these sand beds have merged into the Prairie Bluff chalk.

PRAIRIE BLUFF CHALK

The name Prairie Bluff originally was applied to the uppermost Cretaceous chalk exposed on the Alabama River and was derived from typical exposures at Prairie Bluff, Wilcox County, Ala. (Winchell 1857, p. 84). Hilgard (1871), and later Smith and Johnson (1887), applied the name Ripley to include the upper part of the Cretaceous section in Alabama, incorporating the Prairie Bluff as the uppermost part (fig. 2). Stephenson (1917, p. 250) later defined the Prairie Bluff as a tongue of the Selma chalk as developed in western Alabama, and named the Mississippi equivalent the Oktibbeha tongue (fig. 2). The latter usage prevailed until Stephenson and Monroe (1937, p. 806–809) recognized the presence of a widespread unconformity at the base of the chalk and raised the Prairie Bluff to formation rank.

Like the Owl Creek formation, its northern embayment equivalent, the Prairie Bluff chalk lies within the bounds of the *Exogyra costata* zone and is separated from the Ripley formation below and the Paleocene series above by unconformities. In northern Mississippi the chalk is overlain by the Clayton formation, but southward that formation is overlapped by the Porters Creek clay, which then rests on the Prairie Bluff chalk.

Outcrops of the Prairie Bluff chalk are known as far north as northern Union County and questionably in southern Tippah County (loc. 11). But here the formation is thin and very sandy and merges with the Owl Creek formation. Southward the formation thickens and becomes a chalk, and its outcrop belt follows the general arcuate outcrop pattern of the other Cretaceous formations across Mississippi and Alabama to Bullock County (Monroe 1941, p. 118). East of this county it merges completely with the Providence sand. (See fig. 3.) Although in Alabama the Prairie Bluff chalk is overlapped at several places by Paleocene sediment and is only 15 feet thick at its type locality, nowhere in Mississippi is it completely overlapped.

The formation has the same age relations as those of the Owl Creek formation. It bears *Turritella bilira* Stephenson, which is typical of the Kemp clay of Texas and the Providence sand of Georgia. Stephenson (1914, p. 36) proposed a subzone of the *Exogyra costata* zone, which he designated the *Liopistha protexta* subzone, to include the interval represented by the Prairie Bluff chalk and equivalents, but subsequent work has shown the species to be much longer ranging. The above named turritellid however would well serve the same purpose of a zonal marker.

Faunally, the formation is rich; but unfortunately, with the exception of the microfossils and the oysters, which possess shells composed of calcite, the faunal record is almost restricted to phosphatised internal molds. Although only a few species and genera are recognizable from such material, the very abundance and variety of molds indicate the fauna was large and probably as well diversified as that of the Owl Creek or Ripley. Several additional species that appear to be restricted to the chalk facies of the Prairie Bluff and have proved themselves valuable in differentiating the Prairie Bluff from the chalky facies of the Ripley formation and the Demopolis chalk are *Diploschiza melleni* Stephenson, *Terebratulina? floridana* (Morton), and *Hardouinia aequorea* (Morton). Some cephalopod species hold considerable promise of stratigraphic utility but have as yet not been sufficiently well studied.

The formation consists dominantly of an impure silty to sandy chalk with subordinate amounts of clay, sand, and chalky limestone. The more impure phases are found in the north in Union and Pontotoc Counties. To the south the impurities decrease. Analyses of five samples from the Prairie Bluff chalk from the southern counties (Kemper to Oktibbeha), published by Stephenson and Monroe (1940, p. 205), indicate a calcium carbonate content of 56–82 percent. A range of 15–72 percent was found by the author in tests of over 20 random samples from Pontotoc County southward. The higher contents were found from Chickasaw County southward.

The thickness of the Prairie Bluff chalk varies considerably over the belt of outcrop, with the variation in part accounted for by partial overlap of the younger Paleocene sediment and in part by the erosion interval that followed Cretaceous deposition.

The most northerly definite report of the Prairie Bluff chalk is in northern Union County, where calcareous sands and gray clays bearing *Diploschiza melleni* Stephenson immediately overlie the Keownville limestone member of the Ripley formation at localities 28, 54, and 55, and near the county line by Stephenson and Monroe (1940, p. 226). Throughout Union County the Prairie Bluff chalk is probably no more than 20 feet thick, and its intertonguing relations with the Owl Creek formation have been discussed under the latter formation.

In Pontotoc County, according to the estimate of Priddy (1943, p. 26), the formation reaches a thickness of 65–75 feet, including the sandy upper part that he called the "Owl Creek facies." Priddy made three divisions (lower, middle, and upper or Owl Creek), which were distinguished lithologically and although usable here cannot be carried south. The formation is, however, more calcareous in the vicinity of Pontotoc than to the north. At locality 57 east of Pontotoc (pl. 2), the lower part of the formation, a very sandy and silty chalk, containing abundant phosphatic molds of mollusks, unconformably overlies the limestone units of the Keownville member (pl. 2, fig. 3). Above this unit are more typical blue-gray, clayey, silty chalk units containing numerous specimens of *Hemiaster wetherbyi* de Loriel. No sandy facies of the Owl Creek was distinguished at this locality, but a few feet could occur in a small covered interval.

To the south, in the latitude of Houston and Houlka in Chickasaw County, purer phases of the chalk develop and from here south the Prairie Bluff chalk is exposed in numerous bald spots reminiscent of the similar bald spots of the lowlands underlain by the Selma group. A great profusion of oysters and phosphatic molds, weathered from the chalk, occurs on the surface of the bald spots at many localities. (See sections on "Localities 62–96.")

In Chickasaw County the down dip changes in the formation can be seen on the Houston and Buena Vista road, where sections from 3 miles west of the latter settlement to the vicinity of Houston (Stephenson and Monroe, 1940, p. 197–198) show a change from a basal chalky sand to a compact silty chalk. The formation nowhere in the county appears to exceed 70 feet in thickness.

From Clay County south the upper contact of the Prairie Bluff chalk is very difficult to trace, for the Clayton formation has been overlapped and the chalky Porters Creek clay, having a similar composition, directly overlies the Prairie Bluff chalk. Bergquist (1943, p. 36) estimated the chalk in Clay County to be less than 80 feet thick.

Through Oktibbeha, Noxubee, and Kemper Counties, small exposures of the Prairie Bluff are common and show a rather uniform composition, with thicknesses ranging from about 30 to 80 feet. This outcrop trend continues into Sumter County, Ala., where Monroe (1955) noted 70 feet of Prairie Bluff well-compacted somewhat sandy white to bluish chalk which contains abundant phosphatic molds.

DESCRIPTIONS OF COLLECTION LOCALITIES AND DETAILED STRATIGRAPHIC SECTIONS

In the following descriptions and sections, the geographic position of each locality is given first, followed by the U. S. Geological Survey Mesozoic locality number, name of collector, and the date of collection. In many cases, several people have collected at the same locality, and separate numbers have been assigned to each collection.

Where there is some question as to the exact position of two collections from a given locality, they have been kept separate and assigned different locality numbers.

The stratigraphic sections measured by the author were measured by hand level and tape. Section descriptions quoted from the literature either were not visited by the author or were found to be completely or partly covered. Free use has been made of the field notes of T. W. Stanton and L. W. Stephenson, who made many of the early collections at localities now overgrown. Several early collecting localities are known only by general geographic location, and attempts at finding them have failed. Short discussions, including additional stratigraphic information, are appended to some section descriptions.

LOCALITIES IN THE RIPLEY FORMATION

LOCALITY 1

Creekbeds and bluffs 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. Messler, 1933; USGS 25406, N. F. Sohl 1950–53.

Section of the Ripley formation at locality 1

	Feet
McNairy sand member:	
4. Sand, yellow (weathering to red), thin-bedded, with clayey micaceous partings; exposed in gullies near crest of ridge west of house	15±
3. Sand, reddish and weathered, poorly exposed	15±
2. Covered	15±
Coon Creek tongue (type locality):	
1. Sand, gray-blue to black, silty, clayey, micaceous, glauconitic, calcareous, fossiliferous (USGS 10198, 16951, 25406) with numerous sandstone concretions common and forming falls in bed of creek	27. 0

This is the type locality of the Coon Creek tongue. It is the most prolific single locality for collecting Upper Cretaceous fossil mollusks in the world: 170 genera and 297 species of mollusks were described from this locality by Wade (1926). A more detailed description of the lithologic character and preservation of specimens at this locality can be found in reports by Wade (1917a, 1926). The fossils of unit one occur within the *Exogyra cancellata* zone, which is somewhat lower stratigraphically than the fossil localities of the lower part of the Ripley in Mississippi.

LOCALITY 2

Cut of the Southern Railway, one-half of 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.

Section of Ripley formation (Coon Creek tongue and transitional clay)

[After Stephenson and Monroe (1940, p. 183)]

	Feet
3. Residual yellow finely micaceous and sandy clay	5
2. Weathered light-greenish-gray, finely micaceous, calcareous clay with soft, poorly preserved shells, mostly small	21
1. Massive dark-gray finely micaceous, calcareous clay containing *Exogyra costata* Say, *Crenella serica* Conrad, *Corbula crassiplica* Gabb and other fossils (USGS 6877 and 17234)	4
	30

The above section is near the base of the Coon Creek tongue. Cuts on the same railroad 1.25 miles to the southeast have yielded *E. cancellata* Stephenson at a level probably no more than 20–30 feet below the level represented by the fossiliferous clay of unit 1 above.

LOCALITY 3

Bluff on Hatchie River at Crums' old millsite near Alcorn County line, 13.3 miles (airline) northeast of Ripley, Tippah County, Miss., NE¼SE¼SE¼ sec. 3, T. 3 S, R. 5 E. USGS 552, L. C. Johnson, 1888; USGS 6462, L. W. Stephenson, 1910.

Stephenson and Monroe (1940, p. 188) noted 25–30 feet of thin dark-gray micaceous sandy clay interbedded with thin sand units occurring in the bluff at the base of a hill rising 210 feet above the flood plain of the Hatchie River. Ferruginous sandstone ledges are visible on the hill slopes above the bluff, placing the collections (USGS 552, 603), made near the base of the bluff, near the top of the Coon Creek tongue of the Ripley formation. The laminated and thin-bedded nature of the sand and clay is characteristic of the transition zone between the Coon Creek tongue McNairy sand member.

LOCALITY 4

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.

This collection, by its geographic occurrence coupled with an examination of the matrix containing the fossils indicates the collection to be from the Coon Creek tongue, but what part of the unit is a matter of doubt. The matrix is a very highly micaceous silty, clayey, gray sand. Several scraps of lithified sand present in the collection indicate the presence of sandstone concretions typical of this member. Recent attempts to find this locality visited by Johnson in 1888 have failed. Numerous outcrops of sands of the upper part of the Coon Creek tongue occur in the vicinity, but fossils are preserved only as poor impressions.

LOCALITY 5

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.

Stanton's field notes of 1889 state: "At Bullock's old mill, 2 miles south of Dumas, the rocks of no. 1 are exposed in the hillside and are followed below, after a covered interval of 20 or 30 feet, by 8 or 10 feet of dark marl full of fossils reaching to the water level."

Stephenson and Monroe (1940, p. 188) reported the locality now covered but place the locality in the Coon Creek tongue of the Ripley formation. The fauna (USGS 542, 708) and attached matrix is typical of the Coon Creek but could equally apply to the sands in the upper part of the Ripley formation. The latter suggests itself as a possibility because the fossiliferous sands units occur in a sequence about "20 or 30 feet below" ferruginous limestone which probably belongs to the Keownville limestone member. As the locality is now covered, exact placement in a part of the Ripley is impossible, but the sequence is reminiscent of that at locality 28.

LOCALITY 6

Roadcut on northeast-facing slope of Hall Creek, a tributary of the Tallahatchie River, 2.9 miles (airline) southwest of Dumas, Tippah County, Miss., center S½NW¼ sec. 34, T. 5S, R. 4 E. USGS 25407, N. F. Sohl, 1950-52.

Section of the Coon Creek tongue and McNairy sand member of the Ripley formation at locality 6

	Feet
McNairy sand member:	
6. Sand, yellow, micaceous, silty, with numerous thin ferruginous sandstone ledges; tops hill.	
Coon Creek tongue:	
5. Sand, gray, micaceous, silty, crossbedded; interbedded with a few ⅛-in. thick gray clay stringers	11
4. Clay, light- to yellowish-gray, plastic, micaceous, thin-bedded, with silty partings	2
3. Sand, blue-gray, silty, micaceous, with a few small irregularly shaped sandstone concretions	7
2. Clay, blue-gray, sandy, silty, micaceous with pockets of glauconitic sand, massive and sparingly fossiliferous	5
1. Sand, blue-gray, medium-grained, silty, clayey, micaceous, glauconitic, highly fossiliferous (USGS 25407), with many large fossiliferous concretions	12

This locality shows the transition from the typical fossiliferous sands of the Coon Creek tongue up through thinner bedded strata into the McNairy sand member. The boundary between the two members is arbitrarily picked at the point where ferruginous sandstone layers and lighter colored sands typical of the McNairy begin.

The position of the fossiliferous sand beds in relation to the McNairy appears to hold for most of the localities in this area. (See locs. 15, 17, 18, 19, 23).

LOCALITY 7

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.

The bluffs at this locality are now badly slumped and overgrown. Judging by the faunal content and composition of the adhering matrix, the collection (USGS 709) probably came from about the same position as that of unit 1 of locality 6 and is therefore assigned to the Coon Creek tongue of the Ripley formation.

LOCALITY 8

"Nabers coal bluff" on the land of Rev. W. M. Nabers, about 1 mile south-southeast of Dumas, Tippah County, Miss., sec. 23, T. 55. R. 4 E. USGS 551, L. C. Johnson, 1888; USGS 710, T. W. Stanton, 1889.

T. W. Stanton, who made this collection, quoted in his field notes the following section measured by Hilgard (1860, p. 89):

	Feet
[Owl Creek formation]	
5. Yellowish gray calcareous clay with veins of lime *Exogyra costata*	20
[Ripley formation—Keownville limestone member]	
4. Bored limestone with *Ammonites placenta, Cucullaea capax, C. maconensis, Trigonia,* etc	20
3. Coarse glauconitic sand	10
2. Black laminated clay	2
1. Soft ferruginous limestone	20

Stanton noted that units 2 and 3 were covered at his visit and that number 5 contained many Owl Creek species. Unit 4 yielded echinoids and USGS collections 551 and 710 probably came from this unit. This section finds its counterpart at locality 11. Unit 5 belongs in the Owl Creek formation, and the remainder is in the Keownville limestone member of the Ripley formation characterized by its echinoid- and *Sphenodiscus*-bearing limestone.

LOCALITIES 9 AND 9A

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).

Dr. Stanton in his field notes of 1889 described this locality as follows:

At Landers' mill on Cane Creek, 5 miles northwest of Molino and 9 miles south of Ripley, the exposures, which are small, consist of blue sandy marl forming the bed of the creek, overlain by 2 or 3 feet of very fossiliferous concretionary limestone. A *Trigonia* is especially numerous but the fossils are nearly all in the form of internal casts. Many sharks teeth and fragments of bone have been picked up in the bed of the stream. Above this limestone comes 10 feet of limestone like No. 4 of the Dumas section and with similar fossils, followed by clay with *E. costata.*

Stanton's locality description is hazy, but Stephenson and Monroe (1940, p. 187) traced the old millsite to the land of a Mr. Joe Medlin at the locality listed in the heading (loc. 9). They state that the lower part of the section is obscured. However, when this locality was visited by the author (1956), a section like the lower part of Stanton's was exposed in the bed of Cane Creek drainage ditch.

Section of the upper part of the Ripley formation at locality 9, bed of Cane Creek just below bridge of secondary road, SE¼ NW¼SW¼ sec. 24, T. 5 S., R. 3 E., Tippah County, Miss.

	Feet
1. Sand, blue-gray; like unit 3 but containing no concretions	2.5
2. Greensand, with a moderate amount of quartz sand, sparingly fossiliferous with fossils preserved only as impressions	1.0
3. Sand, blue-gray, silty, micaceous, calcareous, fossiliferous; locally indurated to highly fossiliferous concretionary masses (USGS 26346); forms bed of creek	2.0

Unit 3 appears to correspond to the "2 or 3 feet of concretionary limestone" of Stanton and indeed a comparison of lithologies and faunal content between USGS 714 and 26346 indicates a great similarity. By virtue of the reports of both Stanton and Stephenson and Monroe, one is forced to the conclusion that these collections have come from limestone units assignable to the Keownville limestone member and that the upper clay of Stanton's section probably belongs to the Owl Creek formation. Further evidence, in the form of echinoid-bearing limestone cropping out on the lower slopes of the valley walls of Cane Creek shortly to the south, bears support of such an assignment. In contrast to this evidence are the anomalies of the fauna. *Anomia* cf. *A. ornata* Gabb, *Turritella bilira* Stephenson, and a *Trigonia* which appears to be between *T. eufaulensis* Gabb and *T. angulicostata* Gabb occur here. The first species occurs in the Providence sand of Georgia as does the second. The *Turritella* is restricted to the Kemp clay in Texas. Both formations have been assumed to occupy a position as high or higher than typical Owl Creek. Thus, if this locality is in the upper part of the Ripley formation as the stratigraphic sequence would seem to indicate, the species listed must either have a longer range in Mississippi than elsewhere, or the upper part of the Ripley is younger than previously suspected. In favor of the latter view is the possible occurrence of *Trigonia angulicostata*, supposedly an Owl Creek species, in the Keownville limestone member of Mississippi and the uppermost limestone of the Ripley formation on the Chattahooche River at Alexanders Landing. The occurrence of supposed Owl Creek species is offset by that of species restricted to the Ripley formation such as *Trobus corona* (Conrad), *Turritella hilgardi* Sohl, and *Laxispira lumbricalis* Gabb.

Although the stratigraphic position of the collections from this locality is open to some doubt, it is assigned, subject to further study, to the upper part of the Ripley formation. Collections USGS 714 and 26346 are listed separately as locality 9 and 9A on the chart of distribution.

LOCALITY 10

Dea's Bluff on Mooney's Branch of Big Hatchie Creek, Tippah County, Miss. USGS 548, L. C. Johnson, 1888.

No stratigraphic information accompanied this collection (USGS 548), but from its geographic position and the adhering blue-gray calcareous silty, clayey sand matrix, the fossil assemblage appears to have come from the Coon Creek tongue of the Ripley formation.

LOCALITIES 11, 47, AND 53

Head of ravine, underpass, and roadcut just north of road fork three-quarters of a mile south of Dumas, Tippah County, Miss., center of eastern edge of SE¼ sec. 24, T. 5 S, R. 4 E. USGS 25416, N. F. Sohl, 1950–51; USGS 25424, N. F. Sohl, 1950–51; USGS 25488, N. F. Sohl, 1955.

Section of Prairie Bluff(?), Owl Creek, and Ripley formations at localities 11, 47, and 53, respectively

	Feet
Prairie Bluff(?) chalk:	
11. Sand, brownish-gray to yellow-brown, highly silty, micaceous, with small fossiliferous pebble-sized concretions and numerous phosphatic internal molds (USGS 25488, locality 53): *Cuneolus tippanus* (Conrad), *Nemodon* sp., *Pinna laqueata* Conrad, *Gervillia ensiformis* (Conrad), *Veniella conradi* (Morton), *Cardium* (*Trachycardium*) sp., *Cardium* (*Granocardium*) sp., *Baculites carinatus* Morton, *Discoscaphites iris* (Conrad), *Discoscaphites* sp., *Eutrephoceras* sp., *Avitelmessus* sp., and others	6±
Owl Creek formation:	
10. Sand, blue-gray, silty, micaceous, glauconitic, calcareous, fossiliferous (USGS 25424, loc. 47), with *Turritella bilira* Stephenson, *Trigonia angulicostata* Gabb, and other typical Owl Creek fossils	8. 0
Ripley formation:	
Keownville limestone member:	
9. Sandstone, blue-gray, highly calcareous; weathers brown; fossiliferous (USGS 25416, loc. 11). *Sargana stantoni* (Weller) and other typical Ripley species	1. 0
8. Covered	16. 0
7. Sand, light-grayish-brown, well-compacted, fine-grained, massive, silty, micaceous, calcareous; fossiliferous with poorly preserved small pelecypods	12. 0
6. Covered, limestone float	38. 0
5. Limestone, yellow-brown, sandy, cavernous-weathering, fossiliferous	1. 6
4. Covered, float of limestone and numerous shells of *Exogyra* weathered out from above	8. 0
3. Limestone, yellow-brown, sandy, fossiliferous; *Hardouinia mortonis* (Michelin); only 3 feet exposed in place but slump blocks indicate thickness	5. 0
McNairy sand member (in part):	
2. Covered; this interval includes upper part of McNairy sand member and sands of upper part of Ripley formation below Keownville limestone member, ferruginous sandstone of McNairy dissappears and fossiliferous limestone float begins	59. 4
McNairy sand member:	
1. Sand, yellow, coarse- with interbedded fluted and corrugated ferruginous sandstone ledges which are intermittently exposed in streambed and on valley walls	25. 0

This section is representative of the numerous exposures in ravines in the vicinity of Dumas. The presence of Prairie Bluff sediment here is debateable. The faunal assemblage, with the numerous cephalopods, is much like parts of the Owl Creek formation, but the state of preservation is more typical of fossils of the Prairie Bluff chalk. If this is true Prairie Bluff, it is the northernmost point at which it occurs. The full thickness of the Keownville limestone member is exposed here and exceeds 73 feet—bounded below by a covered interval of 59 feet which may include a few more feet of the Keownville plus sands of the upper part of the Ripley formation.

LOCALITY 12

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.

Stanton in his field notes of 1889 stated:

> There are numerous outcrops of fossiliferous clay marl in the neighborhood (of Molino). The most extensive and and fossiliferous is on C. R. Hall's farm (sec. 5, T. 6 S., R. 4 E.) where for a quarter of a mile along a little creek (Hall's Branch) there is almost continuous exposure of dark clay marl, 10 or 15 feet thick.

Stanton's locality is about 0.5 mile north of locality 17. The collection (USGS 711) was probably from approximately the same position as unit one of locality 17, which places them in the upper part of the Coon Creek tongue of the Ripley formation.

LOCALITY 13

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.

Stanton (1889, field notes) stated his locality to be about 3 miles south of Molino, but this places the locality in an area where no outcrops could be found. Bluffs at the above listed locality approximate his description.

Section of the Ripley formation at locality 13

	Feet
3. Blue-clay marl with many fossils like those at Bullock's old mill but most of them not well preserved	40
2. Pure white and yellow unconsolidated sand with thin layers of clay	10
1. Blue-clay marl in bed of a little stream (North Branch?)	

The fauna at this locality (USGS 712) finds its analog at locality 6, which is 4 miles directly north, where a very similar assemblage of volutes is present. This collection is typical of the Coon Creek tongue of the Ripley formation.

LOCALITIES 14, 15, AND 16

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 6873, L. W. Stephenson, 1910; USGS 17277, W. H. Monroe, 1936; USGS 25408, N. F. Sohl, 1950–52; USGS 25409, N. F. Sohl, 1950–52.

Section of the Ripley formation at localities 14, 15, and 16

	Feet
Ripley(?) formation:	
8. Residuum.	
Ripley formation:	
McNairy sand member:	
7. Sand, white, fine-grained, clayey, interbedded with reddish coarse sand and some 0.2- to 0.3-ft bands of crenulate ferreginous sandstone	30
Coon Creek tongue:	
6. Clay, blue-black, sandy, laminated, micaceous, carbonaceous	.8
5. Sand, yellow, micaceous; alternates with clay like that of unit 6, with impressions of bivalves	5.9
4. Sand, blue-black, massive, silty, micaceous, glauconitic, fossiliferous (USGS 25409, loc. 16)	11.6
3. Sandstone, yellow, weathering yellow brown, micaceous, noncalcareous; interbedded with bands of blue-black to gray sandy noncalcareous clay with individual beds to 0.7 ft thick	9.0
2. Sand, like unit 4, with sandstone concretions, fossiliferous (USGS 25408, loc. 15)	8.0
1. Alluvium of Tallahatchie River bottoms.	

Stephenson and Monroe (1940, p. 191) cited the occurrence of fossils at this locality, but when Stephenson visited this locality in 1910, only an incomplete section was exposed. His collection (USGS 6873 and 17277, loc. 14) probably came from bed 4. Beds 2 and 4 both occur below the McNairy sand member; this places them within the upper part of the Coon Creek tongue.

LOCALITY 17

Roadcut in 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.

Section of the Ripley formation at locality 17

	Feet
McNairy sand member:	
6. Sand, iron-stained-red, micaceous, with a few interbedded clay lenses and bearing *Halymenites major* Lesquereux. Top of hill at road intersection	15±
5. Clay, gray, micaceous, thin-bedded; interbedded with weathered brownish-red clay; sharp basal boundary	1.0
Local unconformity.	
Coon Creek tongue:	
4. Sand, yellow, fine-grained, silty, micaceous	4.5
3. Clay, light-gray, plastic, micaceous; interbedded with thin, ⅛-in. bands of very micaceous silty noncalcareous brownish-clay	8.0
2. Sand, blue-black; like unit 1, but fossils preserved only as molds; locally cemented by iron oxide	1.5
1. Sand, blue-gray, silty micaceous, calcareous, glauconitic, fossiliferous (USGS 25410)	12.0

This locality is analogous to the preceding locality at Lee's old mill site 0.6 mile to the south. Unit 1 very likely correlates with unit 2 of that section.

LOCALITY 18

Scraped area 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.

Section of Ripley formation of locality 18

	Feet
Coon Creek tongue:	
4. Residuum; sand, weathered red and grading to soil	
3. Clay, dark-gray, silty, micaceous, iron-stained; interbedded with red to yellow medium-grained sand	19
2. Sand, blue-gray, silty, calcareous, micaceous, glauconitic, very fossiliferous (USGS 18078, 18629, 18616, and 25411), with a layer of concretions near base of unit that contain crab remains	10.3
1. Covered to lake level	4.0

The fossiliferous unit here is approximately equivalent to unit 2 of section 19 and very similar to unit 1 of locality 32, which also contains a zone of crab-bearing concretions. The main fossiliferous sand beds occur above these crab-containing concretions, and the faunal content (see Faunal list) is typical of the Coon Creek tongue (Harbison, 1945). When weathered out on the surface, the shells are nearly white; but when obtained fresh from excavations, the preservation is almost perfect, and the original color patterns are commonly preserved. This locality has afforded fine collecting over the years, but each year the locality becomes more overgrown.

LOCALITY 19

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.

Section of the Ripley formation at locality 19

	Feet
Sand units of upper part or McNairy sand member:	
10. Clay, gray to brown, sandy, micaceous, much weathered	10
McNairy sand member:	
9. Sandstone, reddish-brown, ferruginous, in corrugated to honeycombed ledges interbedded with coarse-grained yellow sand	12
8. Sand, white, coarse, interbedded with thin ferruginous sandstone ledges	15
7. Sand, reddish-brown; medium-grained; micaceous, base at first ferruginous layer	1
Coon Creek tongue:	
6. Sand, yellow, fine-grained, micaceous	15
5. Covered; line of springs eight feet above base of unit; much yellow-sand float	15
4. Clay, blue-gray, silty, micaceous noncalcareous	7
3. Covered	6.5
2. Sand, blue-gray, silty, calcareous, fossiliferous (USGS 25412); like unit 2 of section 18	16.5
1. Covered, to lake level	7.0

If unit 10 of this section is correctly assigned to the sands of the upper part of the Ripley formation, the full thickness of the McNairy sand member is exposed at this locality and is only 28 feet thick. Two miles north, at locality 11, the McNairy is about 80 thick, and Stephenson and Monroe (1940, pl. 1a) have mapped the member as pinching out within 5 miles to the south.

LOCALITY 20

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.

Section of the Ripley formation at locality 20

	Feet
McNairy sand member:	
15. Sand, red, coarse-grained, with abundant ferruginous sandstone interbedded	65. 0
14. Sandstone, red, ferruginous, corrugated	. 1
13. Clay, gray, sandy; interbedded with thin sand in upper part; lenticular	1–3
12. Sand, white to yellow, fine-grained; weathers iron-stained red	8. 0
11. Sand, yellow, extremely fine-grained and micaceous with some lenticular bodies of dark-gray clay with thin interbedded layers of argillaceous sand as much as 1 ft thick	5. 0
10. Clay, dark-gray, with fine-grained sand partings; base of unit irregular	6. 1
Unconformity(?) local.	
9. Sand, yellow, fine-grained, crossbedded, with lenticular clay bodies like unit 11	4. 0
8. Sand, yellow, medium-grained; interbedded with thin gray-black slightly micaceous clay partings, which thicken and become dominant lithology in upper two feet of unit	5. 5
7. Sand yellow, fine- to medium-grained; crossbedded in part, with many thin platy ferruginous sandstone ledges	4
Coon Creek tongue:	
6. Sand, yellowish, fine-grained, micaceous; interbedded with gray clayey micaceous sand	4. 0
5. Clay, gray, iron-stained, micaceous	. 9
4. Sand, blue-gray; laminated with gray clay partings and a few thin lignitic bands	5. 0
3. Sand, blue-gray, silty, micaceous, calcareous, glauconitic, fossiliferous (USGS 25413)	4. 5
2. Clay, gray; iron stained in part; grades upward into clayey sand which is micaceous, calcareous, and fossiliferous with fragile internal molds of small pelecypods	14. 2
1. Covered to valley floor.	

The section exhibits the gradational character of the boundary between the Coon Creek tongue and McNairy sand member. The dark sand units of the Coon Creek give way upward to the crossbedded and lenticular lighter colored sands of the McNairy, with its characteristic ferruginous sandstone ledges.

LOCALITY 21

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.

Section of the Ripley formation, Coon Creek tongue

	Feet
3. Residuum.	
2. Clay, gray- and yellow-banded, fossiliferous	9
1. Sand, gray-blue, weathering brown, fine-grained, clayey, micaceous, fossiliferous, with fossils as molds in small concretionary masses (USGS 25414)	8

At the base of the slope about 30 feet below the roadcut, clay very similar to weathered transitional clay is present in the bed of Little Camp Creek.

LOCALITY 22

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.

Section of the Ripley formation, Coon Creek tongue

	Feet
1. Sand, blue-gray, massive, silty, micaceous, glauconitic; some thin gray silty clay stringers; abundant fragile generally compressed fossils and few small concretions near base of cut (USGS 25587)	35–40

The lithogic character and fauna, which includes such species as *Anchura substriata* Wade and *Lemniscolittorina berryi* (Wade), is typical of that of the lower part of the Ripley in Mississippi and probably represents the lower part of the Coon Creek tongue. This roadcut is in about the same stratigraphic position as that of locality 21.

LOCALITY 23

Roadcut on new Mississippi State Route 30, east slope of Sweden Hill 0.45 mile northwest of Graham, Union County, Miss., NW¼NE¼NW¼ sec. 20, T. 6 S., R. 5 E. USGS 25494, L. W. Stephenson and N. F. Sohl, 1955.

Section of the Ripley formation

	Feet
McNairy sand member:	
3. Sand, varicolored, irregularly bedded; interbedded with gray clay lenses and corrugated ferruginous sandstone ledges; sand ranges from deep iron-stained reddish brown, to yellow, yellow green, and white; lower part of section with coarse white micaceous sand and irregular gray clay lenses to 3 ft thick; first thick ferruginous sandstone ledges appear 50–53 ft above base and increase in abundance upward, *Halymenites major* Lesquereux abundant	85
Coon Creek tongue:	
2. Silt, tan, micaceous, and gray silty clay, interbedded in thin units	8
1. Sand, blue-gray, silty, micaceous, calcareous, glauconitic, fossiliferous (USGS 25494), with two crab-bearing concretion zones at 15–16 ft above base; other fossiliferous concretions occur 9 ft above base but lack crab remains	26

This section is essentially the same as that of locality 20, which was measured on the old road about 200 yards to the north. The roadcuts here are new and offer a fine sequence of the Coon Creek and McNairy transition from the thin-bedded units of unit 2 to the more massive-bedded units in the upper part of unit 3.

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.

The fossils listed were collected by E. W. Shaw in 1925, and subsequent attempts to precisely locate the collecting locality have been in vain. Other exposures in the near vicinity in secs. 26 and 33, T. 6 S., R. 4 E., expose fossiliferous sands of the upper part of the Ripley formation with the tops of the hills in sec. 33 being capped by the Keownville limestone member. The following list of gastropods is from a locality (USGS 26340) which was found in 1956 during an attempt to locate Shaw's locality. It is in the adjacent section (SW¼NW¼ sec. 26, T. 6 S., R. 4 E.) to the south of locality 24 and appears to be from the same level and may actually be the place from which he collected.

Weeksia amplificata (Wade)
Calliomphalus americanus Wade
Urceolabrum tuberculatum callistum Harbison
Pseudomalaxis cf. *P. ripleyana* Harbison
Margaritella pumila Stephenson
Laxispira lumbricalis Gabb
Turritella trilira Conrad
Turritella howelli Harbison
Cerithium weeksi Wade
Cerithium semirugatum Wade
Seila meeki (Wade)
Turboella tallahatchiensis Sohl
Graciliala calcaris (Wade)?
Gyrodes spillmani Gabb
Euspira rectilabrum (Conrad)
Pyropsis perlata Conrad
Hercorhyncus tippanus Conrad
Stantonella ripleyana (Conrad)
Bellifusus sp.
Volutomorpha sp.
Caveola sp.
Paladmete cancellaria (Conrad)
Fulgerca attenuata (Wade)
Eulima? *persimplicata* Wade
Creonella triplicata Wade
Acteon modicellus Conrad
Ringicula pulchella Shumard

This collection compares well with that from locality 24, and both represent the upper part of the Ripley formation.

LOCALITY 25

Roadcuts on Mississippi State Route 30, 4.9 miles northeast of junction of Mississippi 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; USGS 25489, L. W. Stephenson and N. F. Sohl, 1955.

Section of the Prairie Bluff chalk and Ripley formation at locality 25

	Feet
Prairie Bluff chalk:	
2. Clay, brownish-gray to tan where more weathered, chalky(?); mica as fine disseminated particles, sporadically sandy; highly sideritic, calcareous, fossiliferous (USGS 25489), with numerous phosphatic molds of mollusks and *Exogyra costata* Say, *Gryphaeostrea vomer* (Morton), *Anomia argentaria* Morton, *Paranomia* n. sp., bryozoans, and bone fragments	6
Unconformity.	
Ripley formation, Keownville limestone member:	
1. Limestone, tan, weathered, sandy, fossiliferous (USGS 25504); *Trigonia angulicostata* (Gabb), *Hardouinea mortonis* (Michelin)	2

This exposure is typical of the many small outcrops in the neighborhood and exhibits well the northern extension of the impure facies of the Prairie Bluff chalk.

LOCALITY 26

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.

Section of the Ripley formation at locality 26

[From Stephenson and Monroe (1940, p. 193)]

	Feet
Keownville limestone member:	
Hard cavernous crystalline, sandy limestone; surface consists of a mass of molds of fossil shells etched out by weathering away of the limestone; this bed is of great linear extent at the top of the Ripley formation immediately below the Owl Creek formation in Tippah County, and beneath the Prairie Bluff chalk in Union and Pontotoc Counties	2+
Very fine highly micaceous sand containing *Halymenites major* Lesquereux; 5 ft above base are two large concretionary masses of very hard crystalline limestone, originally a coquina, containing great numbers of mollusks on surface	29
Sands of upper part:	
Fossiliferous calcareous very fine-grained sandstone	6
Very fine micaceous sand	10
Calcareous sandstone	1
Partly indurated glauconitic, micaceous fossiliferous very fine sand; at base a 3-in. bed of well-rounded water worn(?) concretions and one slightly indurated tube of *Halymenites major* Lesquereux (USGS 17276)	12
Local unconformity.	
Thin-bedded very fine, highly micaceous sand containing fossils and some indurated layers of calcerous sandstone; fossils not so well preserved as those in overlying bed; to bottom of small branch on road	45
Concealed to bottom of large branch north of road	20+

The headings above are those of the author.

LOCALITY 27

Small bluff below bridge of St. Louis and San Francisco Railroad over East Branch of Okannatie Creek, 2½ miles east-northeast 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.

Section of the Ripley formation, sands of upper part, at locality 27

	Feet
6. Sand, gray, well-compacted, silty, micaceous, calcareous; becomes weathered upward and covered above railroad cut	8
5. Sandstone, gray, calcareous, micaceous, unfossiliferous	. 6
4. Sand, gray, well-compacted, fine-grained, silty, micaceous, calcareous (sections from here up exposed in railroad cut)	20. 0
3. Sand, greenish-gray, clayey, silty, micaceous, calcareous, glauconitic, fossiliferous (USGS 25415)	8. 0
2. Sandstone, dark-gray, calcareous, fossiliferous; contains internal molds of numerous mollusks (USGS 9508(?))	. 4
1. Sand, like unit 1, exposed in creekbed	2±

Stephenson and Monroe (1940, p. 190) mentioned this locality, and Stephenson in 1910 made a collection here (USGS 9508) from a sandstone which evidently corresponds to that of unit 2 in the above section. The sequence of gray sands with thin indurated ledges of sandstone is typical of the upper part of the Ripley formation below the Keownville limestone member, as at locality 28. This collection is only a poor representation of what might be collected here if care is taken and material is quarried in blocks.

Bluffs on the same creek about 0.9 mile downstream from locality 27 (SW¼NE¼SW¼, sec. 6, T. 8 S., R. 3 E.) or 100–200 yards below the bridge of U. S. Highway 78 expose another section which partly repeats the section at locality 27 and gives direct proof of its position in the section. About 20 feet of fossiliferous clays and marls are exposed in the bluffs and bear *Trigonia thoracia*, *Cyprimeria depressa* Conrad, *Crassatella vadosa* Morton, *Cardium* sp., *Exogyra costata* Say, *Turritella vertebroides* Morton, *Anchura abrupta* Conrad, *Euspira rectilabrum* (Conrad), *Graciliala* sp., *Gyrodes supraplicatus* Conrad, *Stantonella reipleyana* (Conrad), *Liopeplum* sp., *Longoconcha* sp., *Volutomorpha* sp., *Sphenodiscus* sp. The streambed is covered by blocks of limestone of the Keownville, which although not visible on the exposure have slumped from a higher position on the hill slopes. This places the locality 27 section in the upper part of the Ripley formation directly below the Keownville limestone member.

LOCALITIES 28, 29, 30, AND 31

Roadcuts on Mississippi Route 30, on the north-facing slope of Wilhite Creek valley from 0.7 to 1.7 miles south of Keownville, Union County, Miss., from the SE¼SW¼NE¼ to the SE¼ of sec. 30, T. 6 S., R. 4 E. USGS 25491, L. W. Stephenson and N. F. Sohl, 1955; USGS 25485, L. W. Stephenson and N. F. Sohl, 1955; USGS 25492, L. W. Stephenson and N. F. Sohl, 1955; USGS 25508, L. W. Stephenson and N. F. Sohl, 1955.

Section of the Ripley formation and Prairie Bluff chalk at localities 28–31

	Feet
Prairie Bluff chalk:	
28. Clay, greenish-gray (weathered chalk), slightly sandy, micaceous	7. 0
27. Clay, yellow-brown, silty, sandy, micaceous, poorly sorted; sand of medium-size grains of quartz, glauconite, and siderite; calcareous and fossiliferous with abundant phosphatic nodules and molds of mollusks (USGS 25507): *Exogyra costata* Say, *Ostrea tecticosta* Gabb, *Gryphaea mutabilis* Morton, *Diploschiza melleni* Stephenson, *Anomia argentaria* Morton, *Epitomium sillimani* (Morton), *Baculites carinatus* Morton, *Sphenodiscus* sp., and others	1. 5
Unconformity.	
Ripley formation:	
Keownville Limestone member:	
26. Clay, blue-gray to gray, micaceous, calcareous, poorly sorted, with disseminated, medium-size sand grains of quartz and glauconite; fossiliferous; noted *Turritella* sp., *Gryphaeostrea vomer* Morton, *Exogyra costata* Say	3. 0
25. Limestone, yellow-brown, sandy, silty, micaceous, sideritic, fossiliferous (USGS 25511): *Glycymeris rotundata* (Gabb), *Idonearca littlei* (Gabb), *Exogyra costata* Say, cf. *Titanosarcolites* sp., *Cardium (Pachycardium) spillmani* Conrad	4. 5
24. Sand, yellow-brown, fine-grained, highly silty, very slightly micaceous, calcareous, with scattered fossil fragments	1. 0
23. Limestone, like unit 27	1. 0
22. Sand, like unit 26	1. 0
21. Limestone, like unit 27	10. 0
20. Sand, brownish-gray, fine-grained, silty, micaceous, with scattered pockets of darker clay; fossils poorly preserved; *Trigonia eufaulensis* Gabb, *Anomia argenteria* Morton, *Hamulus* sp. (USGS 25508, loc. 31)	1. 0
19. Sand, gray, fine-grained, highly silty, micaceous, calcareous, with abundant indeterminate fossils and fragments	1. 5
18. Limestone, like unit 27	2. 0
17. Sand, brownish-yellow, medium-grained, silty, micaceous calcareous, sparingly glauconitic, fossiliferous, with a zone of cyclostomatous bryozoans near base of unit; *Idonearca capax* (Conrad), *Ostrea plumosa* Morton, *Lima reticulata* Lyell and Forbes, *Turritella trilira* Morton, *Bellifusus* sp. (USGS 25510)	4. 0

Section of the Ripley formation and Prairie Bluff chalk at localities 28–31—Continued

	Feet
Ripley formation—Continued	
Keownville Limestone member—Continued	
16. Sand, gray, well-compacted, massive, finely micaceous; contains numerous lighter colored borings	1.5
15. Limestone, like unit 27 but with numerous echinoids; *Hardouinia mortonis* (Michelin)	3.0
14. Covered (section continues below covered interval in next lowest roadcut)	5.5
13. Limestone, like unit 27; USGS 25509; *Clione* sp., Bryozoa, *Hardouinia mortonis* (Michelin), *Glycymeris rotundata* (Gabb), *Idonearca capax* (Conrad), *Ostrea* (*Arctostrea*) n. sp., *Spondylus* n. sp. *Exogyra costata* Say, *Trigonia thoracia* Morton of Conrad, *Lima* sp., *Anomia argentaria* Morton, *Cardium* sp. *Sphenodiscus lobatus* (Tuomey) of Hyatt	5.0
12. Sand, yellow-brown, medium- to coarse-grained, micaceous	7.0
11. Limestone, like unit 27; (USGS 25492, loc. 30) fauna like that of unit 15 plus *Idonearca littlei* (Gabb), *Crenella serica* Conrad, *Pecten simplicius* Conrad, *Veniella conradi* Morton, and gastropods as listed (exposed at road intersections)	5
Sands of upper part:	
10. Sand yellow to iron-stained-brown; micaceous near top but not at base	46±
9. Sand, gray, very silty, micaceous, slightly glauconitic; very fossiliferous, preservation good (USGS 25485, loc. 29); fossils occur throughout unit but are especially abundant and well preserved in zones 5 ft and 11 ft above base; lower zone is sandier and marked by a dominance of small pelecypods and numerous micrabaciid corals; upper zone occurs at base of a concretionary ledge and larger mollusks such as *Liopeplum*, *Volutomorpha*, *Gyrodes*, and *Exogyra* are common; the concretions are fossiliferous and bear numerous specimens of *Exogyra* and some crab remains	17
Section continues in next lower cut.	
8. Sand, yellow, fine-grained, silty, very micaceous; unit occurs at top of this cut and base of preceding cut	10–12
7. Sand, blue-gray, silty, micaceous, calcareous, with poorly preserved fragile fossils	5
Section below in cut 0.2 mile to north.	
6. Covered	3±
5. Sand, gray-black, silty, micaceous, glauconitic; two indurated ledges about one ft apart occur near base of unit, with fossils preserved as internal molds (USGS 25491, loc. 28)	7.0
4. Covered	2
Section below in cut 0.2 mile to north—Continued	
3. Sand, light-gray mottled with yellow, fine- to medium-grained, highly silty and micaceous, glauconitic; fossiliferous; bears imprints of small pelecypods; *Corbula* sp., *Nucula* sp	3
Section below in road materials quarry west of road.	
2. Sand, greenish-gray (when wet), irregularly iron-stained, medium- to coarse-grained	10
1. Sand, blue-gray to gray, silty, micaceous, calcareous, with poorly preserved fossils	13

As the full thickness of the Keownville limestone member is exposed in this section, it has been chosen as the type. The McNairy sand member is not present here, but it crops out in the hills both to the east and to the north of Keownville; and if it underlies this section, it is thin and the base of this section must be near the contact. The McNairy pinches out shortly to the south and also appears to thin downdip in this area.

LOCALITY 32

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, 1915.

Section of the Keownville limestone of the Ripley formation at locality 32

[From Stephenson and Monroe, 1940, p. 194]

	Feet
Poorly exposed residual material	20
Hard sandy cavernous fossiliferous limestone	27
Dark-gray compact massive very glauconitic finely micaceous sand; recognized *Sphenodiscus* sp. (USGS 6466 and 9522)	11
Hard limestone with prints and molds of fossils	1
Dark compact calcareous greensand	3
Calcareous sandstone containing many molds of fossils (USGS 6466, 9522)	2
Dark-gray partially indurated calcareous glauconitic sand containing molds of fossils (USGS 6466 and 9522)	15

The residual material of this section corresponds to that part of the section which Conant (1942, p. 29, 30) measured here and assigned to the Prairie Bluff chalk. The Caves are near the type section of the Keownville limestone member and show well the typical cavernous weathering of the limestone.

LOCALITY 33

Roadcut on west wall of Tallabinnela Creek, one-quarter of a 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.

Section of the Ripley formation at locality 33

	Feet
Lower part:	
8. Limestone, light-gray, highly silty, sandy, sparingly micaceous; fossiliferous, with fossils both as molds and prints and weathering out on surface (USGS 25417); alternating with silty yellowish-gray sand which is also fossiliferous; units are 1–2 ft thick with limestone forming benches in field adjoining road and capping small falls in drainage ditch	33
7. Silt, light-gray, sandy, micaceous, calcareous, fossiliferous	1. 0
6. Covered, bench in a field north of road indicates probable limestone unit in this interval	6. 0
5. Limestone, gray buff, sandy; fossiliferous: *Exogyra costata* Say, *Anomia argentaria* Morton	4. 3
4. Sand, gray, well-compacted, silty, calcareous; fossiliferous: *Exogyra costata* Say	4. 3
3. Sand, gray, medium- to fine-grained, silty; looks like weathered limestone	4. 0
Transitional clay:	
2. Covered; soil color changes to lighter gray	7. 6
1. Silt, blue-gray, clayey, micaceous, calcareous; weathers brown	10. 3

The limestone exposures in this neighborhood have been known since the time of Hilgard. Their fauna is poorly known because of the difficulty of collecting. At the above locality Stephenson and Monroe (USGS 6471, 18628) also made collections, but I am unsure what exact position the collections came from.

LOCALITY 34

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.

Section of the Ripley formation, transitional clay at locality 34

	Feet
Clay, gray (weathering to tan) micaceous calcareous, glauconitic; cylindrical concretions with phosphatized interiors common and range in size to 8 in. in length and from 1 to 2 in. in diameter; selenite plates and veins common; fossiliferous (USGS 25481): *Exogyra costata* Say, *Anomia argentaria* Morton, *Cymella bella* Conrad?, *Ostrea falcata*, *Caesticorbula crassiplica* (Gabb), *Baculites* sp. *Belemnitella* sp. (See Faunal list.)	30

The clay here and its fauna, with the abundance of *Caesticorbula crassiplica* (Gabb), is much like that at locality 2, northwest of Wenasoga. The fossils are very fragile. Some lignitic partings were noted, and in general the clays in this new cut appear to be weathering rapidly and slumping badly; thus, what is not obscured by cover will soon be lost by leaching.

LOCALITY 35

Pit of 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.

Section of the Ripley formation at locality 35

[Section compiled from Priddy (1943)]

	Feet
Keownville limestone member:	
3. Limestone, brown, sandy, fossiliferous (USGS 18881)	12. 6–18. 4
Upper Part:	
2. Clay, bluish-gray to light-buff, bentonitic, silty, sparingly micaceous; fossiliferous; *Cardium* sp., *Ostrea* sp., *Pecten* sp	7. 0
1. Chalk, gray-white, sandy, micaceous, fossiliferous	2. 7

The bentonite noted above has been commercially mined. The overlying limestone beds are *Sphenodiscus*-bearing limestone typical of the Keownville.

LOCALITY 36

Roadcut overlooking Bob Miller Creek on 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.

This collection (USGS 19086) was made from typical gray silty limestone of the lower part of the Ripley formation just slightly above the level represented by the collections from locality 34.

LOCALITY 37

Pontotoc-Aberdeen road, 6 miles southeast Pontotoc, Pontotoc County, Miss. USGS 6469, L. W. Stephenson, 1909.

Section of the Keownville limestone member of the Ripley at locality 37

[After Stephenson. 1909 field notes]

	Feet
Reddish ferruginous sand apparently grading down into yellowish sandy clay	About 20
Base not well exposed.	
Gray sandy argillaceous limestone with fossils	About 15
Most of the fossils here are in the form of poor casts, and the collecting is not good.	

The presence of *Sphenodiscus* sp. in this collection (USGS 6469) places the section in the upper part of the Ripley formation and probably in the Keownville limestone member.

LOCALITY 38

Roadcuts on new Mississippi State Route 6, 3.5 miles east of Pontotoc. Pontotoc County, Miss., NE¼SW¼ sec. 35, T. 9 S., R. 3 E. USGS 25425, N. F. Sohl, 1951–53, USGS 25418, N. F. Sohl 1951–53.

The following section was first visited in 1951 soon after the cuts were made; subsequent trips have shown the section to be weathering rapidly, and the sand units have become less distinct, and the echinoids in unit 13 are now rarely found complete.

The Keownville limestone member is thin here and represented by only one thin limestone unit. No definite contact between the Prairie Bluff Chalk and Clayton Formation was observed and it may occur in the covered interval of unit 14. The abundance of phosphatic molds near the Ripley and Prairie Bluff unconformable contact is shown in plate 2, figure 4. Concentration of the typical phosphatic molds in the lower part of the Prairie Bluff chalk is common, but they are not restricted thereto.

Section of the Ripley formation, Prairie Bluff chalk, and Clayton formation at locality 38

	Feet
Age indeterminate:	
16. Reddish residual sands grading to soil at top of cut.	
Paleocene:	
Clayton formation:	
15. Sand, yellowish-brown to iron-stained red, coarse- to fine-grained; some minor crossbedding, sorting moderate to poor; micaceous but less so near top; some glauconite; siderite grains in some beds; *Halymenites major* Lesquereux abundant in lower 25 ft	43±
14. Covered	8. 0
Cretaceous:	
Prairie Bluff chalk:	
13. Chalk, blue-gray to light-buff-gray, impure, silty, sandy, very micaceous; jointing common with chalk contiguous to joints weathered buff; fossiliferous, with *Hemiaster weatherbyi* de Loriol abundant and *Exogyra costata* Say, plus numerous poorly preserved fragile pelecypods	18
12. Silt, pale-gray, chalky, sandy, very glauconitic, micaceous with a few well-rounded siderite grains, fossiliferous with numerous phosphatic internal molds of echinoids, mollusks, sponges, and bones (USGS 25425, loc. 57)	6. 1
11. Chalk(?), buff to light-gray; bedding massive; very silty and sandy, slightly micaceous, sideritic; fossiliferous, with abundant phosphatic molds (USGS 25425); base undulatory, resting unconformably on Keownville limestone member	4
Unconformity.	
Ripley formation:	
Keownville limestone member:	
10. Limestone, yellow-brown, very sandy, sideritic, sparingly micaceous; fossiliferous; *Sphenodiscus* sp., *Hardouinia mortonis* (Michelin), *Exogyra costata* Say (USGS 25418, loc. 38); top of unit undulatory	3. 5–4. 5
9. Covered	8. 3
Upper part	
8. Sand (like unit 4), yellow to reddish brown, crossbedded, slightly micaceous, poorly sorted; unit varies laterally and an undulatory smut streak occurs 3–5 ft below top of unit near east end of cut; *Halymenites major* Lesquereux	9. 0

Section of the Ripley formation, Prairie Bluff chalk, and Clayton formation at locality 38—Continued

	Feet
Cretaceous—Continued	
Ripley formation—Continued	
Upper part—Continued	
7. Clay, greenish-gray, silty, sandy; inter bedded with more micaceous irregular iron-stained bands of clay; unit is lenticular, pinching out on north side of road	0. 8–1. 0
Local unconformity.	
6. Sand, white to yellow, medium-grained, cross-bedded, locally slightly indurated	3. 1
5. Sand, red to brownish-yellow, micaceous, slightly sideritic, sparingly glauconitic; finer grained than unit 4	1. 9
4. Sand, brownish, medium- to coarse-grained slightly micaceous; few rounded sideritic grains	4. 7
3. Sand, light-brown, medium-grained, silty, massive	2. 0
2. Covered by road fill; upper 5 ft; appears to be like unit 3. In a new road-metal quarry north of the road, the covered interval is in part exposed, exhibiting iron-stained red to yellow sand bearing numerous specimens of *Halymenites major* Lesquereux	19. 3
1. Sand, gray, silty; clayey in part, locally more compact, but not indurated to a sandstone	7. 2

LOCALITY 39

Roadcuts on old Mississippi State Route 8, about 4.7 miles west of Buena Vista, on the west-facing slope of tributary of Houlka Creek, Chickasaw County, Miss., SE¼ sec. 6, T. 14 S, R. 4 E. USGS 25419, N. F. Sohl, 1952.

Section of the Ripley formation and Prairie Bluff chalk at locality 39

	Feet
Prairie Bluff chalk:	
11. Residual red sand and blocks of limestone to top of hill.	
10. Limestone, gray (weathering brown), massive, silty, micaceous, glauconitic, with scattered grains of siderite; forms ledges and locally appears to grade to chalky limestone	3. 0
9. Chalk(?), brownish, weathered, silty, sandy; softer than unit 8; fossiliferous: *Exogyra costata* Say, *Gryphaea mutabilis* Morton abundant	4. 3
8. Chalk, gray, silty; and glauconitic fossiliferous sand with numerous phosphatic internal molds of mollusks	3. 5
7. Covered	7. 0
Ripley formation Keownville(?) limestone member:	
6. Limestone, buff, weathering brown, silty, sandy; fossiliferous: *Vetericardia crenalirata* (Conrad), *Exogyra costata* Say, *Caesticorbula crassiplica* (Gabb)?, *Anomia argentaria* Morton. *Meretrix?* sp., *Veniella* sp. *Cardium* sp., and gastropods (USGS 25419)	6. 0

Section of the Ripley formation and Prairie Bluff chalk at locality 39—Continued

	Feet
Ripley formation Keownville(?) limestone member—Con.	
5. Covered	4.0
4. Limestone, gray, sandy; like unit 10 but fossiliferous	5.5
Ripley formation undifferentiated:	
3. Silt and sand, gray, micaceous, calcareous; interbedded; fossiliferous: *Inoceramus* sp., *Exogyra costata* Say	49
2. Sand, gray, chalky and calcareous	10.0
1. Sand, light-gray, fine-grained, silty, micaceous, glauconitic; clayey in part; exposed intermittently	60±

The thinning of the Keownville limestone member is evident here, and shortly to the south it pinches out entirely. The sand units are fine grained, and their highly silty nature is indicative of the increased finer constituents of the southern part of the outcrop belt.

LOCALITIES IN THE OWL CREEK FORMATION

LOCALITY 40

Roadcut on Tennessee State Route 57, on west-facing slope of Muddy Creek valley, near old Trimm's mill, 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.

Section of the Owl Creek and Clayton formations at locality 40

	Feet
Paleocene, Clayton formation:	
6. Clay, variegated, silty, micaceous, thin-bedded; interbedded with thin ferriginous sandstone layers at 1 ft intervals	3.0
5. Sandstone, ferruginous; forms bench	1.2
4. Sand, reddish-brown, micaceous, with irregular bedding; some thin ferrugunous sandstone layers	9.8
3. Limestone; blue gray when fresh; weathers tan; fossiliferous but generally with preservation as fragments; base irregular	3.0±
2. Sand, blue-gray, silty, micaceous, glauconitic; many small gray to phosphatic black silty pebbles, many of which are pitted by borings (?); clay and silt pockets several inches long common; coarse detrital sand composed of shell fragments, lignitic scraps, quartz, and glauconite occurs as stringers; shell fragments commonly stained green; well-preserved fossils are abundant, but such typical Paleocene genera as *Venericardia*, *Calyptrophorus*, and *Mazzalina* occur intermixed with such Cretaceous forms as *Parafusus*, *Liopeplum*, *Pterocerella*, and *Baculites;* this is evidently a reworked fauna	5.0
Unconformity.	
Cretaceous, Owl Creek formation:	
1. Sand, blue-gray, very silty and clayey, massive, micaceous, glauconitic, unfossiliferous, slightly plastic when wet	17.7

Southward in Mississippi the base of the Paleocene is generally marked by a limestone similar to unit 3, but at this locality the "marl" of unit 2, reworked from the Owl Creek formation, forms the base. Similar relations are seen in cuts along this same valley wall to the latitude of Walnut in Tippah County, Miss.

LOCALITY 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.

Section of the Owl Creek and Clayton formations at locality 41

[After Stephenson and Monroe (1940, p. 235)]

	Feet
Paleocene, Clayton formation:	
Deeply weathered ferruginous sands and clays	48.0
Hard glauconitic, very fossiliferous limestone with brown phosphatic(?) grains larger than the grains of glauconite; small chunks of greensand from the underlying Owl Creek reworked in the base of the limestone; recognized: *Venericardia* sp. and *Turritella* sp	2.0
Unconformity (contact irregular in detail).	
Cretaceous, Owl Creek formation:	
Tough, compact, micaceous, argillaceous sand with marly glauconitic pockets; many fossil species (USGS 9516)	6.0

This section differs from the preceding in that the limestone of the Clayton formation forms the base of the Paleocene.

LOCALITY 42

Roadcuts on Braddocks farm, on south-facing slope of Walnut Creek valley 3.75 miles east-southeast of Falkner, Tippah County, Miss.. NE¼SE¼SE¼ sec. 16, R. 3 S., T. 4 E. USGS 713, T. W. Stanton, 1889; USGS 25421, N. F. Sohl, 1950–51.

Section of the Owl Creek and Clayton formations at locality 42

[After Stephenson and Monroe (1940, p. 233)]

	Feet
Paleocene, Clayton formation:	
Fine to medium glauconitic, ferruginous sand; a line of pebbles composed of the underlying light-brown very fine sand, at the base	24
Unconformity	
Cretaceous, Owl Creek formation:	
Light-brown very micaceous sand	5
Light blue-gray calcareous micaceous argillaceous sand, rich in fossils	9
Yellow sandy calcareous clay	1.5
Limestone	.5
Yellow sandy calcareous clay	.5
Blue-gray calcareous argillaceous very fine sand containing abundant fossil shells; basal foot contains numerous pebbles of concretionary origin that appear to be waterworn (USGS 713 and 25421, loc. 42)	9
Unconformity	
Ripley formation (Keownville limestone member):	
Hard nodular ferruginous, calcareous sandstone, containing echinoids (USGS 17799)	2.0
Reddish-brown fine to coarse sand containing small brown pellets and abundant tubes of *Halymenites major* Lesquereux	6.0

Outcrops of sand of the Owl Creek formation occur on Walnut Creek at several places upstream from the roadcut, and it was from one of these that Stanton made collection USGS 713. The full thickness of the Owl Creek formation as exposed here is only 25.5 feet. This cut is the first appearance noted of the Keownville limestone member, which is absent to the north.

LOCALITY 43

Roadcut on the north-facing slope of Yancey Hill overlooking Owl Creek valley, Tippah County, Miss., NE¼NE¼ sec. 17, T. 4 S., R. 4 E. USGS 26354, N. F. Sohl and H. I. Saunders, 1956.

Section of the Ripley, Owl Creek, and Clayton formations at locality 43

	Feet
Paleocene:	
Clayton(?) formation:	
4. Sand, reddish-brown much weathered in part may be Cretaceous	About 15
Cretaceous:	
Owl Creek formation:	
3. Sand, blue-gray, micaceous, calcareous; fossiliferous; weathers reddish-brown; 2–4 ft of fresh sand exposed in quarry at base of hill and contain numerous specimens of *Exogyra costata* Say (USGS 26354); similar but weathered sand bearing imprints of Owl Creek species occur in the roadcuts on hill slope	50
Unconformity.	
Ripley formation, Keownville limestone member:	
2. Limestone, yellow-brown, sandy, sideritic; fossiliferous: *Cardium* (*Granocardium*) sp., *Trigonia angulicostata* Gabb, *Sphenodiscus* sp., *Hardouinea mortonis* (Michelin) (USGS 26359)	5–6
1. Sand, light-brown, medium-grained, massive, *Halymenites major* Lesquereux	5

This locality was cited by Stephenson and Monroe (1940, p. 233), but no limestone was then evidently exposed. The contact between the Owl Creek and Ripley formations was well exposed in 1956 in a small quarry at the base of the hill, where the top of the Keownville limestone member is seen to undulate several feet vertically on the quarry face. *Trigonia angulicostata* Gabb also is present here in the Keownville.

The thickness of the Owl Creek is greater here than in any other outcrop in the vicinity.

LOCALITY 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.

The 1910 (book 4) field notes of L. W. Stephenson give the following account of the locality: "The bluffs expose about 10 to 20 feet of dark greenish gray, argillaceous, calcareous, glauconitic sand like that at Owl Creek, and contain the same aggregation of fossils. There are exposures at two places a few hundred yards apart."

Collection USGS 6875 came from the Owl Creek formation at one of these exposures. The picture ascribed to Owl Creek by Stephenson and Monroe (1940, p. 231, fig. 47) is not of the type locality as stated, but of this locality on White Oak Creek.

Stephenson (field notes) notes indurated ledges appearing higher on the hill slopes above the creek about one-half of a mile downstream. These ledges may be the basal part of the Clayton formation, which would indicate that this locality is in about the same position as the collections from the type locality (46) on Owl Creek to the south.

LOCALITY 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.

Section of Owl Creek and Clayton formations at locality 45

	Feet
Paleocene, Clayton formation:	
2. Sand, red; much weathered to top of hill	About 30
Cretaceous, Owl Creek formation:	
1. Sand, blue-gray, silty, micaceous, glauconitic, very fossiliferous (USGS 25422)	About 20

LOCALITY 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.

Section of Owl Creek and Clayton formations at locality 46

[After Stephenson and Monroe (1940, p. 232)]

	Feet
Slope concealed by vegetation	8
Paleocene, Clayton formation:	
Weathered red ferruginous sandy clay	4
Greenish-gray micaceous sandy clay weathered yellow and red in places	3
Weathered brown and red more or less argillaceous marine sand	8
Hard fossiliferous sandy limestone	8
Unconformity (sharp contact).	
Cretaceous, Owl Creek formation:	
Dark-greenish-gray fine compact tough massive micaceous calcareous argillaceous slightly glauconitic sand containing large numbers of well-preserved shells, including many genera and species (USGS 541, 546, 594, 707, 6464, 6876, 25423)	16

The above section is representative of the type locality of the Owl Creek formation. This is the classic area from which Spillman collected the specimens described by Conrad in 1858. The basal limestone of the Clayton formation is not present everywhere in the bluffs and may reflect either lenticularity of the limestone or solution. The presence of a basal clayey unit where the limestone is absent lends support to the latter possibility; that is, loss by solution.

In collecting, quarrying is necessary, as the shells on the surface are generally highly weathered. The best collection made here is that of Stanton (USGS 707) made in 1889. Stanton used dynamite to blast marl off the bluffs; this insured exposures and blocks of fresh material.

LOCALITY 47

The section at this Owl Creek locality is described as unit 10 (USGS 25424) locality 11.

LOCALITY 48

Bed of a small stream 100 yd above crossing of old Pontotoc road just north of 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.

This collection, on a lithologic basis, appears to have come from the Owl Creek formation. The adhering matrix is a brownish-gray micaceous silty fossiliferous sand (USGS 8308).

LOCALITY 49

Roadcut on new Mississippi State Route 15 on the north-facing slope of King Creek valley, 2.5 miles south of junction with U. S. Highway 78, Union County, Miss., NW¼NW¼ sec. 29, T. 17 S., R. 3 E. USGS 26088, N. F. Sohl, 1949–53.

Section of Owl Creek and Clayton formations at locality 49

	Feet
Paleocene, Clayton formation:	
6. Sand, red, coarse-grained, highly weathered	15. 0
5. Sandstone, yellow-brown, sideritic, silty, highly calcareous and fossiliferous; fossils replaced by crystalline calcite, which is leached in many places and retains both the external impressions and the internal molds of numerous reworked specimens of Cretaceous genera such as *Liopeplum, Bullopsis,* and *Anchura* (USGS 26088)	3. 0
Unconformity.	
Cretaceous, Owl Creek formation:	
4. Sand, drab-gray, fine-grained, chalky, silty, sparingly micaceous, sideritic, with a few small pockets of bitumen near top of unit; fossiliferous, with fossils preserved as clayey molds: *Baculites* sp., *Discoscaphites,* sp., *Eutrephoceras* sp. common	12
3. Covered	1. 2
2. Sand, brownish-gray, fine-grained, silty, calcareous, micaceous, sideritic; fossiliferous, with internal molds of mollusks common	4. 7
1. Covered to creek bottom, intermittent exposures of road fill in drainage ditch	18

The contact between the Cretaceous and Paleocene is well exposed here. The number of Owl Creek species reworked into the base of the Paleocene here is high, and a similar calcareous sandstone with reworked Cretaceous fossils can be traced all the way to southern Chickasaw County.

LOCALITY 50

Roadcut on old New Albany-Ecru road, 3 miles south of New Albany on north-facing slope of Kings Creek valley, Union County, Miss. USGS 6872, L. W. Stephenson, 1910.

Section of the Owl Creek formation and Keownville member of the Ripley formation at locality 50

[From Stephenson's 1910 (book 3) field notes]

	Feet
Deep-red, weathered ferruginous, argillaceous sand making up face of slope	60
Gray calcareous finely sandy clay with one ledge of harder calcareous sandstone. Contains oval echinoderms, *Exogyra costata, Pecten venustus, Gryphaeostrea vomer*	10

The second unit of the above includes both basal clay of the Owl Creek formation and limestone of the Keownville limestone member. The fossils listed here came from the clay, which is most probably of Owl Creek age (USGS 6872).

LOCALITY 51

Gullies north and south of cut of St. Louis and San Francisco Railroad, just northwest of station at Wallerville, Union County, Miss., NE¼SE¼ sec. 26, T. 7 S. R. 3 E. USGS 9509, L. W. Stephenson, 1910.

This collection (USGS 9509) is from deeply weathered sands of the Owl Creek formation 25–30 feet above track level and some 15 feet above the Prairie Bluff chalk as interpreted by Stephenson and Monroe (1940, p. 236, 237). The locality from which this collection was made by Stephenson in 1910 is now thoroughly overgrown, as is the railroad cut.

LOCALITY 52

Roadcut on old Pontotoc-Houston road, ½–¾ mile south of Pontotoc, Pontotoc County, Miss. USGS 6470, L. W. Stephenson, 1909.

The yellowish-brown chalky silt matrix adhering to the specimens of USGS 6470 is typical of the silty facies assigned to the Owl Creek formation in this area.

LOCALITIES IN THE PRAIRIE BLUFF CHALK

LOCALITY 53

The section of the Prairie Bluff chalk at this locality is described as unit 11 (USGS 25488) under locality 11.

LOCALITY 54

Roadcut on Mississippi State Route 30, 3.3 miles east-northeast of junction of State Route 15, 0.3 mile east of Baker crossroads, Union County, Miss., SE¼SE¼NW¼ sec. 1, T. 7 S., R. 3 E. USGS 25516, L. W. Stephenson and N. F. Sohl, 1955.

Section of the Praire Bluff chalk at locality 54

	Feet
Age indeterminate:	
Residuum, highly weathered reddish-brown sand	7
Prairie Bluff chalk:	
Sand, bluish-gray, calcareous; fossiliferous (USGS 25516): *Exogyra costata* Say, *Ostrea plumosa* Morton, *Ostrea tecticosta* Gabb, *Gryphaeostrea vomer* (Morton), *Gervillia ensiformis* (Conrad), *Lima acutilineata* (Conrad), *Liopistha protexta* (Conrad), *Baculites carinatus* Morton, *Hemiaster weatherbyi* de Loriol, *Hamulus squamosus* Gabb	3

LOCALITY 55

The section for locality 55 is described as unit 2 under locality 25. The collection (USGS 25489) is assigned to the lower part of the Prairie Bluff chalk.

LOCALITY 57

The section for locality 57 is described as units 11 and 12 under locality 38, it is assigned to the Prairie Bluff chalk (USGS 25425).

LOCALITY 58

Roadcuts 5 miles east of Pontotoc on old Tupelo road, 50–60 ft above Bob Miller Creek, Pontotoc County, Miss. USGS 19083, W. H. Monroe, 1938.

This collection (USGS 19083) is from a small isolated outcrop of chalky limestone questionably ascribed by the collector (W. H. Monroe) to the Prairie Bluff chalk.

LOCALITY 59

Exposure along right bank of small creek ⅛–¼ mile south of the Moblie, Jackson, and Kansas City Railroad (now Gulf, Mobile, and Ohio Railroad) station at Pontotoc, Pontotoc County, Miss. USGS 6852, L. W. Stephenson, 1910.

L. W. Stephenson in 1910 collected this material (USGS 6852) from small 10-foot-thick exposures of calcareous gray sandstone which are now obscured by cover but which correspond in position to unit 1 of the section at locality 60.

LOCALITY 60

Cut on the Gulf, Mobile, and Ohio Railroad one-half of a mile south of Pontotoc, Pontotoc County, Miss. USGS 6854, L. W. Stephenson, 1910.

Section of the Prairie Bluff chalk and Owl Creek and Clayton formations at locality 60

[From Stephenson and Monroe (1940, p. 224)]

	Feet
Clayton formation:	
5. Weathered deep-red ferruginous sand becoming brownish below, and grading into the grayish sand of the underlying bed; fossils: *Venericardia* sp. cf. *V. smithi* Aldrich, *Mesalia pumila* Gabb?, *Enclimatoceras* sp. etc	25
4. Laminated sand and clay, the sand predominating, forming a slightly projecting ledge	4

Section of the Prairie Bluff chalk and Owl Creek and Clayton formations at locality 60—Continued

	Feet
Clayton formation—Continued	
3. Coarse yellowish glauconitic sand with numerous extremely soft shells preserved as clay replacements, interpreted to have been mechanically derived from the underlying Owl Creek formation, though they show only slight indication of having been waterworn; the following were recognized: *Glycymeris* sp., *Crassatella ripleyana* Conrad , *Cardium tippanum* Conrad, *Turritella* n. sp. (= *T. bilira*), *Pugnellus densatus* Conrad?, and *Liopeplum canalis* (Conrad). In the lower foot are numerous mechanically derived chunks of gray argillaceous sand and sandy clay, probably representing a basal Paleocene conglomerate	3.5
Unconformity (obscured by weathering and marked only by a line of clay boulders).	
Owl Creek formation:	
2. Mottled grayish to purplish massive glauconitic sand containing poorly preserved tubes of *Halymenites major* Lesquereux; about midway of this layer in the middle of the cut several feet of the sand, poorly exposed, is indurated to calcareous fossiliferous sandstone, containing *Ostrea tecticosta* Gabb, *Exogyra costata* Say, *Gryhaeostrea vomer* (Morton), and *Pecten simplicius* Conrad	25
Prairie Bluff chalk (sandy facies):	
1. Gray calcareous glauconitic sandstone, the top exposed at one place in the north end of the cut, but appearing in several places in the lower slopes of the branch valley north of the cut; contains many specimens of echinoids of several species, and other fossils	10

When visited by the author in 1951 this cut was obscured by slump and vegetation.

LOCALITY 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. F. Sohl, 1951.

Section of the Prairie Bluff chalk and Clayton formation at locality 61

	Feet
Paleocene, Clayton formation:	
5. Sand, yellow to red, with a few beds of blue-gray clay	37±
Cretaceous or Paleocene:	
4. Covered; weathered sand and soil	45
Cretaceous, Prairie Bluff chalk:	
3. Chalk, yellowish, silty, glauconitic, micaceous	3
2. Chalk, blue-gray (like unit 13 section at loc. 38), silty, glauconitic, sparingly micaceous; fossiliferous, with *Baculites* sp. (USGS 25426)	15
1. Covered from bridge level to base of unit 2. Blue chalky silt exposed in drainage ditch but is evidently road fill. Several large limestone slump blocks occur on slopes west of road, and smaller float blocks of similar material in ditches indicate presence of Keownville limestone member in this unit	15.5

LOCALITY 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.

This is a small roadside exposures of lower Prairie Bluff chalk containing phosphatic internal molds of mollusks (USGS 19064).

LOCALITY 63

Roadcut 2.25 miles (airline) northeast of Houlka, Chickasaw County, Miss., NW¼ sec. 4, T. 12 N., R. 3 E. USGS 25427, N. F. Sohl, 1951.

Section of the Prairie Bluff chalk and the Clayton formation locality 63

	Feet
Paleocene, Clayton formation:	
8. Sand, red; undifferentiated and much weathered to top of hill about	30
7. Silt, weathered red, thin-bedded, sandy, micaceous, with hematite(?) grains	2.1
6. Silt, bluish-gray to buff, calcareous, massive; sand fraction fine-grained; some poorly indurated spherical ferruginous concretions	5.8
5. Clay, yellow, thin-bedded, iron-stained, micaceous, silty, noncalcareous; contains a few smut streaks and pieces of lignitized wood	8
4. Sand, yellow, medium- to coarse-grained, poorly sorted, silty, sideritic, with irregular bedding; lenticular beds of limestone to 4 feet thick occur in unit and contain unidentifiable fossil fragments	4–6
Unconformity.	
Cretaceous, Prairie Bluff chalk:	
3. Silt, blue-gray, chalky, clayey, sandy, micaceous, calcareous, glauconitic; fossiliferous: *Baculites* sp., *Ostrea tecticosta* Gabb, and internal molds of gastropods	5
2. Chalk, blue-gray, silty, clayey; fossiliferous. *Exogyra costata* Say, *Ostrea tecticosta* Gabb, phosphatic internal molds of mollusks (USGS 25427)	17.5
1. Covered to flood plain.	

LOCALITY 64

Roadcut 5.5 miles south-southeast of Houlka, Chickasaw County, Miss., southeast corner sec. 3, T. 13 S, R. 3 E. USGS 17215, W. H. Monroe, 1936.

This is a small roadside exposure of chalk of the lower part of the Prairie Bluff chalk, containing phosphatic internal molds of numerous mollusks (USGS 17215).

LOCALITY 65

Washes in a field just northwest of abandoned Gulf, Mobile, and Ohio Railroad track, 1.25 miles northeast of Houston, Chickasaw County, Miss. USGS 6849, L. W. Stephenson, 1910.

Stephenson in his field notes of 1910 states that this collection (USGS 6849) came from 15 feet of chalky limestone of the Prairie Bluff chalk. The fossils are primarily preserved as phosphatic internal molds, but *Exogyra costata* Say, *Gryphaeostrea vomer* Morton, *Ostrea plumosa* Morton, *O. tecticosta* Gabb, and *Anomia argentaria* Morton all occur well preserved.

LOCALITY 66

Bluffs of Houlka Creek 0.5 mile (?) east of Houston, Chickasaw County, Miss. USGS 612, T. W. Stanton, 1889.

Stanton made this collection (USGS 612) in 1889 and in his field notes states:

> On Houlka Creek, ½ mile east of Houston and down the creek for a mile there is an exposure of light gray and yellowish clays about 30 or 40 feet thick. Fossils are very numerous especially *Exogyra costata* and *Gryhaea vesicularis?* weathered out on the slopes but nearly all, excepting the Ostraeidae, are in the form of internal molds.

The presence of numerous internal molds is typical of the Prairie Bluff chalk, exposures of which are common in the vicinity. The "clays" may have been weathered chalk.

LOCALITY 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.

This collection (USGS 8306) is approximately from the same position as the preceding in the Prairie Bluff chalk and contains phosphatic internal molds.

LOCALITY 68

Roadcut on east-facing slope of Socktahoomak Creek (Houlka Creek?) on the Houston–Buena Vista road (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.

This collection (USGS 6473) has been assigned to the Ripley formation by Stephenson and Monroe (1940, p. 198) but bears phosphatic molds and a fauna much more typical of the chalk facies of the Prairie Bluff.

LOCALITY 69

Cut on the Gulf, Mobile, and Ohio Railroad (formerly Mobile, Jackson, and Kansas City Railroad), 1 mile south of Houston, Chickasaw County, Miss. USGS 4053, A. F. Crider, 1907.

No stratigraphic information accompanied the collection, but it is believed to have come from the basal part of the Midway group containing reworked Cretaceous fossils. The fossils are contained in a calcareous coarse-grained sandstone reminiscent of the lower limestone of the Clayton formation south of New Albany in Union County. Fossils noted are *Cardium* sp., *Ostrea pulaskensis* Harris?, *Crenella serica* Conrad, *Turritella bilira* Stephenson, *Anchura* spp.

LOCALITY 70

Roadcut on Mississippi State Route 15, 1.5 miles south of Houston, Chickasaw County, Miss. USGS 6474, L. W. Stephenson, 1910.

Small roadside exposures of the Prairie Bluff chalk with the typical oyster assemblage of the chalk facies, and phosphatic internal molds of mollusks.

LOCALITY 71

Roadcuts and bald spots on north-facing hill slopes of Cane Creek valley, just 100 to 250 yd east of Mississippi State Route 389, 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.

This collection (USGS 25428) comes from light- to blue-gray silty chalk with *Diploschiza melleni* Stephenson and a great abundance and wide variety of phosphatic internal molds of mollusks. Stephenson and Monroe (1940, p. 219) measured a section along the road to the west of these bald spots that exposed almost 70 feet of the Prairie Bluff chalk, but this section was for the most part obscured when visited by the author. Collection USGS 25428 came from chalks which are probably equivalent in position to the lower units of Stephenson and Monroe's section. This locality has yielded 88 species of mollusks, not including many other indeterminate gastropod and pelecypod molds as well as echinoid, bryozoan, and sponge remains and is the most prolific of the localities yet found in the Prairie Bluff in Mississippi.

LOCALITY 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.

Section of the Ripley formation and Prairie Bluff chalk at locality 72

	Feet
Prairie Bluff chalk:	
3. Residual red sands grading down into chalk	
2. Chalk, buff to gray, sandy, silty, fossiliferous, with phosphatic internal molds and pebbles, *Exogyra costata* Say and *Gryphaea mutabilis* Morton common (USGS 25449)	10. 3
Unconformity (slightly uneven surface).	
Ripley formation:	
1. Sand, white, medium- to fine-grained, angular, very micaceous; locally ferruginous and more indurated forming slight ledges in gully	35. 7

LOCALITY 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.

Section of the Ripley formation and Prairie Bluff chalk at locality 73

	Feet
Prairie Bluff chalk:	
8. Residual sand and soil grading down into chalk	5. 0
7. Chalk, buff- to very light-gray, weathered at top to sandy clay; very fossiliferous, with numerous phosphatic internal molds of mollusks and well-preserved oysters	10. 3
6. Silt, buff, chalky; sparingly fossiliferous; *Exogyra costata* Say, *Gryphaea mutabilis* Morton	8. 2
5. Chalk, blue-gray, massive, sandy, silty; fossiliferous, *Gryphaea mutabilis* Morton, *Eutrephoceras perlatus* (Morton) (USGS 25430)	16. 0
4. Sand, iron-stained red	1. 2
3. Sand, yellow, slightly micaceous	. 6
2. Sand, yellowish-brown (weathered chalk), mottled, becoming yellower upward	1. 0
Prairie Bluff chalk or Ripley formation:	
1. Sand, brown, silty, weathered to bridge level	5. 0

LOCALITY 74

Roadcut and gullies on hillside slope east of a tributary of Standing Reed Creek, 1.5 miles northwest of Montpelier, Clay County, Miss., sec. 5, T. 16 S., R. 4 E. USGS 25431, N. F. Sohl, 1951.

Section of the Prairie Bluff chalk at locality 74

	Feet
5. Soil, to top of hill	4. 0
4. Clay, tan, sandy, glauconitic, jointed, mottled (weathered chalk?)	15. 4
3. Clay, gray, very sandy, fossiliferous	3. 4
2. Chalk, gray-blue, sandy, glauconitic; fossiliferous, (USGS 25431) with numerous phosphatic internal molds	23. 6
1. Alluvium	8. 0

LOCALITY 75

Roadcut east 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.

The roadcut reveals 20 feet of blue-gray fossiliferous chalk containing numerous phosphatic internal molds of mollusks (USGS 25432). Both the geographic position and the abundance of internal molds is indicative of the lower part of the Prairie Bluff chalk.

LOCALITY 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.

Section of Ripley formation and Prairie Bluff chalk at locality 76

[From Stephenson and Monroe (1940, p. 218)]

	Feet
Prairie Bluff chalk:	
Brown sandy clay (residual from chalk)	11
Fine sandy argillaceous chalk containing many phosphatic molds of mollusks; the chalk becomes much more sandy near the base where phosphatic molds are especially abundant (coll. 17228)	13
Unconformity (sharp change in lithology).	
Ripley formation:	
Highly crossbedded very micaceous fine to medium sand	33

LOCALITY 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.

Section of the Prairie Bluff chalk at locality 77

	Feet
Chalk, light-gray, very silty, with some fine sand, glauconitic, sparingly micaceous, fossiliferous, with abundant phosphatic internal molds of mollusks (USGS 25433)	27

LOCALITY 78

Roadcut on Montpelier road 4.5 miles northeast of Cedar Bluff, Clay County, Miss. USGS 6861, L. W. Stephenson, 1910.

Stephenson made this collection from 10 feet of chalky sandy glauconitic clay of the Prairie Bluff chalk. Besides the typical oyster assemblage common to the chalk facies and the accompanying phosphatic internal molds, the diagnostic brachipod *Terebratulina? floridana* (Morton) also occurs here. The outcrop is now obscured by vegetation.

LOCALITY 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.

W. H. Monroe made this collection (USGS 17225) in 1936. Subsequent visits in 1951 and 1955 by the author have failed to locate the section, and it is now most probably covered. Stephenson and Monroe (1940, p. 208) listed the fauna from the locality, and although it includes no diagnostic forms the occurrence is within the outcrop belt of the Prairie Bluff chalk. Most likely the collection is from the upper part of the formation.

LOCALITY 80

Gullies and bald spots on northwest-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.

Collection USGS 25434 was made from small exposures of chalk along a field road and in small adjoining gullies where phosphatic internal molds had weathered out in profusion. Only a few feet of the typical silty blue-gray Prairie Bluff chalk is exposed.

LOCALITY 81

Gullies on Aikin farm about 2⅓ miles north of Starkville, Oktibbeha County, Miss. USGS 6845, L. W. Stephenson, 1910.

Stephenson made collection USGS 6845 in 1910 from gullies exposing typical blue-gray silty Prairie Bluff chalk south of the Starkville-Houston road.

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.

This collection was made from hillside bald spots exposing 30 feet of typical blue-gray silty Prairie Bluff chalk. All but the ostreids are preserved as phosphatic internal molds.

LOCALITY 83

Roadcut at crossroads 3.7 miles (airline) north of Starkville, Oktibbeha County, Miss., NW¼SW¼NW¼ sec. 14, T. 19 N., R. 14 E. USGS 25436, N. F. Sohl, 1951.

Section of the Prairie Bluff chalk at locality 83

	Feet
1. Chalk, blue-gray, sandy, silty, micaceous; fossiliferous, with phosphatic internal molds of mollusks and a typical chalk-facies oyster assemblage (USGS 25436)	10

LOCALITY 84

Gullies near Starkville-Osborn road about 3 miles northeast of Starkville, Oktibbeha County, Miss. USGS 6846, L. W. Stephenson, 1910.

This collection (USGS 6846) is from the lower sandy chalks of the Prairie Bluff which overlie the chalky sand of the Ripley formation.

LOCALITY 85

Roadcut one-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.

Section of the Prairie Bluff chalk at locality 85

	Feet
Age indeterminate:	
3. Residuum, red-brown, sandy; grades upward to soil	1.5
Prairie Bluff(?) chalk:	
2. Chalk, gray, very sandy, and chalky sandstone, with an oyster bed about 26 ft below top and *Exogyra costata* Say scattered throughout. (USGS 25437)	32.0
1. Covered slope.	

This locality is near, if not at, the locality where Stephenson and Monroe (1940, p. 202) noted the Ripley formation cropping out on the hill slopes. The section quoted in their publication was visited by Stephenson in 1910, and the lower slopes are now covered.

LOCALITY 86

Roadcut in Prairie Bluff chalk 1.5 miles east of Mississippi State College at Starkville, Oktibbeha County, Miss. USGS 495, L. C. Johnson, 1889.

LOCALITY 87

Gullies on grounds of Mississippi State College, Oktibbeha County, Miss. USGS 3186, A. F. Crider, 1903; USGS 6843, W. N. Logan, 1910; USGS 6844, L. W. Stephenson, 1910.

Collections USGS 3186, 6843, and 6844 were made from sandy silty chalks of the lower Prairie Bluff in gullies between 1.5 and 2.0 miles east of Starkville, on the campus of Mississippi State College. The slopes on which these gullies occurred are now overgrown. Stephenson's field notes (1910) indicate that sands of the Ripley formation occur within 0.25 mile east of the gullies and underlie the chalk.

LOCALITY 88

Bald spots at road intersection just north of Salem 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.

Section of the Demopolis chalk, Ripley formation, and Prairie Bluff chalk at locality 88

	Feet
Prairie Bluff chalk:	
8. Chalk, blue-gray, sandy, silty; fossiliferous, with abundant phosphatic internal molds and *Diploschiza melleni* Stephenson (USGS 25438)	12. 0
7. Covered (includes part of the Ripley), soils, reddish-brown with limy nodules	15. 0
Ripley formation:	
6. Sand, gray, tan-weathering, silty; probably same as unit 5 but more weathered; one sandstone unit forms a bench in road and on hill slope at about 15 ft above base	15. 5
5. Clay, gray, sandy, silty, micaceous, calcareous, glauconitic; sandier parts become lithified to ledge-forming units 3–5 in. thick	12. 3
4. Covered	3. 0
3. Sand, tan, fine-grained, thin-bedded, micaceous	5. 0
2. Chalk, blue-gray, silty, containing marcasite, *Exogyra costata* Stephenson	6. 0±
Demopolis chalk (Bluffport marl member?):	
1. Chalk, blue-gray, silty, with marcasite concretions; fossiliferous: *Exogyra cancellata* Stephenson, *Anomia argentaria* Morton	17. 7

The full thickness of the Ripley formation is present here and is reminiscent of the Ripley north of Starkville but becomes chalkier to the south. The base of the formation is chosen arbitrarily at the uppermost occurrence of *E. cancellata.*

LOCALITY 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.

This collection definitely belongs in the Prairie Bluff chalk, but no additional stratigraphic information is available.

LOCALITY 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.

This collection (USGS 17242) came from bald spots on hill slopes south of Dry Creek. Stephenson and Monroe (1940, p. 213) stated:

> Fifteen feet of Selma is overlain by 25 feet of Prairie Bluff which is characterized by abundant glauconite . . . . The unconformity is characterized by reworked fragments of Selma in the basal part of the Prairie Bluff and by borings as deep as 3½ feet in the Selma, filled with glauconitic chalk of the Prairie Bluff.

The Selma referred to above is equivalent to the chalk facies of the Ripley formation as used in this report.

LOCALITY 91

Cuts on U. S. Highway 45, 0.6 mile south of Running Water Creek, 5 miles due south of Noxubee River Bridge, Noxubee County, Miss. USGS 6479, L. W. Stephenson, 1909; USGS 17210, L. W. Stephenson and W. H. Monroe, 1936.

Section of the Demopolis chalk, Ripley formation, and Prairie Bluff chalk at locality 91

[Modified from Stephenson and Monroe (1940, p. 115)]

	Feet
Prairie Bluff chalk:	
5. Chalk, blue-gray, hard, brittle, silty, becoming sandy upward; fossiliferous, with numerous phosphatic internal molds (USGS 6479, 17210)	17
4. Limestone, white, argillaceous, sandy	1
Unconformity.	
Ripley formation:	
3. Chalk, blue-gray, silty, sandy; phosphatic internal molds near base	47
2. Chalk, blue-gray to white, argillaceous, fossiliferous	8
Demopolis chalk, Bluffport marl member:	
1. Chalk, bluish-gray to white, silty; fossiliferous: *Exogyra cancellata* Stephenson	28

The thin and chalky nature of the Ripley formation is well displayed in this section. When visited by the author, only intermittent outcrops were visible.

LOCALITY 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.

Section of the Prairie Bluff chalk at locality 92

	Feet
1. Chalk, blue-gray to light-gray, silty, glauconitic; fossiliferous in lower part (USGS 25439)	35

The base of the roadcut is in the lower part of the Prairie Bluff chalk.

LOCALITY 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.

The fossil assemblage represented in collection USGS 17430 is typical of the Prairie Bluff chalk and

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similar to that of locality 94 and probably represents about the same level as unit 4 of that locality.

LOCALITY 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.

Section of the Demopolis chalk, Ripley formation, Prairie Bluff chalk, and Porters Creek(?) clay at locality 94

	Feet
Paleocene:	
Porters Creek(?) clay:	
5. Clay, gray, grading upward to reddish-brown clayey soil	8
Cretaceous:	
Prairie Bluff chalk:	
4. Chalk, blue-gray, silty, sparingly micaceous and sandy, glauconitic, with marcasite nodules; fossiliferous, with oysters found throughout but phosphatic molds concentrated near the top (USGS 25440); chalk weathers light gray tan and is massive; locally, pockets of coarse sand appear that may be fillings of borings; chalk shattered by joints and small faults, with chalk leached adjacent to ruptures to a buff and veins of slickensided selenite filling the void	44.2
Unconformity.	
Ripley formation:	
3. Chalk, tan, very sandy and silty; poorly exposed	25.9
2. Chalk, blue-gray, very sandy and silty, micaceous; fossiliferous: *Exogyra costata* Say, *Gryphaea mutabilis* Morton	38.0
Demopolis chalk; Bluffport marl member:	
1. Chalk, blue-gray like unit 2; becomes less sandy downward and contains *Exogyra cancellata* Stephenson	12.0

The lowest exposure of the above section is in the bed of the creek.

The thicknesses of the units here agree with those to the north and with those in Alabama, but the displacement of part of the section by faulting cannot be overlooked.

LOCALITY 95

Lacy Ford Road, 3,000 ft south of State road to Gainsville and 2.5 miles east of Scooba, Kemper County, Miss. USGS 8307, C. W. Cooke, 1912.

This locality and the following locality 96 are typical of the small bald spots which abound in the region. Generally only a few feet of silty chalk is exposed (USGS 8307).

LOCALITY 96

Scooba-Giles road 3 miles east of Scooba, Kemper County, Miss. USGS 6835, L. W. Stephenson, 1910.

Small roadside exposure of the Prairie Bluff chalk like that of locality 95 (USGS 6835).

PALEONTOLOGY

The classification of the class Gastropoda used in the following descriptions is that of Knight, Batten, and Yochelson (1954). The sequence of treatment on the familial level is modified from Wenz (1938–44).

Descriptions of species are uniformly arranged under the following subheadings:

Diagnosis.—A short summation of the primary distinguishing features of the species.

Description.—A detailed description of the character of the species. This section has been used where a new form is described, where a species was originally incompletely or poorly described or where a redescription is necessary in the light of additional information which will change the concept of the species.

Measurements.—An attempt at indicating the range of variability of the species as defined. No attempt was made at a full statistical treatment.

Discussion.—Includes pertinent information as to variation, stratigraphic range, geographic distribution, and comparisons with other species.

Types: Type specimens and their repositories are listed. The following abbreviations are used: USNM, U.S. National Museum; ANSP, Academy of Natural Sciences of Philadelphia; AMNH—American Museum of Natural History.

Occurrences: The geographic and stratigraphic distribution of the species discussed is given. The numbers given (1–96) refer to localities described in the section "Collection localities," in the distribution table, in figure 4 (the distribution map), and on plate 3. Occasionally the abbreviation USGS Mesozoic colln. is used, which refers to the Mesozoic locality register of the U.S. Geological Survey.

The distribution and abundance of the individual species in Mississippi and Tennessee is summarized in chart form on plate 3 by formation, and locality. The number of specimens found at each locality is listed. The specific number of specimens was used rather than the conventional symbols for abundant, common, and rare to give a more accurate idea of the size of the collection.

PROPOSED NEW GENERA AND SUBGENERA

The following are the proposed new genera and subgenera.

Calliomphalus (Planolateralus)
Dircella
Lemniscolittorina
Graciliala
Arrhoges (Latiala)
Tintorium
Mathilda (Echinimathilda)

PROPOSED NEW SPECIES AND SUBSPECIES

The following are the proposed new species and subspecies.

Acmaea galea
Calliomphalus nudus
(Planolateralus) decoris
angustus
conanti
argenteus spinosus
Teinostoma clara
Damesia keownvillensis
Pseudomalaxis? stantoni
Turritella hilgardi
chalybeatensis
Turboella tallahatchiensis
crebricostata
Trichotropis mississippiensis
Capulus monroei
Pterocerella pontotocensis
Polinices kummeli
Plesiotriton cretaceus
Mathilda (Echinimathilda) corona
(Echinimathilda) unionensis
Promathilda (Clathrobaculus) parvula
Acrocoelum? cereum
Gegania bella prodiga

CHANGES IN GENERIC OR SPECIFIC ASSIGNMENTS

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

Old assignment	*New assignment*
Anisomyon weiseri Wade	*Siphonaria*
Straparolus lapidosa Gabb [not Morton]	*Weeksia deplanata* (Johnson)
Garramites Stephenson	*Calliomphalus (Calliomphalus)*
Garramites nitida Stephenson	*Calliomphalus (Calliomphalus)*
Solarium karapudiense Stoliczka	*Calliomphalus (Calliomphalus)*
Calliomphalus bellulus Stephenson	*Calliomphalus (C.) americanus* Wade
Solarium arcotense Stoliczka	*Pseudomalaxis*
Scalaria cretacea deBoury	*Urceolabrum*
Pseudomalaxis ripleyana Wade (in part)	*Pseudomalaxis pilsbryi* Harbison
Vermicularia (Laxispira) gabbi Wenz	*Laxispira lumbricalis* Wade
Turritella winchelli Shumard	*Turritella tippana* Conrad
Turritella paravertebroides Gardner? of Wade	*Turritella vertebroides* Morton
Turbonilla (Chemnitzia) corona Conrad	*Trobus*
Turbonilla (Chemnitzia) spillmani Conrad	*Dircella*
Turbonilla (Chemnitzia?) coalvillensis Meek	*Dircella*
Cerithium percostatum Wade	*"Claviscala"*
Cerithium simpsonensis Stephenson	*Cerithium semirugatum* Wade
Cerithiopsis meeki Wade	*Seila*
Cerithiopsis quadrilirata Wade	*Seila*
Littorina berryi Wade	*Lemniscolittorina*
Mesostoma costatum Wade	*Turboella*
Mesostoma americanum Wade	*Cerithioderma?*
Anchura (Drepanochilus) calcaris Wade	*Graciliala*
Anchura decemlirata Conrad	*Graciliala*
Anchura johnsoni Stephenson	*Graciliala*
Anchura? campbelli Stephenson	*Graciliala*
Anchura? caddoensis Stephenson	*Graciliala calcaris* (Wade)
Anchura solitaria Whitfield	*Graciliala*
Anchura prolabiata White	*Arrhoges*
Lispodesthes schlotheimi Roemer	*Arrhoges*
Anchura lobata Wade	*Arrhoges (Latiala)*
Anchura? elegans Stephenson	*Arrhoges (Latiala)*
Anchura? plenocosta Stephenson	*Arrhoges (Latiala)*
?*Anchura cibolensis* Stephenson	*Arrhoges (Latiala)*
Anchura rostrata (Gabb) of Weller	*Arrhoges (Latiala)*
Alaria papilionacea Goldfuss of Stoliczka	*Arrhoges (Latiala)*
Dicroloma (Perissoptera) bailyi (R. Etheridge) of Rennie	*Arrhoges (Latiala)*
Drepanochilus? davisi Stephenson	*Anchura*
Drepanochilus? martini Stephenson	*Anchura*
Anchura? lynnensis Stephenson	*Graphidula?*
Anchura? cooki Stephenson	*Graciliala?*
Pugnellus typicus Gabb	*Pugnellus (Pugnellus) densatus* Conrad
Pugnellus abnormalis Wade	*Pugnellus (Gymnarus)*
Pugnellus calcaris Stephenson	*Pugnellus (Gymnarus)*
Pugnellus robustus Stephenson	*Pugnellus (Pugnellus) goldmani* Gardner
Pugnellus levis Stephenson	*Pugnellus (Gymnarus) abnormalis* Wade

Old assignment	*New assignment*
Gyrodes supraplicatus (Conrad) of Stephenson (1923, in part)	*Gyrodes major* Wade
Gyrodes crenata Conrad of Wade	*Gyrodes major* Wade
Gyrodes petrosus (Morton) of Gardner	*Gyrodes americanus* (Wade)
Mammilla americana Wade	*Gyrodes*
Gyrodes subcarinatus Stephenson	*Gyrodes americana* (Wade)
Natica rectilabrum Conrad	*Euspira*
Lunatia carolinensis Stephenson	*Euspira rectilabrum* (Conrad)
Lunatia wadei Cossmann	*Euspira rectilabrum* (Conrad)
Lunatia concinna (Hall and Meek)	*Euspira*
Polinices umbilica Wade	*Globularia* (*Ampullella*)
Polinices stephensoni Wade	*Amaurellina*
Amauropsis lirata Wade	*Pseudamaura*
Ampullospira stantoni Cossmann	*Pseudamaura*
Tritonium univaricosum Wade	*Charonia*
Tuba parabella Wade	*Gegania*
Tuba bella Conrad	*Gegania*
Tuba? manzanetti Stephenson	*Gegania*

DEFINITION 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 axial elements of similar strength.
Carina—A strong spiral ridge which in many specimens forms a whorl angulation (synonymous with keel as here used).
Channeled suture—Suture in a trough.
Colabral—Ornament trending with path of growth lines.
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—Partly plugged umbilicus.
Holocline—Growth lines that are essentially vertical between the sutures.
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 (adaperturally) from upper suture to lower suture.
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 which slope backward (abaperturally) from upper 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 angulation.
Reflected—Inner lip or part thereof which 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, which seals off early whorls from the later whorls.
Shoulder—Flattened band on upper whorl surface lacking the inclination of a ramp and limited by the shoulder angulation.
Sinus—Abapertural curve of the outerlip 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 marked by flexed growth lines marking previous position of anterior siphonal notch.
Teloconch—Shell exclusive of protoconch.
Thread—Very fine elements of ornament.
Turreted—Whorls of spire rising in steps.
Turriculate—(=Turrited)—acute spire generally flat sided.
Window—Circular holes in the shell webbing between outer lip digitations of certain species of *Pterocerella*.

MEASUREMENTS OF SPECIMENS

Measurements of individual specimens are given under a sideheading in each of 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 crushed or distorted specimens had to be used. Such specimens are noted under "Discussions." All measurements are given in millimeters. Larger specimens were measured with vernier callipers, and the smaller forms were measured with the aid of a microscope with a calibrated eyepiece.

The features measured vary with the individual groups. For instance, the Apporhaidae 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 normal or less complex group. Thus, where deemed important or informative, certain additional characters are measured.

Below are listed the abbreviations used as headings of the column of measurements and their definitions.

D—Diamter, 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.
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.
H4W—Height of fourth whorl.
HB—Height of body whorl.
HS—Height of spire.
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.
PW—Penultimate whorl.
WA—Width of aperture.
WS—Width of shoulder, measured from suture to shoulder edge.

PRESERVATION OF SHELLS

A wide variety of fossil preservation is present in the rocks dealt with here.

In the chalks only the oysters, pectens, and such genera as *Anomia* and *Epitonium* preserve their shell structure. The other shells are represented only by phosphatic internal molds. In a few specimens, parts of the shells have been replaced by calcite. Because of such preservation, identification of both gastropods and pelecypods has been very difficult. Therefore the faunal list of the Prairie Bluff chalk is not an accurate representation of the fauna.

The Keownville limestone member of the Ripley formation bears well-preserved species of echinoids and oysters. Other species are generally preserved only as internal or external molds, but a few weathered surfaces, especially where less sandy, bear specimens, replaced by calcite, standing out in relief.

Replacement of shell material by marcasite is not uncommon in the less consolidated material, and such replacement appears to show a preference for the cephalopods.

Less common but none the less noteworthy is the occurrence of shells replaced by beidellite (Ross and Stephenson, 1939; Stephenson, 1939) in the reworked basal beds of the Clayton formation of Pontotoc County. The clay has so perfectly replaced the calcite or aragonite that the shell structure is retained.

Most of the fossils collected came from the black to blue-gray silty and clayey micaceous glauconitic calcareous sand units of the Ripley and Owl Creek formations. These units contain a variable amount of clay, and many times have been erroneously called marls. The specimens in such rocks retain their original structure and commonly color markings, and their state of preservation rivals that of the best Tertiary specimens. Conrad (1858, p. 323) described the preservation of specimens in glowing terms:

> The appearance of these shells is like that of Eocene species which have merely lost their animal matter. The fossils are imbedded in a sandy marl of a dark gray color, the principle constituents of which are fine scales of mica and grains of quartz mixed with fragments of small shells; and though some of the very thin species are distorted the stronger retain their original shapes and are very nearly perfect. Species of *Crassatella*, *Nucula*, and *Meretrix* have the valves united as in life. The external sculpture of all is as sharply defined as in existing species. There are also specimens of *Baculites* and *Scaphites* which exhibit the interior divested of all extraneous matter, and delight the eye with exquisite curves of the foliated septa, whilst the shells glow with brilliant irridescent tints.

In some specimens the shell material has been somewhat altered, and the specimens are extremely fragile. Such fragility appears to be proportional to the porosity and permeability of the matrix. Where the silt and clay content is high, preservation is best. The clay evidently decreases the permeability of the percolating ground waters and acts as a seal. This sort of rock is most common in the lower part of the Ripley formation at such localities as Coon Creek in Tennessee. Wade (1926, p. 10, 11) discussed preservation of the fossils at this locality. Here, as at Owl Creek in Mississippi, in a few specimens even the ligament of such pelecypods as *Idonearca* is preserved.

METHODS OF COLLECTION AND PREPARATION

Fossils occur in three major rock types: unconsolidated sand, limestone, and chalk.

In the chalk the fossils occur primarily as phosphatic internal molds which readily weather from the chalk and present little, if any, problem, as they can be collected in abundance on the surface of the many chalk bald spots that occur on the hillslopes and in meadows. Similarly, little trouble is encountered in collecting from the limestone, where a hammer and chisel are all the equipment that is necessary to collect slabs, on the surfaces of which the specimens weather out in relief. On the other hand, much care is needed in collecting the fragile specimens from the unconsolidated sand units of the Ripley and Owl Creek formations. Two methods were used in collecting from the latter. The first was to collect large blocks of "marl," which were shipped intact for working on in the laboratory. Blocks as much as 2 by 1½ by 1 feet were quarried out with pick, hammer, and thin table-knife blades, which were found to be excellent for use as wedges. Such blades are thin enough that they cause little breakage of blocks during the quarrying. Individual specimens exposed on the weathered face were worked out with stiff-bladed knives. If specimens showed evidence of cracking, considerable adhering matrix was taken with the specimen for support. Once removed, a few specimens broke when they dried out, but on some, clear acrylac spray was applied to the surface for additional support. L. W. Stephenson (1953, oral communication), when collecting, allowed such small blocks to dry thoroughly then immersed them in a glue solution. The glue permeates the surface and when dry gives a hard surface for shipment. A similar procedure can be followed using an alvar solution, but the specimens should be thoroughly dried before immersion.

In the laboratory the specimens can be worked from the blocks by brush and needle, occasionally loosening the matrix with water. Cleaned parts were hardened with an alvar solution as cleaning progressed to prevent breakage and facilitate handling. Wade (1926, p. 11) described a hardening procedure involving immersion of the cleaned specimens in boiling paraffin. This method, however, darkens the shells and tends to build up wax on the surface, which may obscure the finer features of the ornament. Both these disadvantages are circumvented by using alvar. It was necessary to remove the paraffin from many of his types in order to clean the apertures. This was accomplished by boiling in acetone, but there are perhaps more effective organic agents, such as benzene.

The large blocks collected in the field were especially valuable because they yielded the smaller species, which are abundant. The blocks were placed on a large screen in a tub of water. Water was usually sufficient to cause breakdown of the blocks, but small amounts of sodium or other hydroxides added to the water aided in breaking some of the more stubborn blocks. The larger specimens can be picked out as the block breaks down, and breakage thus kept to a minimum. After drying, the residue was examined under the microscope and smaller specimens were picked out with a brush. After separation the smaller specimens were boiled in a very weak solution of hydrogen peroxide to remove adhering clay and mica particles. Too strong a solution of hydrogen peroxide will cause corrosion. After drying, an alvar solution was again applied for hardening of the specimens, which were mounted on a micropaleontologic slide.

SYSTEMATIC DESCRIPTIONS

Class GASTROPODA
Superorder PROSOBRANCHIA
Order ARCHEOGASTROPODA
Superfamily EUOMPHALACEA

Family EUOMPHALIDAE

Although several genera occurring in the Late Cretaceous of the Gulf Coastal Plain have been assigned to the Euomphalidae, none of these belong in that family, and only *Weeksia* Stephenson appears to belong—in the superfamily Euomphalacea. Of the other genera commonly placed here, *Pseudomalaxis* Fischer is an architectonid, and *Hippocampoides* Wade is a magilinid related to *Latiaxis*, but as defined by Wade (1926, p. 175) it encompasses more than one genus.

Family WEEKSIIDAE, new family

Diagnosis.—Peripherally biangulated discoidal gastropods with simple protoconchs; ornament usually poorly developed, except at the whorl angulations; growth lines prosocline on upper whorl surface and form broad sinus in interangulation area.

Discussion.—Three Mesozoic genera *Weeksia* Stephenson, *Discohelix* Dunker, and *Amphitomaria* Koken form a well-knit group differing from typical euomphalids in important features of the growth lines. In the Euomphalidae, as typified by *Euomphalus pentangulatus* Sowerby, the growth lines are sigmoidal in trend over the whorl sides and in other genera are decidedly sinuous on the upper whorl surface. In *Weeksia* the growth lines are slightly arcuate and prosocline on the upper whorl surface and are not sigmoidal but bear a shallow to moderately deep sinus in the interangulation area. Similar differences obtain for the Omphalotrochidae as exemplified by *Omphalotrochus whitneyi* Meek, which develop a sinus in the upper part of the outer lip.

Relationship with the Euomphalacea is borne out not only in shape and protoconch but in the presence, at least in *Weeksia*, of a septal partition separating the earliest whorls. Thus, derivation of this family from the Euomphalidae proper appears reasonable.

Genus WEEKSIA Stephenson, 1941

Type by original designation, *Pseudomalaxis amplificata* Wade, 1926.

Diagnosis.—Discoidal involute moderately large shell with raised naticoid protoconch. Whorls rectangular in cross section and biangulated at periphery.

Discussion.—Wade (1926, p. 175) described two gastropod species from Coon Creek, McNairy County, Tenn., as belonging to the genus *Pseudomalaxis*. His species *Pseudomalaxis amplificata* possesses several features not common to that genus, such as a protoconch elevated above the plane of volution of the teloconch, a square or rectangular whorl profile, involute whorls, and a general lack of ornamentation. On the basis of these differences, Stephenson (1941, p. 257) proposed the new genus *Weeksia*, using Wade's species as the type, and described an additional species *W. lubbocki* from the Navarro group of Texas. Within the genus, he also included *Delphinula lapidosa* Morton and *Straparolus subplanus* Gabb from the Prairie Bluff chalk of Alabama and Mississippi. The last two species are internal molds and can be placed in this genus only with reservation. *D. lapidosa* has the low spire and flat-topped whorls typical of *Weeksia;* but on the basis of whorl profile and manner of coiling, *S. subplanus* appears to be closer to *Hippocampoides*-like forms. *S. deplanatus* Johnson, also from the Prairie Bluff chalk, should be included in *Weeksia*.

Amphitomaria Koken from the Triassic St. Cassian beds of the Tyrolean Alps is very similar in form but possesses a flat protoconch, and the type species *Euomphalus cassiana* Koken, as illustrated, has growth lines with an adapertural-trending sinus in the interangulation area.

The genus is unknown outside the *Exogyra costata* zone of the gulf coast.

Weeksia amplificata (Wade)

Plate 5, figures 40, 41

1926. *Pseudomalaxis amplificata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 175., pl. 59, figs. 1–4.

1941. *Weeksia amplificata* (Wade). Stephenson, Texas Univ. Bull. 4101, p. 257.

Diagnosis.—Largest species of genus and bears moderately wide spaced blunt spinose nodes on whorl angulations.

Description.—Shell of medium size, discoidal, involute, and thick. Protoconch consists of 1½–2 smooth helically coiled whorls with last half protoconch whorl covered by first teloconch whorl and lies above and at slight angle to teloconch plane of volution. Whorls subrectangular in outline, biangulated at periphery and increase in size rapidly. Suture impressed, slightly channeled on some specimens. Sculpture consists of blunted spines on whorl angulations that are alike in strength, number, and spacing on both whorl angulations. Surface of whorls smooth and glazed, marked only by growth lines. Growth lines strongly opisthocline in trend between suture and whorl angulations, flexed over whorl angulation, then slightly sinused in interangulation area; growth lines coarsest on interangulation area and may become raised above shell surface on last part of body whorl, forming an imbricated surface. Aperture subrectangular; lips thin and notched at intersection with whorl angulations; shell material tends to thicken immediately behind aperture, and specimens with a broken aperture show an oval apertural outline with no indication of notching. In latest stage, body whorl tends to become loosely attached or entirely separated from penultimate whorl.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*DA*
1 (holotype)	4.75	3.2	8.25	2.7
1 (hypotype)	5+	9.8	------	15.6
1 (topotype)	5.25	7.7	22.2	9.0
1 (topotype)	3.25	3.75	6.25	3.5
6	5.5	7.5	18.8	7.0
6	4.5	5.9	14.5	5.7
7	5	5.7	19.3	------
16	5.5	5.8	18.4	5.5
18	5.5	7.3	22.5	7.2
18	5.75	8.4	21.8	7.0

Discussion.—The holotype and paratype are incomplete specimens. The former preserves only a few early whorls; the later preserves only the early whorls and part of a large body whorl. Several topotypes in the collections studied are complete and give additional information. Like euomphalids in general, this species possesses a septum which is symmetrically convex adaperturally and which separates the protoconch and part of the first teloconch whorl from the rest of the shell. The angle of inclination of the initial protoconch whorl varies, and in several specimens this whorl shows no indication of being covered. The specimens from the Ripley formation of Mississippi compare well with the type material from Tennessee.

Weeksia lubbocki Stephenson from the Nacatoch sand of Texas is very closely related, differing only to a minor degree in the spacing of the nodes on the peripheral angulations. Available material is not sufficient for assurance that this is or is not a constant feature worthy as a basis for specific distinction.

W. amplificata ranges through the Ripley formation in Mississippi and Tennessee.

Types: Holotype USNM 73097; paratype USNM 73097; hypotype USNM 128382.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 6, 7, 14, 16, 18, 29, 32.

Weeksia deplanata (Johnson)

Plate 5, figures 35, 36

1860. *Straparolus lapidosa* Gabb, (not Morton). Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 300, pl. 48, figs. 5a, b.

1905. *Straparolus deplanatus* Johnson, Philadelphia Acad. Nat. Sci. Proc., v. 57, p. 19.

1941. *Weeksia lapidosus* (Morton). Stephenson, Texas Univ. Bull. 4101, p. 258.

Diagnosis.—Internal molds preserve discoidal shape, quadrangular whorl profile, and manner of coiling of *Weeksia.*

Discussion.—The synonomy indicates the confusion surrounding the status of this species. Gabb's specimens (1860, pl. 48, figs. 5a, b) show features distinctive of *Weeksia*, but Gabb was in error in assigning them to Morton's species. Johnson (1905, p. 20) states:

> The type of this species is what Gabb figured by mistake for the type of *Delphinula lapidosa* Morton. With the specimens there is an original label in Gabb's handwriting, "*Straparolus deplanatus* Gabb Cretaceous Alabama". On the specimen is written the word "type." This seems to be a good species the characters of which are well shown on the figure referred to. It is more depressed than *Straparolus lapidosus* the body whorl being almost uniformly rounded above and below.

The type locality is assumed to be Prairie Bluff, Ala.

Gabb's illustration, although erroneously assigned, and Johnson's subsequent description seem to validate the specific designation. The species is ascribed to Johnson, who used Gabb's unpublished name. The type specimen is preserved in the Academy of Natural Sciences of Philadelphia and compares very well to those from Mississippi here ascribed to *W. deplanata* (Johnson).

Morton's (1834, pl. 19, fig. 7) species *Delphinula lapidosus* has well-rounded shoulders and a somewhat elevated spire and is much more akin to *Hippocampoides liratus* Wade.

Molds of *W. amplificata*, manufactured by hardening the filling and dissolving the shell material, closely approximate the natural molds of *W. deplanata*, but the lack of external ornament naturally prevents a closer comparison. One partial external mold from the Prairie Bluff chalk of Mississippi at locality 71 exhibits fine reflected growth lines and a smooth upper whorl surface much like the species from the Ripley formation.

Although not abundant the molds of this species have a wide distribution in the Prairie Bluff chalk of Mississippi.

Types: Holotype ANSP 1514; hypotype USNM 128383.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 54, 57, 66, 71, 87, 91, 94. Alabama: Prairie Bluff chalk.

Superfamily PATELLACEA
Family ACMAEIDAE
Subfamily ACMAEINAE
Genus ACMAEA Escholtz, 1830

Type by subsequent designation (Dall, 1871, p. 238), *Acmaea mitra* Escholtz, 1830.

Diagnosis.—Small to large subconical shell with anterior slope steepest; external ornament variable, consists of radiating axial ribs and weaker concentric growth lines; aperature subcircular in outline; muscle scars symmetrical and horseshoe shaped.

Discussion.—*Acmaea* is common and widely distributed in both Tertiary deposits and in Recent seas. Its earliest occurrence is in the Triassic, and in the Cretaceous it becomes well established. In the upper Cretaceous deposits of the gulf coast, it rarely occurs, which may be partly explained by the fragile nature of the shell. Aside from the new species *A. galea*, in the following description, only two other species are known in the Gulf region, and both are from Texas, *A.? occidentalis* (Hall and Meek)? of Stephenson, from the Kemp clay, and *A. pilleolus* Stephenson, from the Woodbine formation. Stephenson (1941, p. 257) suggests that *Anisomyon weiseri* Wade, from the Ripley formation of Tennessee, may also belong to *Acmaea.* This species, based on only one specimen, was described and figured by Wade (1926, p. 180), who failed to clean the interior of the shell. When the matrix was removed from the aperture, it was found that the muscle scar pattern was that of *Siphonaria.*

Acmaea galea Sohl, n. sp.

Plate 5, figures 34, 39

Diagnosis.—Small acmaeid with subcircular aperture and shell surface marked by faint concentric growth lines and even fainter thin radial lines.

Description.—Shell small, subconical, moderately thick. Apex lies in shell midline and slightly forward of center. Anterior slope somewhat steeper than posterior slope, but both nearly straight. Surface marked by numerous thin concentric growth lines and thin very weak radial threads which are most prominent on posterior and posterolateral slopes. Shell interior incompletely known; holotype preserves only muscle scars of right side and bears a flattened teardrop-shaped area immediately below apex on posterior slope, but no corresponding flattening is present on shell exterior.

Measurements.—The holotype measures 3 millimeters in height and 10.1 millimeters in diameter.

Discussion.—The presence of the uninterrupted right side muscle impressions negates the possibility of this species belonging to *Anisomyon*, as does the lack of a reflexed apex. Unfortunately the holotype was embedded in a sandstone concretion, and the internal structures were of necessity destroyed to discover the external features.

A. occidentalis (Hall and Meek), from the Pierre shale of the western interior, differs from this species by having a much more depressed and less central apex. According to Meek (1876, p. 295), *A. occidentalis* possesses radial markings on the shell interior but none on the exterior. *A.? occidentalis* (Hall and Meek) of Stephenson (1941, p. 256) is based on specimens too poorly preserved for close comparison, but they appear to possess a less central apex and a more depressed outline than the Ripley species. *A. pilleolus* Stephenson from the Woodbine of Texas is a higher species with a less central apex.

A. galea is very rare and known only from the type locality of Coon Creek, McNairy County, Tenn.

Type: Holotype USNM 128384.
Occurrence: Tennessee: Ripley formation, loc. 1.

Superfamily TROCHACEA
Family ANGARIIDAE

Genus CALLIOMPHALUS Cossmann, 1888

Junior objective synonym, *Callomphalifer* Cossman, 1918.

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

Diagnosis.—Trochiform shell with a nacreous inner shell layer, commonly with beaded or spinose spiral sculpture; base striated; umbilicus wide and with noded margin; aperture round to subround.

Discussion.—This genus was previously placed in the Delphinulidae, a name invalidated by the prior usage of *Angaria* (Bolten) Roeding. Cossmann (1918, p. 91) proposed the name *Callomphalifer* to replace *Calliomphalus* because of the similarity of the later name to *Calumphala* Adams and Angus. According to the rules of zoological nomenclature (article 36) *Calliomphalus* is valid and *Callomphalifer* is a junior objective synonym.

Metriomphalus Cossmann is similar in general character but has a well-rounded base and aperture with a more highly ornamented base than is typical of *Calliomphalus.* Species in several genera of the Trochidae and especially in the Umboniinae bear some resemblance to *Calliomphalus* and a possibility exists that several may belong to this genus, but in general the trochiform outline and general features of ornament and protoconch make distinction simple.

Garramites Stephenson (1941, p. 262), based on a single specimen of the type species from the Nacatoch sand of Texas, appears to be a synonym of *Calliomphalus.* Stephenson placed the genus in the family Trochidae and differentiated it from *Margarites* by "* * * having an angulated rather coarsely crenulated umbilical border. Within the umbilicus a broad, shallow spiral sulcus closely borders the row of crenulations." The features mentioned as distinctive of *Garramites* also characterize *Calliomphalus.* Upon close inspection under favorable light and magnification, the early whorls of *Garramites nitida* exhibit a flat upper whorl surface bordered by a broad shoulder angulation which is noded where crossed by axial threads. These nodes give way on the penultimate and body whorls to the grooves typical of the species. Thus, the development of the early whorls also indicates a close similarity to typical calliomphalid development. The only distinct difference appears to be in the subdued ornament of the body whorl, a feature certainly of no more than specific value.

Calliomphalus has a wide geographic distribution in the late Upper Cretaceous and ranges stratigraphically into the Tertiary deposits of Europe.

On the basis of shape and whorl outline, the genus falls conveniently into two subgenera.

Subgenus CALLIOMPHALUS Cossmann, 1888

Type species, *Turbo squamulosus* (Lamarck), 1804.

Definition.—Trochiform shell having round-sided, adapically flattended whorls with a broadly rounded base; nucleus smooth for about one turn, with first fine axial ornament then strong spiral ornament added; sculpture of body dominated by spiral elements.

Discussion.—*Calliomphalus* s. s. is differentiated from *Planolateralus* Sohl by its round-sided posteriorly shouldered whorls, which lack either a basal keel or axial sculpture on the base.

The following species are included in this subgenus:

Calliomphalus americanus Wade, Ripley formation, gulf coast
(*Calliomphalus*) *nudus* Sohl, n. sp., Ripley formation, Mississippi
cf. *C. americanus* Wade, Coffee sand, Mississippi
cf. *C. americanus* Wade, Crosswicks clay, Delaware
sp., Owl Creek formation, Mississippi
Garramites nitida Stephenson, Navarro group, Texas
Turbo boimstorfensis Griepenkerl, Senonian, Germany
rimosus granulata Kaunhowen, Maestrichtian, Belgium
chiuahuensis Böse, Upper Cretaceous (Vraconian), Mexico
squamulosus Lamarck, Eocene, Paris Basin, France
?*Solarium bailyi* Gabb, Pondoland, South Africa
Solarium karapudiense Stoliczka, Arialoor group, India

Calliomphalus (Calliomphalus) americanus Wade

Plate 5, figures 1–10

1926. *Calliomphalus americanus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 178, pl. 60, figs. 1–3.
1941. *Calliomphalus bellulus* Stephenson, Texas Univ. Bull. 4101, p. 259, pl. 47, figs. 8, 9.

Diagnosis.—Small caliomphalids with ornate sculpture consisting of numerous closely spaced tuberculate spiral lirae that cover both whorl sides and base.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*HA*	*H:D*
1 (holotype)	7	10.37	9.07	3.75	1.14
1 (paratype)	6	6.0	5.5	2.25	1.09
1 (topotype)	7.75	8.9	8.05	3.8	1.10
1 (topotype)	6.5	8.0	7.05	3.3	1.10
1 (topotype)	6.75	9.0	8.7	4.4	1.03
1 (topotype)	6.25	7.0	6.92	3.3	1.01
1 (topotype)	5.5	5.05	4.12	2.52	1.22
1 (topotype)	6.4	7.3	6.17	4.4	1.18
1 (topotype)	7.25	8.5	7.52	3.52	1.13
1 (topotype)	6.0	4.92	4.7	2.35	1.05
1 (topotype)	5.5	4.3	4.47	2.27	.96
18	6.25	5.87	6.05	2.9	.97
18	6.25	6.2	5.25	2.55	1.18
18	6.0	5.62	5.75	2.37	.97
18	5.5	3.8	4.17	1.7	.91
18	5.7	4.95	5.0	2.37	.99
18	5.5	3.57	4.2	1.7	.85
16	5.75	4.92	5.0	2.3	.98
16	5.5	4.0	4.27	1.8	.93
16	5.25	4.05	4.1	1.82	.98
16	5.25	3.62	3.7	1.7	.97
16	4.75	3.05	3.65	1.5	.84
16	6.0	5.7	5.3	2.5	1.07
16	5.5	4.65	4.35	2.3	1.07
6	5.25	3.12	3.12	1.42	1.00
6	5.25	4.37	4.5	2.12	.97
6	6.25	7.8	6.05	2.65	1.28
6	5.25	3.82	4.0	1.95	.90
6	5.25	3.52	3.67	1.82	.96
13	5.25	3.8	3.95	1.8	.96
5	6+	5.8	5.57	2.8	1.04
39	5.5	4.75	5.25	2.32	.90
46	6+	5.6	5.25	2.37	1.06
46	5.0	3.25	3.42	----------	.95

Discussion.—Wade (1926, p. 178) has described this species in detail.

Calliomphalus (*Calliomphalus*) *americanus* occurs in abundance and is well preserved at its type locality on Coon Creek, McNairy County, Tenn. Southward in Mississippi it is present at most of the fossiliferous localities in the lower part of the Ripley formation but diminishes considerably in abundance. This species is the most wide spread of the calliomphalids in the gulf coast, having been found from Texas to the Chattahoochee River region of Georgia. Closely related, if not conspecific, material is present in Survey collections from the Chesapeake Bay and the Delaware Canal of Delaware.

The specimens from the Ripley in Mississippi here assigned, to *C.* (*C.*) *americanus* are close to the type material (compare, pl. 5, figs. 1, 2 and figs. 3–7). Minor differences occur in the general tendency toward a smaller size and a less pronounced spiral ornament, although the number and arrangement of the elements are essentially the same. In addition, the tubercles on the spirals are also more faint. These variations, though less common, are to be found among suites of topotypes but are not considered sufficient basis for subdivision. The measurements given above reflect the general change in average size between the type locality and the Mississippi localities. The ratio of height to width is variable with the smaller values generally coincident with smaller size.

Stephenson (1941, p. 259), in describing *C. bellulus* from the Neylandville marl of Texas, noted that his species was a close analog of *C. americanus* Wade and that it differed primarily in minor features of ornament. In addition, it is from the same stratigraphic position as Wade's species. Upon examination of more than 100 well-preserved topotypes from Coon Creek, I conclude that the range of variability encompassed by these specimens makes necessary the inclusion of *C. bellulus* in *C.* (*C.*) *americanus*.

Two specimens from the Owl Creek formation of Tippah County, Miss., appear to agree well with the specimens from the Ripley but are slightly less obese (pl. 5, figs. 8–10). Further material is necessary to determine if there are any constant differences.

Types: Holotype USNM 73105; hypotypes USNM 76791 (Texas), USNM 128385, 128386, 128387, 128388.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 5, 6, 11, 12, 15–18, 23, 27, 34, 39; Owl Creek formation, locs. 44, 46. Texas: Neylandville marl. Alabama: Ripley formation. Georgia: Ripley formation.

Calliomphalus (Calliomphalus) nudus Sohl, n. sp.

Plate 5, figures 32, 33

Diagnosis.—Small trochiform shell with sculpture of five dominant esentially nontuberculate spiral lirae and very weak axial threads.

Description.—Shell small, trochiform, umbilicate; pleural angle 80°; protoconch unknown; suture impressed. Body broadly rounded down to flattened base. Sculpture of spiral lirae of variable strength, with five major lirae on body; first spiral faintly tuberculate and forms border of a flattened upper whorl surface; body profile steepens below to periphery, where three equally spaced primary lirae occur; fifth primary lirae on basal slope shortly below fourth. Fine secondary spiral threads present between primary lirae but vary in strength and number. Base covered by spiral lirae of equal strength. Aperture incomplete but circular in outline as preserved. Umbilicus wide and deep, extending to apex and bordered by a tuberculate umbilical keel; umbilical wall with cancellate sculpture of equal strength axial and spiral threads.

Measurements.—The holotype measures 6.75 millimeters in height and 6.25 millimeters in width.

Discussion.—The holotype is an external mold preserving four whorls, with the apex obliterated. The general lack of pronounced growth lines and the few nontuberculate but strong spiral lirae of *C.* (*C.*) *nudus* offer a strong contrast to the other highly ornate typical calliomphalids. *Calliomphalus* sp. from the Owl Creek formation is similar in its general lack of ornament but lacks the strong primary spirals and has a well-rounded periphery. Another form, an undescribed species in the U.S. National Museum collections, from the Ripley formation "4 miles below Eufaula, Ala." is very close but lacks the major spiral of the base.

Type: Holotype USNM 128389.
Occurrence: Mississippi: Ripley formation (upper part), loc. 32.

Calliomphalus (Calliomphalus) sp.

Plate 5, figure 11

Diagnosis.—A small calliomphalid with well-rounded whorls but bearing only faintest of spiral ornament on the periphery.

Discussion.—One incomplete specimen from the Owl Creek formation at locality 45 belongs in *Calliomphalus* but exhibits characters which separate it from previously described species. The shell is small and umbilicate and possesses the nacreous layer typical of this genus. The body is broadly rounded on the sides and has a slightly flattened base. Two relatively strong tuberculate spiral lirae are situated immediately below the suture. Below these spirals the body is broadly rounded, with an almost smooth surface covered only by very faint spirals. The basal spiral lirae are thick and more prominent than those of the whorl sides and are nontuberculate, with the most prominent spiral lira delimiting the base and almost forming a keel. The aperture is subcircular, and the umbilicus is deep and bordered by a series of nodes on the umbilical keel.

In general outline and in its rounded whorls and aperatural outline, this species is similar to *C.* (*C.*) *americanus*. It differs significantly in ornament by having weaker and differently arranged spiral elements and a general lack of tuberculations, except near the suture. These differences are sufficient to show that this specimen represents a distinct species, but full description and assignment of a new name should await better material.

Type: Hypotype USNM 128390.
Occurrence: Mississippi: Owl Creek formation, loc. 45.

Subgenus PLANOLATERALUS Sohl, n. subgen.

Type species, *Calliomphalus argenteus* Wade, 1926.

Etymology.—Compounded from the Latin *planus* or flat and *lateralis* or side.

Definition.—Trochoid phaneromphalous shell with a typical calliomphalid aperture, nacreous shell layer, and noded umbilical margin. Protoconch round topped and smooth for about three-fourths of a turn, then develops rather strong axial riblets followed by appearance of thin spiral threads at 1¼ turns. Whorls flat sided and basally angulated.

Discussion.—*Planolateralus* Sohl differs from *Calliomphalus* s. s. in nuclear character, by having flat sided whorls, and by possessing a basal angulation. These features give species of this subgenus a smooth cone-shaped outline with whorls that lack a posterior shoulder or a sutural canal. In addition *Planolateralus* is proportionally higher than wide, reflecting an umbilicus noticeably less broad and flaring than that of *Calliomphalus* s. s.

The following species are included in the subgenus:

Calliomphalus argenteus Wade, Ripley formation, Tennessee
(*Planolateralus*) *decoris* Sohl, n. sp., Ripley formation, Tennessee
(*Planolateralus*) *conanti* Sohl, n. sp., Ripley formation, Mississippi
Calliomphalus (*Planolateralus*) *angustus* Sohl, n. sp., Ripley formation, Tennessee
Calliomphalus (*Planolateralus*) sp., Blufftown formation, Alabama and Georgia
microancelli Stephenson, Navarro group, Texas
trochiformis (Deshayes), Eocene, Paris Basin
crenularis (Deshayes), Eocene, Paris Basin
Trochus decrescens Kaunhowen, Maestrichtian, Belgium

Calliomphalus (Planolateralus) argenteus Wade

Plate 5, figures 15, 29–31

1926. *Calliomphalus argenteus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 179, pl. 60, figs. 4–6 [not 7 and 11].

Diagnosis.—Small trochiform phaneromphalous shell; whorl sides and base ornately sculptured by closely spaced spiral lirae and axial costae which form tubercles where they intersect; thickest spiral element occurs as ribbon at basal angulation.

Measurements.—The following measurements are of topotypes from locality 1. Explanation of measurements and symbols used in this table appears in the section on "Measurements of specimens" (p. 48).

No. *W*	*H*	*MD*	*HA*	*H:D*
7.25	7.7	6.6	2.5	1.16
7+	8.9	8.0	2.7	1.11
7.4	8.1	7.0	2.5	1.15
7.5	7.9	7.0	2.65	1.12
7.2	7.7	7.1	2.4	1.08
7.5	8.9	7.4	2.75	1.20
7.3	6.7	6.1	2.3	1.08
7.25	7.7	6.4	2.7	1.20
7.25	7.4	6.4	2.5	1.15
7.3	8.0	7.3	2.8	1.09
7.25	7.1	6.0	2.5	1.18
7.25	6.7	5.4	2.4	1.24
7.25	7.0	6.5	2.5	1.07
6.75	6.6	6.2	2.5	1.06
7.0	6.9	6.4	2.5	1.08
7.25	6.5	5.7	2.25	1.14
6.5	5.4	5.4	2.1	1.00
7.3	6.7	5.9	2.4	1.13
7.2	6.0	5.0	2.2	1.20
6.7	6.1	5.6	2.2	1.08

Discussion.—Two distinct forms were illustrated by Wade (1926, pl. 60) as belonging to *C. argenteus;* they are here considered as subspecies. The ornate little shells of *C. argenteus* Wade (1926, pl. 60, figs. 4–6) are quite abundant at the type locality, Coon Creek, McNairy County, Tenn. The above measurements indicate a relative uniformity in body proportions, but variation in ornament is considerably greater. The strength and width of the spiral ribbon forming the basal whorl angulation varies both with size of and among individual specimens. Generally there are four major tuberculate spiral lirae on the upper whorl surface above the angulation, but some specimens shown a tendency for the subduing of these lirae, with the upper one being very faint; on other specimens secondary spiral lirae gain some prominance but are never as strong as the primaries.

Calliomphalus (*Planolateralus*) *argenteus* appears on the basis of available evidence to be part of a plexus which began in the Blufftown formation. In the Blufftown of Georgia there is an undescribed species of *C.* (*Planolateralus*) which bears spines on the basal periphery, much in the manner of *C.* (*P.*) *argenteus spinosus*, but the undescribed species is larger in size and has finer ornamentation. Stratigraphically above this, as is seen in figure 7, in the *Exogyra cancellata* zone of Tennessee, *C. argenteus* Wade is found. This species can be split into two groups—those with spines, as in the form from the *E. ponderosa* zone, which is here named *C.* (*P.*) *argenteus spinosus*, and those without, the typical *C. argenteus* Wade. In a suite of more than 400 topotypes the specimens split almost equally into the two categories. In view of the presence in the Blufftown formation of only spinose specimens, this mixture of the two types does not appear explainable on the basis of sex characters. The stratigraphic evidence indicates that in the post-*E. cancellata* strata of Mississippi and Texas only the nonspinose forms survived and developed a tendency for subdued ornament, as is exhibited by *C.* (*P.*) *conanti* and *C.* (*P.*) *microancelli.*

Calliomphalus (*Planolateralus*) *argenteus argenteus* is distinguished from *C.* (*P.*) *conanti* and *C.* (*P.*) *microancelli* by its sharply defined ornament and the well-developed basal angulation.

Types: Holotype USNM 73106; hypotype USNM 128391.
Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation (lower), loc. 2.

Calliomphalus (Planolateralus) argenteus spinosus Sohl, n. subsp.

Plate 5, figures 19, 23–25

1926. *Calliomphalus argenteus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 179, pl. 60, figs. 7, 11 [not figs. 4–6].

Diagnosis.—Small planolateralid with typical tuberculate spiral ornament but having a strong development of spines on the accentuated basal keel.

Measurements.—The following measurements are of topotypes from locality 1. Explanation of measurements and symbols used in this table appears in the section on "Measurements of specimens" (p. 48).

No. *W*	*H*	*MD*	*HA*	*H:D*
7.2	6.4	5.9	2.25	1.08
(?)	10.2	8.4	3.25	1.21
(?)	9.9	7.5	3.2	1.18
6.75	6.0	5.9	2.2	1.02
(?)	8.3	7.1	2.8	1.17
(?)	10.3	8.1	3.3	1.28
(?)	9.8	8.6	3.3	1.14
7.5	9.0	7.3	3.0	1.23
7.5	8.3	7.2	2.8	1.15
(?)	8.0	6.6	2.5	1.21
7.4	8.4	7.2	2.6	1.16
7.3	8.0	7.1	2.6	1.12
7.4	8.2	6.6	2.5	1.24
7.5	8.3	7.4	3.1	1.12
7.5	8.2	6.3	2.6	1.31
7.7	8.4	7.3	2.8	1.15
7.1	7.4	6.5	2.4	1.14
7.2	7.7	6.4	2.4	1.20
7.1	6.6	6.0	2.3	1.11
7.1	7.0	6.6	2.3	1.07

Discussion.—This form differs from *C.* (*Planolateralus*) *argenteus argenteus* primarily in the develop-

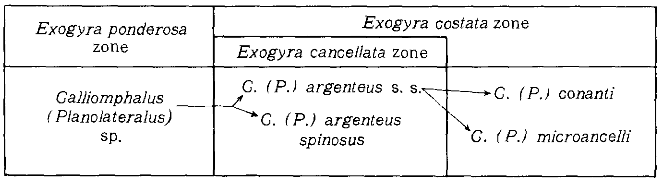

FIGURE 7.—Development of the *Calliomphalus (Planolateralus) argenteus* plexus.

ment of spines on the basal spiral lira. These spines grow from the axial lamellae where they cross the strong spiral which forms the basal whorl angulation. As a comparison of the measurements of the two forms shows, this subspecies grows larger than *C. (P.) argenteus* and has a greater spread of variation in ratio of height to diameter. The variation in ornament also appears to be greater, with the spiral cords varying as to their strength, arrangement, and number. The two types which Wade lumped together as a single species are essentially indistinguishable in their earlier stages but at or about the fifth whorl *C. (P.) argenteus spinosus* develops spines while the *C. (P.) argenteus* s. s. does not.

Types: Holotype USNM 73106; paratype USNM 128393.
Occurrence: Tennessee: Ripley formation, loc. 1.

Calliomphalus (Planolateralus) decoris Sohl, n. sp.

Plate 5, figures 26–28

Diagnosis.—Small trochiform phaneromphalous shell with highly ornate sculpture dominated by two strongly tuberculate spiral lirae at periphery.

Description.—Typical small planolateralid with nacreous inner shell layer. Protoconch poorly known, consists of about two smooth round-topped whorls; suture deeply impressed. Spire whorls number 7–8 and taper evenly; whorls flat-sided and slope steeply to a broadly subangular periphery; base broadly rounded. Sculpture highly ornate; spiral elements consist of both ribbons and lirae which are tuberculated where crossed by axial cords. Periphery of last whorl bears 2 prominent coarse spiral cords, which in turn bear 4 or 5 subsidiary raised spiral threads on their surfaces in addition to axial tuberculae or spines; above peripheral cords are 3 tuberculate ribbons of lesser width and prominance, and below periphery are 13 tuberculate spiral lirae of variable strength. Spiral elements of spire become increasingly subdued toward apex and individually break down to several lirae. Umbilicus wide and noded at its margin; both spiral and axial elements continue onto umbilical walls. Aperture subcircular, slightly wider than high; outer lip rounded, inclined and crenate where intersected by peripheral cords; inner lip margin slightly reflected and extended at junction of apertural margin and umbilical rim.

Measurements.—The holotype from locality 1 measures 9.8 millimeters in height and 8.6 millimeters in diameter.

Discussion.—This highly ornate species has a wider umbilicus and a less angular periphery than other members of this subgenus, but it is placed here on the basis of its strong axial ornament and general outline. No other species as yet described are likely to be confused with *C. (P.) decoris*. The species is rare and restricted to its type locality at Coon Creek, McNairy County, Tenn.

Type: Holotype USNM 128395.
Occurrence: Tennessee: Ripley formation, loc. 1.

Calliomphalus (Planolateralus) conanti Sohl, n. sp.

Plate 5, figures 12–14

Diagnosis.—Small trochiform phaneromphalous planolateralid with numerous low tuberculate spiral lirae and moderately narrow umbilicus.

Description.—Shell small, trochiform, phaneromphalous with nacreous inner shell layer; holotype with about 7¼ rapidly expanding whorls. Protoconch smooth on early whorl with coarse axial costae appearing at slightly more than one whorl, followed almost immediately by fine spiral lirae; suture impressed. Whorl sides slope less steeply than general slope of spire giving an outline interrupted by overhang of periphery of preceeding whorls; periphery subround to subangular; whorl side slopes steeply below periphery to broadly rounded base. Sculpture of axial and spiral elements same size; 8 spiral lirae on upper slope possess subdued tubercles where overridden by somewhat coarser and closer spaced axial cords; base covered by about 10 unequally spaced spirals with poorly defined tubercles and numerous axial lirae. Umbilicus narrow, bordered by a margin bearing low nodes. Aperture incompletely known, subcircular, slightly wider than high and reflexed slightly at junction of inner lip and umbilical margin.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc. or type	No. *W*	*H*	*MD*	*HA*	*H:D*
Holotype	6.75	7.2	5.7	2.4	1.26
6	6.25	4.8	4.25	1.8	1.13
23	5.9	3.75	3.6	1.5	1.04
23	6.6	4.95	4.25	1.8	1.16
7	6.6	5.4	4.9	2.1	1.10
7	6.4	4.9	3.9	1.6	1.25
7	6.7	5.25	4.25	1.8	1.23
7	6.6	4.5	4.0	1.6	1.12
7	6.2	4.3	3.8	1.5	1.13

Discussion.—Variation in the species is primarily restricted to minor differences in the strength of ornament. The low nodes at the umbilical margin are stronger on younger specimens. In character *C.* (*P.*) *conanti* most closely resembles *C.* (*P.*) *argenteus* Wade, but it lacks the sharp angulation of the whorls giving *C.* (*P.*) *conanti* a less uniform slope to the spire, especially on later whorls. In general, Wade's species also has stronger surface ornament and strong nodes bordering the umbilicus but fewer spiral elements on the base. *C.* (*P.*) *microancelli* Stephenson is another related form having subdued ornament and lacking definite whorl angularity. Although this Texas form is difficult to compare because the shell material has been replaced, the species appears distinct from *C.* (*P.*) *conanti* owing to its almost complete absence of tuberculations and possession of fewer spirals.

The species is rare but is found at a number of localities in the lower part of the Ripley formation (post-*E. cancellata* zone) of Mississippi.

C. conanti is named for Louis C. Conant, of the U.S. Geological Survey, who has contributed significantly to the knowledge of the geology of northeastern Mississippi.

Types: Holotype USNM 128396; paratype USNM 128397.
Occurrences: Mississippi: Ripley formation, locs. 6, 7, 13, 17, 23.

Calliomphalus (Planolateralus?) angustus Sohl, n. sp.

Plate 5, figures 20–22

Diagnosis.—Small trochiform phaneromphalous shell with a thick nacreous layer; peripheral angulation high on whorl; sculpture of a reticulate pattern between periphery and base; umbilicus narrow.

Description.—Shell small, trochoid in outline, with a thick nacreous shell layer; about 6½ rapidly expanding whorls on holotype. Protoconch smooth and round topped; ornament of axial costae begins after one turn, with fine spiral lirae appearing on second whorl. Suture impressed. First two teloconch whorls round sided, with succeeding whorls becoming more angular in outline. Last whorl rounded posteriorly; then slopes steeply to peripheral angulation, which is formed by a strong raised tuberculate spiral ribbon; body rounded between peripheral and basal angulation. Above periphery, surface sculpture consists of three tuberculate ribbons thinner and lower than that forming peripheral angulation; transverse costae of this upper surface, colabral in trend but lower and less regular than spiral elements. Between angulations, sculpture changes radically with transverse lirae becoming stronger and more numerous than spiral lirae; intersections of spiral and transverse elements marked by low elongate nodes developing reticulate pattern. Base flat and bears low tuberculate spiral cords and bordered by angulation formed by 2 closely spaced strong tuberculate spiral ribbons. Umbilicus narrow for genus and bears a noded margin; umbilical walls smooth. Aperture incompletely known, subcircular in outline as preserved.

Measurements.—The holotype measures 7.7 millimeters in height and 6.1 millimeters in diameter.

Discussion.—*C.* (*P.*) *angustus* is unlikely to be confused with other described calliomphalids. The umbilicus of this species is narrower than typical for the genus and is closer in this respect to *Planolateralus* than to *Calliomphalus* s. s. It differs from *Calliomphalus* s. s. most markedly by the presence of the peripheral angulation, but this feature is not developed till later whorls, and the early whorls have the typical basal angulation of *Planolateralus.*

The species is rare and known only from the holotype from the Ripley of Coon Creek, Tenn.

Type: Holotype USNM 128398.
Occurrence: Tennessee: Ripley formation, loc. 1.

Calliomphalus? sp.

Plate 5, figures 16–18

Discussion.—Several small trochiform phaneromphalous internal molds from the Prairie Bluff chalk of Mississippi closely approximate the characters of *Calliomphalus* in size, shape, and ornamentation. The whorls of the molds are subcircular in cross section and possess a wide and deep umbilicus. In these features as in their profile, the specimens come closest to *Calliomphalus* s. s. Several molds possess slight reflections of the external ornament, which is seen to be strong spiral lirae. One specimen, from locality 82 in Oktibbeha County, Miss., bears the impression of faint tubercles on the upper whorl surface (pl. 4, fig. 16).

Weller (1907, pl. 55, fig. 22), illustrated an internal mold of *Margarita abyssina* Gabb, from the Navesink marl of New Jersey that is similar in shape and proportion to the Mississippi specimens, with which it is probably congeneric.

Type: Hypotype USNM 128399.
Occurrences: Mississippi: Prairie Bluff chalk, locs. 71, 82.

Family TURBINIDAE
Genus URCEOLABRUM Wade, 1916

1916. *Urceolabrum* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 470.

1917. *Eucycloscala* Cossmann, Rev. Critique Paléozoologie, v. 20, no. 3, p. 99.

1925. *Eucycloscala* Cossmann, Essais Paléoconchologie Comparée, no. 13, p. 286.
1926. *Eucycloscala* Cossmann. Wade, U.S. Geol. Survey Prof. Paper 137, p. 179.
1938. *Eucycloscala* Cossmann. Wenz, Handbuch der Paläozoologie; Gastropoda, pt. 2, p. 337.
1941. *Urceolabrum* Wade. Stephenson, Texas Univ. Bull. 4101, p. 261.

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

Diagnosis.—Small thick phaneromphalous trochiform shell with strong nodose axial costae and circular and heavily reinforced aperture.

Discussion.—The validity of *Urceolabrum* has frequently been questioned by European authors, who generally consider it a synonym of *Eucycloscala*. This confusion has arisen owing to the inadequate original description and the subsequent changing diagnoses presented by Cossmann. Cossmann (1895, p. 742) designated *Trochus binodosus* Münster from the St. Cassian beds of Triassic as the type of his proposed genus *Eucycloscala*. This designation was accompanied by a short negative description. Cossmann's concept of *Eucycloscala* was based on Kittl's (1892, p. 49) reexamination of the type species, which is an anomphalous form lacking the reinforced aperture of Wade's species—*Urceolabrum tuberculatum*. In subsequent publications Cossmann's concept of the genus changed considerably. Cossmann's first significant shift (1912, p. 75, 1915, p. 256) was to cite *Scalaria cretacea* deBoury as the type. Ignoring the original designation, he restricted the genus to Cretaceous forms having an umbilicus and a reinforced peristome like Wade's genus *Urceolabrum*. Seemingly not content with this flagrant violation of the laws of zoological nomenclature, Crossmann (1925, p. 286) later cited still another species, *Scalaria abbreviata* Barrande and deGuerre from the Turonian, as the type species and at this time included *Urceolabrum* as a synonym of *Eucycloscala*. Wenz (1938, p. 337) followed Cossmann in placing *Urceolabrum* in the synonomy of *Eucycloscala* and cited *S. cretacea* as the type species but placed the genus in Turbinidae, not in the Scalaridae, as was done by Cossmann. Cossmann's original citation of a type species cannot be ignored, and, as such, *Eucycloscala* appears to be restricted to the Triassic, and the Cretaceous species such as *Scalaria cretacea* belong to *Urceolabrum* Wade.

Urceolabrum first appears on the gulf coast as an undescribed species from the Wolfe City sand member of the Taylor marl (Campanian) of Texas and continues through the Maestrichtian as it is represented in the region. Shells of the various species are locally quite abundant, and owing to their stout shells they are generally well preserved.

Urceolabrum tuberculatum Wade, the type species, is from the Coon Creek tongue of the Ripley formation. Its immediate predecessors and successors are closely allied and are so similar that only one major morphologic type appears to be present on the gulf coast from Campanian through the Maestrichtian. Thus, this appears to be a species plexus with minor changes being superimposed upon the same stock through time. That these variations are of a subspecific nature is shown by the intergradation of forms within a given suite and by the gradual shift in the mean with stratigraphic position.

Three main trends are seen which manifest themselves as follows from older to younger beds: increase in size, especially height, with time; increase in complexity of ornamentation; wider spacing of ornament elements.

This complex begins with an undescribed form that occurs in the Wolfe City of Texas and Coffee sand of Mississippi (mid-*Exogyra ponderosa* zone) and differs from *U. tuberculatum* s. s. by lacking the spiral cord nearest the suture and has only four primary spirals. *U. tuberculatum* Wade from the *E. cancellata* zone of Tennessee possesses five primary spirals, almost no secondary spirals on the whorl sides, and faint or no spiral ornament on the base. *U. tuberculatum crassum* Stephenson, from the Neylandville marl of Texas (*E. cancellata* zone), is a poorly known subspecies but appears somewhat more obese than the Tennessee form. *U. callistum* Harbison, of the Ripley of Mississippi and Alabama (*E. costata* zone), is treated below as only a subspecies. This form shows a general increase in size and development of secondary spirals on both whorl sides and base and also has a rudimentary fifth tuberculate spiral cord. In the uppermost part of the *E. costata* zone, another undescribed form occurs in the Providence sand of the Chattahoochie River region. This form shows a decrease in the strength of the spiral cords, but another row of nodes develops near the suture. A wider spacing and strengthening of the axial elements, with the axial costae continuous from the suture to the noded umbilical margin accompanies the development of the row of nodes.

Urceolabrum tuberculatum Wade

Plate 6, figures 18–20

1916. *Urceolabrum tuberculatum* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 470, pl. 24, figs. 6, 7.
1917. *Eucycloscala tuberculatum* (Wade). Cossmann, Rev. Critique Paléontologie, v. 20, no. 3, p. 99.

1925. ***Eucycloscala tuberculatum*** (Wade). Cossmann, Essais Paléoconchologie Compareé, v. 13, p. 286, pl. 8, fig. 35, 36.

1926. ***Eucycloscala tuberculatum*** (Wade). Wade, U.S. Geol. Survey Prof. Paper 137, p. 179, pl. 60, figs. 13–14.

Diagnosis.—Small high trochoid phaneromphalous shell with five coarsely noded spiral cords, strong raised transverse costae, and heavily reinforced flaring aperture.

Description.—Shell small, trochiform, phaneromphalous, with seven or less moderately expanding whorls. Protoconch not usually preserved but normally coiled and consists of about 1½ turns clearly demarked from the teloconch by appearance of first ornament. Suture impressed, with an irregular trace owing to intersection of rather coarse transverse costae. Whorls of spire taper evenly, with convex sides; body whorl broadly rounded over periphery, with slope steepening over a rather flat base. Ornament of spire initially dominated by coarse transverse costae, which are noded where overridden by spiral cords; two spiral cords are present on periphery of earliest whorls, with a third being added near suture on about the third whorl. On body whorl, coarse transverse ornament persists on sides but diminishes in strength on base; spiral cords number five on body whorl, with upper and lower pairs closely spaced and intermediate spiral lirae on periphery about equidistant between pairs. Umbilicus moderately wide and deep, bordered by a series of coarse nodes that rise in same manner as those of whorl sides; growth lines continue into umbilicus. Aperture circular, somewhat flared, and surrounded by thick reflected and reinforced lip.

Measurements.—The measurements in the following table are of topotypes from the Ripley formation at locality 1. Explanation of measurements and symbols used in this table appears in the section on "Measurements of specimens" (p. 48).

Ht	*MD*	*H:D*
7.3	5.0	1.46
4.6	3.3	1.39
6.9	4.5	1.53
4.4	3.2	1.37
5.9	4.1	1.43
6.2	4.4	1.40
5.6	4.0	1.40
6.5	4.4	1.47
5.5	4.1	1.32
5.8	4.3	1.35
6.2	4.3	1.44
5.2	3.7	1.40
5.0	4.0	1.25
5.5	4.4	1.25
5.3	4.0	1.32
5.3	3.9	1.36
5.3	3.9	1.36

Discussion.—This small species has a hard thick strong shell which facilitates a fine state of preservation, it is one of the more common gastropod species at its type locality at Coon Creek, Tenn. Variation in proportions is not great, but normal and noticeable differences are present. The ratios of height to width given in the preceding table gives some indication of the spread. Some of the measured differences can be ascribed to variability of expansion of the reinforced apertural rim. The sharpness of the tubercles varies in proportion to the strength of the spiral cords, being sharpest when the cords are thin and raised high. Only very rarely is there any suggestion of secondary cords between the primary spirals. Very faint low but broad spiral cords are present on the base of some specimens, but others have a smooth base.

Urceolabrum tuberculatum callistum Harbison from the Ripley formation of Mississippi differs somewhat in size but is primarily differentiated by the presence of secondary spirals on the whorl sides and well-developed spirals on the base. *Urceolabrum* sp. from the Coffee sand of Mississippi has only four primary spirals, lacking the one nearest the suture.

Types: Holotype USNM 73110; hypotype USNM 128400.
Occurrence: Tennessee: Ripley formation, loc. 1.

Urceolabrum tuberculatum callistum Harbison

Plate 6, figures 15–17

1945. ***Urceolabrum callistum*** Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 81, pl. 2, figs. 13–14.

Diagnosis.—Small phaneromphalous trochoid shells with 4–5 noded primary spiral cords and secondary spirals between the primaries.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Discussion.—The holotype of *Urceolabrum callistum* Harbison is an incomplete specimen from the Ripley formation of Pleasant Ridge Lake, Union County, Miss. (loc. 18), which lacks the reinforced aperture. The specimen also gives a suggestion of having a fifth row of nodes just below the fourth major spiral. Harbison's illustrations (1945, pl. 2, figs. 13–14), are retouched and overemphasize the strength of these nodes. On the 99 topotypes in the Survey collections the fifth row of nodes appears to be a highly unstable feature, both in strength and development, ranging from total absence (common) to specimens in which this row is stronger than on the holotype (uncommon). Such a range is true of other localities in the Ripley of Mississippi. Harbison (1945, faunal list) reports both *U. tuberculatum* and *U. callistum* as being present at the type locality, but in neither her collection at the Academy of Natural Sciences of Philadelphia nor in the Survey collections is there a typical specimen of *U. tuberculatum* s. s.

Loc. or type	*H*	*MD*	*H:D*
Topotype	6. 1	4. 8	1. 27
Do	7. 5	5. 28	1. 41
Do	7. 3	5. 1	1. 43
Do	6. 8	4. 9	1. 39
Do	7. 7	5. 6	1. 38
Do	6. 6	4. 6	1. 43
Do	7. 2	5. 0	1. 44
Do	7. 7	5. 3	1. 45
Do	6. 3	5. 1	1. 23
Do	6. 9	5. 0	1. 38
Do	6. 9	5. 0	1. 38
Do	7. 0	5. 4	1. 29
Do	6. 9	5. 0	1. 38
Do	6. 7	5. 0	1. 34
Do	7. 2	4. 9	1. 47
Do	7. 4	5. 0	1. 48
Do	6. 4	4. 7	1. 28
Do	6. 9	5. 1	1. 35
Do	6. 5	4. 7	1. 38
Do	6. 7	4. 7	1. 42
6	6. 2	5. 1	1. 21
6	7. 4	5. 5	1. 34
6	7. 0	5. 2	1. 35
6	6. 3	4. 9	1. 29
6	7. 3	5. 2	1. 40
6	6. 3	4. 4	1. 43
6	6. 3	4. 4	1. 43
6	6. 9	4. 9	1. 40
6	6. 3	4. 6	1. 37
6	7. 3	5. 6	1. 30
6	7. 6	5. 3	1. 43
24	7. 3	5. 3	1. 43
24	5. 5	3. 9	1. 41
24	6. 1	4. 3	1. 41
17	6. 6	4. 6	1. 45
17	6. 8	5. 1	1. 33
17	6. 2	4. 3	1. 44
17	7. 0	4. 9	1. 42
17	6. 6	4. 5	1. 46
17	6. 3	4. 4	1. 43
17	6. 0	4. 4	1. 36
17	5. 3	4. 0	1. 32
17	5. 4	4. 1	1. 31
16	7. 5	5. 3	1. 41
16	6. 6	4. 6	1. 43
16	6. 1	4. 5	1. 35
16	6. 8	4. 9	1. 38
16	7. 0	5. 0	1. 40
16	6. 2	4. 3	1. 44
16	6. 6	5. 0	1. 32
16	6. 7	4. 7	1. 42
16	6. 1	4. 6	1. 32
16	6. 1	4. 7	1. 29

The measurements given above, when compared with those of the types of *U. tuberculatum* Wade from the older *E. cancellata* zone of Tennessee, show considerable similarity in general size and proportions. When plotted graphically there are no considerable differences and in general the plots of the lines of scatter overlap and exhibit a distinct parallelism. The only consistent difference noted between the two forms is the presence on *U. callistum* of secondary spirals on the whorl sides. In addition this subspecies usually possesses a stronger development of spirals on the base than in *U. tuberculatum* s. s., but in both forms variation in this character are present. Thus, *U. tuberculatum callistum* appears to be not too far removed from *U. tuberculatum* s. s. and appears to have been derived from the Coon Creek form by a gradual suppression of the fifth or lowest spiral cord and a gradual strengthening of the spirals of the base plus the addition of secondary spirals on the whorl sides. Because these changes are gradual and to some degree overlapping, it seems best to consider them as of subspecific rank.

U. tuberculatum crassum is abundant in the lower part of the Ripley formation of Mississippi and has been found at most of the fossiliferous localities.

Types: Holotype ANSP 16239; hypotype USNM 128401.

Occurrences: Mississippi: Ripley formation, locs. 5, 6, 9a, 14–18, 24, 29. Georgia and Alabama (Chattahoochee River region): Ripley formation.

Urceolabrum sp.

Four specimens, three of which are incomplete and all of which are immature, suffice to indicate the presence of members of this genus in the Owl Creek formation of Tippah County, Miss. The specimens differ from *U. tuberculatum callistum* Harbison by their strong axial costae but less prominant tuberculations and by their more subdued secondary spirals. They differ from the undescribed species in the slightly younger Providence sand of Georgia by their smaller size, weaker transverse costae, and less numerous tuberculate spiral cords. The specimens do not warrant illustration.

Occurrences: Mississippi: Owl Creek formation, locs. 41, 46.

Family SKENEIDAE

Genus TEINOSTOMA H. and A. Adams, 1853

Type by subsequent designation (Cossmann, 1888, pt. 3, p. 48), *Teinostoma politum* A. Adams, 1853.

Diagnosis.—Very small thick subdiscoidal shell with depressed spire and flattened base and body whorl overlapping previous whorls; umbilicus wide and plugged with callus.

Discussion.—Wenz (1938, p. 330) divides *Teinostoma* to seven subgenera, which include a wide variety of shapes and umbilical features. A number of the subgenera are not characterized by overlapping of the spire by the body whorl and do not possess umbilical plugs, as is typical of *Teinostoma* s. s. and *Idioraphe* Pilsbry. This has led some workers, such as Woodring (1928, p. 445), to raise the rank of most of these subgenera to genera. The Cretaceous forms dealt with here appear to belong closest to *Teinostoma* (*Teinostoma*).

The type species *T. politum* is a Recent species from the coast of Ecuador, with other closely related species in the Indo-Pacific region. The earliest reported representatives, according to Wenz (1938, p. 330), are to be found in the Kimmeridgian. The genus is poorly represented in Cretaceous rocks, and in no way as abundant as in Tertiary rocks but it is widely distributed. Cretaceous species have been noted from India, Chile, North America, and northern Europe. In the gulf coast of the United States only two Cretaceous species have previously been described —*T.? austinense* Stanton from the Edwards limestone of Texas and *T. prenanum* Wade from the Ripley formation of Tennessee. One additional species, *T. clara* from the Ripley formation of Mississippi, is described here.

Teinostoma prenanum Wade

Plate 6, figures 9, 10

1927. *Teinostoma prenanum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 178, pl. 59, figs. 16, 20, 21.

Diagnosis.—A typical *Teinostoma*, with a smooth shell surface which lacks all trace of spiral ornament but bears very faint growth lines.

Measurements.—The holotype measures 0.8 millimeters in height and 1.7 millimeters in diameter.

Discussion.—Wade's original description is sufficient for identification, but owing to retouching, the illustrations give an erroneous impression and are almost valueless. The holotype is reillustrated here (pl. 6, figs. 9, 10). There is little doubt that this species belongs to *Teinostoma* s. s., but owing to its lack of ornament is essentially indistinguishable from several Tertiary species. However, the lack of ornament does serve to distinguish it from the other associated Cretaceous species on the gulf coast. Several specimens have been collected in the reworked zone at the base of the Clayton formation in Hardeman County, Tenn., (loc. 40, pl. 6, figs. 7, 8), which are indistinguishable from this species, but it is not known whether they belong with the Paleocene or Cretaceous elements in the fauna from that locality.

Type: Holotype USNM 73101.
Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1; Clayton formation, loc. 40 (reworked Cretaceous?).

Teinostoma clara Sohl, n. sp.

Plate 6, figures 2–6

Diagnosis.—Small *Teinostoma* with impressed spiral lines which are punctate on the base.

Description.—Small thick shell with glazed surface, depressed outline and broadly arched apical surface. Protoconch slightly raised above shell surface and consists of about 1½ whorls; junction with conch marked by flattening of upper whorl surface and initiation of colabral growth lines. Sutures indistinct. Teloconch of about two whorls with body whorl partly enveloping penultimate whorl. Body acutely rounded at periphery and more broadly arched above than below. Sculpture of impressed spiral threads, which are absent or extremely faint near suture, becomes stronger on periphery and base; punctations occur where growth lines cross spiral threads and are best developed on base. Aperture subcircular; outer lip prosocline; inner lip concave; parietal lip calloused, with callus continuing into umbilicus and forming a smooth plug.

Measurements.—Explanation of the measurements and symbols in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
16	1.0	1.9
7	.9	1.6

Discussion.—Only two specimens, both from the Ripley formation of Mississippi (locs. 6, 15), are available for study. The holotype (pl. 6, figs. 2, 3), a mature specimen from Union County, lacks a part of the base, but the callus which filled the umbilicus is clearly outlined. The paratype (pl. 6, figs. 4, 6) is an immature specimen, which presents an open umbilicus. Several specimens from the reworked basal unit of the Clayton formation at locality 40 (pl. 6, figs. 1, 11) closely approximate this species.

The presence of the spiral threads serves to distinguish *T. clara* from *T. prenanum.* It is possible that this species may not belong in *Teinostoma* s. s. but in one of the various subgenera in which overlap of the spire is incomplete.

Types: Holotype USNM 128780; paratype USNM 128781.
Occurrences: Mississippi: Ripley formation, locs. 6, 15.

Superfamily NERITACEA
Family NERITIDAE

Genus NERITINA Lamarck, 1816

Type by subsequent designation; Kennard, and others, 1931, p. 24 (Children, 1823, p. 111), *Nerita pulliger* Linné, 1767.

Discussion.—The species here placed in the genus *Neritina* are assigned with considerable misgivings. The one species preserving shell material, *N. densata* Conrad, is based on a poor description and illustration, and the holotype has been lost. The other assignment is of internal molds from the Prairie Bluff chalk that bear considerable similarity in form but lack shell characters enabling definite identification. It is strange that a genus so abundant in the fossil record is so poorly represented in such a widely diversified fauna. Perhaps the answer lies in the paleoecology of the area, with the water too deep and perhaps too saline to provide optimum conditions for this typical littoral to brackish-water genus. If these forms are correctly identified, by their very numbers, they may indicate that they were not indigenous but elements that may have been washed in.

The gulf coast Cretaceous record of *Neritina* is spotty, with several species recognized in the Comanche series of Texas by Stanton (1947, p. 61, 62) and in the Upper Cretaceous (Woodbine) of Texas by Stephenson (1953, p. 146–147). Stephenson's gastropod fauna definitely appears to be of shallower water origin than the Ripley.

Neritina? densata Conrad

1858. *Neritina densata* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 3, p. 288, pl. 46, fig. 37.

Diagnosis.—(Conrad, 1858, p. 288) "Semiglobose, thick, solid, spire concealed, labium callous, rounded, with an interior fold on the upper part."

Discussion.—Johnson (1905) does not list the holotype as being present in the collections of the Academy of Natural Sciences of Philadelphia. A more recent search by the author has failed to locate the specimen. An unnumbered specimen in the collections of that institution labeled "*Neritina densata* Conrad, Tippah County, Miss.," is incomplete but bears typical color markings and judging by the shell material is a fossil species. However, the specimen is smaller than the specimen figured by Conrad and is undoubtedly not the holotype. The locality is too obscure and the specimen in too poor a condition to state that it is more than only a possible representative of the genus in the Cretaceous.

The species described by Conrad is suggestive of *Neritina*, but on the basis of the available information, a definite placement is impossible. Subsequent collections from the type locality on Owl Creek, Tippah County, Miss., have failed to yield any additional specimens.

Type: Holotype (lost).
Occurrence: Mississippi: Owl Creek formation.

Neritina? sp.

Plate 6, figures 12–14

Discussion.—Several internal molds from the Prairie Bluff chalk of Mississippi possesses an outline and shape typical of *Neritina*. The molds reflect a shell of about two postnuclear whorls which expand very rapidly. The aperture is wide and flaring. The molds all have the impressions of rather broad spiral lirae or cords on their external surfaces and numerous crenulations on the interior of the outer lip. The later may reflect teeth on the inner lip. The aperture although flaring is narrowed interiorly or constricted by the inner edge of the parietal lip.

These specimens occur at approximately the same stratigraphic position as the Owl Creek formation and may be representatives of Conrad's species *N. densata*.

Measurements.—Explanation of measurements and symbols used in the following tables appears in the section on "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
57	16.4	16.5
57	17.1	18.4

Type: Hypotype USNM 128402.
Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 67.

Genus DAMESIA Holzapfel, 1888

Type by subsequent designation (Wenz, 1938. p. 419), *Crepidula cretacea* Müller, 1851.

Diagnosis.—Small low-spired shell with rounded whorls whose outer surface is marked by coarse spiral ornament and which possess an aperture with a projecting but nondentate inner lip; immature specimens bear a deep umbilicus, which is almost sealed at maturity.

Discussion.—The taxonomic position of this genus is in doubt. Holzapfel (1888, p. 168) discussed the genus and on the basis of the apertural characters placed it in the Neritidae. Wenz (1938, p. 419) followed Holzapfel but assigned *Damesia* to *Otostoma* as a subgenus. The growth history and presence of the umbilicus in the early stages contradicts an affinity to *Otostoma*. *Damesia* certainly appears to deserve generic and perhaps even subfamilial rank.

The genus is poorly known, being represented by only three species—two from the Aachen Cretaceous deposits of Germany, *D. cretacea* Müller and *D. decheni* Holzapfel; and one from the Ripley formation of Mississippi, *D. keownvillensis*. As known, the range of *Damesia* is small; it is found only in the late Campanian and early Maestrichtian.

This is the first report of the genus outside the type locality of the Greensand of Vaals in Germany.

Damesia keownvillensis Sohl, n. sp.

Plate 5, figures 37, 38; plate 6, figures 40–42

Diagnosis.—Small *Damesia* with thin inner lip and strong flat-topped spirals.

Description.—Shell small; spire low; suture deeply impressed; protoconch consists of one smooth well-rounded whorl slightly elevated above main plane of volution. Whorls three in number, with well-rounded sides and flattened upper surface on early whorls but broadly rounded on adult whorls. Ornament of about 5 widely spaced raised thick flat-topped spiral ribbons, which become subdued on body near aperture; on initial whorl upper 2 spiral cords delimit a flat upper part of whorl surface that is lost as spiral ribbons migrate down onto whorl sides and become subdued or lost. Growth lines weak, reflexed near suture but straight with a prosocline trend over body. Aperture inclined to axis and D-shaped in outline; outer lip rounded, sharp edged but thickening somewhat interiorly; inner lip thick, relatively straight, projecting into aperture; anterior margin sharp edged, bent outward and forms a rim at base of inner lip and partly overhanging umbilicus in immature specimens, but becoming reflexed at later stage and partly covers umbilicus.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
6 (holotype)	2.9	3.9
29 (paratype)	3+	4.5+

Discussion.—In shape and growth history this species closely resembles *D. decheni* Holzapfel, from the Aachen Cretaceous, but lacks the closely spaced coarse spirals and thick axial elements of that species. None of the available specimens appear to be fully adult, but they exhibit enough characters to ally them to *Damesia*. Two of the five available specimens show pronounced axial varices having a rather straight trend. The specimens show distinct color banding represented by darker brown bands that are transverse in arrangement. Several specimens bearing such colorations were bleached in the process of cleaning, and the pattern was lost.

The species is rare, occurring at three localities in the Ripley formation of Tippah and Union Counties, Miss.

Types: Holotype USNM 128403; paratype USNM 128404.
Occurrences: Mississippi: Ripley formation, locs. 6, 24, 29.

Superfamily LOXONEMATACEA

According to Knight and others (1954, p. 174, fig. 1), the Loxonematacea ranged from the Ordovician through the Jurassic. To date, no characteristic forms have been found in the Cretaceous, although the Cerithiacea probably descended from this group. In the collection from the Ripley formation of Union County, Miss., at locality 24, several small immature individuals have been found which show a sculptured nucleus that seems to be allied to that of certain loxonemataceans. The features exhibited by these specimens are, to the author's knowledge, unique and unknown in previously described Cretaceous or Tertiary forms. Although they are described below, their immature state does not allow confident assignment to a given genus. The presence of nuclear sculpture eliminates assignment to the Loxonematidae and Zygopleuridae. The closest parallel appears to be with the Pseudozygopleuridae, which, according to Knight (1930, p. 11), are characterized by zygopleuridlike shells having—

> * * * a minute, rather high-spired nucleus, coiled in the same direction as the later volutions and normally composed of about 3½ whorls, all but the first of which (the smooth protoconch) are ornamented by costae which run transverse to the whorls and have a strong sigmoidal curvature. Although the transition from the nepionic nuclear ornamentation to that of the neanic shell is quite abrupt no varix at this point has been observed.

The specimens under consideration possess transverse costae on the nucleus which simulate those in the pseudozygopleurids, but in general they are more definitely opisthocline, with a lesser tendency for a full sigmoidal trend.

Pseudozygopleurids have been reported only from the Pennsylvanian and Permian(?). In view of the nature of the specimens in hand and the wide time gap, it appears wise only to point out the similarities rather than make a definite assignment until such time as more complete specimens are available and we have a better knowledge of the nuclear characters of the Triassic and Jurassic forms.

Loxonematid gastropod, type A

Plate 6, figures 21, 22

Discussion.—Two specimens, both incomplete and lacking the initial whorl, retain up to 4½ whorls, including the transition from axial sculpture of the nucleus to distinctly spiral sculpture of the early teloconch. The nuclear sculpture consists of thin closely-spaced sharp-topped arcuate prosocline transverse riblets that are narrower than their interspaces. On the specimen figured on plate 6, figure 22, the ribs are present for a little over three whorls and increased in strength with growth. On the base of the last whorl, the trend of these ribs is again reflexed indicating a sigmoidal trend that is masked by the succeeding whorls on the spire. The spiral ornament of the teloconch develops gradually over the last whorl of the larger specimen. At the aperture the axial riblets are no longer visible, and the sculpture is dominated by six strong raised flat-topped spiral lirae that are about equal in strength and spacing.

Measurements.—Both specimens are very small, the larger measuring about 1.2 millimeters in length and the smaller less than 1 millimeter.

Types: Hypotypes USNM 128405, 128406.
Occurrence: Mississippi: Ripley formation, loc. 24.

Loxonematid gastropod, type B

Plate 6, figure 24

Discussion.—This specimen is perhaps the most unusual of the three types discussed here. Nearly three nuclear whorls are preserved—the first is smooth; the second bears thin faint arcuate prosocline axial riblets that fade out on the third whorl as the nucleus again becomes smooth. The teloconch is abruptly introduced by the development of strong, widespaced transverse ribs having a straight orthocline trend. In the axial interspaces there are about five round-topped strong spiral cords which do not override the axial riblets. The base of the last whorl is smooth, lacking both axial and spiral ornament.

Measurements.—The specimen measures about 2.4 millimeters in length.

Type: Hypotype USNM 128407.
Occurrence: Mississippi: Ripley formation, loc. 24.

Loxonematid gastropod, type C

Plate 6, figure 23

Discussion.—This specimen differs from both the preceding types by being proportionally broader, but it is intermediate in ornament. Three and one-half whorls are preserved, but the initial whorl is lacking. Thin closely spaced arcuate prosocline transverse riblets are present on the first 3¼ whorls, which are much like those of type A in character. However, near the aperture there is an abrupt change from these curved transverse riblets to the development of coarse strong transverse costae with faint spiral lirae in the interspaces. The transverse costae of this last stage are almost exactly the same as those developed on the teloconch of type B.

Measurements.—This small specimen measures only 1 millimeter in length.

Type: Hypotype USNM 128408.
Occurrence: Mississippi: Ripley formation, loc. 24.

Order MESOGASTROPODA
Superfamily CERITHIACEA
Family ARCHITECTONICIDAE

Genus PSEUDOMALAXIS Fischer, 1850

Type by monotypy, *Bifrontia? zanclea* Phillipi, 1836.

Diagnosis.—Discoidal shell with very wide umbilicus, flat to low spire, smooth flat protoconch, and whorls angulated at peripheral and umbilical margins, which gives the whorls a subrectangular cross section.

Discussion.—Fischer originally proposed *Pseudomalaxis* as a subgenus of *Solarium.* Iredale (1911, p. 254) subsequently raised it to generic rank but stated that *Bifrontia? zanclea* Phillipi had been misidentified by Fisher and should be replaced by *P. mcandrewi* Iredale. Cossmann (1915, p. 143) believed the old type species to be a true *Pseudomalaxis* and thus a valid type. Cossmann's stand appears to be valid and has been followed by most subsequent workers.

Climacopoma Fischer, a Cretaceous and Eocene genus, is similar but possesses a higher spire and lacks the straight whorl sides of *Pseudomalaxis. Mangonuia* Mestayer, a Recent Indo-Pacific genus also possesses similarities but the apertural angularity is absent, whereas *Calodisculus* Rehder, from the Pliocene, is more highly ornate and possesses a basal angulation as well as an umbilical angulation.

The type species, *Bifrontia? zanclea* Phillipi, is from the Pliocene of Sicily, and Stephenson (1941, p. 258) has cast some doubt on the advisability of assigning Cretaceous species to a Pliocene genus. Generic separation purely based on the time lapse of forms that are so closely similar seems inadvisable, especially if one considers *Spirolaxis* Monterosato of the Miocene as a subgenus of *Pseudomalaxis*, as does Wenz (1939, p. 669).

The genus has a wide distribution in the Upper Cretaceous, but relatively few species have been described. *P. ripleyana* Wade, *P. pilsbryi* Harbison, *P. patens* Stephenson, and *P. pateriformis* Stephenson have been recognized in the *Exogyra costata* zone of the gulf coast. Other Cretaceous species include *Discohelix leana* Gabb from California, *Discohelix simplex* Holzapfel from the Aachen Cretaceous, and *Solarium arcotense* Stoliczka from the Arialoor group of India.

Pseudomalaxis ripleyana Wade

Plate 6, figures 33, 34

1926. *Pseudomalaxis ripleyana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 175, pl. 59, figs. 5–7 [not 8 and 12].

Diagnosis.—Small *Pseudomalaxis* with noncrenulate spiral cords on peripheral whorl angulations and flattened and smooth upper whorl surfaces.

Discussion.—Wade described this species from immature shells, and the two specimens figured by him do not belong to the same species. The holotype figured by Wade (1926) on plate 59, figures 5–7 (USNM 73099), is a juvenile specimen preserving about six whorls and differs rather markedly from the second specimen. On the holotype all trace of crenulations on the raised spiral cords at the periphery are missing and it has a smooth upper whorl surface. In addition, the interangulation area (between peripheral and umbilical angulation) slants outward away from the axis. In all other gulf coast species, this area is inclined inward toward the shell axis. In addition, these species have coarse growth lines which form nodes or crenulations where they cross the spiral cords. Although specimens of *P. ripleyana* are rare and restricted to the type locality, all available specimens show these characters to be constant.

Types: Holotype USNM 73098; hypotypes USNM 128409, 128410.

Occurrence: Tennessee: Ripley formation, loc. 1.

Pseudomalaxis pilsbryi Harbison

Plate 6, figures 25–28, 31

1926. *Pseudomalaxis ripleyana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 175, pl. 59, figs. 8, 12 [not 5–7].

1945. *Pseudomalaxis pilsbryi* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, pl. 1, p. 81, figs. 5–7.

Diagnosis.—*Pseudomalaxis* with flat to slightly convex upper conch surface profile and spiral cords that are sharply crenulate where crossed by growth lines.

Description.—Discoidal shell of moderate size; apex flat to slightly convex. Protoconch of about 2¼ smooth and round-topped turns; first volution slightly submerged; junction with conch accompanied by flattening of upper whorl surface and addition of peripheral spiral cord. Whorls 5–6 in number and bicarinate, with subrectangular cross section; outer whorl face flat to slightly excavated. Sculpture ornate, consisting of numerous spiral cords; peripheral cord strongest, but cords decrease in strength toward suture. Below periphery, cords are of about equal strength with exception of stronger cord on basal angulation. Transverse riblets sharp, colabial, and thin in spiral interspaces but raised and accentuated, forming crenulations where they cross spiral elements. Umbilicus wide and deep, with walls oramented in later stages but only crenulate cord of umbilical carinae present on early whorls. Aperture subrectangular in outline.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*
18 (holotype)	6	2.5	9.0
18 (topotype)	5½	2.2	6.5
18 (topotype)	5½	2.4	7.5
18 (topotype)	5	1.6	5.6
6	6¼	4.1	11.0
6	6	3.4	10.0
6	5¾	2.9	8.0
16	6½	3.7	10.8
16	6	3.2	9.4

Discussion.—As here interpreted, this species shows great variability. The topotypes, like the holotoype, are rather consistent in having a flat spire; but at other localities, specimens show a range from a flat to moderately convex outline and seem to be intergradational. The same holds true of the umbilical width. Some specimens, such as those from Lee's Mill, Union County, Miss. (loc. 16), have a more convex upper surface, which makes for a narrower and proportionately deeper umbilicus. Even with these changes in shape, the pattern of ornament stays remarkably similar, varying only to a minor degree in the strength of development. Thus, as these differences appear to be intergradational within a given population, they are certainly of less than specific value.

The specimen from Coon Creek that Wade (1926, pl. 59, figs. 8, 12) figured as belonging to *P. ripleyana* is an immature specimen belonging to this species. Mature specimens from subsequent collections made at Coon Creek agree well with the type material but generally are flat spired, with little tendency for a convex upper surface.

Pseudomalaxis patens Stephenson from the Navarro group of Texas is also a related species but invariably has a much higher and more convex apex and well-developed spiral ornamentation is absent. *P. pateriformis* Stephenson from the Owl Creek formation differs in the absence of the well-developed spirals and also has less rapidly expanding whorls.

Pseudomalaxis pilsbryi Harbison is widely distributed in the Ripley formation of Mississippi and Tennessee but is rather uncommon at the individual localities.

Types: Holotype ANSP 16235; paratype USNM 103755; hypotypes USNM 73098B, 128411, 128412.

Occurrences: Mississippi: Ripley formation, locs. 5, 6, 9a, 16, 18, 22–24, 29. Tennessee: Ripley formation, loc. 1.

Pseudomalaxis sp. A

Plate 6, figure 30

Discussion.—Two incomplete specimens from the Ripley formation of localities 1 and 6 show characteristics that differentiate them from known species; however, their state of preservation does not warrant the assignment of a new name. In shape they are much like *P. pilsbryi* Harbison but differ in the early stages of development and even more noticeably in ornament. The transverse riblets are much closer in strength to the spiral cords than in Harbison's species, and the peripheral carinae bear a number of thin spiral lirae rather than one major cord. In addition, well-developed ornament is present on the umbilical walls at a very early stage and is almost as strong as that of the whorl surfaces.

Type: Hypotype USNM 128413.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, loc. 6.

Pseudomalaxis pateriformis Stephenson

Plate 6, figures 35, 38

1955. *Pseudomalaxis pateriformis* Stephenson, U.S. Geol. Survey Prof. Paper 274-E, p. 124, pl. 21, figs. 19–21.

Diagnosis.—Shell large for genus, discoidal, flat spired, with very wide and shallow umbilicus; ornamentation subdued, consisting of a prominent crenulate spiral cord on periphery and numerous thin noncrenulate spiral lirae over upper surface; growth lines very faint.

Measurements.—The holotype measures 13 millimeters in width and about 4 millimeters in height.

Discussion.—*Pseudomalaxis pateriformis* is based on the holotype from the bluffs of Owl Creek, Tippah County, Miss., and several molds from the Owl Creek formaton of Stoddard County, Miss. The subdued axial ornament separates it from the Ripley species, and its flat spire differentiates it from the Texas Navarro form *P. patens* Stephenson.

Types: Holotype USNM 20448; paratype USNM 128173.

Occurrences: Mississippi: Owl Creek formation, loc. 46. Missouri: Owl Creek formation.

Pseudomalaxis? stantoni Sohl, n. sp.

Plate 6, figures 29, 39, 43, 44

Diagnosis.—Shell small, subdiscoidal, with apex convex, and with one or two strong peripheral cords and strong basal carina.

Description.—Small subdiscoidal shell with a convex apex. Protoconch small, bulbous, immersed, consisting of about one turn, which lies at an angle to conch axis; suture impressed. Whorls have rounded upper surface and are basally subcarinate on early whorls but develop strong circumbilical carination on later whorls. Ornamentation begins with two spiral cords on upper whorl surface, which migrate to whorl sides, becoming fixed in position at 1½ to 2½ whorls; upper cord visible just above suture on spire; lower cord reaches periphery and is covered on all but immature specimens; on mature specimens cords diminish in strength and are usually absent on body whorl. Closely spaced round-topped colabral transverse riblets occur on first three whorls but are absent on body. Umbilical walls free of ornament in late stages, but early whorls bear transverse riblets that crenulate the umbilical carina. Aperture sublenticular, angulated anteriorly.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
6 (holotype)	0.9	2.0
6 (paratype)	(?)	2.3

Discussion.—The generic assignment of this species is questionable. It is similar to *Pseudomalaxis* in its umbilical character and mode of growth and in having the characteristic immersed protoconch. However, the whorls are not biangulated, do not possess the typical subrectangular whorl cross section of *Pseudomalaxis*, and have a greater degree of protoconch deviation. The form fits in no other related genera. Although all the eight available specimens are very small and the possibility of their being juvenile is great, the sequence of ornamentation is distinct and sufficient to distinguish the form even if larger specimens are found. The species is known from four localities in the Ripley formation of Union and Tippah Counties, Miss., but is rare.

Pseudomalaxis stantoni is named in honor of T. W. Stanton, who made many of the early collections studied in the report.

Types: Holotype USNM 128414; paratypes USNM 128415.

Occurrences: Mississippi: Ripley formation, locs. 6, 15, 24, 27, 29.

Pseudomalaxis sp. B

Plate 6, figures 32, 36, 37

Diagnosis.—Shell small, flat spired, with peripheral, basal, and umbilical whorl angulations giving the whorl a subsquare cross section.

Measurement.—The only specimen, a small incomplete shell, measures 3.1 millimeters in diameter.

Discussion.—*Calodisculus* Rehder is a monotypic subgenus characterized by its discoidal form and square cross section of whorl. The specimen here under discussion shows certain features similar to those of the type species and differing from *Pseudomalaxis* s. s. The specimen is immature and incomplete and is not considered sufficient for the assignment of a specific name. Surface ornament consists of broad spiral ribbons and raised transverse riblets which are accentuated to low elongate nodes on the ribbon nearest the suture. Ornament is subdued on the rounded whorl sde, but the umbilical margin is noded. Interiorly on the umbilical wall, another noded angulation is present, with a rather broad excavated area between the margin and wall angulations. This form differs from *Discosolis retifera* Dall, the type of *Calodisculus*, from the Pliocene of Florida, by its more subdued ornament, less square cross section of whorl and more rounded whorl sides. Although this specimen probably does not belong in the subgenus, it is of a similar type and farther removed from *Pseudomalaxis* s. s., which is peripherally biangulated and possesses no umbilical angulation.

Type: Hypotype USNM 128416.
Occurrence: Mississippi: Ripley formation, loc. 23.

Genus **MARGARITELLA** Meek and Hayden, 1860

Type by original designation, *Solarium flexistriatum* Evans and Shumard, 1851.

Diagnosis.—Small thin discoidal shell with nacreous inner shell layer; umbilicus deep, open, and moderately wide; umbilical margin crenulate.

Discussion.—In his description Meek (1876, p. 300) stated that *Margaritella* did not possess a crenulate umbilical margin. Stephenson (1941, p. 275) reexamined the type material and found the holotype to be an internal mold, but a figured paratype displayed evidence of a crenulate margin. After examining the type material, I agree with Stephenson's interpretation. The crenulations on the paratype are faint, but their subdued character is due to the fact that they are only reflections of the external crenulations on the inner shell layer and not the orginal exterior.

The physical form of the shell, its outline, and umbilical character seem to ally the genus to the Architectonicidae, but the presence of the thick nacreous layer is reminiscent of the Trochacea.

The type species is from the Upper Cretaceous of the western interior. Other species are rare but are to be found in the Upper Cretaceous of the gulf coast and in Europe.

Margaritella pumila Stephenson?

Plate 7, figures 1, 2, 9

1941. *Margaritella pumila* Stephenson, Texas Univ. Bull. 4101, p. 272, pl. 49, figs. 9, 10.

Diagnosis.—Small thin discoidal shell with row of nodes at suture and crenulate umbilical margin.

Description.—Shell small, thin, and discoidal, with nacreous inner shell layer. Protoconch of about 2¼ smooth rounded volutions, slightly raised above plane of the spire. Suture impressed. Upper whorl surfaces broadly arched; periphery acutely angular; base arched. Umbilicus deep, less than one-third total diameter. Ornament first appearing as strong colabral costae which traverse whorl surface from suture to suture. After about three-fourths of first teloconch whorl, these ribs retract and become concentrated to strong nodes at posterior suture. Nodes increase in strength for one-half to three-fourths of a whorl and then become faint, so that at mature aperture only mere traces remain. Where main ribs, from which sutural nodes develop, die out, their place is taken by low wide flat-topped closely-spaced transverse ribbons, whose width increases with growth. Spiral ornament develops later than transverse and is faint until later whorls, where it forms broad spiral ribbons that become slightly accentuated where they cross transverse ribbons and form a checkerboard pattern. Base sculptured by both transverse costae and spiral ribbons; costae arcuate in trend, thicken toward umbilicus; ribbons narrow and closely spaced near periphery, absent on medial part of base and reappear as two broad spiral ribbons contingent to umbilicus.

Measurements.—A hypotype measures 0.8 millimeter in height and 8 millimeters in maximum diameter.

Discussion.—The above description is based on specimens from the Ripley formation of Mississippi. In size and overall shape the Ripley specimens, although fragile and generally dorsoventrally crushed, appear to compare favorably with the holotype from the Nelandville marl of Texas, though, some differences in ornamentation are rather striking. The Mississippi specimens have a highly ornamented upper and lower surface, only faint traces of which can be seen on the holotype. The holotype, however, is a poorly preserved specimen, with the shell material replaced by calcite that has failed to preserve well the finer features of the ornament. It is therefore with some question in mind that this material is assigned to Sephenson's species.

The fragile nature of the shells makes recovery highly improbable and may in part account for the rarity of the species.

Types: Holotype USNM 76828; paratype USNM 76829; hypotypes USNM 20497, 128417, 128418.
Occurrences: Mississippi: Ripley formation locs. 13, 15–18, 24, 29.

Margaritella? sp.

Plate 7, figures 6, 12

Four internal molds from the Prairie Bluff formation of Mississippi have the low discoidal shape, moderately wide umbilicus, and angulated periphery of *Margaritella.* Unfortunately they show no signs of ornamentation, but they do exhibit a slight expansion of the body near the aperture. The type species of *Margaritella* is also an internal mold with features of ornament known only from paratypes. Except for larger size, the Prairie Bluff specimens compare well with the type species *M. flexistriata* (Evans and Shumard).

Type: Hypotype USNM 128419.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 67, 71, 84, 90.

Superfamily CERITHIACEA

Family VERMETIDAE

Only one genus, *Laxispira* Gabb, assignable to this family is present in the fauna of the *Exogyra costata* zone of Mississippi and Tennessee. Wade (1926, p. 158) assigned specimens from Coon Creek, Tenn., (*Serpulorbis marylandica* Gardner and *S. tennesseensis* Wade) to *Serpulorbis* Sassi, a junior subjective synonym of *Lemintina* Risso. Both of Wade's specimens, even if specifically distinct, possess the shell structure of serpulids and thus definitely do not belong to *Lemintina* nor in the Molluska.

Genus LAXISPIRA Gabb, 1877

Type by monotypy *Laxispira lumbricalis* Gabb, 1877.

Diagnosis.—Shell loosely, but regularly, coiled in the manner of *Vermicularia;* surface ornament of spiral lirae; aperture round to tear-drop shape.

Discussion.—Gabb (1877, p. 301) in describing the genus discussed its affinities as follows:

> A curious genus, the relations of which are not clear to me. I propose it to receive some shells which have been long known as internal casts in the marls of New Jersey, but of which the surface was unknown until quite recently. In general form they might be compared to a partially uncoiled *Turritella.* From that genus they differ, however, in whorls not being in contact, and from *Vermetus* and the allied genera in being regular spirals, but not having the apex either turritelloid, or attached.

Dall (1892, p. 307) placed *Laxispira* in *Siliquaria* Bruguière, 1789, (=*Tenagodes* Guettard, 1770), but that genus bears a spiral slit; furthermore, it is not regularly coiled. Wenz (1939, p. 679) treated *Laxispira* as a subgenus of *Vermicularia*, but if regular coiling and absence of a spire are sufficient criteria for distinction from *Tenagodes* and its allies, there would appear to be sufficient basis for differentiation from *Vermicularia.* The genus is here considered a distinct genus.

Laxispira includes the following Upper Cretaceous species: *L. lumbricalis* Gabb from the gulf coast, *L. turritelliformis* Vogel from Irnich Germany, *L. cochleiformis* (Müller) and *L. pinquis* Holzapfel from Aachen, and *L. trochleata* Böhm from the Senonian of Bavaria. The distribution pattern is of interest in its restriction to the gulf coast and northern European areas, which is an exception to most of the gulf coast species and may indicate a preference for the temperate if not the cooler waters.

Laxispira lumbricalis Gabb

Plate 7, figures 3–5

1877. *Laxispira lumbricalis* Gabb, Philadelphia Acad. Nat. Sci. proc. for 1876, p. 301, pl. 17, figs. 6–7.

1883. *Laxispira lumbricalis* Gabb. Tryon, Structural and Systematic Conchology, v. 2, p. 309, pl. 79, fig. 14.

1892. *Laxispira lumbricalis* Gabb. Whitfield, U.S. Geol. Surv. Mon. 18, p. 148, pl. 18, fig. 25.

1892. *Siliquaria lumbricalis* Gabb. Dall, Wagner Free Inst. Sci. Philadelphia Trans., v. 3, pt. 2, p. 307.

1907. *Laxispira lumbricalis* Gabb. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 706, pl. 81, figs. 1, 2.

1912. *Vermicularia lumbricalis* (Gabb). Cossmann, Essais Paléoconchologie Comparée, v. 9, p. 143.

1926. *Laxispira lumbricalis* Gabb. Wade, U.S. Geol. Survey Prof. Paper 137, p. 159, pl. 55, figs. 5, 8.

1939. *Vermicularia* (*Laxispira*) *gabbi* Wenz, Handbuch der Paläozoologie, Gastropoda, pt. 3, p. 679.

Diagnosis.—Open but regularly coiled shell with round whorl cross section; sculpture of slightly beaded spiral lirae.

Description.—Shell an open-coiled spiral; protoconch of a little more than two smooth trochoid to loosely coiled volutions. Whorls circular in cross section. Sculpture of raised spiral lirae of varying widths; lirae possess rounded nodes on their upper surfaces which are formed as the growth lines become accentuated in crossing the lirae; secondary lirae present in the spiral interspaces. Aperture slightly longer than wide, with thin uninterrupted lips; in some mature specimens posterior extremity of aperture becomes somewhat angulated.

Discussion.—Most of the shells are rather small, generally 2 centimeters or less in height and rarely more than 1 centimeter in width. *L. lumbricalis* is common in the Ripley formation, and in a few places it is present in considerable abundance. Its range, both stratigraphic and geographic, is broad. It has been reported from the *Exogyra ponderosa* zone through most of the *E. costata* zone. Although no specimens have been found in the Owl Creek formation, its possible presence is indirectly indicated by the occurrence of several poorly preserved specimens from basal limestones of the Clayton formation that yield a reworked Cretaceous fauna. Geographically the species has been reported from New Jersey to Mississippi, but none have been noted from Texas. The generalized nature of the shell with its variability of form and absence of individualistic ornamentation does not lend itself to specific differentiation. Compared with the type material from New Jersey the Ripley specimens are generally smaller in size and possess secondary spirals that are not mentioned as being present on the types. A comparison with topotypes from New Jersey may show other differences not now discernible and might favor a separate designation for these forms.

Types: Holotype ANSP lost; hypotype ANSP; hypotypes USNM 32950 (Tennessee), and USNM 128420 and 128421 (Mississippi).

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Coffee sand (USGS Mesozoic loc. 25483); Ripley formation, locs. 2, 5–7, 9a, 13, 15–18, 27, 29, 32, 36; Clayton formation, reworked Cretaceous material at base (USGS Mesozoic locs. 19087(?), 4053(?). Alabama and Georgia: (Chattahoochee River Region), Ripley formation. Delaware: Crosswicks clay. New Jersey: Merchantville and Woodbury clays.

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Type by monotypy, *Turbo terebra* Linné, 1758.

Diagnosis.—Slender multiwhorled turriculate to turrited shell with flat, concave, or convex whorls; aperture ovate; sculpture highly variable.

Discussion.—The genus was originally proposed by Lamarck in 1799 to contain only the type species *Turbo terebra*, but since that time the number of described species has risen to astronomical proportions. The genus is one of the best represented of the later Mesozoic genera and is even more abundant in the Tertiary. Merriam (1941) estimated that there are over 700 described species of *Turritella.*

As one might expect in such a large group, the taxonomy has become exceedingly complicated by the proposal of numerous subgeneric categories, many of which appear to be synonyms.

The primary difficulty in dealing with the genus has been the determination of which characters exhibited by the shells are diagnostic for subgeneric differentiation. The list of characters used is long and varies with the individual worker. Such features as apical angle, ornament, whorl profile, and shape of aperture have been used by many as a classificatory basis. Such specifically variable features as those listed above where used for supraspecific distinction have more generally led to confusion rather than clarification. As exhibited by the works of Guillaume (1924), Merriam (1941), Bowles (1939), and Ida (1952), the recent trend is to consider growth lines the feature of primary importance and to consider ornament, upon which prior classification was based, too variable to be of genetic significance. Guillaume (1924) proposed five main broad divisions for the European Tertiary turritellids, based on the trend of the growth lines; but as Stewart (1927, p. 352) and Woodring (1928, p. 348) have pointed out, names already existed for his categories.

The important features of Guillaume's work, as summarized by Merriam (1941, p. 32), are:

1. Within the European region since the beginning of Tertiary time, successive groups of turritellas have appeared, each characterized by a particular growth-line trace.
2. Each of the groups seems to be independent.
3. The sinus of the external lip, limited by two points of inflection, is relatively narrow and deep in the oldest Tertiary group, which is also the one that disappears first from the European region; the sinus becomes reduced progressively in the groups of most recent appearance.

In speaking of Guillaume's groups Merriam (1941, p. 33) states: "for example, the growth lines of *T. terebra* and *T. terebralis* are similar, but the characters of nuclear ornamentation differ to such a degree that the two species cannot well be placed in the same division." Because of the seeming constancy of the development of the primary spirals of the nuclear whorls, Merriam (1941, p. 34), followed by Bowles (1939, p. 270), added the character of the apical whorls to those of the outer lip or growth lines to subdivide the turritellids into groups in the areas with which they were concerned. This has led to subdivisions such as the unicostate group, bicostate group, and others, indicative of the number of primary spirals on the apical whorls.

To this point the method of classification has the merit of simplicity, and it avoids the usage of subgeneric taxons that are either poorly defined or biologically unsupportable. However, complications again arise, as the various categories and "stocks" present in one area do not hold for another. Thus Bowles had to introduce new "stocks" for the Atlantic and gulf coast turritellids not covered by Merriam's west coast "stocks." The same holds true for Ida's studies of the Japanese turritellids. Ida (1952, p. 1–21) set up a complicated terminology for the description of turritellids primarily to facilitate biometric analysis. Such a terminology, however, only increases the already overburdened and confusing nomenclature. He again includes so many characters that the taxonomy of the group is rapidly coming round to a full cycle; the simplicity of Merriam's system is being lost, and a return to preexisting confusion is in the offing.

As dealt with here, the simplified form of designation of Bowles (1939) is followed where practicable. In some specimens, state of preservation does not allow for definite placement.

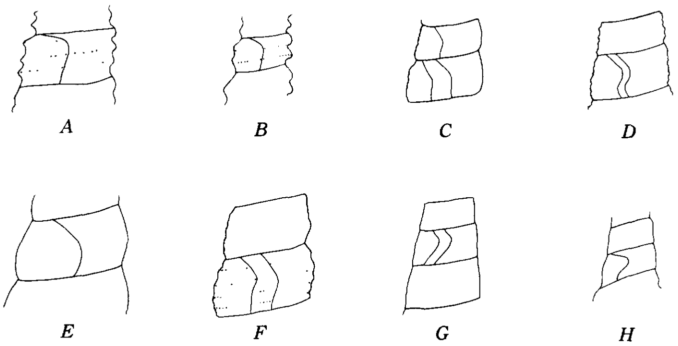

FIGURE 8.—Comparison of growth-line trend of the species of *Turritella* from the Ripley and Owl Creek formations. *A*, *Turritella trilira* Conrad, *B*, *T. bilira* Stephenson; *C*, *T. howelli* Harbison; *D*, *T. tippana* Conrad; *E*, *T. macnairyensis* Wade; *F*, *T. vertebroides* Morton; *G*, *T. unionensis* Sohl; *H*, *T. chalybeatensis* Sohl.

The phylogeny of the turritellids has been adequately discussed by Merriam (1941, p. 18–26).

The Upper Cretaceous gulf coast turritellids differ distinctly from those of the Lower Cretaceous. Typical Comanche species, such as *Turritella seriatimgranulata* Roemer and *T. belviderei* Cragin possess noded spiral ornament. Similar ornament is also typical of the Cenomanian (Woodbine) species described by Stephenson (1952, p. 153), which are more closely related to the Comanche species than to the Upper Cretaceous species. On the Upper Cretaceous species both nodes and beading are absent and they are closer in appearance to the Tertiary species. Some of the Campanian - Maestrichtian species show considerable affinity for Tertiary forms. Merriam (1941, p. 23) pointed out the similarity of *T. vertebroides* Morton to his *T. chicoensis* stock. *T. hilgardi* Sohl and *T. kellumi* Stephenson are similar in many ways to the *T. humerosa* group of Bowles, especially to the Paleocene species such as *T. aldrichi* Bowles. The *Turritella trilira* group, including *T. bilira* Stephenson and *T. quadrilirata* Johnson, forms a tightly knit group ranging through the *Exogyra ponderosa* and *E. costata* zones. This group probably possessed representatives in the Upper Cretaceous of other regions as represented by *T. figari* Quass from Libya and *T. bonei* Baily from South Africa. The *T. trilira* group is similar to some species of the *T. nasuta* complex of the Wilcox and Claiborne groups of the gulf coast but belongs to a distinct bicostate rather than to a tricostate group.

Figure 8 indicates the growth line traces typical of the gulf coast species from the Ripley and Owl Creek formations. As can be seen, the growth lines are distinct for the individual species and are, in themselves, sufficient for specific differentiation. In addition they aid in placing the species within the main groups. For example, in the list below, three species are listed under the bicostate group. Two species, *T. trilira* and *T. bilira*, are closely related in having a similar growth line trend and developmental history. Although *T. howelli* is bicostate initially, it differs in later stages in its growth line as well as its type of ornament and therefore belongs to another subgroup. A study of the growth lines is especially valuable in such species as *T. tippana*, in which ornament is highly variable.

The Ripley and Owl Creek species are placed as follows:

Biscostate group:
- *Turritella trilira* Conrad
  - *bilira* Stephenson
  - *howelli* Harbison

Tricostate group:
- *Turritella tippana* Conrad
  - *vertebroides* Morton

Multilirate group(?):
- *Turritella macnairyensis Wade*
  - *hilgardi* Sohl

Placement uncertain:
- *Turritella chalybeatensis* Sohl

These groups are used informally pending clarification and stabilization of subgeneric categories.

BICOSTATE GROUP

Turritella trilira Conrad

Plate 7, figures 8, 10, 17, 20, 27, 28

1860. *Turritella trilira* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 4, p. 285.
1861. *Turritella corsicanna* Shumard, Boston Soc. Nat. History Proc. v. 8, p. 196.
1901. *Turritella trilineata* Hill, U.S. Geol. Survey 21st Ann. Rept., pt. 7, pl. 48, fig. 3.
1902. *Turritella trilineata* Hill. Hill and Vaughan, U.S. Geol. Survey Geol. Atlas, Austin Folio (no. 76), fig. 47.
1906. *Turritella trilira* Conrad. Weller, New Jersey, Geol. Survey, Paleontology, v. 4, p. 699, pl. 79, figs. 4, 5.
1906. *Turritella trilira* Conrad. Veatch, U.S. Geol. Survey Prof. Paper 46, pl. 11, fig. 4.
1923. *Turritella trilira* Conrad. Stephenson, North Carolina Geol. and Econ. Survey, v. 5, p. 360, pl. 90, figs. 2–9.
1926. *Turritella trilira* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 161, pl. 56, fig. 3.
1926. *Turritella trilira* Conrad. Stephenson, Alabama Geol. Survey Special Report no. 14, pl. 92, fig. 15.
1940. *Turritella trilira* Conrad. Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 15, fig. 7.
1941. *Turritella trilira* Conrad. Stephenson, Texas Univ. Bull. 4101, p. 286, pl. 52, figs. 1–5.
1944. *Turritella trilira* Conrad. Shimer and Shrock, Index Fossils of North America, p. 493, pl. 201, fig. 13.

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

Measurements.—Explanation of measurements and symbols used in the following table appears in the section on "Measurements of specimens" (p. 48).

Loc.	*PA* (in degrees)	*H*	Estimated *H*	*MD*
1	17.5	52.6	69.0	21.0
1	18.0	47.0	79.0	21.5
1	19.0	37.5	48.0	14.6
1	18.0	50.0	63.0	18.0
1	16.0	36.0	58.0	17.5
1	17.0	37.0	70.0	18.0
1	14.5	51.0	60.0	17.2
1	15.0	43.5	56.0	17.0
18	16.0	42.5	52.0	18.3
18	16.0	42.8	57.0	19.0
18	15.0	36.0	49.0	15.5
18	16.0	21.0	27.0	7.8
18	16.5	16.0	19.0	6.6
40	17.0	56.0	76.0	19.0

Discussion.—Consistently *Turritella trilira* Conrad is one of the most abundant, widely distributed, and long-ranging gastropod species in the Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plains.

As the name implies, the species is characterized by bearing three prominent, thin, and sharp-crested spirals that vary in strength from cords (pl. 7, fig. 20) to high shelves (pl. 7, fig. 27). A fourth spiral (pl. 7, fig. 8), not visible on the spire, forms a basal carination below which there is a flat and rather smooth base. Very faint microscopic spiral threads occur in the interspiral spaces and on the base of adult specimens. Some specimens with the spire broken reveal a distinctive partition or septum which separates the early whorls from the adult part of the teloconch. This septum is convex in the direction of growth and is drawn out to a curving cone at its apex. This septal form may be distinctive of *T. trilira* as it differs from the typical symmetrical hemispherical septum in most other species of *Turritella.* On the initial whorls, ornament begins with only two spirals (pl. 7, fig. 10), with the medial of the three primaries developing at a later stage.

T. trilira is very common in both the Owl Creek and the Ripley formations. Variations occur in size and in strength of ornament. Specimens from the Owl Creek appear to be larger on the average than those from the Ripley formation, but equally large specimens also occur in the latter, but with less frequency. In ornament and outline, variation is common. The specimen on plate 7, figure 20, from the Ripley formation of Union County, Miss., illustrates a form with subdued spiral ornament. Other specimens from the same locality possess moderately to very highly raised spiral shelves. Thus all these variations seem to be infraspecific. Possibly the most unusual occurrence of this species is at locality 17, near Molino, Union County, Miss., where a roadcut in the lower part of the Ripley exposes round pockets of concentrated shell material that contain a great abundance of small specimens of *T. trilira,* all less than 1 inch long. In the sand surrounding the pockets, specimens are of a more normal adult size and are well scattered through the sand, as is typical of the lower part of the Ripley. Thousands of specimens could be collected at this one locality alone.

The holotype is not present in the collections of the Academy of Natural Sciences of Philadelphia. The type locality is not known beyond being in Tippah County, (either Tippah or northern Union County of the present boundaries, fig. 4), Miss. Stephenson (1941, p. 286) based his discussion of the species on specimens from locality 15 in Union County, which is probably close to the type locality but is in the lower and not the upper part of the Ripley, as he states.

Turritella quadrilirata of the *Exogyra ponderosa* zone and *T. bilira* from the upper part of the *E. costata* zone possess similar growth lines (see fig. 8) and a similar developmental history. All begin their ornamentation with two primary spiral lirae and form an evolutionary sequence beginning with the quadrilirate form in the *E. ponderosa* zone and ending in the *E. costata* zone with the bilirate form.

T. deatsvillensis Stephenson, from the Kemp clay of Texas, is, according to Stephenson (1941, p. 293), closely analogous to *T. trilira* but "differs in having a wider apical angle, and a secondary lira between the second and third primaries." *T. figari* Quass, from beds of posible Maestrichtian age in the Libyan desert, is another very close analog of *T. trilira* but has a slightly less reflected growth line in the available figures. *T. bonei* Baily, from Pondoland, South Africa, is also similar but has a slightly slimmer spire. The close similarity of these forms raises suspicions as to their relationships but must be viewed with caution, as this simple type of ornament also recurrs on later Tertiary species.

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

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 3–12, 14–18, 22–24, 27, 29, 30, 32, 33; Owl Creek formation, locs. 43, 45, 46; Prairie Bluff chalk, locs. 54, 57, 71, 72, 75, 87, 88; Coffee sand. Texas: Wolfe City sand member of the Taylor marl, Anacacho limestone, San Miguel formation, Neylandville marl, Nacatoch sand, Corsicanna formation. Arkansas: Brownstown marl, Saratoga chalk, Nacatoch sand. Alabama: Blufftown, Cusseta, and

Ripley formations, Providence sand and Prairie Bluff chalk. Georgia: Blufftown formation, Ripley formation, and Providence sand. North Carolina: Black Creek and Peedee formations. Maryland: Matawan and Monmouth formations. New Jersey: Wenonah sand.

Turritella bilira Stephenson

Plate 7, figures 16, 23

1941. *Turritella bilira* Stephenson, Texas Univ. Bull. 4101, p. 268, pl. 52, figs. 9–16.

Diagnosis.—High-spired, tapering medium-sized turritellid bearing two sharp-crested thin spiral flanges on the whorl sides.

Measurements.—Explanation of measurements and symbols used in the following table appear in the section on "Measurements of specimens" (p. 48).

Loc.	*H*	Estimated *H*	*MD*
Georgia (holotype)	19.2+		6.7
USGS 9515 (Clayton formation)	35.0	35.0	12.1
40 (Clayton formation)	7.0	10.0	3.0

Discussion.—*Turritella bilira* occurs widely from Texas to Georgia; locally, as at its type locality in the Providence sand on Pataula Creek, Ga., it occurs in some abundance. Throughout its range, aside from Mississippi, the species is restricted to the latest Cretaceous beds. In Mississippi it may range slightly lower in the section into the Ripley formation. (See discussion of "Locality 9".) In form this species is much like *T. trilira* but is smaller and is easily distinguished by its characteristic ornament.

The species exhibits considerable variation, especially in its pleural angle and the strength of the spirals.

T. bilira is rare in the Cretaceous of Mississippi and Tennessee—only one specimen at each of two Owl Creek localities, one specimen from the Prairie Bluff chalk, and several specimens supposedly from the Ripley formation of Tippah County have been found. However, it is quite commonly found reworked into the basal limestone of the Clayton formation (Paleocene). All the specimens from this area conform more closely to the paratype figured by Stephenson (1941, pl. 52, figs. 10–13) than to the holotype.

Types: Holotype USNM 76867 (Georgia), paratype USNM 76868 (Georgia), hypotypes USNM 76870 (Texas) and USNM 128432 and 128433 (Mississippi).

Occurrences: Tennessee: Clayton formation (reworked Cretaceous at base), loc. 40. Mississippi: Ripley formation, locs. 9, 9a; Prairie Bluff chalk, loc. 57; Clayton formation (reworked Cretaceous material), locs. 60, 69. Texas: Kemp Clay. Alabama: Providence sand. Georgia: Providence sand.

Turritella howelli Harbison

Plate 7, figures 11, 13, 14, 18, 19

1907. *Turritella vertebroides* Morton. Weller, New Jersey Geol. Survey, Paleontology, v. 4, pl. 78, fig. 14.

1945. *Turritella howelli* Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 47, p. 82, pl. 3, figs. 19–20.

Diagnosis.—Medium-sized turritellid of bicostate group, with convex whorl sides bearing 4–6 major spiral lirae and a rounded base with numerous spirals.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
18	55.0	18.5
18	45.2	15.0
18	40.0	12.8
18	43.5	14.4
18	46.0	16.3
18	44.0	14.0
18	40.2	13.5
16	46.1	15.2
16	44.5	16.0
16	46.3	16.0
16	43.2	13.5
16	51.4	16.3
6	48.0	15.0
6	52.0	16.2
6	50.5	15.1
6	44.8	14.0
6	44.8	15.0

Discussion.—This species is easily distinguished from *Turritella vertebroides* by its rounded base, which is marked by numerous spirals, and by its more numerous but less prominent spiral lirae on the whorl sides. J. A. Gardner (1916, p. 489) noted the specimen figured by Weller (1907, pl. 78, fig. 14) as not belonging to *T. vertebroides* and distinguished it from her *T. paravertabroides* of Maryland by its rather larger size, its more flattened whorls, its sculptured apical region, its broader primaries with numerous intercalated secondaries, and its less strongly lirated base. In trend of growth line, however, *T. howelli* does appear to be related most closely to the Maryland species.

Turritella howelli is very abundant in the lower and middle parts of the Ripley formation of Tippah and Union Counties, Miss., but only one specimen has been found as low as the *Exogyra cancellata* zone. There seems to be a direct relationship between the abundance of specimens of *T. howelli* and *T. tippana* at a given locality. At localities where the one is abundant, the other is rare. As the balance of the rest of the fauna is not much disturbed or changed, this anomaly does not appear to be an ecologic discrimination as much as a possible competition factor. It is possible that both species competed for the same niche, and at places where one had a firm foothold the other had difficulty in surviving. That *T. tippana* survived after *T.*

howelli may be due to the former's being less closely restricted in habit.

Types: Holotype ANSP 16711; paratype USNM 21128; hypotypes USNM 128434–128436.

Occurrences: Mississippi: Ripley formation, locs. 4-6, 12–19, 24, 29. Alabama: Ripley formation. Georgia: Ripley formation.

TRILIRATE GROUP

Turritella tippana Conrad

Plate 7, figures 7, 15, 21, 22, 30–32

1858. *Turritella tippana* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 3, p. 333, pl. 38, fig. 19.

1862. *Turritella winchelli* Shumard, Boston Soc. Nat. History Proc., v. 8, p. 196.

1907. *Turritella tippana* Conrad. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 100, pl. 79, figs. 6, 7(?).

1926. *Turritella tippana* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 162, pl. 66, fig. 9.

1926. *Turritella encrinoides* Morton. Wade, U.S. Geol. Survey Prof. Paper 137, p. 160, pl. 56, fig. 4.

1940. *Turritella winchelli* Shumard. Stephenson, Texas Univ. Bull. 4101, p. 289, pl. 53, figs. 1–3.

1955. *Turritella tippana* Conrad. Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 126, pl. 22, figs. 20–22.

Diagnosis.—Medium to large turritellid with numerous secondary spiral lirae of variable strength between the three primary spiral cords of the whorl sides; lower two primaries closely spaced; base with spiral striae; growth line sinuous.

Description.—Conrad's original description (1858, p. 333) is as follows:

Subulate, sides straight; volutions carinated with revolving lines, two in each volution larger than the others, remote one nearly equal in size, nearly medial and three other fine lines; whorls of spire carinated at base.

More detailed descriptions have been provided by Weller (1907) and Stephenson (1955).

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*PA*	*H*	Estimated *H*	*MD*
46 (topotype)	19.0°	64.0	65.0	21.7
46 (topotype)	18.5°	57.4	60.0	17.0
46 (topotype)	18.0°	53.9	79.0	20.2
46 (topotype)	18.5°	44.0	59.0	17.0
46 (topotype	17.5°	32.5	51.0	14.8
1	19.0°	38.1	52.0	14.1
1	17.5°	42.5	59.0	15.3
1	19.0°	37.1	44.0	13.1
1	17.5–	43.1	55.0	16.5
1	16.0°	35.6	42.0	12.2
31	------	56.4	79.0	21.7
44	19.0°	44.3	64.0	18.2
45	16.0°	54.6	60.0	18.0

Discussion.—Conrad's description and illustration are both poor, and the holotype is no longer in the collections of the Academy of Natural Sciences of Philadelphia. Fortunately, sufficient topotype material is available from Owl Creek, Tippah County, Miss., to indicate the wide range of variability of the species.

Turritella tippana is typified by its flat-sided whorls and ornate but variable surface sculpture. Three primary spirals cords of almost equal strength dominate this sculpture. The first is situated near the suture at about ⅕–¼ the whorl height; the other two are more closely spaced and situated on the lower one-half of the whorl. Secondary spiral lirae vary greatly both in strength and in numbers (compare pl. 7, figs. 7, 21, 30–32) and, though always subdued on the spire, may rival the primaries in strength on the body. The growth line of *T. tippana* (see fig. 8 and pl. 7, fig. 22) is distinctive, being more sinuous than that of any other representative of the genus in the *Exogyra costata* zone. Specimens are rather fragile and few are recovered in a complete condition. The earliest whorls of the conch, if retained, show a dominant lower spiral that carinates the whorls, but although much subdued the other two primary spirals are present and appear to ally this species with the trilirate group. The variation in ornament cited above will not serve as a basis for distinguishing more than one species, as an almost complete range of variation may be found in a single population of a given locality. The uniformity in early stages of development and in trend of growth line also favors the retention of these variations within a single species.

Wade (1926, pl. 56, fig. 4) figured a turritellid from Coon Creek, as belonging to *T. encrinoides* Morton. This species is based on fragmentary material, and the character of the species is in doubt. Wade's specimen appears to belong to *T. tippana.*

The New Jersey specimen that Weller (1907, p. 100) assigned to this species is from the Marshalltown formation, a position stratigraphically lower than the occurrence of *T. tippana* in the gulf coast. I have not studied the specimen, and, although the illustration gives some faint evidence of a different growth line, the ornament might well fall within the range of variability of the species. Gardner (1916, p. 491) noted the presence of *T. tippana* in the Monmouth formation of Maryland but figured no specimen. Only one specimen labeled *T. tippana* could be located in the Gardner collection of Maryland Cretaceous fossils at the U.S. National Museum. It is a very incomplete and much compressed specimen. Where visible, the spiral lirae are subdued, and the part of the base preserved suggests it was smooth. Thus this occurrence should be held in question until better preserved specimens are available.

T. winchelli Shumard from the Nacatoch sand of Texas appears to be a synonym of *T. tippana.* The available Texas specimens show a variation in ornament similar to that of *T. tippana* and have a spirally striated base, three primary spiral cords, a similar apical angle, identical growth lines, and early whorls which show the same developmental characters as those of the Mississippi species. The specimens of *T. winchelli* figured by Stephenson (1941, pl. 53, figs. 1–3) appear slimmer and have more subdued ornament. They are all small and must be compared with equivalent growth stages of *T. tippana.* When so compared, these differences do not appear to be significant (compare with pl. 8, fig. 7). The pleural angle falls within the range of variation, as does the range of variation in sculpture. The more subdued ornament of the Texas forms is at least in part due to the mode of preservation.

The species as here defined ranges through the *Exogyra costata* zone of the gulf coast and is questionably present near the top of the *E. ponderosa* zone on the Atlantic Coastal Plain. As is true of the other turritellids, this species is abundant in many places and is consistently large and less variable in size than other species of *Turritella.*

Types: Holotype ANSP, lost (Mississippi); hypotypes USNM 73073 (Mississippi), USNM 20419 (Mississippi), USNM 76872 (Texas), USNM 76873 (Texas), USNM 128179 (Missouri), 128180 and 128428–128431 (Mississippi).

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1; Clayton formation (reworked Cretaceous material at base), loc. 40. Mississippi: Ripley formation, locs. 4, 9–11, 18, 22, 25, 31–33; Owl Creek formation, locs. 43–46; Prairie Bluff chalk, locs. 51, 55, 59, 71, 88; Clayton formation (reworked Cretaceous material at base) of Union County. Missouri: Owl Creek formation. Arkansas: Nacatoch sand. Texas: Navarro group–Nacatoch sand. New Jersey: Marshalltown formation (questionable specimen reported). Maryland: Monmouth formation (questionable specimen reported).

Turritella vertebroides Morton

Plate 8, figures 1–4, 12

1834. *Turritella vertebroides* Morton, Synopsis of the organic remains of the Cretaceous Group of the United States, p. 47, pl. 3, fig. 13.

1892. *Turritella vertebroides* Morton. Whitfield, U.S. Geol. Survey Mon. 18, p. 146, pl. 18, figs. 13–18.

1907. *Turritella vertebroides* Morton. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 293, pl. 78, figs. 15, 16(?), 17 [not 14].

1926. *Turritella vertebroides* Morton. Wade, U.S. Geol. Survey Prof. Paper 137, p. 161, pl. 61, fig. 1.

1926. *Turritella paravertebroides* Gardner? Wade, U.S. Geol. Survey Prof. Paper 137, p. 160, pl. 56, fig. 5.

1941. *Turritella vertebroides* Morton. Stephenson, Texas Univ. Bull. 4101, p. 290–291, pl. 53, figs. 5–13.

1944. *Turritella vertebroides* Morton. Shimer and Shrock, Index Fossils of North America, p. 491, pl. 202, figs. 9–12.

1955. *Turritella vertebroides* Morton. Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 126, pl. 22, figs. 16–19.

Diagnosis.—Large turritellid with four major spiral cords on the well-rounded whorl sides and a fifth at the base that delimits a flat smooth base; growth lines flexed medially.

Discussion.—This is one of the more widespread better documented species of *Turritella* on the gulf coast. There is a moderate amount of variation in ornament, but the flat smooth base and the four strong major spiral cords on the whorls of the spire easily distinguish it from other Cretaceous turritellids of the gulf coast. The ornament becomes quite subdued on the spire, with the lower or fourth primary cord predominating. Secondary spiral elements occur between the majors, generally as fine spiral threads (pl. 8, fig. 1, 2); but at places, as at some of the localities from the middle part of the Ripley in Mississippi, several of the secondaries may approach the primaries in strength (pl. 8, figs. 2, 4). These stronger secondaries can be distinguished by their sharpness or by tracing their development back on to the spire, where they are subdued. In the large full adult, there is a tendency for loosening of coiling, and the whorl at the aperture may become completely free. (See pl. 8, fig. 3.) Several specimens with broken spires show a hemispherical septum which seals off the early parts of the spire.

The specimen figured by Wade (1926, pl. 56, fig. 5) as *T. paravertebroides* Gardner? appears to be a *T. vertebroides* Morton with several secondary spiral lirae increased in strength. It possesses the basal characters of Morton's species, not Gardner's. The species ranges through the *Exogyra costata* zone throughout the gulf coast. Weller (1907, pl. 78, figs. 14–17) figured specimens from Alabama and New Jersey. Weller's figure 14 is not a specimen of *T. vertebroides* but of *T. howelli* Harbison, and figures 15 and 17 from the Navesink marl of New Jersey are indeterminable molds. Thus, no absolute proof has been presented as to the presence of the species in New Jersey. In the Navarro group of Texas Stephenson (1941, p. 290, 291) has reported four varieties of *T. vertebroides*, differentiated on the basis of fine details of ornament and ranging from the Neylandville marl to the Kemp clay. The preservation of the types make it difficult if not inadvisable to assign Mississippi specimens to these subdivisions.

Types: Holotype ANSP (Mississippi); hypotypes USNM 32955 (Tennessee), USNM 21128 (Alabama), USNM 128181 (Mississippi).

Occurrences: Tennessee: Ripley formation, loc. 1; Clayton formation (reworked Cretaceous material at base), loc. 40. Mississippi: Ripley formation, locs. 3, 4, 6, 8, 10, 11, 14–18, 22–24, 26–29, 33, 37; Owl Creek formation, locs. 41, 43–46, USGS 6875; Prairie Bluff chalk, locs. 52–55, 71, 72, 74, 75, 82, 83, 87, 88, 91, 94; Clayton formation (reworked Cretaecous material at base), Tippah and Union Counties, Miss. Texas: Navarro group—Neylandville marl through Kemp clay. Arkansas: Nacatoch sand. Missouri: Owl Creek formation. Alabama: Prairie Bluff, Ripley, and Providence formations. Georgia: Ripley formation.

MULTILIRATE GROUP?

Turritella macnairyensis Wade

Plate 7, figure 29

1926. *Turritella mcnairyensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 159, pl. 56, fig. 2.

Diagnosis.—Medium-size turritellid with plump well-rounded whorls and base; generally with 9 or 10 low fine spirals on whorl sides.

Measurements.—A hypotype (USNM 128440, pl. 7, fig. 29) measures 28.5 millimeters in height and approximately 11 millimeters in diameter.

Discussion.—This rare species is not well known. Only 2 specimens, 1 of which is the holotype, are present in the collections of the U.S. National Museum. *Turritella macnairyensis* is not likely to be confused with other turritellids of the *Exogyra costata* zone. In shape and ornament it most closely resembles *T. houstoni* Stephenson, from the Nacatoch sand of Texas, but has plumper whorls and a rounded base. *T. austini* Stephenson, from the same formation, has plump whorls but again possesses a flattened base.

Types: Holotype USNM 32956; hypotype: USNM 128440.
Occurrence: Tennessee: Ripley formation, loc. 1.

Turitella hilgardi Sohl, n. sp.

Plate 8, figures 5, 6, 10

Diagnosis.—Slim turritellid of medium size with numerous flat-sided whorls sculptured by many closely spaced spirals; growth lines sinuous.

Description.—Shell of medium size, turriculate; pleural angle 15° to 19°; whorls flat-sided, giving a smooth outline to the spire. Protoconch unknown; suture slightly impressed. Whorls numerous, 14 on the largest but incomplete specimen. Sculpture of numerous closely spaced round-topped spiral cords which are wider than interspaces, with lowest cord the strongest; maximum of 25 cords noted on largest paratype. Spirals decrease in strength and number on early whorls until the only easily recognizable one left is the lowest one. Growth lines sinuous, prosocline on upper third leading to a deep sinus above mid-length, steeply opisthocline on lower two-thirds with angle of inclination lessening near suture. Aperture unknown.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
18 (holotype)	28.7+	10
5 (paratype)	47.2	12

Discussion.—The form and ornament exhibited by this species, as well as the distinctive sinuosity of the growth lines, is more typical of the Tertiary turritellids than of the Cretaceous species. Only one Cretaceous species is similar—*T. kellumi* Stephenson from the Peedee formation of North Carolina. *T. kellumi* possesses an impressed suture that is especially prominent on the earlier whorls, has numerous crowded and sometimes somewhat irregular spiral lirae (as many as 22 spiral lirae, as on the penutimate whorl of the holotype), and also has broadly rounded whorl sides. *T. hilgardi* from Mississippi, in contrast, possesses indistinct to somewhat appressed sutures, fewer and more regular spirals, flat to slightly concave whorl sides, and in addition never attains as large a size as the North Carolina species. *Turritella* sp. Stephenson (1941, pl. 54, fig. 8), from the Navarro group in Texas, although poorly preserved, probably belongs in this species. In the early Tertiary beds of the gulf coast, there are a number of species which show considerable similarity in form and ornament. *T. aldrichi* Bowles, from the Midway group, has less flexed growth lines and a more impressed suture. *T. nasuta* Gabb (Palmer, 1937, pl. 25, fig. 9), a variable species from the lower part of the Claiborne group of Alabama, is very close in some individuals in ornament and always in growth line.

T. hilgardi is restricted to the Ripley formation and is rather rare.

This species is named for E. W. Hilgard, an early State Geologist of Mississippi.

Types: Holotype USNM 128445; paratypes USNM 128446, 128447, 128448, 20522.
Occurrences: Mississippi: Ripley formation, locs. 5, 7, 9, 9a, 18, 29. Texas: Navarro group, Nacatoch sand (fragment reported).

GROUP UNCERTAIN

Turritella chalybeatensis Sohl, n. sp.

Plate 7, figures 24–26

Diagnosis.—Medium-sized turritellids with medially constricted whorls, a distinctly carinate and deviating body, and a very sinuous outer lip.

Description.—Shell of medium size, turriculate; pleural angle 18°. Protoconch unknown; suture impressed. Whorls numerous, 14 on holotype, medially constricted owing to subcarinae developed shortly above and below suture; body whorl develops strong basal carina and tends to deviate; base flat and striated. Ornament of numerous closely spaced faint spiral lirae over whorl sides and base; two spirals are larger and tend to form subcarinations at one-quarter and three-quarters the distance down the whorl face; lower lira develops to strong basal carina near aperture. Growth lines faint on spire and strengthening near aperture where they show a distinctly sinuous trend strongly prosocline on upper one-quarter whorl, developing a strong and deep sinus over medial part and becoming opisthocline on lower one-half whorl; on body they are again reflexed to proscoline over round-topped basal carinae. Aperture subcircular; outer lip thin, exhibiting a deep sinus and slight expansion on upper one-half of its length; inner lip smoothly rounded.

Measurements.—Explanation of measurements and symbols used in the following table appears in section "Measurements of specimens" (p. 48). Measurements are of topotypes from locality 46.

Loc.	*H*	*MD*	*HA*	*WA*
46	23.8	8		
46	17+	7	3.5	3.5

Discussion.—*T. chalybeatensis* is a distinctly different species, easily separated from the other described Cretaceous species from the gulf coast on the basis of its whorl profile and distinctive growth line. Its true position in the grouping used here is in doubt, as the available specimens lack the earliest whorls. The two major spirals can be traced back on the spire to an early stage but are preceded by whorls devoid of ornament, but this lack of ornament may be due to the state of preservation of the specimens.

T. chalybeatensis is restricted to the Owl Creek formation of northern Mississippi and is relatively rare.

Types: Holotype USNM 128437; paratypes USNM 128438, 128439.

Occurrences: Mississippi: Owl Creek formation of Tippah County, locs. 41, 46.

Turritella cf. T. encrinoides Morton

Plate 8, figure 9

1834. *Turritella encrinoides* Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 47, pl. 3, fig. 7.

1892. *Turritella encrinoides* Morton. Whitfield, U.S. Geol. Survey Mon. 18, p. 143, pl. 18, figs. 19, 22.

1907. *Turritella encrinoides* Morton. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 694, pl. 78, figs. 10–13.

Discussion.—Numerous internal molds characterized by their flat sides and closely spaced whorls occur in the Prairie Bluff chalk of Mississippi. These molds bear a considerable resemblance to internal molds from the Upper Cretaceous of New Jersey figured by Whitfield and Weller and assigned to *T. encrinoides.* The holotype, as figured by Morton (1834, pl. 3, fig. 7), is fragmentary and retains only a few patches of ornament but has a similar flat-sided outline. No well-preserved material that can definitely be placed in this species is known, but the category serves as a useful repository of these distinctive internal molds.

T. encrinoides Morton of Wade (1926, pl. 56, fig. 4) is a well-preserved specimen but is merely a variant of *T. tippana* Conrad.

Types: Hypotypes ANSP, USNM 128449.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 71–73, 80, 82, 83, 88.

Turritella sp.

Discussion.—Among the most common forms present in the collections of phosphatic molds from the Prairie Bluff chalk are high-spired specifically indeterminable specimens that appear to belong to *Turritella.* Variations in whorl outline and inclination of the whorl to the axis indicate that more than one type is present, but without an indication of surface ornament there is no hope of relating them to previously described species. Their very abundance does, however, serve to indicate that *Turritella* was as well represented in the chalk as in the sand facies. Illustration of such specimens is unwarranted.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 54, 57, 58, 66, 70–74, 79–84, 87, 88, 90, 92–94.

Genus TROBUS Stephenson, 1955

Type (by original designation), *Trobus buboanus* Stephenson, 1955.

Diagnosis.—Large, thick, high turrited shells, with numerous flattened to excavated concave whorls; sutures in deep furrows overhung on mature whorls by flange like extensions of the upper whorl surfaces; base with coarse spiral cords; aperture with moderately thick callus on parietal lip.

Discussion.—Stephenson's generic diagnosis (1955, p. 127) was based upon the type species and in his sense was monotypic. The above diagnosis is emended to include another species, *Chemnitzia corona* Conrad, from the Ripley formation of Mississippi, which exhibits all essential features of the genus and is probably the ancestor of the type species. The apertures and apexes of all known specimens are incomplete, and thus, its true relationships are in doubt. In shape and manner of growth *Trobus* appears to be related to *Turritella* and is provisionally assigned to the family Turritellidae. One specimen of *Trobus corona* from the Ripley formation of Mississippi (USNM 128450) shows evidence of a septal partition which is very similar to that found in a number of the turritellids. *Trobus* is known only from the Ripley and Owl Creek formations of Mississippi and Missouri. Specimens are rare, but the members are large forms with distinct sutural characters that obviate confusion with other known groups.

Trobus buboanus Stephenson

Plate 8, figures 20, 21

1955. *Trobus buboanus* Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 127, pl. 22, figs. 23–25.

Diagnosis.—Shell large, thick, with high turreted spire; apical angle 13°, suture in a deep furrow; whorl sides flat, with fine spiral threads; later whorls develop two thick, coarse, raised, round-topped spiral carinae; base rounded with three coarse spiral cords.

Measurements.—Explanation of measurements and symbols used in the followng table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	Estimated *H*	*MD*
46 (holotype)	111	150	40
46 (topotype)	97	140	42

Discussion.—The holotype is the only well-preserved specimen of this large and distinctive species. Other localities have yielded only fragments, but they are sufficient to show the species to be widespread in the Owl Creek formation and the uppermost part of the Ripley formation. *T. buboanus* is easily distinguished from *T. corona* (Conrad) because it possesses a basal carina and lacks strong spirals on the whorl side. The upper carina, which overhangs the sutural furrow on the later whorls of the holotype, begins to become crenulate but never to the degree found in *T. corona.*

Types: Holotype USNM 20423.

Occurrences: Mississippi: Owl Creek formation, locs. 44, 45, 46, and observed in roadcut exposure on U.S. Route 72, 2.25 miles east of junction of Mississippi State Route 15. Missouri: Owl Creek formation.

Trobus corona (Conrad)

Plate 8, figures 19, 22

1860. *Turbonilla* (*Chemnitzia*) *corona* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 4, p. 287, pl. 45, fig. 50.

Diagnosis.—Large thick turreted shell, with flat whorl sides bearing 2–4 broad flat-topped spiral ribbons in a median position; sutures in a deep furrow overhung by a sharp strongly carinate projection of upper whorl margin; base rounded, with 2 strong sharp spiral lirae.

Measurements.—All specimens incomplete. Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*PA* (in degrees)	*MD*	Estimated *H*
18	25	32.5	90
23	22	44.0	145
7	23	34.8	105
9 (mold)	27	40.0	140
Tippah County (holotype)	27	28.0	73

Discussion.—The only form closely related to *Trobus corona* is *T. buboanus*, from the Owl Creek formation. However, *T. buboanus* is slimmer and differs much in its details of ornament—it bears three basal spiral cords, possesses a basal carina, and lacks spiral ornament on the median whorl area.

All available specimens of *T. corona* are incomplete, missing both the apex and complete apertures. The available seven specimens do, however, indicate that there are some minor variations. The holotype (ANSP 15593) preserves only about 2¾ whorls and lacks both apex and aperture. It exhibits not only the three primary spiral ribbons mentioned in Conrad's original description but also a traceable fourth ribbon. (See pl. 8, fig. 22.) In addition, there are depressions on the whorl slope just above the suture corresponding in position to the serrations of the upper whorl flanges of the succeeding whorl. This latter feature is poorly developed on other specimens. The spiral ribbons mentioned vary on different specimens, and some specimens exhibit as few as two (pl. 8, fig. 19). The largest specimens (locs. 9, 23) indicate that in the advanced stages of growth the spiral ornament of the whorl sides becomes obscure.

Conrad states only that his specimen came from the Ripley formation (= group in Conrad's usage) of Tippah County, Miss., and on the basis of subsequent finds it is assumed that the holotype is from the Ripley formation, not the Owl Creek.

Types: Holotype ASNP 15593; hypotype USNM 128450.

Occurrences: Mississippi: Ripley formation, locs. 6, 9, 18, 23, 28.

Family THIARIDAE
Subfamily MELANATRIINAE

Genus MELANATRIA Bowdich, 1822

Type by subsequent designation, *Trochus flumineus* Gmelin, 1790 (= *Melania fluminea* Gmelin).

Diagnosis.—Large thick cerithoid shell with strongly ornamented whorls; early whorls apically ribbed, with later addition on whorls of a spinose shoulder. Spirals thick and coarse; aperture subrounded; outer lip sinuous in profile.

Discussion.—*Melanatria* is definitely present in the rocks of early Tertiary age in Europe and ranges into the Recent. The material here assigned to *Melanatria* is incomplete but is close in shape and ornament to typical forms. Better preserved material is necessary before a definite assignment can be made.

Melanatria? cretacea Wade

1926. *Melanatria cretacea* Wade, U.S. Geol. Survey Prof. Paper 137, p. 158, pl. 55, figs. 1a, 1b, 2.

Diagnosis.—Shell large, cerithoid; early whorls with coarse colabral axial costae that increase their curvature on later whorls and finally develop spines at the periphery; spirals broad and flat topped, overriding the axial costae.

Discussion.—This species is based on two incomplete shell fragments figured by Wade. Neither the apex nor the aperture are preserved, but in shell and development of ornamentation the species agrees with typical melanatriids. No subsequent specimens have been found, and it is impossible to extend our knowledge of the species or to state decisively where it belongs. One fragmentary specimen evidently allied to this species has been collected in the Owl Creek formation.

Types: Holotype USNM 32947; paratype USNM 32947a.
Occurrence: Tennessee: Ripley formation, loc. 1.

Melanatria? sp.

Plate 9, figures 38, 39

Discussion.—One fragmentary specimen from the Owl Creek formation of Tippah County, Miss., preserving parts of the body and penultimate whorls, agrees with the major generic features cited under the diagnosis of *Melanatria.* The specimen is of medium size and is turreted and exhibits strong colabral ribs which, on the body, become flexed and strongly noded at the periphery. Strong broad spiral cords and ribbons override the ribs on the whorl sides and also cover the base, where the transverse ribs have diminished in vigor. The aperature is incomplete, but part of a strong parietal callus is preserved.

This specimen is similar to *Melanatria cretacea* Wade, differing primarily by its smaller size and the lesser noding and reflection of the transverse ribs. Better preserved specimens are necessary for a more complete comparison.

Type: Figured specimen USNM 128455.
Occurrence: Mississippi: Owl Creek formation, loc. 45.

Family PROCERITHIIDAE
Subfamily PROCERITHIINAE
Genus NUDIVAGUS Wade, 1917

Type by original designation, *Nudivagus simplicus* Wade, 1917.

Diagnosis.—Large turriculate shells with numerous smooth flat-sided whorls forming evenly tapering spires. Sutures deeply impressed; growth lines prosocline; aperture subovate to subrhombohedral; anterior canal short and slightly curved; inner lip smooth, lightly callused on columellar lip.

Discussion.—*Nudivagus* was proposed by Wade to include the type species from the Ripley formation of Tennessee, *Cerithium* (*Fibula*?) *detectum* Stoliczka, from the Arialoor group of India, and *Pseudomelania astonensis* Huddleston, from the Inferior oolite of England. The subovate apertural outline, short curved anterior canal, and lack of a thick parietal wall callus, serve to distinguish *Nudivagus* from *Gymnocerithium* Cossmann but ally it to the Procerithiidae.

Nudivagus simplicus Wade

Plate 8, figure 14

1917. *Nudivagus simplicus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 297, pl. 19, figs. 4, 5.
1925. *Nudivagus simplicus* Wade. Cossmann, Essais de Paléoconchologie Compareé, v. 13, p. 268, pl. 10, fig. 14, and pl. 11, figs. 22, 23.
1926. *Nudivagus simplicus* Wade. Wade, U.S. Geol. Survey Prof. Paper 137, p. 156, pl. 54, figs. 6, 14.
1940. *Nudivagus simplicus* Wade. Wenz, Handbuch der paläozoologie: Gastropoda, v. 6, Abt. 1, p. 729, fig. 2111.

Diagnosis.—Large *Nudivagus* with rounded early whorls, which become flat sided on later whorls and slightly excavated on upper one-third of body; whorl-surface smooth except for fine, microscopic low spiral threads and slightly prosocline growth lines.

Discussion.—*Nudivagus simplicus* is abundant at its type locality, Coon Creek, Tenn., but it is very fragile and good specimens are infrequently found. The most complete specimen yet collected is the holotype, which lacks the earliest whorls and the extreme anterior tip. Wade's illustration of the holotype somewhat distorts the aperture; judging by other specimens, it should be somewhat longer than shown. Specimens of *Nudivagus? cooperensis* Stephenson, from the Neylandville marl of Texas, have poorly preserved shell surfaces, but faint spiral threads are evident. This species differs primarily by having rounder whorls, a narrower and more elongate aperture, and slightly prosocline growth lines. *Nudivagus* sp., from the Ripley formation of Mississippi, is too poorly known for comparison.

Types: Holotype and paratype USNM 32928.
Occurrence: Tennessee: Ripley formation, loc. 1.

Nudivagus sp.

Plate 8, figure 13

Discussion.—*Nudivagus* is represented in the Ripley formation of Mississippi by only one incomplete, specifically indeterminable specimen. This specimen has flat whorl sides ornamented by fine spiral threads and deeply impressed sutures, which simulate characters to be seen on the holotype of *N. simplicus.* The specimen, although too incomplete to be placed with assurance in *N. simplicus*, lacks the convex whorl sides of *N. cooperensis* Stephenson and definitely does not belong to that species.

Type: Figured specimen USNM 128454.
Occurrence: Mississippi: Ripley formation, loc. 18.

Family POTAMIDIDAE

Genus DIRCELLA Sohl, n. gen.

Type species—*Turbonilla* (*Chemnitzia*) *spillmani* Conrad.

Etymology.—Diminutive of Dirce, wife of Lycus, King of Thebes. Gender, feminine.

Diagnosis.—Medium to large elongate turriculate shells with impressed sutures and a sculpture of strong axial costae and broad spiral ribbons; base bordered by an angulation on early whorls but well rounded on body; aperture subovate, subangulate posteriorly and well rounded anteriorly; inner lip broadly excavated; callus spread over a resorbed surface.

Discussion.—In the earlier stages of development the shells of this genus simulate features to be seen on several Eocene genera. *Harrisianella* Olsson, from the Saman formation of Eocene age of Peru, has a similar shape and axial ornament but has a *Terebra*-like fasciole. *Lagunites* Olsson, also from the Eocene of Peru, possesses an angular base and similar axial ornament but lacks spiral ornament and has a short and twisted columella. According to Olsson (1929, p. 19), there is no tendency for a rounding of the body of the adult, and at maturity the aperture is expanded. The general lack of knowledge of the apertural features of these Eocene genera makes further comparison difficult, but they appear to at least belong to the same family, probably the Potamididae.

The only other species that appears to be assignable to the genus at present is *Turbonilla* (*Chemnitzia?*) *coalvillensis* Meek of the western interior Upper Cretaceous but this may be a root from which some of the Eocene genera like those mentioned above arose. *Vascellum* Stephenson, from the Cenomanian of Texas, possesses similar ornament and form in the type species *V. vascellum*, but all species possess a short and twisted anterior canal, a feature lacking in *Dircella* and placing *Vascellum* in the Cerithiidae.

Dircella spillmani (Conrad)

Plate 8, figures 7, 8, 11, 15–18

1860. *Turbonilla* (*Chemnitzia*) *spillmani* Conrad, Philadelphia Acad. Nat. Sci. Jour., v. 4, p. 287, pl. 46, fig. 48.

Diagnosis.—Medium-sized turriculate shells with flat-sided whorls ornamented by broad flat-topped spiral ribbons that override strong broad colabral transverse costae.

Description.—Medium-sized thick turriculate shells with numerous flat-sided whorls. Protoconch unknown; suture impressed, irregular in trend. Whorls flat sided and basally subangulated on earlier parts but with rounded base at maturity. Whorls of spire ornamented by five closely spaced strong broad spiral ribbons, with a spiral cord just above suture; this cord marks position of basal subangulation of early whorls; on base of body, spirals are less broad and are commonly broken into nodes arranged in about eight rows. Transverse sculpture consists of generally arcuate strong colabral costae which are continuous suture to suture but are absent on the base in early growth stages but continue with diminished vigor onto base at maturity. Aperture subovoid, acutely angular posteriorly, and broadly rounded anteriorly; outer lip incomplete; inner lip smooth and broadly excavated, callus extending out onto body and sharply bounded because resorption of shell over basal area lowered shell surface before callus deposition.

Measurements.—The specimens are all incomplete and measurements would be inadequate. The largest specimen, lacking both the apical end and part of the body, measures 67 millimeters in height and 24 millimeters in diameter.

Discussion.—Johnson (1905, p. 22) listed the holotype of *Dircella spillmani* as being present in the collections of the Academy of Natural Sciences of Philadelphia, but it could not be located recently. A paratype (Conrad, 1860, pl. 46, fig. 28, ANSP 15591) is available (see pl. 8, fig. 15), and although it preserves only a part of one whorl, it bears the ornament typical of the specimens here described. The holotype as figured by Conrad (1860, pl. 46, fig. 48) preserves three whorls but lacks both apex and anterior extremity. This figure indicates a typical form with five spiral ribbons on the whorl sides and corresponds closely to the specimen figured on plate 8, figure 18.

The spiral ornament is perhaps the most constant and uniform feature of the species. All available specimens persist in having only five spiral ribbons on the whorl sides, followed by a spiral cord at the suture. Variation in angularity of the spire appears to be considerable, as a comparison of figures 7 and 11 on plate 8 shows. Both specimens are from the same locality; the largest one (USNM 20416a) is the best preserved specimen available and represents the most typical form; the other (USNM 128451) is probably the most aberrant both in pleural angle and in the suppression of the axial costae on the whorl sides. In all specimens the axial costae are inclined and generally arcuate; but, as the specimen shown in figure 8, plate 9 (USNM 20416B) indicates, some specimens bear essentially straight costae. This specimen also exhibits the best examples of basal sculpture and the resorbed area bordering the columellar lip. The resorbed area is highly unusual and is probably of more than specific value. All specimens preserving a mature body whorl exhibit such an area, and the one small specimen (USNM 128452; pl. 8, figs. 16–17) available also possesses it, but it is not quite so well defined as in the later stages of development.

No other species of *Dircella* are known on the gulf coast at present, and the type species is restricted to the Owl Creek formation and reworked Cretaceous material at the base of the Clayton formation.

Types: Holotype lost; paratype ANSP 15591; hypotypes USNM 24016A, B, 128451, 128452, 128453.

Occurrences: Mississippi: Owl Creek formation, loc. 46. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40.

Family CERITHIIDAE
Subfamily CERITHIINAE

Genus CERITHIUM Bruguière, 1789

Type by virtual tautonymy, *Cerithium adansonii* Bruguière, 1789, ("La Cerite" of Adanson is considered the lectotype of *C. Adansoni*).

Diagnosis.—Turriculate to turreted shells with numerous flat to round-sided whorls; sculpture ornate; varices common; aperture lenticular; outer lip expanded and thickened within; anterior canal short, curved, and usually bounded above by a ridge at base of columellar lip.

Discussion.—The name *Cerithium* is one of the more commonly used names in Mesozoic gastropod literature. Frequent misapplication of the name now necessitates a complete revision of the group. At present *Cerithium* is divided into numerous subgenera that are based primarily on features of the aperture. Considerable confusion exists as to what species should be accepted as the type and also as to the limitations of the various subgenera. This confusion has been increased by the constant referral of internal molds to the genus by a wide variety of authors. *Cerithium* is used here in the sense of Stewart (1926, p. 355), who believes that the only way to save the name *Cerithium* is to accept *C. adansonii* Bruguière as the type species. If the first subsequent designation, *C. virgatum* Montford, is accepted, the name *Cerithium* becomes a synonym of *Clava*. The above usage by Stewart has not met with universal approval. Cossmann (1906, p. 66), followed by Wenz (1940, p. 765) and others, have selected *C. nodulosum* Bruguière to serve as the type species and assigned *C. adansonii* to *Pyrazus*. There appears to be no legal basis for the retention of *C. nodulosum* as the type species, when previous designations exist and when *C. adansonii* does appear to be a *Cerithium.*

Cerithium first appeared in the Jurassic period and steadily increased in abundance, reaching a climax in the Eocene epoch. In present seas it is a common form generally found in the littoral zone and in brackish water. During Cretaceous time *Cerithium* was abundant and well represented in the faunas of most areas. In the Upper Cretaceous deposits of the gulf coast, numerous species have been collected and described, but no conscientious effort has been made to place them in any of the numerous subgenera.

Three species have been described from the Ripley formation of Tennessee and Mississippi. As yet no direct evidence exists for their presence in the Owl Creek formation, but closely related forms have been noted by Stephenson (1941, p. 294) in the Corsicana marl and Kemp clay of Texas. Indirect evidence, an external mold (pl. 9, fig. 22) collected in a railroad cut south of Houston, Miss., at USGS Mesozoic locality 4053, points to the possible presence of an undescribed species of *Cerithium* in the Prairie Bluff chalk. This specimen occurred in the reworked bed at the base of the Paleocene and probably came from the Cretaceous.

Cerithium percostatum Wade, from the Ripley formation of Coon Creek, Tenn., is a "*Claviscala.*"

Cerithium weeksi Wade

Plate 9, figures 7, 9–14

1926. *Cerithium weeksi* Wade, U.S. Geol. Survey Prof. Paper 137, p. 154, pl. 54, figs. 1, 2.

Diagnosis.—Medium-sized cerithiid with numerous flattened whorls ornamented by many spiral threads and lirae, some of which are beaded. Body basally subcarinated by a strong spiral cord; base flattened.

Aperture subovate, posteriorly notched; outer lip flared and fluted at junction with spiral lirae; anterior canal short, moderately broad, curved, and bounded above by a ridge on base of columellar lip.

Measurement.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.[1]	*H*	*MD*	*H:D*
1	17.1	5.3	3.22
1	27.1	8.2	3.30
1	19.6	5.9	3.32
1	17.2	5.1	3.37
1	17.3	5.5	3.14
1	26.7	7.8	3.42
1	25.6	7.9	3.24
1	18.3	5.9	3.10
1	16.3	5.1	3.19
1	18.0	6.0	3.00
5	27.2	9.2	2.99
USGS 279 (Ala.)	23.4	7.9	2.96
USGS 279 (Ala.)	21.4	7.4	2.89

[1] All but specimens from locs. 5 and USGS 279 are topotypes.

The specimen from locality 5 occurs at a higher stratigraphic position than the topotypes and falls at the lower end of the range of variability shown by the type specimens. Unfortunately the specimens from the Ripley formation are mainly incomplete and are too few to indicate if there is any significant difference. Specimens from about the same position as locality 5 in Alabama (USGS Mesozoic loc. 279) also show a lower ratio of height to diameter.

Discussion.—This is the most common and widespread of the cerithids occurring in the Upper Cretaceous strata of the gulf coast. Its ornate beaded spiral lirae and development of varices in addition to its greater pleural angle serve to distinguish *C. weeksi* from *C. nodoliratum* and *C. semirugatum*, with which it occurs.

At its type locality on Coon Creek, McNairy County, Tenn., *C. weeksi* is moderately abundant, and suites of topotypes exhibit variation in size, proportions, and ornament. Variation in size and proportion are well shown in the measurements given in the table, which are primarily of mature forms. The holotype lacks both apex and aperture, but numerous topotypes preserve these features (pl. 9, fig. 10). Larger specimens exhibit a beading of the major spiral cords of the base that does not develop in the earlier growth stages. The spiral lirae of the whorl sides exhibit considerable variation in strength and beading. The beads range from equidimensional nodes to elongate nodes and spines.

Specimens from the Ripley formation of Mississippi and Alabama assigned to this species agree well in arrangement of the sculpture elements but have more subdued nodes (pl. 9, figs. 12, 13). In size, the Mississippi specimens are comparable, and no significant differences were noted. The measurements, especially the ratio of height to diameter, of specimens from the Ripley formation of both Mississippi and Alabama show a change in proportions from the Tennessee specimens. Unfortunately, available material is insufficient to establish the significance and constancy of this divergence. Most likely it is a population difference, as the other morphologic features compare well.

Cerithium sp. of Stephenson (1941, p. 294), from the Navarro group of Texas, is an immature specimen but shows considerable similarity to *C. weeksi.*

Types: Holotype USNM 32935; hypotypes USNM 20507, 128456, 128457, 128458.

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, locs. 5, 7, 18, 29. Alabama: Ripley formation. Georgia: Ripley formation.

Cerithium nodoliratum Wade

Plate 9, figures 15, 16, 24

1926. *Cerithium nodoliratum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 155, pl. 54, figs. 4, 5.

Diagnosis.—Medium-sized cerithiids, with acuminate spire and flat-sided whorls marked by three prominent spiral ribbons, which in turn are topped by square-shaped nodes where crossed by the growth lines; aperture with a twisted anterior canal of moderate length.

Measurements.—The holotype is the only available specimen sufficiently complete to merit measurement. It is 25 millimeters in height and has a maximum diameter of 6.4 millimeters but lacks the extreme apical tip.

Discussion.—Although similar in shape and type of ornament, *Cerithium nodoliratum* and *C. semirugatum* are easily separated by the presence on the latter of a fourth and somewhat subsidiary spiral ribbon between the second and third primary spiral ribbons. The two species are probably closely related, and although no available specimen of *C. nodoliratum* retains its nuclear whorls, the earliest preserved growth stages are very similar to those of *C. semirugatum.* Wade (1926, p. 154) cites as an added difference the lack of ornament on the base of *C. nodoliratum.* This feature is exhibited by the holotype, a mature specimen, but immature specimens do possess numerous spiral threads which cover the base. Wade's (1926, pl. 54, fig. 4) illustration of the holotype is considerably retouched, which overemphasizes the width of the spiral ribbons, and the holotype lacks any indication that the anterior canal has been broken and repaired, so that the anterior canal has become somewhat distorted in trend. Only one specimen has been found in the Ripley formation of Tippah County, Miss., and this specimen, although preserving only several whorls, has the whorl profile and ornament typical of the species.

Types: Holotype USNM 32937; hypotypes USNM 128459, 128460.

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, loc. 6.

Cerithium semirugatum Wade

Plate 9, figures 4–6, 8, 20

1926. *Cerithium semirugatum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 155, pl. 54, fig. 21; pl. 55, fig. 6.

?1940. *Cerithium simpsonensis* Stephenson, Texas Univ. Bull. 4101, p. 294, pl. 54, fig. 9.

Diagnosis.—Shell small; spire slim and acuminate; early whorls subcarinate, becoming flat sided; the later whorls bear four major spiral ribbons, the first and third of which are developed later on the spire than the second and fourth; aperture incomplete on known specimens but anterior canal deep, moderately wide and twisted.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurement of specimens" (p. 48).

Loc.	*H*	*MD*	*HA*
1 topotype	Incomplete	3.4	1.5
1 topotype	4.25	1.5	.65
1 topotype	4.85	1.65	.75
17		1.8	.8
17		3.0	1.+

Discussion.—*Cerithium semirugatum* Wade is a rare and poorly known species. Only 10 specimens are available for study—the holotype, 6 topotypes, 2 specimens from locality 17 and 1 from locality 29 in Union County, Miss. The specimens from the Ripley formation of Mississippi are all incomplete but compare well with the type material from Coon Creek, Tenn., differing only by having a slightly slimmer outline and by proportionally stronger development of the basal noded spiral ribbon. One topotype preserves the protoconch, which consists of about 3½ whorls. The first whorl is smooth and well rounded. On the second whorl, thin transverse riblets appear but are restricted to the upper whorl area near the suture. At 2¼ whorls the riblets have migrated, almost reaching the whorl midpoint; and a slight angulation has begun to develop near the lower suture. This angulation develops to a dominant peripheral carina on the third whorl, and the riblets develop a reflexed but prosocline trend. This peripheral carina gives rise to the lowest spiral ribbon on the first teloconch whorl and remains the lowest throughout growth, with the addition of later spiral elements posteriorly on the whorl sides.

The closest affinities of this species appears to lie with *C. nodoliratum* Wade, which differs primarily in the possession of only three spiral ribbons. *C. simpsonensis* Stephenson from the Corsicana marl of Texas has a similar number of noded spirals and may well be conspecific. The Texas species differs slightly by having spirals of uniform strength and has a lesser basal angulation. Such differences in my opinion should deserve no more than subspecific rank. *Cerithium recticostum* Sowerby and *C. pseudoclathratum* d'Orbigny from the Maestrichtian of Belgium also are similar and belong to the same group as these two species from the Ripley formation. This grouping may deserve subgeneric designation, but I hesitate to propose another category for an already overcrowded and confused genus.

Cerithium semirugatum Wade ranges through the lower part of the Ripley formation in Mississippi and Tennessee.

Types: USNM 32945; hypotypes USNM 128461–128464.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 17, 29.

Cerithium sp.

Plate 9, figure 22

Discussion.—Indirect evidence points to the possible presence of an undescribed species of *Cerithium* in the Prairie Bluff chalk. In a cut of the Memphis, Jackson, and Kansas City railroad south of Houston (loc. 69) both an external and an internal mold of a medium-sized cerithiid have been found in basal limestone of the Clayton formation associated with reworked Cretaceous fossils. The early whorls bear four spiral ribbons that are noded where crossed by transverse ribs, and these whorls are succeeded by whorls marked only by transverse ribs, followed in turn by a smooth-surfaced slightly inflated body. The internal mold shows evidence of a short twisted anterior canal. The earliest whorls show an affinity to the *C. nodoliratum* type, but on the later whorls ornament is suppressed.

Although probably reworked from the Cretaceous into the base of the Clayton, there is some possibility of this form's actually being a Tertiary species. As the stratigraphic position of the collection is not assured, no new name has been assigned.

Types: Figured specimen USNM 128466.

Family CERITHIOPSIIDAE

Genus SEILA A. Adams, 1861

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

Diagnosis.—Small, very slender flat-sided shells with smooth, swollen protoconch whorls; sculpture of 3–6 smooth strong raised spiral cords with numerous fine growth-line threads in the spiral interspaces; aperture subovate; anterior canal short, bounded by a swelling on base of columellar lip.

Discussion.—*Certhiopsis meeki* Wade and *C. quadrilirata* Wade, both from the Ripley formation of Tennessee and Mississippi, possess swollen protoconch whorls, strong spiral ornament with fine transverse threads in the spiral interspaces, and a basal keel. These features are characteristic of *Seila* A. Adams rather than *Cerithiopsis* Forbes and Hanley.

This assignment is subject to some qualification in that the fold at the top of the anterior canal is stronger than that typical of *Seila* and somewhat reminiscent of *Cerithina* Holzapfel and *Cerithiella* (*Stilus*) Jeffreys. Both genera differ, however, in ornament and in protoconch character.

Seila is known from Upper Cretaceous beds throughout the world. Recent species are few and somewhat limited to the warmer waters. Many fossil species originally assigned to *Cerithiopsis* and allied genera probably belong here.

Seila meeki (Wade)

Plate 9, figures 17–19, 21

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

Diagnosis.—Small flat-sided shells with 3 raised, strong spiral ribbons on the whorl sides and 1 low ribbon on the base; fine flat-topped transverse threads or ribbons are present in interspiral areas.

Description.—Shell small, spire tapering regularly. Protoconch incomplete but showing a minimum of three regularly coiled globose whorls; last protoconch whorl wider than first teloconch whorl and marked by fine prosocline transverse threads, with essentially no trace of spiral ornamation; whorl profile of last one-half turn flattens as spiral lirae increase in prominance until they are dominant, with transverse threads becoming visible only between the three prominant spiral ribbons of teloconch whorl sides. On body; lowest, or third, spiral ribbon forms a basal angulation, immediately below which a fourth but weaker spiral ribbon occurs. Aperture incomplete, but a distinct short anterior siphon present, bordered above by sharp fold at base of columellar lip.

Measurements.—Explanation of measurements and symbols of topotypes used in the following table appears in the section "Measurement of specimens" (p. 48).

Loc.	*H*	*MD*
1	8.6	2.1
1	7.5	2.0
1	[1] 8.1	2.7
1	[1] 7.0	2.3

[1] Incomplete.

The larger specimens, if complete, would probably reach a total length of about 15 millimeters. Unfortunately, most specimens are incomplete, lacking parts of both the apex and aperture of the shell.

Discussion.—*Seila meeki* is easily distinguished from *S. quadrilirata* (Wade), as it possesses 3 evenly spaced flat-topped ribbons instead of 4 round-topped cords, with the lowest 2 ribbons most closely spaced. In addition, the 2 species also differ in their early development—*S. meeki* has fewer protoconch whorls, and *S. quadrilirata* has an earlier appearance of the spiral whorl angulation.

The species has been recognized in the Ripley formation of both Mississippi and Tennessee. At its type locality at Coon Creek, Tenn., specimens are not uncommon, but elsewhere they are very rare. In the available material, there appears to be little morphologic variation, either stratigraphically or geographically.

Types: Holotype and paratype USNM 32946; hypotypes USNM 128467–128468.

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, locs. 17, 29.

Seila quadrilirata (Wade)

Plate 9, figures 27, 35

1926. *Cerithiopsis quadrilirata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 157, pl. 54, fig. 17.

Diagnosis.—Shell small; protoconch swollen; whorls flat sided and with 4 round-topped spiral cords, the lower 2 most closely spaced.

Description.—Shell small; whorls flat sided; spire tapering evenly to a swollen enlarged protoconch, which consists of 4–5 smooth surfaced whorls; early protoconch whorls with well-rounded sides, which in later stages develop an angulation near base that eventually gives rise to a spiral cord on teloconch. Sculpture of 4 round-topped spiral cords; lower 2 cords more closely spaced and form a basal keel, below which on the base proper is a low broad spiral ribbon. Fine, threadlike closely spaced proscoline growth lines occur in interspiral spaces. Aperture incomplete and poorly known.

Measurements.—The holotype is the most complete specimen available and, according to Wade (1926, p. 157), measures 11 millimeters in height and 1.8 millimeters in width.

Discussion.—This species is rare and known only from incomplete material. Only two specimens are known from the type locality and several more from the Ripley formation of Union County, Miss.

The four spiral cords and their spacing differentiate *S. quadrilirata* from other species in the genus. *S. meeki* has three spiral cords wider spaced axial threads and an ornamented protoconch. Wade (1926, p. 157) believed this species to be analogous to *Cerithiopsis bicostata* Kaunhowen, of the Maestrichtian of Belgium; but on the basis of illustrations and description, the two species are certainly not conspecific and probably not congeneric.

Types: Holotype USNM 32943; hypotype USNM 128471.
Occurrence: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, loc. 29.

Seila sp.

Plate 9, figure 23

Discussion.—Two small, incomplete specimens from the Ripley formation of Union County, Miss., bear ornamentation and apertural features which ally them to *Seila*. Both specimens retain only several whorls but exhibit a distinctive ornament consisting of three round-topped spiral cords, of which the uppermost is the strongest. The interspiral spaces are narrower than the spiral cords and lack any evidence of transverse ornament. As is typical of the other species in the genus, a swelling at the base of the columellar lip evidently formed the upper boundary of a twisted anterior canal.

These specimens appear to be related to *S. meeki* (Wade), and like that species they possess three spiral elements on the whorl sides, but the spirals are round rather than flat topped, and transverse ornament is lacking in the interspiral spaces. In addition, the proportional width of the spirals is greater than in Wade's species, and they are not equal in strength. The specimens appear to be a distinct species, but they are too incomplete to serve as types.

Type: Figured specimen USNM 128470.
Occurrence: Mississippi: Ripley formation, loc. 27.

Family LITTORINIDAE

Genus LEMNISCOLITTORINA Sohl, n. gen.

Type species *Littorina berryi* Wade, 1926.

Entymology.—From the Latin lemniscus (ribbon) and *Littorina* (a genus of gastropod). Gender feminine.

Diagnosis.—Medium-sized *Littorina*-like shell with rounded whorls, strong somewhat nodose spiral ornament, and strong growth lines with low arcuate opisthocline trend that forms a broad, shallow sinus on lower part of body.

Description.—Medium-sized anomphalous turbinate to spindle-shaped, moderately thick shell. Spire tapering evenly; protoconch unknown; suture impressed. Whorls gently rounded. Sculpture dominated by strong raised spiral cords with low closely spaced nodes; growth lines are fine raised threads that have a shallow sinus. Aperture subovate, posteriorly angulated to a shallow narrow channel, well rounded anteriorly; outer lip thin, crenulate at intersection of spiral cords, with striations continuing on interior of lip a short distance into shell interior; inner lip excavated; parietal lip has moderate callus; columellar lip slightly reflexed.

Discussion.—This genus closely approximates *Littorina* Ferrussac and *Littorinopsis* Mörch but differs primarily in the inclination of the columella and outer lips. In both genera the aperture, outer lip, and growth lines indicate a direct prosocline trend; spiral ornament is not so strong, and apertural callus is greatly developed. *Lemniscolittorina* appears closer to *Littorinopsis*, representatives of which may be present in the Cretaceous.

The genus at present is monotypical. Several species from India described by Stoliczka (1868) may belong here, but the descriptions and illustrations are insufficient for certain placement.

Lemniscolittorina berryi (Wade)

Plate 9, figures 29–31, 36

1926. *Littorina berryi* Wade, U.S. Geol. Survey Prof. Paper 137, p. 166, pl. 58, figs. 2, 3.

Diagnosis.—Strong medium-sized turbinate shell with gently rounded whorl sides; ornament consists of raised flat-topped to slightly nodose spiral ribbons that number four on the penultimate whorl.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*H:D*
1 (holotype)	26	16.0	1.62
1 (topotype)	[1] 35	16.0	2.18
22	[1] 27	14.5	1.86
22	[1] 25	13.5	1.85
22	13	9.0	1.42

[1] Estimated.

Discussion.—The measurements given in the table indicate a considerable variation in obesity of the shell, but in features of ornament the specimens as known show a great similarity.

Wade (1926) stated that another congeneric species, *Littorina conipacta* Gabb, was present in the Cretaceous of California and represented the only other member of the genus in the Cretaceous of North America. Gabb (1876, p. 303) assigned this species to *Ataphrus* Gabb, and this placement appears to be correct (Stewart, 1927, p. 316).

No other forms as yet described appear to be assignable to the genus. *Lemniscolittorina berryi* is restricted to the Ripley formation, where it is rare.

Type: Holotype USNM 73083.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, loc. 22.

Superfamily RISSOACEA
Family RISSOIDAE

Genus ANTEGLOSIA Vokes, 1948

Type by original designation, *Anteglosia essoensis* Vokes, 1948.

Diagnosis.—Small turriculate shell much like *Rissoina* but with sigmoidal growth lines, pitted to smooth whorl surfaces, and an aperture with an inner lip appressed for its entire length.

Discussion.—Vokes (1948, p. 146) proposed this genus to include the type species and two species, *Rissoina tennesseensis* Wade and *R. subornata* Wade, from the Ripley formation of Coon Creek, Tenn. *Rissoina accuminata* (Müller) of Stoliczka, from the Arialoor group of India, also appears to belong in this category. It is entirely possible that *Anteglosia* should be treated as a subgenus of *Rissoina* d'Orbiguy, but it appears to be distinct from any of the subgenera as yet proposed. *Rissoina* s. s. typically possesses strong axial ornament and a distinct siphonal fasciole, as does *Phosinella* Mörch. *Mirarissoina* Woodring possesses an anal notch and straight opisthocline growth lines, whereas *Zebinella* Mörch is more closely ornamented than *Anteglosia* and has a varicose outer lip. Other subgenera similarly differ in ornament, growth-line trend, and shape.

The type species occurs in the Raritan formation (Cenomanian) in the subsurface of New Jersey; thus, the genus ranges throughout the Upper Cretaceous. It is possible that some forms assigned to other subgenera belong in this group. In general the shells are small and fragile and are generally found only where conditions of preservation were ideal.

The specimen described by Wade as *Rissoina fragilis* Wade is a small smooth-surfaced shell that belongs neither in *Rissoina* nor in *Anteglosia*. The holotype is probably an immature specimen, mellanellid in character, but is generically indeterminable.

Anteglosia tennesseensis (Wade)

Plate 9, figures 1–3

1926. *Rissoina tennesseensis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 167, pl. 58, figs. 26, 27.

1948. *Anteglosia tennesseensis* (Wade). Vokes, Maryland Dept. Geology, Mines and Water Bull. 2, p. 147.

Diagnosis.—Small shell with high evenly tapering spire; protoconch trochoid, consisting of three smooth whorls gradually grading to teloconch; teloconch whorls round sided and with pitted surface; outer lip sharp, sinuous, and thickening behind aperture.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*HA*	*WA*
1 [1]	[2] 9+	7.4+	2.8	2.4	1.7
1	[2] 8.0	6.3+	2.2+	(?)	1.1+
1	7.0	4.2	1.5	1.3	.85
6	[2] 7+	5.0	1.9	1.6	1.1
18	7.5	5.1	2.0	1.8	1.25
18	7.0	4.7	1.7	1.4	.95
17	6	[2] 3.9	1.2	(?)	.6
24	7.5	6.0	2.25	2.0	1.4
24	7.0	5.3	2.0	1.7	1.2
24	[2] 6	4+	1.4	(?)	.8
24	6.0	3.8	(?)	1.1	(?)
16	6–7	4.7	1.75	1.5	.8+
16	6.0	3.7	1.25	1.0	.7
16	6.0	3.6	1.25	1.1	.75

[1] Holotype.
[2] Estimated.

Discussion.—*A. tennesseensis* differs from the type species *A. essoensis* by its greater size, its round-sided whorls, and the broad axial and spiral elements which are so equal in strength that the interspaces lend a pitted appearance to the shell surface of the spire.

The holotype is incomplete, lacking the apex, but is the largest known specimen. Wade's illustrations (1926, pl. 58, figs. 26, 27) are retouched and do not reproduce the pitting of the spire so typical of the species. On the holotype this pitted surface becomes irregular and distorted as the growth lines became increasingly strong on the body. All topotypes are younger specimens and show the ornamentation to be quite variable as to strength of development. One topotype with a broken spire shows that a septum is developed separating the early whorls from the rest of the shell.

Specimens from the Ripley formation of Mississippi are all smaller than the holotype and also show a more consistent, regular, and well-developed pitted surface that continues to the aperture. In general the whorls also appear to be more well rounded, but the differences appear to fall so close to the range of variation of the topotypes that no new name is proposed. On several specimens the inner lip is seen to become free at the anterior extremity and in this way differs from one of the primary generic features of *Anteglosia* as defined by Vokes. As this does not appear to be a constant feature its value is questioned.

Types: Holotype USNM 73096; hypotype 128472.
Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 6, 15, 16, 17, 18, 24, 27, 29.

Anteglosia subornata (Wade)

1926. *Rissoina subornata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 168, pl. 58, figs. 23 and 24.
1948. *Anteglosia subornata* (Wade). Vokes, Maryland Dept. of Geology, Mines and Water, Bull. 2, p. 147.

Diagnosis.—Small thin shell with few broadly round-sided whorls; ornamentation of fine spiral threads and low obscure lirae; growth lines sinuous; parietal callus absent, columellar lip thin and appressed.

Measurements.—The holotype from the Ripley formation at locality 1 measures 4.2 mm (+) in height, 2.1 mm in diameter, with an apertural height of 1.8 mm and an aperatural width of 1.2 mm.

Discussion.—This species is known only from its type locality. Its sinuous outer lip and general shape ally it to the Rissoidae, and following Vokes' suggestion it is provisionally assigned here to *Anteglosia.* The holotype is small and is probably an immature form differing from *A. tennesseensis* by its lack of punctuate sculpture and presence of definite spiral ornament as well as its less rounded whorls and less sinuous growth lines. It is closer to *A. essoensis*, the type species from New Jersey, than to *A. tennesseensis* but has stronger ornament and less strongly flexed growth lines.

A. subornata (Wade) is extremely rare and known only from two specimens, both of which came from the type locality on Coon Creek, Tenn.

Type: Holotype USNM 73095.
Occurrence: Tennessee: Ripley formation, Coon Creek member, loc. 1.

Anteglosia sp.

One specimen from the collections under study from the Owl Creek formation although preserving only a part of the spire appears to be assignable to *Anteglosia.* Its protoconch, rounded whorl sides, and pitted surface sculpture are reminiscent of *A. tennesseensis* (Wade), of the lower part of the Ripley formation, but owing to the lack of more complete specimens further comparison is impossible. Aside from this one poor specimen the genus is otherwise unknown this high in the section.

Type: Mentioned specimen USNM 128473.
Occurrence: Mississippi: Owl Creek formation, loc. 46.

Genus TURBOELLA Leach (in Gray), 1847

Type by subsequent designation (Gray, J. E., 1847, p. 152), *Turbo parvus* da Costa, 1778.

Diagnosis.—Small strong anomphalous conical shells with blunted but evenly tapering spire 1½ times body height; whorls rounded to swollen; sculpture dominated by strong transverse costae on whorl sides with base generally smooth; aperture subovate, outer lip thickened by a varix.

Discussion.—The species from the Ripley formation here placed in *Turboella* differ from *Apicularia* Monterosato by having a blunt spire, broader outline, and proportionally larger aperture.

Cretaceous representatives of the genus are few. Besides the three Ripley species discussed here, *Rissoa reussi* Geinitz, from the Cenomanian of Bohemia, and *Rissoa oldhami* Stoliczka, from the Arialoor group of India, may also belong in the genus.

Turboella had its roots in the Jurassic period with such forms as *Calvadosiella* Wenz and *Trochoturboella* Cossmann, which are assigned by Wenz (1939, p. 620) as subgenera of *Turboella. Turboella* is closer to Wenz's *Calvadosiella* than to *Trochoturboella*, but no species of *Turboella* have been described from deposits of earlier than Cenomanian age. Although Tertiary representation is greater than Cretaceous, few species are known from the present seas.

Turboella costata (Wade)

Plate 9, figures 25, 26

1926. *Mesostoma costatum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 155, pl. 54, figs. 10, 11.

Diagnosis.—Shell very small; protoconch proportionally large, blunt; teloconch whorls few and large with base smooth but with whorl sides bearing numerous coarse, closely spaced transverse costae; aperture subovate, expanded anteriorly; inner lip reflexed.

Discussion.—This species is based on the holotype, a small immature specimen from the Ripley formation of Coon Creek, Tenn. It is closely related to *T. tallahatchiensis*, from the Ripley formation of Mississippi but differs in shell proportions, protoconch, ornament, and apertural outline, as discussed under the latter species. The immaturity and incomplete nature of the holotype makes comparison difficult and may actually accentuate the noted differences.

Type: Holotype USNM 32941.
Occurrence: Tennessee: Ripley formation, loc. 1.

Turboella tallahatchiensis Sohl, n. sp.

Plate 9, figures 37, 40–43

Diagnosis.—Small stout conical shells, ornamented by strong round-topped transverse costae and less strong round-topped spiral cords; aperture subovate, outer lip reinforced by a varix.

Description.—Shells small, less than 3 millimeters high; spire conical, blunted apically, and less than two-thirds total shell length; surface glazed. Whorls of conch 3–4 in number; protoconch proportionally large and globular, consisting of about two normally coiled, round-sided whorls with very faint microscopic spiral lines; junction with conch gradual, with whorls flattening and transverse ornament appearing. Suture impressed. Whorls very gently rounded on sides; base well-rounded and sloping steeply. Sculpture on early whorls consists of numerous closely spaced transverse costae; first spiral elements appear adjacent to suture on second teloconch whorl, followed on later whorls by increased spacing of transverse elements, which is accompanied by addition of numerous spiral lirae of lesser strength; on body, ribs are colabral and extend down over periphery onto base with decreasing strength; spiral lirae present on both sides and base. Aperture subovate, flaring anteriorly; outer lip sharp at edge, thickened and reinforced behind by a varix; outer lip interiorly thickened and frequently with 7 or 8 small denticles well back from aperture; inner lip appressed on parietal wall, loosening and straightening over columellar lip and exposing a narrow umbilical chink.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*HB*	*H:D*
15 (holotype)	1.8	1.1	0.8	1.63
15	1.9	1.2	.8	1.58
15	1.65	1.05	.7	1.57
15	1.75	1.1	.75	1.59
15	1.65	1.05	.7	1.57
29	1.95	1.15	.9	1.65
29	2.1	1.25	.95	1.68
24	1.6	.95	.7	1.68
24	1.95	1.15	.9	1.61
24	1.7	1.0	.75	1.70
24	1.65	.95	.65	1.73
24	1.95	1.1	.85	1.77
24	1.75	1.0	.7	1.75
24	1.6	1.0	.7	1.6
16	2.1	1.15	.95	1.82
6	1.75	1.1	.75	1.59
17	1.95	1.2	.9	1.62
17	2.0	1.2	.9	1.66

Discussion.—This stout little shell occurs well preserved and in some abundance at localities in the Ripley formation of Mississippi. Compared with *T. costata* (Wade), this species has more widely spaced axial costae and a proportionally smaller protoconch, develops spiral ornament at an early stage, and is basally less angular. None the less, the two species are quite similar in gross aspect. To find other forms which are similar, one must look to the Eocene and Oligocene of France, where such species as *T. nana* (Lamarck) and *T. inflexicostata* Cossmann occur.

Variation within the species is not great, and as the measurements indicate, size and proportions are rather uniform within a given population. In ornament the numbers of transverse costae are quite uniform, but strength and breadth of the costae vary moderately (pl. 9, figs. 37, 40). The spiral lirae on the other hand vary considerably both in strength and in the degree of the surface covered. The spiral swelling or strong cord immediately below the suture is always present, as are the strong cords at the base, but in some specimens the whorl sides may be almost completely devoid of spiral ornament (pl. 9, fig. 40).

When spiral ornament is well-developed, the time of its first appearance is variable. Some specimens with coarse spiral lirae or cords on the body show a spire almost totally devoid of spiral sculpture (pl. 9, fig. 43), whereas others exhibit such sculpture from a very early stage.

In Mississippi, *T. tallahatchiensis* ranges through the lower part of the Ripley formation and into the upper part but has not been found in the Keownville limestone member.

Types: Holotype USNM 128787; paratypes USNM 128784–128786.

Occurrence: Mississippi: Ripley formation, loc. 6, 15, 16, 17, 24, 29. Georgia: Ripley formation.

Turboella crebricostata Sohl, n. sp.

Plate 9, figures 32–34

Diagnosis.—Small conical shell ornamented by low broad closely spaced flat-topped transverse costae, but generally lacking spiral ornament.

Description.—Shell small, less than 2 millimeters high; spire conical, blunted apically; surface glazed. Protoconch of a little more than two plump smooth-surfaced round-sided whorls; junction with teloconch moderately abrupt, with addition of fine transverse costae and gradual flattening of whorl sides. Suture impressed. Whorls of conch 3–4 in number; early whorls round sided, becoming flattened on later whorls; base broadly convex, sloping steeply from periphery. Sculpture dominantly transverse; transverse costae of early whorls low, gently rounded on upper surface and very closely spaced; on later whorls axial costae increase in breadth, are generally flat topped and closely spaced. Spiral ornament generally absent, but on holotype they are erratically and poorly developed on the base. Aperture subovate, widening anteriorly; outer lip sharp, reinforced by a varix exteriorly, interiorly thickened and bearing eight denticles on holotype; inner lip not completely preserved.

Measurements.—The holotype from locality 29 measures 1.6 millimeter in height and 0.9 millimeter in diameter.

Discussion.—The numerous crowded axial costae of the early whorls, the broad, flat closely spaced costae of the body, and the general absence of spiral ornament all serve to distinguish *T. crebricostata* from *T. costata* and *T. tallahatchiensis.*

The holotype from locality 29 is an immature specimen but is the best preserved specimen of those available. The paratypes are all incomplete specimens but supplement the primary type by indicating that later whorls continue to carry the typical broad transverse costae and lack spiral ornament.

Types: Holotype USNM 128788; paratype USNM 128789.
Occurrence: Mississippi: Ripley formation at loc. 29.

Superfamily CALYPTRAEACEA
Family TRICHOTROPIDAE
Subfamily TRICHOTROPINAE

Genus TRICHOTROPIS Broderip and Sowerby, 1829

Type by original designation, *Turbo bicarinata* Sowerby, 1821.

Diagnosis.—Medium-sized turbinate phaneromphalous shell with proportionally large peripherally carinate or angulated body; ornament variable, generally dominated by spiral cords.

Discussion.—Many cretaceous representatives of this genus have been assigned to the genus *Gyrotropis* Gabb. Cossmann (1906, p. 193) retained the name *Gyrotropis* but was confused as to its meaning. He evidently was unable to consult Gabb's original description and based his discussion on Fischer's "Manual de Conchyliologie" (1880–87). Accompanying his discussion is an inadequate handdrawn illustration of *T. konicki* (Müller) that exaggerates the umbilicus and misrepresents both shape and ornament. This misconception of a wide umbilicus perpetuated by Cossmann, and more recently by Wenz (1940, p. 892), arose because the holotype of Gabb's *Gyrotropis* is an incomplete specimen, lacking the anterior part of both columella and aperture. Gabb's figure (1876, pl. 17, fig. 5) gives the erroneous impression that the aperture is complete and the umbilicus is wide rather than a chinklike opening. Stephenson (1923, pl. 93, figs. 6, 7) gives an accurate illustration of Gabb's type *G. squamosus.*

Trichotropis is represented by a number of species in modern seas but appears to be restricted to cooler waters or the deeper reaches of more temperate waters. This is a decided contrast to the Cretaceous distribution in temperate shallow-water deposits.

In the Cretaceous of the Gulf and Atlantic Coastal Plains *Trichotropis* is represented by three species—*Trichotropis imperfecta* Wade from Tennessee, *Gyrotropis squamosus* Gabb from North Carolina, and the new species *Trichotropis mississippiensis* Sohl. Other Upper Cretaceous species have been described from India and Germany. These species all bear a close resemblance to *Trichotropis* s. s., and no necessity is seen for separating them, although no early Tertiary representatives are known. Some doubt as to assignment is bound to arise, not only on the basis of the time gap and ecologic association but also of shell structure, as is especially well shown by *T. imperfecta* Wade. This species displays a rough and imbricated surface similar to that of some of the forms in the Coralliophilidae. It is possible that if more material were available the familial assignment of these species would be changed. If such proves to be true, the name *Gyrotropis* would be available for these forms, but it would have to be redefined.

Trichotropis mississippiensis Sohl, n. sp.

Plate 10, figure 22

Diagnosis.—Medium-sized *Trichotropis* with 2 strong peripheral cords that form a bicarinate body whorl; 2 spiral lirae present between peripheral cords.

Description.—Shell of medium size, turbinate, thin; holotype of about five rapidly expanding whorls. Protoconch of a little more than two whorls, subovate in cross section, unornamented; junction with teloconch abrupt, whorls first becoming ornamented then flattening to a shoulder and developing an angulation. Suture impressed and bordered by a spiral ridge; suture tends to become channelled in later stages. Body whorl flattened to a gentle ramp between suture and periphery, flat between peripheral carinae and steeply sloping over base. Sculpture dominated by spiral lirae; 6 lirae of variable strength occurring over upper ramp, 2 between the peripheral carinae, and 9 below periphery. Transverse sculpture of fine colabral threads that form nodes where they override spiral lirae and in proportion to strength of spirals are weaker on body than on spire. Growth lines weak on spire, increasing in strength on body, and possess a prosocline trend that is strong on ramp and becomes almost orthocline on periphery. Aperture incomplete, sublenticular; outer lip thin and sharp, edge crenulated at junction with peripheral carinae; inner lip broadly excavated, columellar lip sharp and slightly reflexed over narrow, deep umbilicus; umblicus bounded by a round-topped carina; umbilical walls smooth except for growth lines and growth lamellae.

Measurements. — The holotype measures 14.3+ millimeters in height and 12.1 millimeters in diameter.

Discussion.—*Trichotropis mississippiensis*, with its distinctive ornament, rather high spire, and elongate umbilical fissure is not likely to be confused with *T. imperfecta* Wade, which has a massive body and low spire. *T. squamosus* Gabb has more numerous spirals, is concave between its peripheral carinae, and bears strong growth lamellae. *T. konicki* Müller, from the Aachen deposits, is close in character to this species but has a wider umbilicus, a serrated umbilical rim, and strong growth lamellae on the whorl sides.

The species is restricted to the Ripley formation of Mississippi and is known from only a few incomplete specimens.

Types: Holotype USNM 128474; paratype USNM 128475.
Occurrence: Mississippi: Ripley formation, locs. 16, 18.

Trichotropis imperfecta Wade

Plate 10, figures 29, 33

1926. *Trichotropis imperfecta* Wade, U.S. Geol. Survey Prof. Paper 137, p. 157, pl. 54, figs. 3, 18.

Diagnosis.—Shell large; spire very low; suture channelled; body whorl large, much expanded, and bicarinate at periphery; ornament of coarse spiral ribbons and very coarse growth lamellae.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Type	*H*	*MD*	*HA*	*WA*
Holotype	60.5+	53	32.5+	19
Topotype	50.0	55	27.0	24

Discussion.—This large species, with its low spire, inflated body, and rough exterior surface is not likely to be confused with other species of *Trichtrotropis*. It does belong near *T. mississippiensis*, however, in possessing an elongate narrow umbilicus and roughly bicarinate whorl.

Only 2 specimens, the holotype and 1 topotype, are available for study. Both specimens are incomplete, and in addition the topotype is laterally compressed, accounting for the discrepancy of measurements. Wade's illustrations (1926, pl. 54, figs. 3, 18) are slightly reduced and retouched but faithful. A supplementary figure of the type is included here to show the nature of the umbilicus.

Type: Holotype USNM 32936.
Occurrence: Tennessee: Ripley formation, loc. 1.

Genus TURBINOPSIS Conrad, 1860

1860. *Turbinopsis* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 289.
1876. *Cancellaria* Gabb, Philadelphia Acad. Nat. Sci., v. 28, p. 300.
1892. *Modulus* Dall, Wagner Free Inst. Sci. Philadelphia, v. 3, p. 295.

Type by monotypy *Turbinopsis hilgardi* Conrad, 1860.

Diagnosis.—Conrad's generic description (1860, p. 289) serves well as a diagnosis. "Turbinate; spire conical; whorls channeled at the suture; umbilicus profound; inner and outer lip continuous above and separated from the body whorl; columella concave with a very oblique fold near the basal margin."

Discussion.—Besides the type species, *Turbinopsis hilgardi*, from the Ripley formation of Tippah County, Miss., Conrad originally included some molds from the Upper Cretaceous of New Jersey and placed the genus in the Cancellaridae. Dall (1890–1903, p. 289) reviewed the genus and although stating that the umbilicus was exceptionally wide placed it in the Modulidae as a synonym of *Modulus*. Cossmann (1896, p. 8) at first agreed with Dall's assignment but later (1906, p. 202) doubted his original stand and decided *Turbinopsis* was closer to *Gyrotropsis* Gabb (=*Trichotropis* Bowdich and Sowerby), or perhaps belonged to the Fossuridae. Whitfield (1892, p. 99) described five species of internal molds from New Jersey and placed them in *Turbinopsis*. He then assigned the genus to the Cancellaridae. Weller (1907, p. 794) followed Whitfield's assignment of *Turbinopsis* but doubted the position of the molds described.

In my opinion the genus belongs in the Trichotropidae. *Lirpsa* Stephenson is similar to *Turbinopsis* in its high spire and wide umbilicus, which is bordered by a keel, but differs by having a body carination and by its broad reflexed inner lip and rounded anterior apertural margin.

Aside from the type species, all others assigned to this genus are too poorly known to be assured of their placement here.

Turbinopsis hilgardi Conrad

Plate 10, figures 17, 18

1860. *Turbinopsis hilgardi* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 289, pl. 46.
1876. *Cancellaria hilgardi* (Conrad). Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 68, p. 300.
1896. *Turbinopsis hilgardi* Conrad. Cossmann, Essais Paléoconchologie Compareé, v. 3, p. 8, fig. 1.

Diagnosis.—Medium-sized phaneromphalous turbiniform shell ornamented by broad spiral ribbons; aperture well rounded posteriorly, anteriorly angulated; umbilicus broad, open, and deep.

Description.—Shell of medium size, thick; spire of moderate height. Protoconch of holotype erect, unornamented, 1¼ turns preserved plus the scar of one-half turn more. Pleural angle 98°. Whorls 3–4 in number rapidly expanding. Suture deeply impressed, almost channelled. Body whorl well rounded, slightly constricted at base but sloping steeply to umbilical margin. Surface covered by rather broad flat-topped spiral ribbons that are strongest on the periphery but broader and more closely spaced over the rounded upper surface of whorl. Prosocline growth lines cover surface and are strongest near aperture, where they wrinkle the shell surface and partly obliterate the spiral ribbons. Aperture an inverted drop in outline, acutely angular anteriorly; outer lip well rounded and thick; inner lip excavated and not in contact with penultimate whorl at aperture. Umbilicus broad, open, and flaring, bordered by sharp ridge and marked within by continuation of growth lines.

Measurements.—The holotype measures 26.3 millimeters in height and 29 millimeters in maximum diameter.

Discussion.—The holotype is preserved in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 14956) and is the only specimen of *Turbinopsis hilgardi* known. The specimen is listed as having been collected from the Ripley formation of Tippah County, Miss. However, it could feasably have been collected from the Owl Creek formation or even from northern Union County, which at the time of description was a part of Tippah County.

The many subsequent collections made in this region have failed to yield additional specimens, and with the possible exception of several internal molds from the Prairie Bluff chalk of Mississippi and others from New Jersey, no other members of the genus are known.

Type: Holotype ANSP 14956.
Occurrence: Mississippi: *Exogyra costata* zone.

Turbinopsis? cf. T. curta Whitfield

Plate 10, fig. 31

1892. *Turbinopsis curta* Whitfield, U.S. Geol. Survey Mon. 18, p. 102, pl. 12, figs. 3–6.
1907. *Turbinopsis? curta* Whitfield. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 798, pl. 96, figs. 4, 5.

Discussion.—Internal molds from the Prairie Bluff chalk of Mississippi are quite similar to molds from the Navesink marl of New Jersey described by Whitfield as belonging to *Turbinopsis.* Although actually indeterminate generically, the structures present are suggestive of the genus by being turbiniform in outline with an open umbilicus and an acute angulation at the anterior end of the aperture.

Types: Holotype ANSP; hypotype USNM 128476.
Occurrences: Mississippi: Prairie Bluff chalk, locs. 71, 74, 80, 82, 88, 92.

Turbinopsis? cf. T. depressa Gabb

Plate 10, figure 28

1861. *Turbinopsis depressa* Gabb, Philadelphia Acad. Nat. Sci. Proc., p. 321.
1892. *Modulus depressus* (Gabb). Whitfield, U.S. Geol. Survey Mon. 18, p. 152, pl. 17, figs. 6, 8.
1907. *Turbinopsis depressa* Gabb. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 794, pl. 98, figs. 6, 11.

Discussion.—A few molds from the Prairie Bluff chalk of Mississippi seem close to the New Jersey molds described by Gabb as *Turbinopsis depressa.* One specimen from locality 57 preserves an impression of the ornamentation of the umbilical wall, and like the type species it is covered by rather coarse growth lines. In apertural and umbilical features the Mississippi specimens approximate the genotype. However, the upper surface of the body is less well rounded, and the spire appears to be less elevated.

These specimens do more closely approximate the form of *Turbinopsis* than do those assigned to *T? curta.*

Types: Holotype ANSP; hypotype USNM 128477.
Occurrences: Mississippi: Prairie Bluff chalk, locs., 57, 71, 75, 94.

Turbinopsis? sp.

Plate 10, figures 30, 32

Discussion.—One specimen from locality 82 in the Prairie Bluff chalk may belong in this genus. It is an internal mold preserving three rapidly expanding whorls. The specimen is larger and higher spired than the type species but possesses a similar apertural outline and a rounded upper body surface and reflects strong spiral body ornament.

Type: Figured specimen USNM 128478.
Occurrence: Mississippi: Prairie Bluff chalk, loc. 82.

Genus **CERITHIODERMA** Conrad, 1860

Type by monotypy *Cerithioderma prima* Conrad, 1860.

Discussion.—The type, a Claibornian species described by Conrad, exhibits a circular aperture with a flaring outer lip and a twisted short anterior canal.

Wade (1926, p. 155) described and assigned to the genus *Mesostoma* Deshayes two species from the Ripley formation of Tennessee—*M. americanum* and *M. costatum*. *Mesostoma* Deshayes, 1861, is preoccupied by *Mesostoma* Ehrenberg, 1837, a turbellarid worm, and in addition appears to be a synonym of *Cerithioderma* Conrad, 1860.

The first species described by Wade, *M. americanum* (see pl. 9, fig. 28), is specifically indeterminate and is based on a single incomplete specimen. The illustration (Wade, 1926, pl. 54, figs. 10, 11) is much retouched, as the holotype possesses an incomplete spire with the ornament obscured by wear. When studied by Wade, the aperture was incomplete and obscured by matrix that not only filled the aperture but covered the inner lip. Upon removal of the matrix the inner lip was seen to be reflexed and flared anteriorly, partly but not completely covering an umbilical slit. No anterior canal was seen. The specimen appears to be an immature shell that may belong in the Trichotropidae, but with neither nucleus, complete aperture, nor knowledge of adult characters, a definite placement in any genus would be foolhardy. The lack of any evidence of an anterior canal alone would seem to negate an assignment to *Cerithioderma* Conrad.

The second species, *M. costatum* Wade, has here been reassigned to the genus *Turboella* Leach.

Genus **ASTANDES** Wade, 1917

Type by original designation, *Astandes densatus* Wade 1917.

Diagnosis.—Medium-sized anomphalous trochoid shell with round-sided whorls marked by numerous strong spiral lirae and thick colabral axial ribs; aperture D-shaped; outer lip dentate; anterior canal short.

Discussion.—Wade (1917b, p. 299), in proposing *Astandes* included the type species *Astandes densatus*, from the Ripley formation of Tennessee, and two European Late Cretaceous species—*Tritonium cretaceum* Müller, from Vaals, Germany, and *Tritonium* cf. *T. cretaceum* Müller of Kaunhowen. All the species are rather poorly known, and our knowledge of the genus essentially rests on the holotype of the type species.

Astandes densatus Wade

1917. *Astandes densatus* Wade, Philadelphia Acad. Nat. Sci. Proc., v. 69, p. 299, pl. 17, figs. 7, 8.
1925. *Astandes densatus* Wade. Cossmann, Essais Paléoconchologie Compareé, v. 13, p. 273, pl. 8, figs. 18–19.
1926. *Astandes densatus* Wade. Wade, U.S. Geol. Survey Prof. Paper 137, p. 158, pl. 54, figs. 19, 20.
1940. *Astandes densatus* Wade. Wenz, Handbuch der Paläozoologie: Gastropoda, pt. 4, p. 892, fig. 2622.

Discussion.—Wade (1926, p. 158) states that several specimens were available to him when he erected the genus *Astandes* and described *A. densatus*. I have seen only the holotype, and subsequent collecting at the type locality on Coon Creek, Tenn., has failed to unearth any further material.

Types: Holotype USNM 32944.
Occurrence: Tennessee: Ripley formation, loc. 1.

Family **CAPULIDAE**
Subfamily **CAPULINAE**

Genus **CAPULUS** Monfort, 1810

Type by original designation, *Patella ungarica* Linné, 1757.

Diagnosis.—Medium-sized cap-shaped shell with loosely to tightly coiled nucleus, subcircular aperture, and horseshoe-shaped muscle scars that open anteriorly; surface sculpture of radial threads or costae.

Discussion.—Unconfirmed reports place the first appearance of *Capulus* in the Jurassic. Definite members of the genus are well known from most parts of the Cretaceous sections in many areas of outcrop. Modern-day distribution of *Capulus* is somewhat more restricted. In general they inhabit the shallower waters of the Atlantic and Mediterranean coasts, but a few forms are known from the deeper waters and several from the Pacific Ocean.

In the Upper Cretaceous of the Gulf Coastal Plain the following species have been described: *Capulus spangleri* Henderson, *C. cuthandensis* Stephenson, *C. erectus* Stephenson from the Nacatoch sand of Texas; *C.? microstriatus* Stephenson from the Corsicana marl of Texas; *C. corrugatus* Wade and *C. monroei* Sohl, n. sp., from the Ripley formation of Tennessee; *C. cuthandensis* Stephenson? from the Prairie Bluff chalk of Mississippi.

In addition, undescribed forms are present in the U.S. Geological Survey collections from the Demopolis chalk of the Selma group of Alabama, and from the Cusseta sand and Blufftown formation, also of the Selma group, of the Chattahoochee River region of Georgia and Alabama.

Most of these species are incompletely known, as they are based on internal molds, but the molds show sufficient characters to place them in the genus.

Capulus monroei Sohl, n. sp.

Plate 10, figures 8, 9

Diagnosis.—Medium-size capulid with low outline; surface sculpture dominated by concentric growth lines; radial lines numerous and faint near apex but develop to stronger ribs near margin.

Description.—Shell of medium size, fragile, cap shaped; apex curved backward strongly and coiled; protoconch tightly coiled, consisting of about 1½ whorls; aperture subovate, incomplete on the holotype. Sculpture dominantly of concentric growth lines that wrinkle the shell surface; in addition twelve faint, round-topped low radial ribs on the body, with interspaces several times greater than ribs; ribs not present on apex but increase in strength toward margin.

Measurements.—The holotype measures 5.4 millimeters in height, with the aperture 15.3 millimeters long and 9.4 millimeters wide.

Discussion.—*Capulus monroei* is rare in the Ripley formation, and no completely preserved specimens are available. The best specimen, the holotype, has an incomplete aperture; but in spite of the lack of perfectly preserved material, the species is distinct. The lack of appreciable twisting of the apex and general lack of radial ornament on the apex serves to distinguish this species from the other Cretaceous species of the coastal plain. *C.? microstriatus* Stephenson, from the Corsicana marl of Texas, is the closest approach to this species but possesses a much higher outline, a more circular aperture, and a surface covered by faint, thin radial threads which do not develop into ribs.

The species is named in honor of Watson H. Monroe, who has materially contributed to the knowledge of gulf coast stratigraphy.

Types: Holotype USNM 128479; paratype USNM 128480.
Occurrence: Tennessee: Ripley formation, loc. 1.

Capulus corrugatus Wade

Plate 10, figures 10–12

1926. *Capulus corrugatus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 166, pl. 58, fig. 4.

Diagnosis.—Medium-sized moderately high capulids, with 15–16 strong radial costae ornamenting the exterior and with 2 broad, strong costae occurring on the posterior triangular area immediately below the beak.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	Min*D*
1 (holotype)	10 ?	20.0	----------
1 (topotype)	13.8	27.2	23.7
Texas (*C. spangleri*)	16.0	19.0	18.0
Do	17.0	30.0	----------

Discussion.—Wade described this species from imperfect material; the holtoype lacks the posterior margin, and the apex is fractured. The only illustration given is an interior view of the compressed specimen. Stephenson (1941, p. 273) stated that *C. corrugatus* might be conspecific with specimens from the Navarro group he assigned to *C. spangleri* Henderson, but topotypes of Wade's species from subsequent collections indicate distinct differences between the Texas and Tennessee material. *C. corrugatus* is a higher but less broad shell than *C. spangleri* and possesses more radial costae, but the greatest difference lies in the presence of two broad, strong ribs on the triangular area beneath the beak of the species from the Ripley formation, whereas the Texas form has an essentially smooth surface. The measurements given in the table also serve to indicate a certain degree of difference.

I am at a loss to understand how Wade measured the height of the much compressed holotype, which is still imbedded in matrix.

The species is rare and restricted to the Ripley formation at Coon Creek, Tenn.

Types: Holotype USNM 73048; hypotype USNM 128481.
Occurrence: Tennessee: Ripley formation, Coon Creek tongue, loc. 1.

Capulus cuthandensis Stephenson?

Plate 10, figures 13–16

1941. *Capulus cuthandensis* Stephenson, Texas Univ. Bull. 4101, p. 274, pl. 50, figs. 24–26.

Diagnosis.—Large high cap-shaped shells; aperture subcircular; surface covered by numerous strong radial ribs with a narrow, deep prominant sulcus situated between two strong radial ribs of the right anterolateral slope.

Discussion.—The types from the Nacatoch sand of Texas are internal molds that preserve the interior reflections of the surface ribs. The most distinctive character appears to be the deep sulcus on the right anterolateral slope. Several molds from the Prairie Bluff chalk of Mississippi bear a close resemblance to the Texas forms. They are all incomplete but show the typical high outline, the numerous radial ribs that occur over the whole surface, and the distinctive sulcus. The Mississippi specimens occur at a higher stratigraphic position than the Texas specimens but are certainly very closely related, if not conspecific.

Types: Holotype (from Texas) USNM 76832; paratypes (3) USNM 76833; hypotype 128482 (from Mississippi).

Occurrence: Mississippi: Prairie Bluff chalk, locs. 87, 94.

Genus THYLACUS Conrad, 1860

Type by monotypy, *Thylacus cretaceus* Conrad, 1860.

Diagnosis.—Small- to medium-size irregular cap-shaped shell with a smooth tightly coiled trochoid protoconch; surface roughened by concentric growth lines; aperture irregular in outline, widening anteriorly; muscle scars horseshoe-shaped, opening anteriorly and developing free supporting plates.

Discussion.—On the basis of the smooth trochoid nucleus and lack of a separate attachment plate, this genus appears to be closer to *Capulus* than to *Hipponix* and is placed in the Capulidae. It has been treated as a questionable subgenus of *Capulus* by Wenz (1940, p. 898), but he evidently was unaware of the internal supporting plates for the muscles. These supports appear early in the development of the individual and, by their uniformity of character and persistence through the growth stages of the individuals seen, seem to merit a separation from *Capulus* as a distinct genus. Further support for generic separation is seen in the highly specialized living habit of restriction to attachment to the columella of gastropods.

Thylacus cretaceus Conrad, the type species from the Ripley formation of Mississippi, appears to be the only species referable to the genus. Aside from the occurrence in the *Exogyra costata* zone of the East Gulf Coastal Plain, Stephenson (1923, pl. 88, figs. 20, 21) has reported the species from the upper part of the *E. ponderosa* zone of North Carolina. This later assignment is based on one somewhat worn and compressed specimen that definitely belongs to the genus but may be a different species.

Thylacus cretaceus Conrad

Plate 10, figures 1–4, 7

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

1923. *Thylacus cretaceus* Conrad. Stephenson, North Carolina Geol. and Econ. Survey, v. 5, p. 55, pl. 88, figs. 20–21.

1926. *Thylacus cretaceus* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 166, pl. 58, figs. 1, 5, 11.

1940. *Capulus* (?*Thylacus*) *cretaceus* (Conrad). Wenz, Handbuch der Paläozoologie: Gastropoda, pt. 4, p. 898, fig. 2641.

1945. *Thylacus cretaceus* Conrad?. Harbison, Philadelphia Acad. Nat. Sci. Proc., v. 97, p. 82, pl. 3, figs. 15–16.

Diagnosis.—Medium to small, twisted pear-shaped shell with globular naticoid protoconch, roughened outer surface with only faint radial ornament, and internally bearing thin lamellae like plates for muscle support.

Description.—Shell medium to small, pear shaped in outline; beak posterior, twisted and extending beyond posterior margin. Protoconch naticoid, consisting of about 2½ globular whorls; protoconch smooth on early stages, later developing growth lines that are first noticeable as wrinkles near the upper suture, then extend completely across whorl; junction with conch marked by an abrupt flaring of shell plus an increase in strength and sinuosity of growth lines. Body whorl expands rapidly, becomes flaring anteriorly, and its median plane twists until it lies at a considerable angle to axis of protoconch. Surface much roughened by rather coarse and sinuous growth lines; radial ornament obscure and generally absent; where present it consists of short low round-topped ribs appearing between surface wrinkles. Aperture irregular in outline, flaring anteriorly; apertural lip sinuous, with major sinuses at left anterolateral and right posterolateral positions; lip thickens and broadens posteriorly, with a flat area generally present beneath beak. Muscle scars horseshoe shaped and open anteriorly, developing supports in earliest stages of growth; supports are groovelike under beak and extended out laterally and anteriorly to bladelike extremities which loosen and become free near their tips.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*L*	*LA*	*WA*
1	1.2	2.1	1.8	1.5
1	2.0	2.7	2.5	1.9
1	3.1	7.0	6.2	3.7
1	2.5	5.4	4.9	3.0
1	4.6	10.5	8.7	5.0
1	5.9	12.2+	10.2+	7.0
1	6.9	14.5	12.6	7.7
1	3.8	8.8	7.5	4.9
1	5.1	12.3	11.0	6.1
1	4.4	11.2	9.0	5.1
15	3.5	6.7	5.6	3.7
15	3.6	8.3	7.1	4.0
15	2.0	4.0	3.6	2.4
15	2.1	3.8	3.2	2.0
18	3.0	5.8	5.0	2.5
18	1.6	3.2	2.8	1.7
40	3.2	8+	7+	4.4
42	3±	7+	5.7	4.0
44	6.5	1.4	1.25	1.4

Discussion.—*Thylacus cretaceus* is an attached form living on the columella of gastropods. Almost all specimens in the collections under study have come from the matrix of the larger gastropods, and individuals have been noted in place on the columella by Wade (1926, p. 166) and by me. In no instance has an attachment scar been noted. The shape of the shell reflects the living habit. Its sinuous apertural lip is so arranged that the animal lived with its anterior end directed obliquely posterior to the columellar axis of the host. The earliest stages of *Thylacus* were probably spent in a free and unattached condition, as is shown by the normal naticoid protoconch. The rapid expansion of the postprotoconch whorl and subsequent twisting of the body reflects the asumption of an attached condition. That other members of the fauna from the Ripley formation occasionally assumed a similar habit is shown by a specimen of *Anomia perlineata* Wade (pl 10, figs. 5, 6), which has assumed a shape typical of *Thylacus*. As the measurements in the table indicate, once the individual settles down to its attached habit the shell increases in length much more rapidly than in width. These figures also show that variation is linear and not haphazard. Thus it appears, both from the fact that the growth lines reflect sinuses constantly in the same place and from the relative uniformity of proportional size at a given growth stage, that they were much restricted as to mode of life and place of attachment. It is believed on the basis of the available evidence that the species was restricted to a life of attachment to the columella of gastropods. Because they have been recovered mostly from the apertures of volutes like *Volutomorpha*, forms with long, relatively straight columellas, they may also have been restricted to living on only a certain few genera. One individual was recovered from the aperture of a *Euspira rectilabrum* (Conrad), and three from specimens of *Morea*.

The type of *Thylacus cretaceus* Conrad is not present in the collections of the Philadelphia Academy of Natural Sciences and is presumed lost. The illustration and the diagnosis afforded by Conrad (1860, p. 290) are poor but sufficient for identification. Conrad did not note the presence of the internal muscle supports, and owing to this, various authors have considered the genus a possible synonym of *Capulus*. To further confuse the issue, Conrad cited the type locality as "Tippah County, Ala." instead of Mississippi. Foreign authors such as Wenz have perpetuated the errors. Wade (1926, p. 166) states that the holotype was from Owl Creek, Miss. Only one specimen of *Thylacus cretaceus* has been recovered there but several more have been collected from other Owl Creek localities. I have considered most of the species from Tippah County described in Conrad's 1860 paper as coming from the Ripley formation, as many of the species described are restricted thereto.

Types: Hypotypes USNM 31958, USNM 73028, USNM 128483–128485; ANSP, Harbison collection.

Occurrence: Tennessee: Ripley formation, loc. 1; Clayton formation (reworked Cretaceous material at base), loc. 40. Mississippi: Ripley formation, locs. 5, 9a, 15, 16, 18. Owl Creek formation, locs. 42, 44, 46; Coffee sand.

Genus **CRUCIBULUM** Schumacher, 1817

Type by subsequent designation (Gray, 1847), *Patella auriculata* Chemnitz and Dillwyn, 1788 = *Patella auricula* Gmelin = *Crucibulum planum* Schumacher.

Diagnosis.—Subconical shell of medium size with subcentral spiral nucleus and rapidly expanding body; aperture subcircular, with funnel-shaped muscle-support platform that adheres to the apex or body wall.

Discussion.—*Crucibulum* has not been reported from strata older than Miocene. One poor immature specimen from the Ripley formation of Union County, Miss., may belong to the genus. *Crucibulum* is common in the later Tertiary deposits and is abundant in the warmer waters of present-day seas, ranging from the Indian Ocean to the Atlantic coast of North America. In life the adult settles and becomes essentially sessile, although it retains the power of locomotion.

Crucibulum? sp.

Plate 10, figures 20, 21

Discussion.—One small, immature and incomplete specimen only 2.1 millimeters in length, from the Ripley formation, displays certain features characteristic of *Crucibulum*. The specimen preserves only the apex with all the body margin broken. The protoconch is naticoid, consisting of about 1½ somewhat worn whorls. From the junction with the conch, the body flares out rapidly. Closely spaced round-topped radial ribs mark the body surface. This radial ornament is faint, and what form the ribs assume on the adult is unknown. Interiorly the curved muscle platform is attached directly to the apex by means of two raised broad ridges that are extensions of the body wall. The internal supports, although also broken, indicate that they become free and unattached above the point of cementation.

With the material at hand a definite assignment of this specimen cannot be made, but the character of the structures present suggests a close relationship to *Crucibulum*, and it definitely appears to belong in the Calyptraeacea.

Type: Figured specimen USNM 128487.

Occurrence: Mississippi: upper part of Ripley formation, loc. 29.

Superfamily STROMBACEA
Family XENOPHORIDAE

Genus XENOPHORA Fischer de Waldheim, 1807 (includes Endoptygma Gabb, 1877)

Type by subsequent designation (Gray, 1847) *Trochus conchyliophora* Born, 1780 (= *Xenophora laevigata* Fischer de Waldheim).

Diagnosis.—Medium-sized trochoid shell; whorls peripherally angular; surface roughened by attached shells; aperture subquadrangular; outer lip angulated at the periphery and opisthocline; lip concave at base; parietal callus reflected over umbilicus.

Discussion.—The earliest representatives of this genus are to be found in Crataceous strata. These Cretaceous species indicate that the peculiar habit of plastering material to the exterior shell surface was adopted at an early time in the history of *Xenophora.* In some specimens the animal appears to have been selective as to the material attached. The Ripley specimens from the Ripley formation on Coon Creek, Tenn., preferred bivalves of the genus *Caesticorbula*, although other shells also have been noted. The Recent species from the West Indies that were examined seemed to show no such selectivity, as they cement a wide range of material to their shells.

The total number of described species is not very great. In part this may be due to the opinion expressed by Dall that there was no essential difference between the Tertiary and Cretaceous forms. In contrast, Woodring (1928, p. 376) has expressed the opinion that too many American Tertiary forms have been lumped under the name *Xenophora conchyliophora.* Secondly, the species are all superficially similar, with the surface obscured; thus differentiation on the basis of ornamentation is impossible, and one must rely primarily on proportions. All the gulf coast forms from the *Exogyra costata* zone have been lumped under the name *X. leprosa* (Morton), a species based on internal molds. Other occurrences are rare in this area, but a similar form is present in Survey collections from the Blufftown formation of the Chattahoochee River region, and Stephenson (1953, p. 152) has noted the presence of another specifically indeterminate *Xenophora* in the Woodbine formation of Texas.

Endoptygma Gabb is essentially like *Xenophora*, except for the presence of an incised groove on the base of the internal mold. This groove is present on several specimens from the Prairie Bluff chalk of Mississippi here assigned to *X. leprosa* (pl. 10, fig. 23). The specimens show that the groove does not appear until a late stage of development. This feature then may be just a senile character of no generic significance. Specific differentiation of *Endoptygma umbilicatum* (Tuomey) may be justifiable, but even this stand is doubtful, and the presence of the groove is treated here as of no essential significance.

Xenophora leprosa (Morton)

Plate 10, figures 19, 23–27

1834. *Trochus leprosa* Morton, Synopsis of the Organic Remains of the Cretaceous Group of the United States, p. 46, pl. 15, fig. 6.
1864. *Phorus leprosa* (Morton). Meek, Check list of the invertebrate fossils of North America, Cretaceous and Jurassic, p. 18.
1868. *Onustus leprosus* (Morton). Conrad, *in* Cook, E. H., Geology of New Jersey, p. 728.
1892. *Xenophora leprosa* (Morton). Whitfield, U.S. Geol. Survey Mon. 18, p. 135, pl. 17, figs. 16–19.
1892. *Xenophora conchyliophora* (Born). Dall, Wagner Free Inst. Sci. Trans., v. 3, pt. 2, p. 306 [in part].
1907. *Xenophora leprosa* (Morton). Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 690, pl. 78, figs. 1–3.
1926. *Xenophora leprosa* (Morton). Wade, U.S. Geol. Survey Prof. Paper 137, p. 162, pl. 56.
1926. *Xenophora leprosa* Morton. Stephenson, Alabama Geol. Survey Special Rept. 14, pl. 91, fig. 9.
1941. *Xenophora leprosa* (Morton). Stephenson, Texas Univ. Bull. 4101, p. 285, pl. 52, figs. 17–19.
1944. *Xenophora leprosa* (Morton). Shimer and Shrock, Index fossils of North America, p. 485, pl. 199, figs. 10–11.

Diagnosis.—Shell of normal size for genus—a little more than half as high as broad; apical angle, 88°–95°; whorl base subcarinate; base broad and concave.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
71	27.4	41.0
71	21.0	29.0
71	20.0	32.0
88	13.5	21.0
76	23.0	36.0
78	14.0	24.0
57	23.0	33.5

Discussion.—Until Wade in 1926 described an incomplete specimen of *Xenophora* from the Ripley formation at Coon Creek, Tenn., this species was known only from internal molds from the chalk facies. Wade's specimen is compressed and preserves only part of the body, but does serve to show the roughened nature of the exterior and the presence of moderately fine spiral lirae that bear a thin incised spiral thread on their tops. The base of the specimen exhibits roughened growth lamellae that preserve both the contour of the outer lip and the reflected callus which covers the umbilicus. Subsequent collecting at this locality has produced only two additional specimens. These specimens preserve the apical part of the shell. The protoconch consists of almost four whorls, the first of which is slightly depressed, the rest are helically coiled

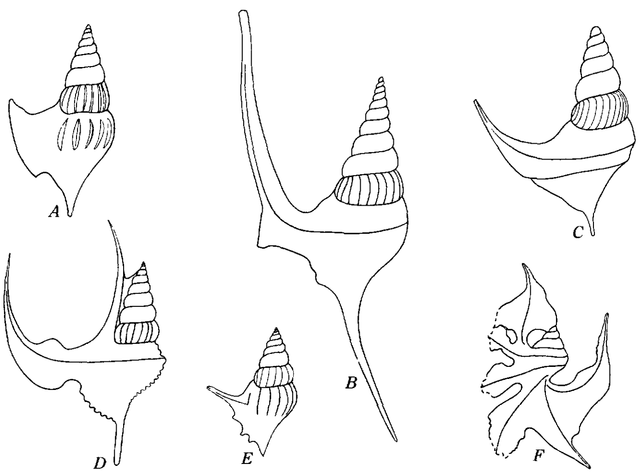

FIGURE 9.—Comparison of outer lip and form of anterior canal in the various apporhaid genera of the Ripley and Owl Creek formations. *A*, *Arrhoges*, (*Latiala*), × ½; *B*, *Anchura*, × ½; *C*, *Drepanochilus*, × 1; *D*, *Helicaulax*, × ½; *E*, *Graciliala*, × 1; *F*, *Pterocerella*, × ½.

and grade rather abruptly into the whorls of the teloconch. The conch whorls flatten rapidly and immediately start to bear attached foreign material. The only identifiable attached specimens are of the bivalve *Caesticorbula crassiplica* (Gabb).

Xenophora leprosa (Morton) is one of the most common and widespread of the gastropod species in the Prairie Bluff chalk. Unfortunately, the state of preservation as phosphatic internal molds does not preserve sufficient detail of the surface to indicate the nature of the material attached or to provide criteria for the subdivision of the species. The abundance of the material in the chalk as opposed to its sparse representation in the "marl" facies may be due to ecologic limitations.

Types: Holotype ANSP; hypotypes USNM 76863 (Texas); USNM 73072 (Tennessee), USNM 128488–128490 (Mississippi).
Occurrence: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, loc. 29; Prairie Bluff chalk, locs. 57, 67, 71, 72, 73, 75, 76, 78, 80, 81, 82, 87, 88, 90, 91, 94.

Family APORRHAIDAE

The aporrhaids, characterized by their turreted spire and expanded outer lip, reached their maximum development during the Cretaceous period. Both in variety and in abundance they are among the best represented of the gastropods in the Upper Cretaceous of the gulf coast.

The group is highly variable in form and ornament and has been subdivided to numerous genera and subgenera. Most of these subdivisions are based on the form of the outer lip and to some extent on relatively minor features of the posterior canal, a highly variable feature. (See fig. 9.) Many of the names are undoubtedly synonyms, but no concentrated effort has been made to set the group on a firm taxonomic foundation. The aporrhaids thus remain in need of a thorough monographic treatment, which is beyond the scope of this report.

Genus GRACILIALA Sohl, n. gen.

Type species, *Anchura* (*Drepanochilus*) *calcaris* Wade, 1926.

Etymology.—Compounded from the Latin gracilis (slender) and ala (wing).

Description.—Shell of medium size; spire high, turriculate; whorls generally 6–8; sides well-rounded ornamented by the fine spiral threads and numerous curved strong transverse ribs that die out below periphery; aperture elongate and lenticular, acute posteriorly and drawn out to a short, narrow anterior canal; outer lip expanded to a long, narrow, and tapering spur, grooved interiorly and with a corresponding external ridge that dries out on the body; inner lip with moderately heavy well-defined callus over the entire length.

Discussion.—This genus is proposed for a group of species common in the Campanian and Maestrichtian sediments of the Gulf and Atlantic Coastal Plains. In size and general features the genus bears its closest resemblance to *Drepanochilus* Meek but differs distinctly in several important ways. *Drepanochilus* is characterized by the presence on the body of strong spiral ridges, the strongest of which occurs at the periphery and carries out onto the wing as the exterior reflection of the interior channel. The extended wing is also narrower and less reflexed in *Graciliala* and possesses several minor digitations which frill the margin. *Anchura* differs by its less globular protoconch, more ornate sculpture, broad wing with both anterior and posterior extensions, and long anterior canal. Other genera show similar differences.

Included species are—

Anchura (*Drepanochilus*) *calcaris* Wade, Ripley formation of Mississippi, Tennessee, Alabama, and Georgia.
Anchura decemliratus Conrad, Owl Creek formation of Mississippi and Tennessee.
Anchura johnsoni Stephenson, Black Creek formation of North Carolina.
Anchura? campbelli Stephenson, Navarro group of Texas.
Anchura? caddoensis Stephenson, Navarro group of Texas (=*A. calcaris* Wade).
Anchura solitaria Whitfield, Merchantville clay of New Jersey.

In addition there are undescribed species present in the Cusseta sand and Blufftown formation of Alabama and Georgia and in the Wolfe City sand member of the Taylor marl of Texas.

This genus is in distinct contrast to such genera as *Drepanochilus* and *Anchura* in its narrow geographic and stratigraphic range. It appears to have developed from *Drepanochilus* by a suppression of the peripheral cord and angulation.

Graciliala calcaris (Wade)

Plate 11, figures 1–4, 6

1926. *Anchura (Drepanochilus) calcaris* Wade, U.S. Geol. Survey Prof. Paper 137, p. 152, pl. 53, figs. 5, 8, 13.

1941. *Anchura? caddoensis* Stephenson, Texas Univ. Bull. 4101, p. 302, pl. 56, figs. 3, 4.

Diagnosis.—Shell of average size for genus; whorls plump, generally 7–8 in number, with well-rounded sides ornamented by 15–17 curved colabral transverse ribs that decrease in strength near aperture; anterior canal narrow and short, with elongate narrow spur and 2–3 short blunt digitations on anterior slope.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc. or type	No. *W*	*H*	*MD*	*H4*	*D4W*	*H4W*: *D4W*
1 (holotype)	7.25	24.0	7.3	1.8	4.3	0.42
1 (paratype)	7?	18+	7.7	1.55	3.4	.46
1 (topotype)	7.0	21.4	9.0	1.6	3.8	.42
1 (topotype)	8.25	24.3	8.7	1.5	3.5	.43
1 (topotype)	7.0	24.4	9.3	1.9	(?)	(?)
1 (topotype)	4.75	9.6+	4.5	1.8	4.1	44
1 (topotype)	4.75	7.5+	3.6	1.6	3.4	.47
1 (topotype)	4.5	8.25+	3.9	1.65	3.9	.42
6	7.0	17.1	7.1	1.7	3.75	.46
6	6.0	17.1	7.6	2.1	4.75	.44
6	6.75	15.1	6.7	1.6	3.7	.43
6	6+	16.0	7.6	(?)	(?)	(?)
6	6+	15.1	5.7	(?)	(?)	(?)
6	6.0	19.2	7.1	2.4	5.4	.44
6	6+	17.4	6.8	2.1	4.75	.44
6	6.0	13.8	5.9	2.1	4.3	.48
6	6.0	15.9	6.5	2.1	4.75	.44
6	5.75	14.3	6.4	(?)	3.4	(?)
6	5.75	14.3	6.2	2.0	4.5	.44
6	4.75	11.2	4.7	(?)	4.2	(?)
6	7.0	19.0	7.9	1.7	4.0	.42
6	5+	11.4	4.7	(?)	(?)	(?)
6	5.5	13.5	5.6	1.9	4.1	.46
6	5.25	12.3	5.3	2.2	4.5	.49
6	6.75	17.0	6.4	1.5	3.6	.42
6	7.0	20.7	8.6	1.8	4.2	.43
6	6+	17.4	6.6	1.8	3.8	.46
6	5.25	13.8	6.3	2.3	4.9	.47
6	5.75	14.4	6.0	1.8	4.3	.42
6	6.0	16.2	6.0	2.1	4.6	.46
18	6.5	19.0	7.3	1.6	4.2	.38
18	7.25	21.4	8.8	1.8	4.0	.45
18	6+	16.7	7.3	1.7	4.1	.41
18	6.2	16.4	7.7	1.7	4.1	.41
18	6.0	15.1	7.3	2.0	4.7	.42
18	6.7	17.2	7.3	2.1	4.4	.48
18	6+	15.5	6.9	(?)	(?)	(?)
18	7.0	21.4	9.3	1.9	4.6	.41
18	6+	15.5	7.0	1.7	3.9	.41
18	5+	13.6	5.2	(?)	(?)	(?)
18	5.25	13.6	6.0	2.25	5.0	.45
18	6.25	14.4	5.9	1.8	4.0	.45
18	6.2	15.7	6.4	1.8	4.0	.45
18	6.5	15.8+	7.6	1.75	4.1	.43
18	5.75	15.7	7.6	1.61	(?)	(?)
13	6+	19.5	8.7	1.9	4.5	.42
13	6+	16.2	6.9	1.8	3.9	.42
13	(?)	20.1+	8 4	2.1	5.0	.42
12	6.25	18.0	7.0	1.8	4.25	.40
12	4.25	10.4	4.4	(?)	4.4	(?)
12	5.8	15.0	5.9	1.8	4.2	.43
12	5.5	15.2	6.2	2.3	5.1	.45
12	5.25	11.4	5.0	2.0	4.1	.49
12	5.75	16.1	7.2	2.25	5.0	.45
12	6.0	16.2	6.7	2.0	4.3	.47
12	6.5	21.1	8.0	2.1	4.4	.48
7	6+	20.0	7.6+	2.0	5.1	.39
A. caddoensis Stephenson (holotype)	6+	17.4	6.7	1.9	4.2	.48

Discussion.—*Graciliala calcaris* is one of the most common gastropod species in the Ripley formation and is represented in the collections studied by hundreds of specimens. The expanded outer lip is extremely fragile, and although the rest of the shell is generally recovered complete, the lip extremity is most often missing. There is considerable gradational infraspecific variation in size and shape. As the above measurements indicate, Mississippi specimens commonly reach a larger size and at the same growth stage are more obese than the stratigraphically lower specimens from the Coon Creek tongue of the Ripley of Tennessee. The number of transverse ribs appears quite constant regardless of the stratigraphic position and thus leads to a proportionally wider spacing on the more obese specimens (compare pl. 11, figs. 2 and 6). It is assumed that the individual did not have the ability to resorb the expanded outer lip, and when once formed, the animal had reached maturity. As thus defined, the populations show considerable variation in size at maturity. Within a given population the smallest mature form may be less than one-half the size of the largest mature individual. The number and strength of digitations on the anterior slope of the outer lip is also evidently variable; usually there are 2 digtations, but 1 individual from locality 6 (pl. 11, fig. 6) showed 3. While the end members of these local populations may appear to be distinct, there is always considerable overlap, and the various populations are considered conspecific.

A.? caddonensis Stephenson from the Nacatoch sand of Texas, agrees well in size and shape with the specimens of *G. calcaris* (Wade) from Mississippi. In my opinion it falls within the range of variability of Wade's species as here defined.

Aporrhais decemlirata Conrad is a closely related species from the Owl Creek formation of Mississippi and Tennessee. Comparison with that species is difficult owing to lack of well-preserved material of that species. The figure of the holotype (Conrad 1858, pl. 35, fig. 11) shows a specimen having somewhat shorter whorls that are quite obese, transverse ribs that are less numerous, and an outer lip that lacks the digitations on the anterior slope.

Anchura johnsoni Stephenson, from the Snow Hill marl member of the Black River formation of North Carolina, is larger and possesses a thicker, less tapering outer lip spike and a more steeply inclined outer lip anterior slope that bears two coarser, blunter digitations than *G. calcaris.*

Anchura? campbelli Stephenson, from the Neylandville marl of Texas, is poorly known, but on the known specimens has more numerous, more closely spaced transverse ribs and a stouter outer lip.

A. solitaria Whitfield, from the Merchantville formation of New Jersey, has a longer anterior canal, lacks the digitations of the anterior slope of the outer lip, but has a longer and narrower spike than *G. calcaris* (Wade).

Types: Holotype USNM 32928 (Tennessee); hypotypes 128493, USNM 76923 and 76924 (Texas), USNM 128491 and 128492 (Mississippi).

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 4, 5, 6, 7, 9, 9a, 11, 12, 13, 14, 15, 16, 17, 18, 21, 22, 23, 29(?). Texas: Navarro group, Nacatoch sand. Alabama and Georgia (Chattahoochee River region): Ripley formation.

Graciliala decemlirata (Conrad)

Plate 11, figures 5, 11

1858. *Aporrhais decemlirata* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 3, p. 130, pl. 35, fig. 11.

Discussion.—The holotype of *G. decemlirata* is not present in the collections of the Academy of Natural Sciences of Philadelphia and must be presumed lost. No other mature specimens are available for study, and the identification of the species rests primarily upon Conrad's original description and illustration. His description of this species (Conrad, 1858, p. 130) is as follows:

> Spire elvated, acute; volutions nine, convex, longitudinally costate, and finely striated transversely; ribs distant, prominent, angular, acute, short on the back of the body, but extending in front to a carinated line which borders the labrum; transverse striae distinct at base; labrum extended into the rostrum above the middle, where it is angulated and subcarinated and channelled within.

The type locality of *G. decemlirata* is the Owl Creek formation on Owl Creek, Tippah County, Miss. Several immature topotypes are available for study but lack the mature aperture and outer lip.

The species appears to be related to *G. calcaris* (Wade) but according to Conrad's illustration has a shorter outer-lip extension, lacks the digitations of the outer-lip anterior slope and has fewer more widely spaced transverse ribs. Immature specimens collected from the Owl Creek formation and assigned to Conrad's species show consistent differences from Wade's species in the early growth stages. The nucleus of the two species is of the same type, but *G. decemlirata* (Conrad) possesses a larger, more obese protoconch which bears almost one complete turn more than the average specimen from the Ripley formation, and in general the transverse ribs of the early whorls are less numerous and not so well defined, and commonly are thin and weak. The whorls themselves are generally better rounded on the side, and spiral ornament is proportionately stronger.

Types: Holotype lost; hypotypes (immature) USNM 128494, 128495.

Occurrences: Tennessee: Clayton formation (reworked Cretaceous material at base) loc. 40. Mississippi: Owl Creek formation, loc. 41, 43, 44, 45, 46.

Genus DREPANOCHILUS Meek, 1864

Type by original designation, *Rostellaria americana* Evans and Shumard, 1857 = *Drepanochilus evansi* Cossmann, 1904.

Diagnosis.—Medium-sized high-spired shells with convex whorls; ornament dominated by axial ribs on spire but develops two or more strong spiral cords at and below periphery on body; upper cord extends onto upturned narrow spur of expanded outer lip; anterior canal short.

Discussion.—The single upward to upward and backward reflected spike of the outer lip, as exemplified by *Drepanochilus*, is common to a large number of genera, such as *Arrhoges* Gabb and *Hemichenops* Steinmann and Wilckens. *Drepanochilus*, however, differs from these forms by its strong spiral cords restricted to the body whorl. Some authors (Wenz, 1940, p. 911) have lumped the above genera as subgenera under *Drepanochilus*. There is some merit to such a grouping, but it is considered that such a taxon would be worthy of subfamilial rank.

Members of this genus are found as early as the Aptian and range into the Eocene of Tunisia and North America. In the Upper Cretaceous series of the Gulf Coastal Plain, the genus appears only in the upper part of the section in beds of Campanian and Maestrichtian age. In general, specimens are rare and fragile and are rarely recovered complete. *Drepanochilus quadriliratus* Wade, from the Ripley formation of Tennessee and *D. triliratus* Stephenson and *D. texanus* Stephenson, from the Navarro group of Texas, are typical drepanochilids. Several other forms such as *D. martini* and *D. davisi* Stephenson, also from Texas, probably do not belong here but in *Anchura*, with such forms as *A. substriata* Wade that develop a basal angularity on the early whorls.

Drepanochilus quadriliratus (Wade)

Plate 11, figure 22

1926. *Anchura (Drepanochilus) quadriliratus* Wade, U.S. Geol. Survey Prof. Paper 137, p. 151, pl. 53, figs. 2, 4.

Diagnosis.—Shell above average size for the genus; body with four strong spiral cords, the upper one strongest and occurring at the periphery and extending out onto the expanded outer lip.

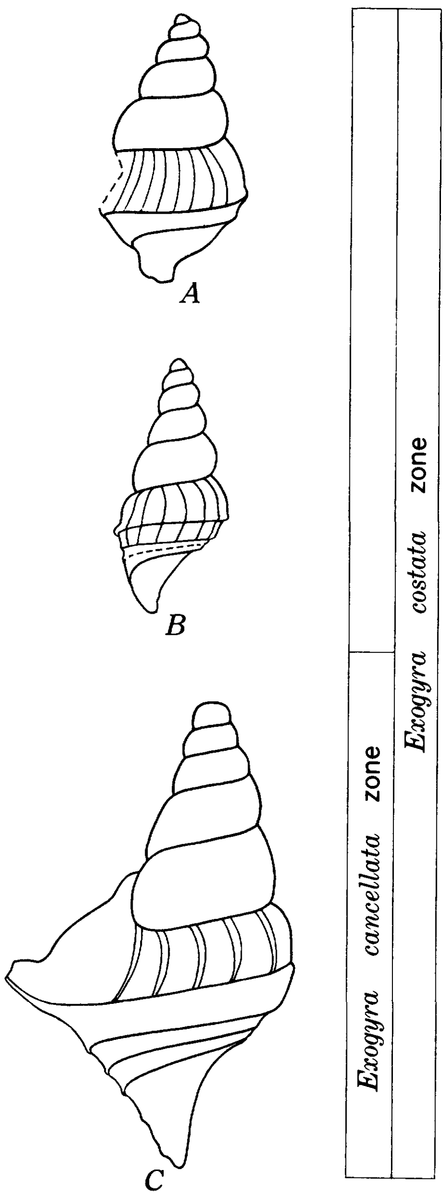

FIGURE 10.—Development of *Drepanochilus texanus* Stephenson. (*A*), from the Kemp clay of Texas, by the progressive suppression of the body cords from *Drepanochilus triliratus* Stephenson (*B*), from the Navarro group of Texas, and *Drepanochilus quadriliratus* Wade (*C*), from the Ripley formation of Tennessee.

Measurements.—The incomplete holotype measures 31.4 millimeters (extimated total 36.0) in height and 13.3 millimeters in width (Wade, 1926, p. 151). A smaller but more complete topotype measures 25 millimeters in height and 9.2 millimeters in width.

Discussion.—Only three specimens are available for study—all from the type locality at Coon Creek, Tenn., and they are incomplete, lacking the full extension of the outer lip. *D. triliratus* Stephenson, from the Navarro group of Texas and the Ripley formation of Mississippi, is closely related and probably derived from *D. quadriliratus* Wade by the suppression of the third body spiral. (See fig. 10.) *D. texanus* Stephenson from the Kemp clay is a smaller, obese form with only 2 spirals that appears to have developed from *D. quadriliratus* by the suppression of the lower 2 spirals. This seems to indicate an evolutionary sequence involving three species, which in summary show differentiation by decrease in the number of spirals with decreasing age (4–3–2), increase in obesity with decreasing age, and decrease in average size.

The tendency for an increase in obesity and a decrease in size was also noted in the *Graciliala calcaris* (Wade) plexus but was not so well displayed.

The type species *D. evansi* Cossmann (pl. 11, fig. 23, 26), from the Fox Hills sandstone of the western interior, has only two body spirals, which are noded at the intersection of the ribs, and in general has closer spaced, more numerous, and finer axial ornament as well as better developed spiral ornament on the spire.

Types: Holotype USNM 32927; hypotype USNM 128496.
Occurrence: Tennessee: Ripley formation, loc. 1.

Drepanochilus triliratus Stephenson

Plate 11, figure 12

1941. *Drepanochilus triliratus* Stephenson, Texas Univ. Bull. 4101 p. 308, pl. 57, figs 9, 10.

Diagnosis.—Shell small for genus; ornament of spire dominated by numerous well-defined closely spaced curved transverse ribs; on body there are three strong spiral cords, the upper of which is strongest and is noded at the intersection with the axial ribs.

Measurements.—The holotype from Texas is incomplete and measures 17+ millimeters in height and 7.5 millimeters in diameter (Stephenson, 1941, p. 308).

Discussion.—The holotype is from the Neylandville marl of Texas. In Mississippi the species occurs at a higher stratigraphic position, in the Ripley formation. Specimens are extremely rare and their presence in Mississippi is indicated only by fragments of the body whorl that bear the typical three spiral cords.

D. triliratus is close to *D. quadriliratus* and probably arose from it by suppression of the third spiral cord, of which faint indications remain. The species appears to lie, both morphologically and stratgraphically, in a position intermediate between *D. quadriliratus* and *D. texanus* (fig. 10).

Types: Holotype USNM 76963 (Texas); hypotype USNM 128497 (Mississippi).
Occurrence: Mississippi: Ripley formation, locs. 6, 18. Texas: Neylandville marl and Nacatoch sand.

Drepanochilus sp.

Plate 11, figures 7, 8

Discussion.—Two internal molds, from the Prairie Bluff chalk of Mississippi at locality 92, preserve the reflection of external ornamentation typical of the genus *Drepanochilus.* In size and obesity of the whorls, they suggest *D. texanus*, from the Kemp clay of Texas. The smaller specimen (pl. 11, figs. 7, 8) has the reflection of two distinct spirals cords, but there is also a faint indication that a third cord may have been present; therefore, specific placement is questionable. The larger specimens (USNM 124899), although more obese than is the type of *D. triliratus*, possesses three distinct spiral cords and probably belongs to that species.

Genus ARRHOGES Gabb, 1868

Type by monotypy, *Chenopus occidentale* Beck, 1847.

Diagnosis.—Medium to moderately large high-spired shells; whorls numerous with convex sides; ornament of numerous closely spaced spiral threads and axial ribs, both of which decrease in strength on the body; aperture subovate; outer lip broadly expanded, thick, ending in an upturned blunt lobe.

Discussion.—The general ornament of the spire and the character of the protoconch of *Arrhoges* are similar to those of *Drepanochilus*, to which this genus has frequently been assigned as a subgenus. *Arrhoges*, however, possess no development of strong angulating spirals on the body and possesses a strong broad outer lip instead of the thin tapering spike of *Drepanochilus*. The two are, however, related closely and in any subfamilial grouping should probably be placed near one another.

The type species is from recent deposits of the North Atlantic, and the genus is present throughout the Tertiary System. Most of the Cretaceous forms assigned to *Arrhoges* are not typical and may be subdivided to two types. The first type is that dealt with below as a new subgenus typified by forms (like *Anchura lobata* Wade) which possess a terminal thickening of the outer lip accompanied by a bilobation at the terminus and lack any internal grooving of the lip. The second type is characterized by a bifurcating of the upper part of the lip, as in *Anchura prolabiata* White, from the Greenhorn limestone equivalent of Utah, and *Lispodesthes schlotheimi* Roemer (Holzapfel, 1888, p. 119), from the Aachen Cretaceous of Vaals, Germany.

Subgenus Latiala Sohl, n. subgen.

Type species, *Anchura lobata* Wade, 1926.

Etymology.—Compounded from the Latin latus (broad) and ala (wing); gender, feminine.

Diagnosis.—Average-sized arrhogids with broad, thick outer lip, which is thickened and bilobed at the terminus, with one lobe directed upward and a second blunter one directed downward; interior of outer lip not grooved; inner lip only lightly callused.

Discussion.—I have been unable to trace this group into beds either younger or older than the late Late Cretaceous. Within this time span, however, they managed to attain a considerable distribution. The following species appear to belong to this subgenus:

Anchura lobata Wade, Ripley formation of Tennessee and Mississippi.
Anchura? elegans Stephenson, Nacatoch sand of Texas.
Anchura? plenocosta Stephenson, Nacatoch sand of Texas.
?*Anchura cibolensis* Stephenson, Kemp clay of Texas.
Anchura rostrata (Gabb). Weller, Merchantville clay of New Jersey
?*Anchura pennata* (Morton). Weller, Navesink marl of New Jersey.
Alaria papilionacea Goldfuss. Stoliczka, Trichnipoly group of India.
Dicroloma (Perissoptera) bailyi (R. Etheridge) of Rennie. Pondoland, South Africa.

The listed species form a tight, well-knit group closely similar in shape, development of ornamentation of the spire and body, and in formation of the outer lip. *Dicroloma* Gabb (=*Alaria* Morris and Lycett), to which some of these forms have been assigned has a carinate body like *Drepanochilus* but differs distinctly by having a long curved anterior canal and two long curved blade like digitations on the outerlip. *Perissoptera* Tate is close in having similar spire ornament but differs by possessing an elongate anterior siphon as well as a well-developed posterior canal. In addition, it has an outer lip divided into a reflexed, elongate, narrow upper blade and a broad blunt lobe, similar to that of the group typified by *Anchura prolabiata* White.

Arroges (Latiala) lobata (Wade)

Plate 11, figures 9, 13–15

1926. *Anchura lobata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 150, pl. 52, figs. 11, 12.
1941. *Anchura? lobata* Wade, Stephenson, Texas Univ. Bull. 4101, p. 298, pl. 56, fig. 15.
1941. *Anchura? lobata media* Stephenson, Texas Univ. Bull. 4101, p. 299, pl. 55, figs. 8–10.

Diagnosis.—Shell of average size for the genus; transverse ribs thin, closely spaced on spire more, widely spaced on later whorls and weakening on the body; broad varices at intervals; spiral ornament of fine but strong closely spaced lirae on spire but extremely faint on the later whorls and body.

Measurements.—Explanation of the measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc. or type	No. *W*	*H*	*MD*	*H3W*	*D3W*	*H3W*: *D3W*
1 (holotype)	7+	48.5	16.6	2.1	4.8	0.46
1 (topotype	7.0	44.3	14.7	2.35	5.25	.44
1 (topotype)	6.75	33.7	13.4	2.3	5.75	.40
1 (topotype)	5.25	26.2+	10.3	2.25	5.25	.45
1 (topotype)	4.5	16.2	7.3	2.05	5.0	.41
1 (topotype)	4.0	15.0	5.9	2.5	5.25	.44
1 (topotype)	3.75	13.7	5.1	2.25	(?)	(?)
1 (topotype)	3.25	11.2	5.0	(?)	5.0	(?)
5	7.0	42.5	15.3	2.3	5.75	.40
Texas (hypotype)	7?	48.1	17.5	2.4	5.1	.47
A. lobata media	(?)	(?)	17.4	2.15	4.7	.46
Paratype, USNM 76911)	5.25	26.8	(?)	2.6	5.75	.45
Do	(?)	(?)	(?)	2.45	5.4	.45
A. elegans Stephenson	5+	20.0	8.8	2.25	5.25	.45
Paratype	3.25+	16.4	7.2	(?)	(?)	(?)
Do	4.+	20+	8.8	2.5	5.75	.43
Do	4.75	19.2	7.9	2.4	5.5	.44

Discussion.—This species occurs well preserved and in moderate abundance at its type locality of Coon Creek, Tenn. Elsewhere it is rare in number of specimens, but its distribution is wide. Immature specimens lacking the outer lip may be mistaken for the much more common *Graciliala calcaris*, as the ornament of the early spire is superficially similar. However, *Anchura (Latiala) lobata* possesses a larger, more globose protoconch, and if care is taken, the two can easily be separated even at their earliest stages (pl. 11, fig. 9). A suite of 33 topotypes indicates that there is a moderate amount of variation in the spacing and strength of the sculptural elements. Specimens from the Ripley formation of Mississippi assigned to this species agree well with the type material and fall within the range of variability. In general the specimens from the Ripley in Mississippi are of similar size, but the spacing of the axial ribs is slightly greater. The specimens from the Nacatoch sand of Texas described by Stephenson as *Anchura lobata* have even wider spacing of the ribs but appear to agree well enough in other respects to be considered conspecific. *Anchura? lobata media* Stephenson, from the Nacatoch sand, is, according to Stephenson (1941, p. 299), differentiated on the basis of smaller size, sharper, more numerous axial ribs, and a better defined subsutural constriction. He states that these differences are constant in a suite of 20 specimens from the type locality. Size is an extremely variable criterion, as the collections of *Graciliala calcaris* (Wade) show. That species appears to have a wide range in size in mature individuals; thus, size criterion appears to have little value in the Apporhaidae for specific differentiation. We have already stated that the suite of topotypes shows variation in ornament; thus, the criteria for the differentiation of this variety appear to be dubious. *A.? elegans* Stephenson also from the Nacatoch may be a distinct species from *Anchura lobata*, for it shows more numerous transverse ribs. But here again, smaller size cannot be called on to account for specific difference in this group. Stephenson (1941, p. 299) states: "The variety (*A.? lobata media*) is intermediate in size and in the coarseness of its ornamentation between the typical *A.? lobata* and *A.? elegans*." This view accompanied by the fact that the "species" are all found within the same formation at relatively the same level and in the same area leads one to suspect that the three separate taxons proposed are actually a gradational series. Unfortunately, available material is insufficient for a statistical check; but as the measurements of the available material given above indicate, proportional size appears to be very similar. In my opinion these distinctions merit no more than varietal differentiation.

A.? plenocosta Stephenson, also from the Nacatoch, has a stouter outline and a thicker shell than *L. lobata* Wade and in addition possesses coarse nodes on the body which develop at the upper ends of the axial ribs. The transverse ribs on the spire also are considerably coarser than Wade's species.

Arrhoges (Latiala) bailyi (R. Etheridge), (Rennie, 1930, p. 217) from Pondoland, South Africa, is a close analog, but with the quality of the available illustrations and description of the species involved, direct comparison is difficult.

Types: Holotype USNM 32925; hypotyes USNM 128500 and 128501, USNM 128502 (Mississippi), and USNM 76098–76911 (Texas).

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 5, 16, 23, 24(?), 29, 32(?). Texas: Nacatoch sand.

Arrhoges (Latiala) cf. A. (L.) lobata (Wade)

Plate 11, figure 21

Discussion.—A number of moderate-sized internal molds from the Prairie Bluff chalk of Oktibbeha and Chickasaw Counties, Miss., preserve the shape and impression of an outer lip like that of *A. (Latiala) lobata* Wade. All the specimens are smaller than is typical of forms from the Ripley formation but are larger than *A. (Latiala)* species, from the Owl Creek formation.

Type: Figured specimen USNM 128503.

Occurrence: Mississippi: Prairie Bluff chalk at locs. 71, 87.

Arrhoges (Latiala) cf. A. (L.) plenocosta (Stephenson)

Plate 11, figure 17

1941. *Anchura? plenocosta* Stephenson, Texas Univ. Bull. 4101, p. 299, pl. 56, fig. 14.

Discussion.—Numerous internal and external molds reworked into the basal beds of the Clayton formation of Union and Chickasaw Counties, Miss., preserve the reflection of an outer lip characteristic of this group. Specifically they appear to be close to *A. (Latiala) plenocosta* (Stephenson) in possessing the reflection of strong nodings of the body whorl. In addition the shape and size of the shell and traces of the sculpture on the spire indicate a form much like Stephenson's species from the Nacatoch sand of Texas.

Types: Figured specimen USNM 128504.

Occurrence: Mississippi: Clayton formation (reworked Cretaceous specimens at base), USGS Mesozoic locs. 9515, 6468, 19087, and locs. 60, 69.

Arrhoges (Latiala) sp.

Plate 11, figures 10, 16

Discussion.—Several specimens from the Owl Creek formation appear to be distinct from *Arrhoges (Latiala) lobata* (Wade), but for reasons of preservation and lack of sufficient material, they are not given new specific names. Furthermore, *A. (L.) lobata* (Wade) shows considerable variation, and an abundance of material should be available before definite distinction should be made.

The first specimen (USNM 128505; see pl. 11, fig. 16) is a crushed individual from Braddock's farm, locality 42, Tippah County, Miss., which lacks parts of the body and spire. It does retain the wing and in general greatly resembles Wade's species *A. (L.) lobata.* On the body it has thinner but more continuous transverse ribs that are more closely spaced than is typical of species from the Ripley, but further comparison is difficult owing to its state of preservation.

Several other specimens from the Owl Creek formation of Tippah County, Miss., at localities 42 and 46 are quite distinct. These specimens are all small—the largest (USNM, 128506 see pl. 11, fig. 10) is only about 14 millimeters high (lacking part of spire), and the other is even smaller, but both are mature, possessing the full growth of the outer wing. Unfortunately, the shells are thin and fragile, and the ornamentation of the spire is nearly obliterated. The relationship of these specimens to the larger individual discussed above is uncertain. The possibility is great that they are conspecific, indicating, as has been noted in other species of the aporrhaids, that the lip development is not a function of size.

Genus HELICAULAX Gabb, 1868

Type by subsequent designation (Cossmann, 1904), *Rostellaria ornata* d'Orbigny, 1843.

Diagnosis.—Medium-sized high-spired apporhaid; whorls well rounded and ornately sculptured by both transverse and spiral elements; transverse ribs commonly noded on body; aperture subovate, produced to a moderately long and narrow anterior canal; posterior canal reflexed, elongate, and adnate to spire; outer lip flaring; upper edge curves up and tapers to a spike; inner lip heavily calloused.

Discussion.—*Helicaulax* Gabb is distinguished from *Anchura* Conrad by the presence of the elongate posterior canal that is adnate to the spire for most of its length. *Araeodactylus* Harris and Burrows, from the Paleocene of Europe and the Western United States, is similar but possesses a posterior canal attached to the spire for its full length and has a narrow, straight spikelike anterior canal.

Only one species, *H. formosa* Stephenson, from the Owl Creek formation, is known in the Cretaceous System of the gulf coast. *Helicaulax* is probably best represented in the Upper Cretaceous of Europe by such species as *H. ornatus* (d'Orbigny), from the Turonian of France, and *H. granulata* (Sowerby) of Holzapfel, from the Aachen sand. Cossmann (1904, p. 64), followed by Wenz (1940, p. 918), treats *Helicaulax* as a subgenus of *Aporrhais* da Costa (=*Chenopus* Phillippi) and cite the Albian-Senonian as its range. This is based on a misconception that at least in part is due to Gabb's original description. In defining the genus Gabb (1868, p. 145) placed 3 species in it—the type species from France and the 2 California species *H. bicarinata* Gabb and *H. costata* Gabb. The first of these, *H. bicarinata*, is from the Horsetown formation and, according to Stewart (1927, p. 364), belongs to *Tessarolax* Gabb. The second California species, *H. costata*, is cited by Cossmann (1904, p. 65) as occurring in the Senonian, but actually it is from the Martinez formation of Paleocene age, and according to Stewart (1927, p. 366), it too is not a *Helicaulax* but an *Araeodactylus* Harris and Burrows. Other species, such as *Helicaulax stenoptera* Goldfuss (Holzapfel, 1888, p. 116), which lack the posterior adnate spike typical of the genus, also must be removed. A critical study of the genus would no doubt exclude other referred forms, but as it now stands the genus is represented only in the Upper Cretaceous (Cenomanian-Senonian).

Helicaulax formosa Stephenson

Plate 11, figures 18–20, 24, 25

1955. *Helicaulax formosa* Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 128, pl. 21, figs. 7–9.

Diagnosis.—Shell of average size for genus; whorls quite convex; sculpture of spire dominated by transverse ribs; sculpture of body dominated by strong spiral cords which are noded where crossed by ribs; third cord from suture carries out onto broad, elongate outer lip, whose upper edge has a minor digitation and a curved tapering spike; posterior canal attached for almost full length of spire.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*MD+W*
46 (holotype)	(?)	41.0	10	24
46 (hypotype)	(?)	(?)	(?)	38
46 (topotype)	8+	37.0	(?)	(?)
46 (topotype)	8+	36.0	10	(?)
46 (topotype)	(?)	(?)	(?)	33
40	(?)	36.5	(?)	26+

Discussion.—The holotype is an incomplete specimen lacking part of the body whorl, and the outer lip is preserved only as an impression. Topotypes in the Survey collections, as well as other reworked Cretaceous specimens from the base of the Clayton formation of Tennessee (loc. 40) unavailable to Stephenson, give further details as to the character of the species. The specimens from Tennessee figured on plate 11, figures 20, 25, exhibit crenulations and minor digitations on the anterior slope of the outer lip. These digitations form where the spiral cords of the body intersect the outer lip. One paratype (USNM 20434, pl. 11, fig. 18) is somewhat larger than the holotype and demonstrates quite well the thick pad of callus that develops on the inner lip and continues up onto the spire, forming the elongate exhalent canal. Another paratype (USNM 20434, pl. 11, fig. 19), although preserving little or no shell material, indicates the full extent of the outer lip. The upper edge of the outer lip is scalloped by minor digitations. A linear depression on the inner side of the wing corresponds in position to the major spiral cord of the body and carries out onto the exterior surface of the wing and termites in an upward-curved tapering spike.

Examination of the more than 20 specimens available from Mississippi and Tennessee the species shows a remarkable lack of variation for such an ornate form. The number of primary spiral cords, general proportions, and characters of the outer lip all appear uniform.

The type species *Rostellaria ornata* d'Orbigny, from the Turonian of France, is similar to *H. formosa* but differs in the number of primary spirals and in accessory features of the outer lip. *Helicaulax granulata* (Sowerby) of Holzapfel is not so closely related, possessing an outer lip which is proportionately much more narrow and elongate.

H. formosa is restricted to the Owl Creek formation but occurs in some profusion in the upper Mississippi Embayment area of Mississippi, Tennessee, and Missouri.

Types: Holotype USNM 128189; paratypes USNM 20434 (seven specimens); hypotypes USNM 128187 (Missouri) and USNM 20437, 128507, and 128508 (Mississippi and Tennessee).

Occurrence: Mississppi: Owl Creek formation, locs. 41, 46. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40. Missouri: Owl Creek formation.

Genus ANCHURA Conrad, 1860

Type by monotypy, *Anchura abrupta* Conrad, 1860.

Diagnosis.—Medium- to large-sized apporhaid with high, evenly tapering spires; protoconch simple, grading evenly with spire; sculpture ornate, with both strong transverse and spiral elements, commonly noded; aperture sublenticular; anterior canal long and narrow; outer lip terminates in a broad, blunt lateral edge; posterior edge extended to an upward curved spike of various length; anterior edge terminates in a blunt lobe.

Discussion.—Cossmann (1904, p. 93) placed *Anchura* as a subgenus of *Dicroloma* Gabb and cited *Rostellaria carinata* Mantell, from the Albian of England, as its type species. He makes no mention of *A. abrupta* Conrad in his discussion but cites Conrad as the author of the genus. This error may have arisen from misinterpreting Gabb's list of species (1868, p. 145) belonging to the genus *Anchura* as being all synonyms of the same species, with Mantell's species the oldest. Although weak, this explanation appears to be the only possible reason for overlooking Conrad's species. Wenz (1940, p. 923) takes the opposite view and assigns *Dicroloma* as a subgenus of *Anchura*. The two forms differ decidedly; *Dicroloma* has a bifurcating or doubly digitate outer lip and a shell which in gross aspect bears considerable resemblance to *Pterocerella* Conrad. The long anterior canal and lack of body carinations separate *Anchura* from *Drepanochilus* Meek, and the presence of a long posterior canal distinguishes *Helicaulax*, although the latter appears closely related.

The total range of the genus is in doubt and must await a reevaluation, as many forms lumped into the genus certainly do not belong to it. This confusion has perhaps arisen through the inclusion of *Anchura* as a subgenus under various genera by some authors and consideration of *Anchura* as a full genus with many subgenera (*Drepanochilus*, for example) by others. It has been common to include forms such as *Rostellaria carinata* Mantell within the scope of *Anchura*. This Albian form shows some relationship, but if accepted as a true anchurid, it opens the way for inclusion of many less closely related forms that appear more closely related to *Drepanochilus*. Cossmann (1904, p. 93) followed this procedure and, although recognizing *Drepanochilus* as a separate genus, placed *Dimorphosoma kinklispira* J. S. Gardner and other related Neocomian and Aptian forms in the genus *Anchura*. In my opinion these species belong with *Drepanochilus*. Of the Upper Cretaceous forms included by Cossmann, only *Rostellaria requieniana* d'Orbigny, from the Turonian, appears to belong to the genus. *Anchura traversa* Gabb, which he lists as from the Turonian of California, is actually an Eocene form, probably belonging to *Drepanochilus*, according to Stewart (1927, p. 362).

In this restricted sense *Anchura* is essentially confined to the Upper Cretaceous, where it is found greatly developed and it has been reported in most of the major faunal studies. In North America and especially in the gulf coast areas, the genus is well represented in beds ranging in age from Cenomanian through Maestrichtian. The earlier forms, such as *A. turricula* Stephenson from the Woodbine formation of Texas, show a distinct relationship to the type species and are probably direct antecedents. In the later Cretaceous deposits a number of species have been described from the Navarro group and equivalents. These are treated in more detail in the specific discussions, but the following list summarizing their placement seems appropriate here.

Anchura abrupta Conrad, Ripley formation.
  convexa Wade, Ripley formation.
  substriata Wade, Ripley formation.
  lamari Stephenson, Nacatoch sand (possibly a synonym of *A. substriata*).
  bexarensis Stephenson, Kemp clay (specifically indeterminate).
  noakensis Stephenson, Kemp clay and perhaps in the Prairie Bluff chalk.
Drepanochilus? davisi Stephenson, Nacatoch sand (sepcifically indeterminate).
Drepanochilus? martini Stephenson, Nacotoch sand (=*Anchura abrupta Conrad*).

Species assigned to *Anchura* by others but reassigned here are as follows:

Anchura? hoggi Stephenson, Kemp clay (Neogastropoda?).
Anchura? lynnensis Stephenson, Nacatoch sand (=*Graphidula?*).
Anchura? campbelli Stephenson, Neylandville marl (=*Graciliala*).
Anchura caddoensis Stephenson, Nacatoch sand (=*Graciliala calcaris* Wade).
Anchura? cooki Stephenson, Corsicana marl (=*Graciliala?*).
Anchura? cibolensis Stephenson, Kemp clay (=*Arrhoges* (*Latiala*) sp., immature).
Anchura lobata media Stephenson, Nacatoch sand (=*Arrhoges* (*Latiala*)).
  lobata Wade, Ripley formation and Nacatoch sand (=*Arrhoges* (*Latiala*)).
Anchura? plenocosta Stephenson, Nacatoch sand (=*Arrhoges* (*Latiala*)).
Anchura? elegans Stephenson, Nacatoch sand (=*Arrhoges* (*Latiala*)).
Anchura? pergracilis Johnson, Ripley formation (=*Remera*).
Anchura (*Drepanochilus*) *calcaris* Wade, Ripley formation (=*Graciliala*).
Anchura decemlirata Conrad, Owl Creek formation (=*Graciliala*).

Anchura abrupta Conrad

Plate 12, figures 1, 4–9, 12

1860. *Anchura abrupta* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 284, pl. 47, fig. 1.
1868. *Anchura abrupta* Conrad. Gabb, Am. Jour. Conch., v. 4, p. 145, pl. 14, fig. 15.
1883. *Anchura abrupta* Conrad. Tryon, Philadelphia Acad. Nat. Sci., v. 2, p. 194, pl. 60, fig. 83.
1940. *Anchura abrupta* Conrad. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 4, p. 922, fig. 2705.
1941. *Drepanochilus? martini* Stephenson, Texas Univ. Bull. 4101, p. 306, pl. 57, fig. 5.
1944. *Anchura abrupta* Conrad. Shimer and Shrock, Index Fossils of North America, p. 497, pl. 203, fig. 22.

Diagnosis.—Shell large, high spired; whorls numerous and rounded; sculpture ornate; anterior canal very long and broadly curved; outer lip thick, with upper edge curving upward and tapering into a gently curved spike much longer than spire; lower margin of lip terminates in a blunted lobe.

Description.—Large thick-shelled anchurid with high evenly tapering spire and numerous plump round-sided whorls; suture impressed; protoconch of a little more than three smooth round-sided whorls expanding at a normal and uniform rate. Sculpture ornate, consisting of both axial and spiral elements; axials of early whorls consist of fine colabral arcuate riblets with flattened tops, developing on later whorls a wider spacing and increasing in strength but decreasing in arcuateness; spirals broaden on body, are round topped, and decrease in strength, becoming almost indistinguishable below periphery. Spiral ornament begins as fine, thin spiral lirae numbering 8–10 on early whorls with thinner spiral threads in spiral interspaces; major spirals increase in strength with growth, becoming raised, thickened, and noded where they cross axial ribs; major spiral lirae number 6–7 on penultimate whorls and 13–14 on body; fourth spiral below suture develops to an angulation near aperture and continues onto outer lip. Aperture sublenticular, slightly notched posteriorly; outer lip broad, grooved interiorly at position of external ridge; upper margin of lip curved into an elongate tapering spine extending beyond spire; anterior lip termination forms short blunt lobelike extension; anterior slope frilled. Inner lip thickly callused; callus pad raised above shell surface and extends out onto shell surface.

Measurements.—Although representatives of this species are rather abundant, well-preserved specimens such as those on plate 12, figures 1, 4, 12, are extremely rare. Most specimens lack the outer lip, the anterior canal, or parts of the spire. Measurements of such specimens are thus rather meaningless. Therefore only measurements of the most complete individual (USNM 20559) is given.

Tip of anterior wing spike to tip of anterior canal	116
Tip spire to tip anterior canal	92.6
Height of body whorl	59.6
Width with wing	37.5

Discussion.—The identification of *Anchura abrupta* Conrad rests solely upon the original illustration and description. No additional specimens have been illustrated, although the original figure has been reproduced by various authors. Unfortunately the type (presumed lost) was originally incomplete, preserving only the body whorl, anterior canal, and an incomplete extension of the outer lip. The type locality is uncertain and given only as Tippah County, Miss. This could be in either the Ripley or Owl Creek formation, but on the basis of criteria previously discussed, it is believed to have come from the Ripley formation. The largest specimen here illustrated comes from what was most likely a place close to the type locality. These outcrops were known to the early workers, and many were cited and collected from by Hilgard (1860, p. 88) as early as 1856. The Ripley specimens agree well with Conrad's illustration.

Variation within this species is considerable. Suites from a given locality show a variation in the pleural angle from 20°–30°; this lends some specimens a more obese outline than others (compare pl. 12, figs. 1, 4). Ornament is constant in pattern, but variations in strength of both spiral and transverse elements appear with the individual specimen.

Anchura substriata Wade is similar to *A. abrupta* in ornament but possesses an accessory spike on the upper surface of the outer lip and is generally larger at maturity. At the same growth stage the Tennessee form also has stronger and more direct transverse ribs. *A. convexa* Wade bears two blunt digitations on the upper surface of the outer lip; it is smaller; the third (not the fourth) spiral cord below the suture rides out onto the outer lip and possesses fewer spiral elements on the penultimate whorl than the type species.

Drepanochilus? martini Stephenson from the Nacatoch sand of Texas is based on incomplete material, but the holotype appears to be an immature specimen of *Anchura abrupta.* This specimen bears the typical spire ornament of arcuate transverse ribs and finer spiral elements of Conrad's species.

Types: Holotype lost; hypotype USNM 20559, 128509–128513.
Occurrences: Mississippi: Ripley formation, locs. 5, 6, 7, 14, 15, 18, 29. Texas: Nacatoch sand.

Anchura substriata Wade

Plate 12, figures 2, 3, 10, 11, 13

1926. *Anchura substriata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 149, pl. 52, fig. 10.

Diagnosis.—Large high-spired anchurid; whorls of spire basally subangular, but body well-rounded; sculpture ornate; transverse ribs rather direct; outer lip has short secondary spur on the upper edge.

Measurements.—Explanation of the measurements in the following table appears in the section "Measurements of specimens" (p. 48). The following measurements give the size range of a number of adult specimens from the type locality at Coon Creek, Tenn. Because most of the specimens are incomplete and only certain measurements could be made, there is a disparity in the number of specimens per given character.

Aspect and total specimens measured	Holotype	Range of topotypes	Average	*A. lamari*
Pleural angle (9) degrees	27	27–35	30.7	31
Total height mm	81.7	----------	----------	----------
Height body (2) mm	39.0	39	39.0	----------
Diameter with wing (4) mm	48+	48–57	55.0	----------
Diameter without wing (7) mm	----------	24–28	27.0	27
Height spire (4) mm	42+	42–47	44.7	43

Discussion.—Variation in ornament is manifested primarily in strength of development. One topotype shows a considerable deviation in the spacing of the upper spiral of the body and on the penultimate whorl bears only 5, instead of 6 primary spiral cords. This disparity of spacing is probably accounted for by the loss of one of the upper primary cords. Aside from this specimen the ornament pattern is uniform, with the fourth spiral increasing in strength near the aperture and continuing out onto the expanded outer lip to form a curving ridge extending to the prolonged tip. Fine secondary spiral threads occur between the primary cords and commonly on top of the cords. They vary considerably in number and strengthen as they continue onto the expanded outer lip. The inner-lip callus has a uniform outline and is always sharply defined. In addition the callus is thickest over the columellar lip and extends out over the body, especially on the base. Once the outer lip has formed, the shell ceases to grow spirally, and additional growth is restricted to the building up of the callus deposits on the inner lip and the interior of the outer lip. Each succeeding lamellar layer is laid down over a lesser area than the preceding layer (pl. 12, fig. 13). In this later stage the groove on the interior lip becomes shallower and narrower.

Wade's illustration of the type is considerably retouched and misleading. The noding of the spiral cords are accentuated, and the intercord spaces are actually equal to or greater than the width of the spiral cords. The outer lip of the holotype has been broken and repaired and is actually shorter than is typical.

Anchura abrupta Conrad lacks the secondary spike of the upper outer lip edge, is smaller and has a smaller average pleural angle than Wade's species. In addition, the upper, curved main spike of *A. substriata* (pl. 12, fig. 11) is not drawn out to such an extreme that it extends beyond the tip of the spire. In other respects the two must be considered closely related because the type and arrangement of the ornamentation elements are extremely similar. *A. lamari* Stephenson, from the Nacatoch sand of Texas, is another similar species but it possesses only five spiral cords on the penultimate whorl, a feature uncommon but not unknown in *A. substriata*. The possibility that these two species are conspecific is great but cannot be proved until the character of the outer lip of *A. lamari* is known. *Drepanochilus? davisi* Stephenson is based on immature and specifically indeterminable specimens. It does belong in *Anchura*, however, as it possesses the typical spire ornament and subangular basal contour typical of the early whorls of other species of *Anchura*. (See pl. 12, fig. 3.) *A. convexa* Wade possesses two secondary spurs on the upper edge of the outer lip, and the third spiral of the body is strongest instead of the fourth as on *A. substriata*.

Types: Holotype USNM 32924; hypotypes USNM 128514–128516.

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, loc. 22. Texas: Nacatoch sand (questionable specimen reported).

Anchura convexa Wade

Plate 13, figures 15, 16

1926. *Anchura convexa* Wade, U.S. Geol. Survey Prof. Paper 137, p. 151, pl. 52, figs. 8, 9.

Diagnosis.—Medium-sized high-spired anchurid with obese well-rounded whorl sides; transverse ribs and closely spaced spiral lirae that number five on penultimate whorl; third lirae below suture strongest and carries out onto expanded lip; outer lip broad, with two secondary digitations at upper edge.

Discussion.—Only the holotype and three topotypes, all incomplete, are available for study. All specimens show the small size, the well-rounded whorls, the 4–5 spiral lirae on the whorls of the spire, and the stronger development of the third lirae of the body whorl. These features, plus the occurrence of the two minor digitations of the upper edge of the outer lip and a tendency for formation of a posterior canal that reaches the spire above the penultinate whorl, serve to distinguish *Anchura convexa* from *A. substriata* and *A. abrupta*.

Type: Holotype USNM 32923.

Occurrence: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1.

Anchura noackensis Stephenson?

Plate 13, figures 6, 23–27

1941. *Anchura noakensis* Stephenson, Texas Univ. Bull. 4101, p. 295, pl. 55, figs. 6, 7.

Diagnosis.—Large robust anchurid with well-rounded whorls constricted near suture; sculpture coarse on body; transverse ribs strong, raised, colabral and prosocline in trend, with broad, shallow sinus on constricted band below suture; outer lip incompletely known.

Discussion.—The holotype and figured paratype of *A. noakensis* Stephenson, from the Kemp clay of Texas, are both incomplete specimens. Neither specimen clearly shows the features of the whorls nor the anterior canal or outer lip. They are, however, distinctive in their large size and constricted upper-whorl area as well as in their well-rounded whorl sides and coarse ornament. A number of specimens from the Prairie Bluff chalk (all internal molds) and several specimens reworked into the base of the Clayton formation of Mississippi and Tennessee seem to agree quite well in size, outline, and ornament with the Texas species. The pleural angle of these forms ranges from 24°–27°; both type specimens have pleural angles of 26°. The maximum diameters of the types is 32–34 millimeters and in the larger molds from Mississippi a general maximum of about 31 millimeters. Several molds and the reworked specimens preserve a pattern of ornament (see pl. 13, figs. 23, 25) and coarse axial ribs typical of the type specimens. The earlier whorls, as preserved in these molds, show little or no tendency for basal constriction but are well rounded, and several specimens preserve a reflection of the shape of the outer lip. The specimen from the Prairie Bluff chalk of Oktibbeha County, Miss., shown on plate 13, figure 27, is smaller than average, but it possesses the typical rounded-whorl profile of *A. noakensis* and preserves the reflection of an outer lip that is much like that of *Anchura abrupta* Conrad, which also lacks minor digitations of the upper edge of the outer lip.

An internal mold from the Navesink(?) marl of New Jersey illustrated by Weller (1907, pl. 82, figs. 1, 2) and assigned by him to *Anchura abrupta* Conrad (=*Rostellaria nobilis* Whitfield) has similar proportions and characters of profile to those of the Prairie Bluff molds assigned to *A. noakensis?*.

Types: Holotype Kemp clay of Texas USNM 76902; paratype as above USNM 76905; hypotypes USNM 128517–128521.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 67, 71, 72, 80, 83, 87, 89, 90, 91, 93, 94. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40. Mississippi: Clayton formation (reworked Cretaceous material at base); Union County, USGS Mesozoic coll. 9515; Chickasaw County, USGS Mesozoic coll. 4053.

Anchura sp.

Plate 13, figures 17, 18, 20–22

Discussion.—Rather well preserved but incomplete and specifically indeterminate specimens from the Owl Creek formation of Mississippi may belong to a new species. These specimens possess an angular whorl base and an ornament typical of the *A. substriata* group (compare with pl. 9, fig. 3), although there does appear to be a characteristic posterior restriction of the whorl more in the manner of *A. noakensis*. *A. bexarensis* Stephenson, from the Kemp clay of Texas, is closely related, but preservation does not allow close comparison.

Molds from the Prairie Bluff chalk of Mississippi possessing a subangular whorl base and bearing the reflection of a surface ornament composed of coarse axial ribs and strong basal spirals are similar and probably conspecific with the Owl Creek forms. The molds are relatively common in the Prairie Bluff and show no definite distributional patterns.

There is a definite possibility that more than one species is represented here, but the structure of the specimens is not sufficiently preserved to permit assignment of a new name or the placing of the forms in a preexisting species.

Types: Figured specimens: USNM 128523; 20445a, b; 20434.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 67, 71, 72, 75, 82, 83, 87, 88, 90, 94; Owl Creek formation, locs. 45, 46.

Anchura? sp.

Plate 13, figures 13, 14

Discussion.—Internal molds from the Prairie Bluff chalk of Mississippi differ significantly from the other molds in this formation and possibly may not belong to the genus. From the *Anchura* sp. previously discussed, they differ by the lack of the basal angulation of the body. *A. noakensis* has well-separated whorls, whereas this form has appressed whorls. The shape of the outer wing is not preserved, but reflections of the external ornament preserved on the surface of the molds indicate that axial ribs were moderately strong, as were the spirals. The third spiral below the suture was strongest and became raised near the aperture and probably carried out onto the wing. Remnants of nodes are common, and perhaps the ribs were noded in the fashion of *Arrhoges* (*Latiala*) *plenocosta*. Although no scars of an extended posterior canal were seen, the posterior part of the body is somewhat reminiscent of *Helicaulax;* and on the basis of the preserved features, the possibility of the forms belonging to that genus cannot be discarded.

Type: Figured specimen USNM 28340.

Occurrence: Mississippi: Prairie Bluff chalk, locs. 68, 71, 72, 82, 83, 84, 87, 88, 90.

Genus PTEROCERELLA Meek, 1864

Type by original designation, *Harpago tippana* Conrad, 1858.

Diagnosis.—Shell of medium size; spire of moderate height; whorls smooth to carinate; outer lip greatly expanded to six flat and thin digitations of variable shape; amount of separation of wings varies from complete separation to joining with a shell webbing.

Discussion.—*Pterocerella* Meek was treated as a subgenus of *Chenopus* by Cossmann (1904, p. 70). *Chenopus* Phillippi is a synonym of *Aporrhais* da Costa, and Wenz included Meek's genus as a subgenus of *Apporhais*. *Aporrhais* has four well-joined digitations, with a thick outer lip, high spire, ornamented surface, and a callus thickening formed completely around the aperture. *Pterocerella* has no such thickening of the aperture, has six thin digitations and a spire of moderate height, and with the exception of carinations the whorls are relatively free of ornament. *Tridactylus* J. S. Gardner includes, according to Wenz (1940, p. 924) and Cossmann (1904, p. 96), forms such as *Tridactylus arachnoides* (Müller), from the green sand of Vaals. This form is close to *Pterocerella* in general character but differs in the number and arrangement of digitations and in some features of the aperture. It probably deserves separate generic assignment, but the name *Tridactylus* is not applicable, being preoccupied three times before Gardner's use in 1875 for a reptile, an insect, and a bird. The name *Cultrigera* Böhm, 1885, may be available for these forms.

Pterocerella is restricted to the Upper Cretaceous Series of the Gulf and Atlantic Coastal Plains and is represented by relatively few species.

Pterocerella tippana (Conrad)

Plate 13, figures 3, 5, 19

1858. *Harpago tippana* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 3, p. 331, pl. 35, fig. 25.
1864. *Pterocerella tippana* (Conrad). Meek, Smithsonian Misc. Colln. 177, p. 20, 36.
1868. *Pterocerella tippana* (Conrad). Gabb, Am. Jour. Conch., v. 4, p. 146, pl. 14, fig. 20.
1883. *Pterocerella tippana* (Conrad). Tryon, Structural and systematic conchology, v. 2, p. 195, pl. 60, fig. 90.
1904. *Chenopus (Pterocerella) tippana* (Conrad). Cossmann, Essais Paléoconchologie comparée, pt. 4, p. 70, fig. 3 [line drawing].
1940. *Pterocerella tippana* (Conrad). Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 13, fig. 3.
1940. *Aporrhais (Pterocerella) tippana* (Conrad). Wenz, Handbuch der Paläozoologie: Gastropoda, pt. 4, p. 920, fig. 2697.

Diagnosis.—Medium-sized pterocerellid; whorls of the spire smooth surfaced; bicarinate body that has only one spiral swelling on base.

Measurements.—Measurements are made with difficulty because most of the specimens are incomplete. All specimens measured are mature, having developed the expanded outer lip.

	Millimeters
Height of shell	18–23
Height, including wings (probably exceeded in some incomplete specimens)	58
Width of body	11–14
Width of body with wings (a composite estimate)	45

Discussion.—The holotype, an incomplete specimen from the Owl Creek formation of Tippah County, Miss., is not present in the collections of the Academy of Natural Sciences of Philadelphia, but 16 topotypes in the Geological Survey collections preserve all the features of the species.

Variation in size in the mature individuals is considerable, but all show the lack of carinations of the spire. Generally only the lateral wing that developed from the lower peripheral carination is free. The upper 2 digitations are joined for much of their length by a shell webbing, as are the anterior 3. Near the upper end of the upper digitation, the blade flares (see pl. 13, fig. 19) and comes in contact with the spire. Neither of these features is constant, as is shown by the topotype illustrated on plate 13, figure 3, which has three well-separated digitations, indicating that joining of the digitations may be a gerontic feature.

Pterocerella poinsettiformis Stephenson, from the Nacatoch sand of Texas, differs from this species by having strong carinations on the spire whorls, two subperipheral spiral swellings and more direct, less curved digitations. The specimens that Wade (1927 p. 153) assigned to *P. tippana* probably belong with *P. poinsettiformis.*

The New Jersey specimens placed in *P. tippana* by Weller (1907, p. 718) are specifically indeterminable internal molds.

Types: Holotype lost; hypotypes USNM 20435, 128525, 128-526.

Occurrences: Mississippi: Owl Creek formation, loc. 46. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40.

Pterocerella poinsettiformis Stephenson

Plate 13, figures 1, 2

1907. *Pterocerella tippana* (Conrad). Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 718 [in part], pl. 83, fig. 1 [not fig. 2].
1926. *Pterocerella tippana* (Conrad). Wade, U.S. Geol. Sur- Prof. Paper 137, p. 151, pl. 53, figs. 3, 4.
1941. *Pterocerella poinsettiformis* Stephenson, Texas Univ. Bull. 4101, p. 309, pl. 58, figs. 9–12.

Diagnosis.—Large pterocerellid with carinate spire; peripherally bicarinate body with two spiral swellings below periphery, and rather direct digitations of outer lip.

Measurements.—The holotype is the most complete specimen and measures about 59 millimeters in height, including wing spread; spire 17 millimeters high; 54 millimeters in width, including the wing spread, and 21 millimeters in diameter, excluding the wings.

Discussion.—The above measurements indicate this to be a species larger than *P. tippana.* In addition, *P. poinsettiformis* also possesses carinae on the spire, two subperipheral spiral swellings, and another faint spiral between the carinae of the body that are not present on Conrad's species. Stephenson's very detailed description (1941, p. 310) of this species included the following remarks:

> The specimens from the Coon Creek tongue of the Ripley formation, at Coon Creek Tennesse, which Wade referred to *P. tippana* (Conrad), resemble the Texas species, in that the whorls of the spire bear a prominent, narrow carina, but the spire is markedly more slender and the wings are less widely separated; the presence of the carina and other differences warrant the recognition of the Coon Creek shells as belonging to a species distinct from *P. tippana.*

I agree that the specimens from the Coon Creek tongue do not belong to *P. tippana*, but I do believe the specimens belong to Stephenson's species. The specimen figured by Wade (1926, pl. 53, fig. 6), as do other specimens from the same locality, shows details of body ornament exactly matching that of *P. poinsettiformis*, including the same number of spiral swellings on the base and the faint spiral ridge between the carinae of the body. The only difference appears to be the less direct grooves on the outer lip digitations, this feature is not considered sufficient basis for separate specific designation. One specimen from Coon Creek exhibited a hemispherical septum separating the nucleus from the rest of the shell. Another specimen (USNM 20530, loc. 7) from the Ripley formation of Tippah County, Miss. (see pl. 13, fig. 2), agrees well with the type material, differing only by having stronger body carinations. Other specimens in the Ripley formation of Mississippi appear to represent a new species differing by their small size and lack of spiral swellings on the base.

Types: Holotype USNM 76969 (Texas); paratypes USNM 20994, 21061, 76970 (Texas); hypotypes USNM 32929 and 128524 (Tennessee) and USNM 20530 (Mississippi).
Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc 1. Mississippi: Ripley formation, loc. 7.

Pterocerella pontotocensis Sohl, n. sp.

Plate 13, figures 4, 12

Diagnosis.—Small pterocerellid with carinae on spire and body, but whorls otherwise smooth; digitations, as known, completely joined by webbing.

Description.—Shell small; spire tapers evenly; body expands rapidly near aperture; whorls of spire and body peripherally sharply bicarinate. Aperture sublenticular; inner lip loose and not in contact with parietal wall; outer lip much expanded, with 6 supporting ridges on exterior and corresponding grooves on interior; 2 of the ridges are extensions of body carinae; shelly web connects all ridges, interrupted only by circular windows near aperture between second and third and third and fourth ridges; sixth ridge bifurcates from fifth ridge and curves upward, with blade expanding until it reaches and becomes adnate to spire.

Discussion.—This species is known from two molds from the Prairie Bluff chalk of Mississippi. The molds preserve the external features of ornament and show the character of the last whorl and expanded lip sufficiently well to indicate that they are distinct from other described species. They are smaller than the two previously described species but are similar to *Pterocerella poinsettiformis* by having a spire with carinate whorls. They differ from that species by possessing shell webbing between the digitation supports and by the left digitation extending to the spire. From *P. tippana* (Conrad) the species differs by most of the above characters and especially in bearing carinae on the spire.

Other incomplete specimens from both the Owl Creek and Ripley formations of Mississippi may belong to this species, but in their incomplete condition are specifically indeterminable.

Types: Holotype USNM 128527; paratype USNM 128528.
Occurrence: Mississippi: Prairie Bluff chalk, locs. 57, 71.

Pterocerella species A

Plate 13, figures 7–9

Discussion.—A number of small incomplete specimens from the Ripley formation and one specimen from the Owl Creek of Mississippi bear a resemblance to *Pterocerella pontotocensis* in size and by possession of carinate spire whorls, but they are too incomplete for confident specific identification. The spire of these forms is not much different from that of the specimens from the Coon Creek tongue of the Ripley assigned to *Pterocerella poinsettiformis*. These forms mature at a much earlier stage, and unattached wings preserved in the collections indicate the digitations are connected by shell "webbing" for most of their length. Other incomplete specimens indicate that the bodies preserve no trace of spiral swellings below the periphery. The one specimen from the Owl Creek formation at locality 46 agrees well with the Ripley specimens but may be somewhat less slender.

Types: Figured specimens USNM 128529, 128530.
Occurrences: Mississippi: Ripley formation, locs. 5, 6, 16, 18, 24, 29; Owl Creek formation, loc. 46.

Pterocerella species B

Plate 10, figures 10, 11

Discussion.—A number of molds from the Prairie Bluff chalk appear to belong to the genus. In size and by possession of carinae on the whorls of the spire and the presence of spiral swellings on the base, they suggest *P. poinsettiformis* Stephenson.

Type: Figured specimen USNM 128532.
Occurrences: Mississippi: Prairie Bluff chalk, locs. 66, 71, 75, 83.

Family COLOMBELLINIDAE

Genus COLOMBELLINA d'Orbigny, 1842

Type by subsequent designation d'Orbigny (1842, p. 347), *Rostellaria monodactylus* Deshayes, 1842.

Diagnosis.—Small thick medium- to low-spired shell with thickened dentate outer lip, heavily callused and reflected inner lip, short anterior canal, and short to extended posterior canal.

Discussion.—The type species *Colombellina monodactylus*, from the Neocomian of France, possesses an extended posterior canal not seen on the gulf coast species *C. americana* Wade. In this respect the species is closer to *Columbellaria* Rolle—a genus restricted to the Jurassic of Europe and possibly ancestral to *Colombellina.* I have no comparative material at hand, but it is possible that Wade's species belongs to the Jurassic genus or that the two generic names are synonymous.

Wenz (1940, p. 926) and others have erroneously cited d'Orbigny as the author of the type species. Deshayes described *Rostellaria monodactylus* in 1842 (p. 14). As was his custom when he changed a generic assignment, d'Orbigny (1842, p. 347) transferred the authorship of species to himself when he cited *R. monodactylus* as the type species of his new genus *Colombellina.*

Colombellina? americana Wade

Plate 14, figures 1–3, 6, 7

1926. *Columbellina americana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 153, pl. 53, figs. 14–15.

Diagnosis.—Small low-spired shells with proportionally large body whorl and thickened aperture; outer lip thick and dentate, interrupted by short posterior canal and deep curved short anterior canal; inner lip callused, dentate, with callus spreading out onto body.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc. or type	*H*	*MD*	*HA*	*WA*
Holotype	5.6	3.9	3.4	3.0
Topotype	5.3	4.0	3.8	3.0
Do	5.9	4.3	4.3	3.3
Do	6.0	4.3	4.1	3.2
Do	6.5	4.6	4.7	3.7
Do	6.7	4.6	4.7	-------
Do	7.1	5.0	5.1	3.5
Do	7.9	5.6	5.0	4.2
Do	8.2	6.2	5.7	4.6
7	5.7	4.3	3.8	2.9

Discussion.—This species is well represented at its type locality on Coon Creek, Tenn., but only one specimen has been found in the Ripley formation of Mississippi. Both the topotypes and the Mississippi specimens agree well with the holotype. The development of the expanded aperture is assumed to be a feature of maturity, and specimens possessing this feature vary much in size. Many of the specimens show the protoconch to be broken and the teloconch to be sealed by a septum which is adapically hemispherical and continuous with the inner shell layer.

Wade's assignment of this species to *Colombellina* (as *Columbellina* Geinitz) may have been based on the resemblance to *C. subaloysia* d'Orbigny, from the Neocomian of Europe. This species shows no extended posterior canal. Both the type species and *C. ornata* from the Upper Cretaceous of France, as originally illustrated by d'Orbigny (1842, pl. 226, figs. 6, 7), show an extended posterior canal. Without suites of the type material, how much emphasis should be placed on the presence or absence of this character is doubtful. Until such a study can be made, applying the name *Colombellina* to new species is hazardous. *C. americana* may well be more closely related to *Columbellaria,* a Jurassic genus lacking the posterior elongation. That genus has not yet been reported in the Cretaceous, but the possibility exists that some species assigned to *Colombellina* may belong in *Columbellaria.*

Types: Holotype USNM 32933; hypotypes USNM 128533, 128534.

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, loc. 7.

Family Strombidae

Genus PUGNELLUS Conrad, 1860

Type by monotypy, *Pugnellus densatus* Conrad, 1860.

Diagnosis.—Low-spired strombids that at maturity develops a thick and expanded outer lip; aperture sublenticular; anterior canal generally short; outer lip reinforced and thick; inner lip smooth; callus coats body in latest stages and obscures original shape of body and spire.

Discussion.—This genus is characteristic of the Late Cretaceous and reached a considerable distribution. Conrad (1860, p. 284) stated: "This genus embraces four known species, all of which characterize the Cretaceous period. One occurs in South America and two in India. The latter are *Strombus uncatus* Forbes, and *S. contortus* Sowerby." Of these, the South American species *P. tumidus* Gabb, from Chile, has been placed in *Conchothyra* by Stewart (1927, p. 358) and more recently in *Torgnellus* by Olsson (1944, p. 93). *Conchothyra* McCoy *in* Hutton, differs from *Pugnellus* by the possession of angular whorls and the suppression of the anterior canal. *Torgnellus* Olsson is more massive and lacks the external ornament typical of *Pugnellus.* Both the above are Pacific Cretaceous genera. *Strombus contortus* Sowerby, from India, probably belongs in Gabb's subgenus *Gymnarus,* which differs from *Pugnellus* s. s. by having a hook-like extension of the outer lip. In addition, *P. fusiformis* (Meek) of Stanton (Benton shale of Colorado), *P. granuliferus* Stoliczka (Arialoor group of India), *P. manubriatus* Gabb (Chico formation of California), *P. auriculatus* Woods (Pondoland, South Africa), *Pugnellus abnormalis* Wade (Ripley formation of Tennessee and Mississippi) and *P. calcaris* Stephenson (Eutaw formation of Mississippi), all seem to belong to this later category. The following belong in *Pugnellus* (*Pugnellus*): *P. densatus* Conrad (Ripley and Owl Creek formation of the Atlantic and Gulf Coastal Plains), *P. goldmani* Gardner (*E. costata* zone, Texas to Maryland), *P. uncatus* Stoliczka (Arialoor group, India), *P. crassicostatus* Noelting (Baluchistan), *Pugnellus* sp. of Pervinquière (?) (Tunisia), *P. pauciplicatus* Stephenson (Snow Hill, North Carolina), and an undescribed species from the Wolfe City sand member of the Taylor marl of Texas. As indicated by the range of the above species, the genus first appeared in the Turonian, being present at this time in North America in California and Colorado. *Gymnarus* did not appear on the gulf coast until the Santonian and was closely followed in the Campanian by the appearance *Pugnellus* s. s. The development of the genus in the gulf coast reached a maximum of diversification unmatched in any other area of Cretaceous outcrop. In this connection it is interesting to note the complete lack of the genus in the Upper Cretaceous of Europe. Although it has been suggested by Cossmann and others, neither *Strombus crassilabrum* Zittel, from the Gosau beds of Austria, nor *Pugnellus africanus* Quass, from Libya, appear to be true pugnellids. The same holds true of the New Zealand species assigned to this genus.

Both Gabb (1876, p. 298) and Stewart (1926, p. 359) have questioned the validity of *Pugnellus densatus* as the type species. Gabb, on the basis of specimens from Pataula Creek, Ga., submitted to him by Dr. Little, then state geologist of Georgia, proposed a new species, *P. typicus*, to serve as the type species. These specimens were quite large for the genus, but he considered them conspecific with Conrad's original illustration of *Strombus densatus* from the Owl Creek formation of Mississippi. He stated that these Pataula Creek specimens—

> have enabled me to discover that it is a very different shell from that which the same author called *Pugnellus densatus*, in the 4th volume of the same work, p. 284, pl. 46, fig. 31 [Conrad, 1860]. It is more than twice as large as adults of the latter species, the canal is straight, and the outer lip is not so thickened. The first species, that from the 3d volume [Conrad, 1858], must retain the specific name, and that in the fourth volume must be renamed. I, therefore, name it *P. typicus*, since that species was the one for which the genus was first founded.

Gabb's assumptions are incorrect. The holotype from the Owl Creek formation and the second figured specimen from the Ripley formation of Mississippi are conspecific, as can be shown by a comparison of material from the type localities. In addition, *P. typicus* would have been a misnomer because *P. densatus* has precedence; and the large specimens from the Providence sand of Pataula Creek, to which Gabb referred, most likely belong to *Pugnellus goldmani* Gardner.

One specimen preserved in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 15009) is from Pataula Creek and bear a label in Gabb's handwriting. It may be one of the specimens on which he based his opinion. This specimen, although lacking the outer lip, has the size, shape, and body ornament typical of Gardner's species. Other large pugnellids from the Providence sand in the Geological Survey collections substantiate this view.

Pugnellus densatus Conrad

Plate 14, figures 4, 5, 9, 10, 13–16, 19, 20

1858. *Strombus densatus* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 3, p. 330, pl. 25, fig. 14.
1860. *Pugnellus densatus* Conrad. Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d. ser., v. 4, p. 284, pl. 46, fig. 31.
1876. *Pugnellus typicus* Gabb, Philadelphia Acad Nat. Sci. Proc., v. 28, p. 298.
1904. *Pugnellus densatus* Conrad. Cossmann, Essais Paléoconchologie Comparée, v. 6, p. 37, pl. 7, figs. 4, 5.
1907?. *Pugnellus densatus* Conrad. Weller, New Jersey Geol. Survey, Paleontology, v. 4, pl. 10, fig. 6.
1923. *Pugnellus pauciplicatus* Stephenson (?), North Carolina Geol. and Econ. Survey, v. 5, p. 373, pl. 92, figs. 11, 12.
1926. *Pugnellus densatus* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 148, pl. 52, figs. 4, 5.
1940. *Pugnellus densatus* Conrad. Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 13, figs. 1, 2.
1940. *Pugnellus* (*Pugnellus*) *densatus* Conrad. Wenz, Handbuch der Paläozoologie: Gastropoda, v. 4, p. 940, figs. 2748, 2747.
1944. *Pugnellus densatus* Conrad. Shimer and Shrock, Index fossils of North America, p. 497, pl. 203, figs. 27, 28.

Diagnosis.—Medium to moderately large thick shell that develops an expanded and much thickened outer lip at maturity; body smooth in early stages developing colabial, frequently noded transverse ribs on latter part of body whorl; extremity of outer lip much thickened with bluntly rounded short anterior and posterior projections; gerontic stage marked by excessive secretion of callus extending from aperture over body as a ridge carrying onto spire and obscuring sutures.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD+Wi*	*MD*
1	68.0	----	26.0
1	48.0	32.8	20.1
1	41.0	----	19.0
1	37.7	26.9	17.0
1	37.0	29.0	----
1	44.3	30.5	17.0
5	38.0	28.5	16.3
6	40.0	27.5	18.0
18	42.0	27.0	18.5
18	33.0	24.5	----
18	37.5	26.0	----
16	33.5	23.5	15.0
16	35.0	25.0	14.3
7	50.5	----	----
46	46.0	30.5	----
46	----	36.0	21.0
46	40.5	27.5	18.5
46	46.0	36.0	20.5
46	48.0	----	23.0

Discussion.—Both Wade (1926, p. 148) and Stephenson (1941, p. 311) described the species in detail. Stephenson gave an excellent account of the developmental history of a variety, *P. densatus nacatochanus*, which essentially parallels the development of *P. densatus densatus*. Variation within the species is considerable in any one suite from a given locality. This variation is due primarily to the uneven distribution of callus and to the degree of gerontism displayed by the individual specimen. In the above measurements it has been assumed that maturity is reached when the thickened extremity of the outer lip has developed, but considerable change occurs after this stage has been reached. The two right rows of figures (4, 5, 9, 10, 13–16, 19, 20) on plate 14 indicate the sequence of change from early mature to gerontic stages, beginning with the youngest at the top. Although the body ceases to enlarge, the outer lip continues to develop in size by the addition of increments of shell to the outer edge. (See pl. 14, figs. 4, 9, 13, 15, 20.) This lip not only continues to grow outward but also upward and downward from this edge, forming short, blunt projections. On the body, callus is deposited on all surfaces except on the upper two-thirds of the latter part of the body whorl where the axial ribs are found. Especially thick pads of callus are formed on the spire, where a strong ridge develops above the lip; this leaves a deep channel between the ridge and the upper edge of the outer lip (pl. 14, fig. 19). This channel probably marked the position of a fold of the mantle. Another noticeable feature is the callus pad formed on the parietal lip just above the columellar lip (pl. 14, figs. 14, 16). On some specimens this pad becomes strongly raised above the body, changing the entire surface contour.

Considering the great amount of individual variation in a given suite, it is difficult to form any sound basis for a division of the species, but some slight differences can be noted that have some stratigraphic relation. The topotypes as well as the other specimens from the Owl Creek formation show a greater tendency for development to the advanced degree noted above. That is, they more commonly develop the massive shells heavily encrusted with callus, and also they show a greater tendency to develop nodes on the ribs (pl. 14, figs. 19, 20). The specimens from the Ripley formation of Mississippi are all smaller, indicating earlier maturity. In addition, the Ripley specimens do not develop to such a late stage, and there is a less excessive secretion of callus. That the size factor is not of specific distinction is shown by the suite of specimens from the Coon Creek tongue of the Ripley formation of Tennessee, some of which are comparable in size to the Owl Creek forms, differing only by their tendency for lesser development of nodes. The number of transverse costae varies with the individual specimen and does not appear to be a specific character.

The specimen illustrated by Conrad (1860, pl. 46, fig. 31) is an immature form probably from the Ripley formation of Tippah County, Miss. The holotype has been lost, but a hypotype is still preserved in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 15016) and compares well with the specimen on plate 14, figures 4, 5.

Pugnellus densatus nacatochanus Stephenson, from the Nacatoch sand of Texas, probably deserves separate varietal designation, being more massive and consistently larger, but it is certainly not specifically different. *P. pauciplicatus* Stephenson, from the Snow Hill member of the Black Creek formation of North Carolina, is extremely close to *P. densatus* as here interpreted. Stephenson (1923, p. 374) states—

> This species is very close to *Pugnellus densatus* Conrad * * * from Owl Creek, Tippah County, Miss., but that species has a greater number (7 or 8) of and longer axial folds, on each one of which on the inflated portion of the whorl is developed a rather prominent node * * *.

The types of Stephenson's species are fragmentary and difficult to compare. They show essentially the same features as the Mississippi specimens assigned to *P. densatus*, on which 7–8 axials are very commonly present. The coarseness of the axials is as variable a feature on the North Carolina specimens as it is on the Mississippi material. In all, no constant features were displayed which would yield these forms status as a distinct species, although with better preserved material the body proportions might allow for varietal distinction.

As here defined, the species is typical of the *E. costata* zone of Texas to New Jersey but locally is present in the uppermost part of the *E. ponderosa* zone.

Types: Holotype lost; hypotoypes ANSP 15016, USNM 128-535–128540.

Occurrences: Mississippi: Owl Creek formation, locs. 43, 44, 45, 46; Ripley formation, locs. 1, 4, 5, 6, 14, 15, 16, 18, 23, 27, 28, 29, 30, 31, 33. Tennessee: Ripley formation, loc. 1; Clayton formation (reworked Cretaceous material at base), loc. 40. Texas: Nacatoch sand (a variety). Chattahoochie River region: Cusseta sand and Ripley formations. Alabama: Providence sand (Perote member, Bullock County). North Carolina: Black Creek formation (Snow Hill marl member). Maryland: Monmouth formation. New Jersey: Wenonah(?) sand.

Pugnellus (Pugnellus) densatus Conrad?

Plate 13, figure 8

Discussion.—A number of internal molds from the Prairie Bluff chalk of Mississippi exhibit features typical of *P. densatus.* Although they do not preserve the reflection of the outer lip, making specific identification questionable, they do show the size, outline, and reflections of the axial costae typical of the species. Stratigraphically they are close to the position of the type material, where large specimens are abundant, but the Prairie Bluff specimens are generally of a smaller size than those of the Owl Creek formation.

Types: Hypotype USNM 128541.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 66, 67, 71, 74, 75.

Pugnellus (Pugnellus) goldmani Gardner

Plate 14, figures 11, 12, 17, 18; plate 15, figures 12, 14, 17

1916. *Pugnellus goldmani* Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 468, pl. 17, figs. 5, 6.

1941. *Pugnellus robustus* Stephenson, Texas Univ. Bull. 4101, p. 312, pl. 58, figs. 1–4.

Diagnosis.—Shell large, with typical pugnellid outer lip bearing distinct protuberance on anterior part; development of transverse ribs on body variable; surface with subdued ornament of spiral threads and growth lines that are obscured in later stages by a callus covering.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD+Wi*	*MD*	*HS*
Texas (holotype of *P. robustus*)	68	55.0	32.5	18.0
Texas (paratype)	69	53.0	32.5	17.0
7		51.5	29.5	19.5
4	67	46.0	31.5	17.8
40	79		35.5(?)	23.0
46	78	53+	34.5	18.0

Discussion.—This species has been described in detail by Stephenson (1941, p. 312) under the name *Pugnellus robustus.* The holotype from Maryland is a thin-shelled incomplete specimen lacking the outer lip and a segment of the anterior part of the shell, and it has not reached the final stage of callus covering. In shape and the presence of subdued collabial axial ribs and fine faint spiral threads on the body, it is indistinguishable from the earlier stages of *P. robustus* Stephenson of Texas.

Specimens assignable to this species from the Owl Creek and Ripley formations of Mississippi and from the Providence sand of the Chattahoochee River region fill much of the geographic gap between the Maryland and Texas occurrences.

The Mississippi specimens are rare but are sufficient to show a moderate amount of variation, and all specimens possess the typical body ornament of spirals. The Ripley specimen shown on plate 14, figures 17, 18, and that from the reworked Cretaceous in Tennessee on plate 15, figures 14, 17, bear strong ribs. On some specimens these ribs are noded. Other specimens, like that from the Owl Creek formation (pl. 15, fig. 12), Tippah County, Miss., show a suppression of the spirals that is typical of the holotype and most of the Texas specimens. Specimens with both strong and subdued ribs appear at the same stratigraphic level. Spiral ornament also varies in strength, and the stronger spiral elements fan out onto the outer lip, deviating from a true spiral trend as they near the aperture. Finer secondary spiral lirae, however, can be seen on younger, less callused specimens that continue a straight trend to the edge of the outer lip, as is seen on the holotype and the figured specimen from locality 6.

Pugnellus (*Pugnellus*) *densatus* possesses more numerous and proportionally stronger axial ribs and has a different pattern of callus deposition on the spire. Further, it is smaller and lacks the projection of the anterior part of the outer lip as well as having less well developed spiral ornament.

P. (*P.*) *goldmani* shows a distinct pattern of distribution in time that may reflect migration of the species from Texas to Maryland. *P. goldmani* in Texas occurs only in the Nacatoch sand (lower *E. costata* zone), an equivalent of the Ripley formation of Mississippi. In the Mississippi embayment the form ranges through the Ripley and Owl Creek. In Alabama and Georgia as in Maryland, *P.* (*P.*) *goldmani* is found only in the beds of the upper part of the *Exogyra costata* zone.

Types: Holotype (Maryland)—Gardner Collection on deposit with the U.S. National Museum; hypotypes USNM 7695 (Texas) and USNM 128542–128544 (Mississippi).

Occurrences: Mississippi: Ripley formation, locs. 4, 6, 18, 23, 28, 31 (?); Owl Creek formation, loc. 46. Tennessee:

Clayton formation (reworked Cretaceous material at base), loc. 40. Alabama: Providence sand of Bullock County. Georgia: Providence sand of Pataula Creek. Maryland: Monmouth formation.

Pugnellus (Pugnellus) sp.

Plate 15, figures 10, 11, 15, 16

Discussion.—About 20 internal molds from the Prairie Bluff chalk of Mississippi in shape and by possession of a thickened outer lip appear to belong to the genus *Pugnellus*. These specimens are in distinct contrast to those from the same formation that were assigned to *P. densatus?* by lacking any reflection of external ornament and by being slimmer. In addition, they have a flat, raised broad band on the body which covers a little more than the medial third of the body. The band begins at the aperture (see pl. 15, figs. 15, 16), revolves spirally around the body, and dies out on the outer lip. The base of the band is delimited by a raised spiral ridge. I know of no described species of *Pugnellus* that would leave the impression of such a ridge on an internal mold. The outer lip is not completely enough preserved on any specimen to state definitely to which subgenus the specimens belong.

Types: Hypotypes USNM 28335a, b.
Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 66, 71, 75, 82, 84, 87.

Subgenus GYMNARUS Gabb, 1868

Type by monotypy, *Pugnellus* (*Gymnarus*) *manubriatus* Gabb, 1868.

Diagnosis.—Gabb, 1868, p. 139, states—

General form of *Pugnellus;* outer lip less heavy and produced posteriorly to a hook; anterior canal slightly produced and straight; incrustation not covering the entire shell, the back being exposed.

Discussion.—This subgenus is more characteristic of the Indo-Pacific region than of the gulf coast. *Pugnellus abnormalis* Wade appears to belong here, as it has a posterior extension of the outer lip extremity. The form differs primarily from that described by Gabb by the whole surface being covered with callus.

Pugnellus (Gymnarus) abnormalis Wade

Plate 15, figures 1, 6, 9, 13

1923. *Pugnellus* sp. Stephenson, North Carolina Geol. and Econ. Survey, v. 5, p. 374, pl. 93, fig. 12.
1926. *Pugnellus abnormalis* Wade, U.S. Geol. Survey Prof. Paper 137, p. 149, pl. 52, figs. 6, 7.
1927. *Pugnellus levis* Stephenson, U.S. Natl. Mus. Proc., v. 72, art. 10, p. 22, pl. 9, figs. 1–5.

Diagnosis.—Large smooth-surfaced pugnellid with thick pad of callus on base of body near aperture that extends up spire as a round-topped ridge; outer lip expanded, much thickened posteriorly, with lip bent back posteriorly; upper edge of this extension bearing a groove.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD+Wi*	*MD*
Tennessee (holotype)	84+	66+	39.0
North Carolina (hypotype)	----------	----------	36.0
13	75+	64	33.0
18	----------	----------	32.0
9	[1] 78	----------	33.5

[1] Estimated.

Discussion.—The holotype of *Pugnellus levis* Stephenson (pl. 15, fig. 9), from the Peedee formation of North Carolina, is an incomplete specimen lacking the outer lip and having both the anterior part and the extreme tip of the apex broken. Stephenson differentiated this species from *P.* (*Gymnarus*) *abnormalis* on the basis of its having a shorter spire and being less elongate. The state of preservation of the specimen, however, does not allow a comparison of elongation; and the tip of the spire has been worn down, so that it is shorter. The two specimens compare well in their body dimensions, the North Carolina specimen being somewhat slimmer only. Judging by the amount of callous deposit, it is probably a slightly younger specimen, which with increased callous accretion would become more obese. In arrangement of callus, lack of ornament, and general shape, the two are indistinguishable, and *P.* (*G.*) *levis* appears to be a synonym of *P.* (*G.*) *abnormalis.* The specimens from the Ripley formation here assigned to this species are all incomplete but compare well with the type. In general they are somewhat smaller and slightly thinner shelled. One specimen from locality 29 preserves an almost complete outer lip extremity which shows that the broken end of the lip of the holotype has lost very little of its original length. The lip is terminated in a blunt sinus, and the groove near the posterior edge probably continued as a curved spike beyond the blunted end of the wing.

This species, with its smooth surface and pointed spire, is unlikely to be confused with any species of *Pugnellus* (*Gymnarus*) yet described. *P. abnormalis* is restricted to the lower part of *Exogyra costata* zone in Mississippi, Tennessee, and North Carolina and is rare.

Types: Holotype 32922 (Tennessee); hypotypes USNM 73446, 73447, and 31870 (?) (North Carolina) and USNM 20492 (Mississippi).

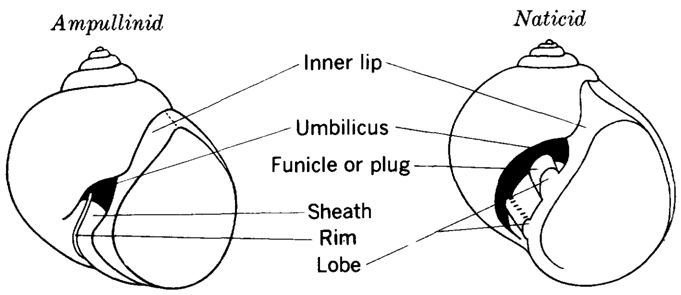

FIGURE 11.—Terminology applied to the Naticidae and Ampullinidae (after Wrigley, 1946).

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, locs. 9, 13, 18, 23, 29. North Carolina: Peedee formation.

Superfamily CYPRAEACEA

Family CYPRAEIDAE

Discussion.—Members of this well-known family are absent in the Ripley and Owl Creek formations of Mississippi. Elsewhere in the Atlantic and Gulf Coastal Plains, the following species have been described: *Cypraea gracilis* Stephenson and *C. nuciformis* Stephenson, from the Navarro of Texas, and *C. mortoni* Gabb, from the Navesink marl of New Jersey. Undescribed specimens from the Marshalltown formation of Delaware and the Prairie Bluff chalk of Alabama are also present in the Geological Survey collections. For the most part these specimens are known only in the form of internal molds. it is strange that, with such a wide and varied univalve fauna in the Ripley formation, no cypraeids have been recovered from these strata. The presence of internal molds in the Prairie Bluff chalk of Alabama indicates that eventually specimens may be discovered in the same formation in Mississippi.

Superfamily NATICACEA

Family NATICIDAE

Both Dall (1892, p. 362) and Wrigley (1949, p. 10) have pointed out many of the difficulties in working with the fossil naticids and ampullinids of the Tertiary. Among the many factors are the lack of color patterns, general absence of sculpture, sexual differences in form, and corrosion of the shell, which is especially noticeable near the suture. The latter factor leads to the assumption of a shouldered form in specimens normally lacking pronounced shoulders. These difficulties apply equally well to the Mesozoic species, with the additional factor that opercula are virtually unknown and that the shells are much more commonly recrystallized; this makes the identification of the various shell layers impossible. Dall relied heavily upon opercular character for differentiation, but the emphasis placed on the umbilical characters by Wrigley is much more useful in the study of fossil species. A number of shell features appear to be almost wholly restricted to these groups, and Wrigley (1946, p. 88) has offered some useful terms for them. With minor changes, his terminology has been accepted here, and figure 12 is a slightly modified version of the explanatory figures given by him.

Subfamily GYRODINAE

Genus GYRODES Conrad, 1860

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

Diagnosis.—Medium- to large-sized subglobose low-spired shells with wide deep umbilicus free of callus; ornament restricted to growth lines and commonly nodes or crenulations near suture and at umbilical margins; aperture subovate, inclined; inner-lip callus very thin.

Discussion.—I am in agreement with Stephenson (1923, p. 358) that *G. supraplicatus* and *G. crenatus* are synonyms, but the type is by monotypy, not subsequent designation of Gardner (1916, p. 496). The holotype, an incomplete specimen from the Owl Creek formation of Mississippi, has evidently been lost, because it is not now present in the collections of the Philadelphia Academy of Natural Sciences. The types of *G. crenatus* Conrad are preserved in the collections of that institution (ANSP 15133) and are labeled as collected from Tippah County, Miss., by Dr. Spillman. These specimens are probably from the Ripley formation. Both specimens preserved are in rather deplorable condition. In size neither specimen matches the figure given by Whitfield (1892, pl. 16, fig. 5, 6). That author makes no mention of a size reduction of the figure, and it is probable that his figure represents a third specimen. These specimens, although smaller than is typical of specimens from the Owl Creek formation agree well and appear to be conspecific Both Tryon (1883, p. 206) and Cossmann (1925, p. 103) are in error in citing *G. alveatus* Conrad, a synonym of *G. spillmani* Gabb, as the type species.

Gyrodes is most typical of the Upper Cretaceous although it is represented in the Albian by such forms as *Natica gaultina* d'Orbigny (1842, pl. 173, figs. 3, 4). Hardly a single monographed major Late Cretaceous fauna lacks some representative of the genus. On the basis of umbilical margin and suture character, *Gyrodes* might be split into three main types: forms typified by *G. supraplicatus*, which have a crenulate and sharp umbilical margin and crenulations near the suture; those bearing a smooth whorl-surface and rounded umbilical margin, as in *G. americanus* (Wade); and those with a rounded umbilical margin and a noncrenulate but distinctly channeled suture, such as *G. spillmani* Gabb. Distribution for each of the groups, like that for the genus is worldwide.

In the gulf coast all types are represented. The earliest known species occurs in the Woodbine formation of Texas, and in the gulf coast *Gyrodes* continues to be present through the remainder of the Cretaceous. The species appear to be quite hardy and are not affected by facies changes. They appear in all lithologic types from sand through limestone to chalk. Because of their thin shell in proportion to their size, specimens commonly are found crushed or otherwise distorted.

In such a variable group one would expect a rather wide distribution of species. Thus, many of the gulf coast species have analogs in the faunas of other areas, but comparison is limited by the lack of material and the need for reliance on published illustrations of variable quality.

Gyrodes supraplicatus (Conrad)

Plate 16, figures 1–5, 9, 13, 19

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

1860. *Natica (Gyrodes) crenata* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2d ser., v. 4, p. 289.

1892. *Gyrodes crenata* Conrad. Whitfield, U.S. Geol. Survey Mon. 18, p. 126, pl. 16, figs. 5, 6.

1923. *Gyrodes supraplicatus* (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, v. 5, pl. 89, figs. 3 and 5 [not 1, 2].

1941. *Gyrodes supraplicatus* (Conrad). Stephenson, Univ. Texas Bull. 4101, p. 280, pl. 51, fig. 13–16.

1955. *Gyrodes supraplicatus* (Conrad). Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 125, pl. 21, figs. 15, 16.

Diagnosis.—Medium to large size, very low spired gyrodids with posteriorly flattened whorls bearing crenulations and having a strongly crenate, sharply angulated umbilical margin; inside umbilicus is a second, less sharp and crenate spiral carina separated from the first by a broad sulcus; outer lip thin at margin, sharply notched anteriorly at maturity.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48). There are a number of other specimens in the collections studied, but they are not complete enough for measurement.

Loc.	No. *W*	*H*	*MD*	*DU*	*HB*
46 (topotype)	(?)	44.6	50.0	37.0	6.3
46 (topotype)	6	32.5	34.5	24.4	32.0
5	6.2	32.0	38.0	26.0	38.0
29	6 ?	24.0	29.0	18.0	27.6
18	6.3	32.0	38+	21.0	28+

Discussion.—A full and detailed description of the species has been given by Stephenson (1941, p. 280). *Gyrodes supraplicatus* is closely related to, if not directly descended from, *G. major* Wade, from the Coon Creek tongue of the Ripley formation of Tennessee. The two species are very close and can most easily be distinguished in the mature stages. *G. major* Wade (1926, pl. 57, figs. 4, 7, 11) in its later stages of growth develops a rounding of the umbilical margin and an almost complete loss of the carination on the interior of the umbilicus. *G. supraplicatus*, even in the extremes of growth (see Stephenson, 1941, pl. 51, fig. 16), continues to retain the umbilical carina as a sharp ridge, and if any change is noticeable it involves the strengthening of this ridge. (See pl. 16, fig. 19.) On the type species (see pl. 16, figs. 4, 19), the band between the umbilical carina and the interior carina is concave, whereas in *G. major* this band is flat to broadly rounded and raised (pl. 16, fig. 10). *G. conradi* Meek, from the Carlile shale equivalents of the western interior, is very similar to *G. supraplicatus* by bearing a sharply carinate umbilical margin and a flattened shoulder. Two places on the umbilical margin of the holotype are preserved, and these indicate the carination to have been crenulate. This species, however, is smaller than *G. supraplicatus*, lacks the strong crenulations of the shoulder margin and has a proportionally broader, flat to slightly convex area between the umbilical carination and the spiral carination of the umbilical wall. *G. conradi* Meek of Stanton (1893, p. 136), from the Colorado group of Colorado, is also closely related but appears to differ from Meek's species by having a proportionally broader shoulder, higher spire, narrower umbilicus, and narrower flattened area between the umbilical marginal carina and the umbilical wall carina, both Meek's and Stanton's species are from the Carlisle shale, but the form described by Stanton may be somewhat younger.

The specimens here assigned to *G. supraplicatus* (Conrad), from the Ripley and Owl Creek formations of Mississippi, agree quite well. There are minor variations in elevation of the spire and obesity of the body, but they appear to be insignificant. The specimens from the Nacatoch sand of Texas described by Stephenson (1941, p. 280) show a strong development of the umbilical angulation but in other respects agree well with the Mississippi specimens. The species is widespread in the *Exogyra costata* zone and locally is abundant, but well-preserved specimens are a rarity.

Types: "Cotypes" ANSP 15133; topotype USNM 20440; hypotypes USNM 128545, 128546 and 20992, 76851 (Texas).

Occurrences: Mississippi: Ripley formation, locs. 3, 5, 6, 14, 16, 17, 18, 22, 23, 27, 29; Owl Creek formation, locs. 43, 46, 48. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40. Texas: Nacatoch sand, Corsicana marl, Kemp clay.

Gyrodes major Wade

Plate 16, figures 6, 7, 10, 11, 15

?1923. *Gyrodes supraplicatus* (Conrad) (part) Stephenson, North Carolina Econ. and Geol. Survey, v. 5, p. 358, pl. 89, figs. 1, 2 [not figs. 3–5].

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

1926. *Gyrodes crenata* Conrad. Wade, U.S. Geol. Survey Prof. Paper 137, p. 164, pl. 57, figs. 1–3.

1941. *Gyrodes (Gyrodes) crenata* Conrad. Wenz, Handbuch der Paläozoologie; Gastropoda, v. 5, p. 1018, fig. 2921.

1944. *Gyrodes supraplicata* (Conrad). Shimer and Shrock, Index fossils of North America, pl. 198, figs. 10, 11, 12.

Diagnosis.—Medium- to large-size shell; whorls posteriorly flattened and crenate; umbilical margin normally subcarinate in early stage, becoming rounded in late stages.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Type	No. W	*H*	*MD*	*DU*	*HB*
Holotype	(?)	54.0	64.0	40.5	48.0
Hypotype	7.0	29.0	39.0	27.0	27.5
Topotype	(?)	31.0	35.5	23.5	25.0
Do	6.2	22.7	28.5	17.0	20.0
Do	6.7	28.0	31.5	18.5	24.5

Discussion.—The original concept of the species under consideration was quite narrow and based primarily on the largest specimen, the holotype. It was distinguished primarily on the basis or size and the general lack on this specimen of a sharp umbilical margin. Younger specimens show other significant differences. Although they possess an umbilical carina analogous to that of *Gyrodes supraplicatus* (Conrad), the strength of this feature in the immature or smaller specimens varies quite considerably. On some individuals it is relatively well rounded, (pl. 16, fig. 11) and in others, sharp (pl. 16, fig. 15); but in most specimens it does not bear crenulations as strong as those of Conrad's species. As indicated by the measurements, the proportional width of the umbilicus of *G. major* is variable but in general is less than that of the Mississippi species, especially in the smaller specimens. Other differences have been pointed out in the discussion of *G. supraplicatus.* The specimen Wade (1926, p. 164) referred to *G. crenata* is an abberrant form probably belonging to *G. major*, as in the later stages of its growth it begins to lose the angularity of the umbilical carina and it possesses a flat to gently arched platform inside the umbilicus between the two angulations. The chief difference from a typical specimen of *G. major* shown by this specimen is the flattened or sunken spire. *G. supraplicatus* (Conrad) of Stephenson (1923, p. 358), from the upper part of the *E. ponderosa* zone of North Carolina, is close stratigraphically to the type locality of *G. major;* but the specimen is small and crushed; and although it is impossible to assign it definitely to this species, it does have a proportionally narrow umbilicus. A small specimen in the Survey collection from the Coffee sand of Mississippi (USGS Mesozoic loc. 17254) agrees well with small topotypes, bearing a sharp but noncrenulate umbilical margin. *G. rotundus* Stephenson, from the Navarro group of Texas, is similar in proportions to *G. major* but has a well-rounded umbilical margin at an early stage. This lack of angularity, plus a less flattened posterior area on the whorls, lends specimens of this species a plump, well-rounded whorl outline.

Types: Holotype USNM 73077; hypotypes USNM 73076, 128547 and 128548 (Tennessee) and USNM 31845 (North Carolina).

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Coffee sand (questionable specimen reported). North Carolina: Snow Hill member of the Black Creek formation. (questionable specimen reported).

Gyrodes spillmani Gabb

Plate 16, figures 14, 17, 18 20, 21; plate 17, figure 27

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

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

1883. *Gyrodes alveata* Conrad. Tryon, Structural and systematic conchology, v. 2, p. 206, pl. 64, fig. 70.

1892. *Gyrodes petrosus* (Morton). Whitfield, U.S. Geol. Survey Mon. 18, p. 127, pl. 16, figs. 1–4.

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

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

1944. *Gyrodes petrosa* (Morton). Shimer and Shrock, Index fossils of North America, p. 483, pl. 198, figs. 13–15.

1955. *Gyrodes spillmani* Gabb. Stephenson, U.S. Geol. Survey Prof. Paper 274–E, p. 125, pl. 21, figs. 13, 14.

Diagnosis.—Shell thin, rather small for genus; whorls with a narrowly channeled shoulder delimited by a raised sharp carina.

Description.—Small- to medium sized shell with low spire. Protoconch small, consists of two smooth raised whorls. Suture impressed, whorls number 4–5. Whorls broadly rounded on sides, developing a shoulder on second teloconch whorl; shoulder flat to excavated, variable in width and bordered by narrow commonly sharp carina. Sculpture lacking save for prosocline growth lines, which are most strongly developed on shoulder. Aperture subovate, inclined to axis, posteriorly angulated, anteriorly rounded; outer lip thin, simple; inner lip slightly sinuous over columellar area; parietal callus thin in small forms, thickening with increased shell size. Umbilicus flaring and open, has subangular margin in small specimens that rounds off with increased growth.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*WS*	*HB*	*DU*
1	30.0	33.0	4.0	25.0	19.0
1	18.0	20.5	2.8	15.0	13.6
5	24.0	27.0	3.0	18.7	17.0
18	19.5	24.0	2.8	17.0	17.5
72	20.0	23.0	2.7	17.0	16.5
66	17.0	17.0	2.0	12.0	10.0
46	20.0	19.5	1.9	16.0	13.0
46	15.5	17.5	1.8	12.5	(?)
27	19.0	20.0	1.8	15.5	14.0

Discussion.—Although specimens of this species are not uncommon, their thin shells generally have been crushed or distorted. With such preservation it is commonly difficult to determine whether features shown by individual specimens are due to distortion or variation. The type locality of *G. spillmani* is not known exactly and was given only as "Cretaceous limestone of Mississippi" (Gabb, 1861, p. 320), but Stephenson (1941, p. 284) states that matrix on cotypes in the collections of the Philadelphia Academy of Natural Sciences matches the lithologic character of the Prairie Bluff chalk. I have studied these specimens and believe one may belong to *G. petrosus* (Morton). Conrad's type specimen of "*G. alveata*" is preserved in the same institution (ANSP 1531) and is in poor condition. This specimen is labeled as from Tippah County, Miss., collected by Dr. Spillman, and compares well with specimens from the Ripley formation.

A comparison of internal molds from the Prairie Bluff chalk of Mississippi with better preserved material from the Ripley and Owl Creek formations of Mississippi and Tennessee indicates little basis for specific separation of the material. All specimens possess the channeled or excavated shoulder, although at all stratigraphic levels there is variation in the width of the shoulder and the strength of the marginal carina. The small specimen figured by Wade (1926, pl. 57, fig. 6) is typical of forms having a low and less sharp carina. Unfortunately, Wade's illustrations do not show either the shoulder or the umbilicus. The umbilicus of the specimen shows well that in the younger stages the umbilical margin is subcarinate. A larger specimen from the same locality, shown on plate 16, figure 18, exhibits an umbilicus of a more advanced stage and is well rounded. In general, specimens from the higher stratigraphic positions, such as those from Owl Creek formation have the sharpest umbilical carinae.

The New Jersey specimens figured by Whitfield (1892, pl. 16, figs. 1–4) as *G. petrosus* (Morton) compare well with the molds of *G. spillmani* from the Prairie Bluff chalk of Mississippi. *G. acutimarginata* (Röemer) from the Cretaceous of Aachen, Germany, is of the same general type as this species, differing primarily in body proportion. *G. spillmani* is not likely to be confused with other species of *Gyrodes.*

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

Occurrences: Mississippi: Ripley formation, locs. 4, 5, 6, 9a, 16, 17, 18, 27; Owl Creek formation, locs. 43, 46, 51. Prairie Bluff chalk, locs. 55, 57, 65, 66, 71, 74, 83, 87. Tennessee: Ripley formation, loc. 1; Clayton formation (reworked Cretaceous material at base), loc. 40. Texas: Nacatoch sand and Corsicana marl. Alabama: Prairie Bluff chalk. New Jersey: Navesink marl.

Gyrodes americanus (Wade)

Plate 16, figures 8, 12, 16, 22; plate 17, figures 28, 31, 32

1916. *Gyrodes petrosus* (Morton). Gardner, Maryland Geol. Survey, Upper Cretaceous, p. 496, pl. 13, fig. 8.

1926. *Mammilla americana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 165, pl. 57, figs. 10, 14.

1941. *Gyrodes subcarinatus* Stephenson, Texas Univ. Bull. 4101, p. 283, pl. 52, figs. 22, 24, 26.

Diagnosis.—Shell of small to moderate size for genus; whorls plump, slightly flattened posteriorly, and sharply rounded at umbilical margin; surface free of ornament except for strong opisthocline growth lines.

Description.—Shell of medium size, thin; spire low; protoconch consists of about 2½ raised smooth whorls. Suture impressed; whorls number six on largest specimen. Later whorls bear relatively narrow flat to slightly depressed shoulder, varying in development with individual specimens; early whorls may lack a shoulder; body sides well rounded, plump; umbilical margin sharply rounded; umbilical wall has slight angulation near margin. Whorl surface smooth, with exception of strongly prosocline growth lines. Aperture steeply inclined to axis, subovate, slightly angulated posteriorly, and sharply rounded anteriorly; outer lip thin at edge, broadly arched; inner lip somewhat sinuous and slightly reflexed over umbilicus; callus thin in small specimens, thickening with size. Umbilicus moderately wide.

Measurements.—Explanation of measurements and symbols used in the followng table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*HB*
1 (holotype)	44.0	48	33.0
Mississippi (hypotype)	23.0	28	17.0
Texas (hypotype)	18.5	21	19.0
6	23+	29−	17+
7	27.0	34−	22.0
12	19.0	24	15.0
Maryland	27.0	38	21.5

Discussion.—The above measurements must be viewed with caution, as most of the specimens are distorted owing to crushing. *Mammilla* to which Wade assigned this species is a Pliocene to Recent genus and is characterized by a stout shell with relatively thick parietal callus, a very low spire, and very elongate aperture. Wade's holotype, the only known specimen from the type locality, is also the largest known specimen. The specimens on which Stephenson based *G. supraplicatus* are all smaller but agree well in character with the early whorls of the Tennessee and Mississippi material. Variation in the width and strength of the posterior shoulder is considerable, as is variation in the strength and presence of the angulation on the interior of the umbilicus. In general the specimens from the Ripley formation of Mississippi are larger than the Texas specimens, and one specimen from locality 7 in Tippah County approaches the holotype in size and shows that with an increase in size there is a tendency for a thickening of the parietal callus and a smoothing of the umbilical wall.

The specimens assigned by Gardner (1916, p. 496) to *G. petrosus* (Morton) agree with *G. americanus* in size, presence of a shoulder that lacks crenulations, and a rounded umbilical margin. These specimens occur in Maryland in a part of the Monmouth formation thought to be higher stratigraphically than the level of the species in Texas or the Mississippi embayment area. *Gyrodes depressus* Meek (1876, p. 159) and *G. depressus* Meek of Stanton (1893, p. 135), from the Turonian of the western interior, although doubtfully conspecific are both close to *G. americanus*, differing in body proportions and by having a less highly inclined aperture. *G. tellenus* Stoliczka of Rennie, from Pondoland, South Africa, closely simulates the proportions, size and features of *G. americanus.*

Types: Holotype USNM 73080 (Tennessee); hypotypes USNM 76859, 76860, and 76861 (Texas); and USNM 128550 (Mississippi).

Occurrences: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation, locs. 6, 7, 12, 15, 17.

Gyrodes petrosus (Morton)

Plate 15, figures 2–5

1834. *Natica petrosa* Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 48, pl. 19, fig. 6.

1861. *Gyrodes petrosa* (Morton). Gabb, Synopsis of the Mollusca of the Cretaceous formation, Am. Philos. Soc. Proc., v. 8, p. 61.

1905. *Gyrodes petrosus* (Morton). Johnson, Philadelphia Acad. Nat. Sci. Proc., v. 57, p. 21.

?1907. *Gyrodes petrosus* (Morton) [part]. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 689, pl. 77, figs. 13–15 [not 17–18].

1927. *Gyrodes petrosus* (Morton). Stephenson, Alabama Geol. Survey Spec. Rept. 14, pl. 91, fig. 10.

1941. *Gyrodes petrosus* (Morton). Stephenson, Texas Univ. Bull. 4101, p. 282, pl. 51, figs. 1–7.

Diagnosis.—Small internal molds of *Gyrodes* with low outline, depressed spire, whorls rapidly expanding and broadly rounded; aperture highly inclined to axis; umbilicus wide and flaring, with rounded margin.

Discussion.—Molds of this small species are numerous in the chalk facies of the Gulf Coastal Plain from Texas to the Chattahoochee River region of Alabama. Most, if not all, specimens assigned *G. petrosus* from the Atlantic Coastal Plain belong in other species. There is little correlation in either size or shape with species known from well-preserved material, and this constancy of size is judged to be an indication of a distinct species that may have been ecologically restricted to areas of chalk deposition.

The specimens in the Survey collections from the Prairie Bluff chalk of Mississippi agree well in all respects with topotypes from Prairie Bluff, Wilcox County, Ala., and with the holotype (ANSP 15140).

Types: Holotype ANSP 15140 (Alabama); hypotypes USNM 76858 (Texas), USNM 76857 (Alabama), USNM 128554 (Mississippi).

Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 66, 68, 70, 71, 72, 73, 74, 75, 78, 80, 81, 82, 83, 84, 87, 88, 90, 91, 92, 93, 94. Texas: Neylandville and Corsicana marls. Alabama: Prairie Bluff chalk. New Jersey: Merchantville, Wenonah, Navesink, and Red Bank formations (questionable specimens reported).

Gyrodes abyssinus (Morton)

Plate 15, figures 7, 8; plate 17, figures 26, 29, 30, 33

1834. *Natica abyssina* Morton, Synopsis of the organic remains of the Cretaceous group of the United States, p. 49, pl. 13, fig. 13.

1861. *Gyrodes abyssina* (Morton). Gabb, Synopsis of the Mollusca of the Cretaceous formation, Am. Philos. Soc. Proc., v. 8, p. 115.
1876. *Gyrodes abyssinis* (Morton). Gabb, Philadelphia Acad. Nat. Sci. Proc., v. 28, p. 295.
1892. *Natica abyssina* Morton. Whitfield, U.S. Geol. Survey Mon. 18, p. 123, pl. 15, figs. 9–12.
1907. *Gyrodes abyssina* (Morton) [part]. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 683, pl. 77, figs. 7–9.
1926. *Gyrodes abyssinus* (Morton). Stephenson, Alabama Geol. Survey Spec. Rept. 14, pl. 92, fig. 14.
1940. *Gyrodes abyssinus* (Morton). Stephenson and Monroe, Mississippi Geol. Survey Bull. 40, pl. 15, fig. 6.
1944. *Gyrodes abyssina* (Morton) Shimer and Shrock, Index Fossils of North America p. 483, pl. 198, figs. 16, 17.

Diagnosis.—Medium- to large-sized internal molds of *Gyrodes* having low spire and rounded umbilical margin but lacking posterior shoulder.

Discussion.—This species is known only in the form of internal molds. The type locality is in the Prairie Bluff chalk at Prairie Bluff, Wilcox County, Ala., and the holotype is preserved in the collections of the Academy of Natural Sciences of Philadelphia. *Gyrodes abyssinus* is well represented in the chalk facies of the gulf coast and has been reported from the marls of the Atlantic Coastal Plain. In Mississippi the species is very common in the Prairie Bluff chalk and has also been reported from the upper part (Demopolis chalk) of the Selma group.

Its size and wide umbilicus is comparable to *Gyrodes supraplicatus* (Conrad). Several umbilical fillings of molds from the Prairie Bluff chalk have preserved a reflection of the ornament of the umbilical margin and walls. The specimen figured on plate 15, figure 7, from locality 71, shows that the umbilicus was crenulate and carinate. Thus, it appears that the molds may be conspecific with *G. supraplicatus*, the type species, which is known only from well-preserved material in the Ripley and Owl Creek formations. Such an assignment would necessitate the dropping of Conrad's name in favor of Morton's. Until more complete features of the ornament can be exhibited, it is deemed unwise to follow such a course.

The species *G. abbotti* Gabb, from the Navesink marl of New Jersey, which Weller (1907, p. 683) assigned to this species, differs by having a flattened upper whorl surface and probably deserves a separate designation.

Types: Holotype ANSP (Alabama); hypotype (New Jersey) USNM 128553, 128552, and USNM 73641 (Mississippi).

Occurrences: Mississippi: Prairie Bluff chalk, locs. 57, 58, 65, 67, 68, 71, 72, 79, 80, 81, 82, 83, 84, 87, 89, 90, 91, 92, 93, 94; Demopolis chalk (specimen reported). Alabama: *Exogyra costata* zone. Maryland (?): *E. costata* zone. Delaware: *E. costata* zone. New Jersey: *E. costata* zone.

Subfamily NATICINAE

Genus POLINICES Montfort, 1810

Type by original designation, *Polinices albus* Montfort, 1810 (= *P. mammilaris* (Lamarck)).

Diagnosis.—Shell ovoid, commonly thick; sutures appressed; aperture subovate, posteriorly angular, well rounded anteriorly; inner lip heavily callused on parietal area, with callus invading and partly filling umbilicus.

Discussion.—Stewart (1927, p. 325) discussed the problem of the type species, and Woodring (1928, p. 385) gives further discussion and includes *Natica brunnea* Link as an additional synonym of *Polinices albus*.

Most Cretaceous naticinids have rather involved synonomies, with a given species being at one time or another assigned generally to 1 of 4 genera—*Polinices*, *Natica*, *Lunatia*, or *Euspira*. *Polinices* has been one of the most misused names, and most Cretaceous species that have been assigned here belong in *Euspira*. *Euspira* differs from *Polinices* primarily by having an abutted or impressed rather than appressed suture, as well as being globose in outline instead of ovoid. Other differences rest in the filling of the umbilicus by callus, which in *Polinices* is usually complete.

At present and in the Tertiary, *Polinices* s. s. was common and widespread, but relatively few species can be distinguished in the Upper Cretaceous rocks of the world. The only species in the gulf coast Upper Cretaceous assignable to *Polinices* is *P. kummeli* Sohl, from the Owl Creek formation and Providence sand (Maestrichtian).

Polinices kummeli Sohl, n. sp.

Plate 17, figures 1–4, 8, 9

Diagnosis.—Medium-sized subglobose polinicid with stout shell; surface of whorls smooth; aperture elongate-subovate, parietal callus very thick, partly to almost totally filling umbilicus.

Description.—Shell of medium size, ovate to subglobose; spire rather low; pleural angle 90°–100° on adult specimens and to 112° on immature specimens. Protoconch of 2½–3 smooth round-topped whorls, slightly elevated above succeeding whorls and possessing impressed sutures; suture of teloconch appressed. Whorls broadly rounded on sides and increases rapidly in height than width. Sculpture absent on the glazed surface except for prosocline growth lines that are gently flexed near suture. Aperture subovate, posteriorly subangulated, anteriorly well rounded; outer lip trends obliquely backward from suture and is broadly rounded in profile; inner lip merges with thick callus on parietal area. Umbilicus incompletely filled; funicule present on sheath of umbilical wall just below suture.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*HA*	*WA*
46 (holotype)	20.0	14+	14	--------
46 (paratype)	16.0	13	10	7
40 (paratype)	19.0	17	13	8

Discussion.—The measurements given above indicate considerable variation in the body proportions. In part, this variation is explained by virtue of all specimens having undergone some degree of compression. The amount of filling of the umbilicus also varies from relatively open to almost completely filled. In spite of these variations the specimens are remarkably consistent in their apertural features and in the shape of the callus.

The species is rather rare and is only found in the latest Cretaceous strata from Mississippi to Georgia.

The species is named for Bernhard Kummel of Harvard University who materially aided the author in early stages of this work.

Types: Holotype 128555; paratype USNM 128556, 128557, 128558, 128559, 20439.

Occurrence: Mississippi: Owl Creek formation, loc. 46. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40. Georgia: Providence sand.

Genus EUSPIRA Agassiz (in Sowerby), 1838=Lunatia Gray 1847=Labellinacca Cossmann, 1919

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

Diagnosis.—Medium- to large-sized globose shell, with abutting to impressed sutures; umbilicus open and small to medium sized and lacks a funicle.

Discussion.—Stewart (1926, p. 324) discussed the selection of the type species. He based his judgement on the French translation of Sowerby, and although the German edition, which Stewart did not see, predates it, they both agree. The confusion surrounding the type species has caused misconceptions as to the nature of the genus. The name *Lunatia*, also a victim of confusion, has been applied to the species assignable to *Euspira*. Both *Euspira* and *Lunatia* are distinguished primarily by the possession of an open umbilicus and lack of a funicle. Distinction between the two appears impossible, and I believe the names to be synonymous. Wrigley (1946, p. 14) arbitrarily retains both generic names stating:

> This genus (*Euspira*) is used for fossil species which resemble the living *Lunatia* Gray, 1847, which could be treated as a synonym of *Euspira*, except for the consideration that the animal of a living species is, or can be known while that of a fossil is not.

The Cretaceous species here placed in *Euspira* are assigned on the basis of the umbilical characters. Most have at one time or another been placed in *Polinices* but lack either the suture, shape, or umbilical features of that genus. In shape and general features they are close to *Natica* and have so been assigned by some authors, but none possess the funicle typical of that genus. Meek (1876, p. 311) discussed *Lunatia* and the possibility of species such as *L. subcrassa*, *L. concinna* and *L. occidentalis*, which he described from the Upper Cretaceous series of the western interior, belonging in *Euspira*. He mentioned that *N. glaucinoides* should be the type of *Euspira* but, if accepted, would make *Lunatia* a synonym of *Euspira*. His final decision, arrived at somewhat arbitrarily, is that the name *Lunatia* should be kept.

In the Upper Cretaceous series of the gulf coast, species of *Euspira* are not numerous but are found at all levels. In numbers of individuals they are among the most common of the gastropods. The Woodbine species assigned by Stephenson (1953, p. 150–151) to *Natica* lack the funicle of that genus and probably belong in *Euspira*.

Euspira rectilabrum (Conrad)

Plate 17, figures 5–7, 12–14

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

1923. *Lunatia carolinensis* Conrad. Stephenson, North Carolina Econ. and Geol. Survey, v. 5, p. 356, pl. 88, figs. 17–18 [not 19].

?1925. *Lunatia wadei* Cossmann, Essais Paléoconchologie Comparée, v. 13, p. 135.

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

1941. *Polinices rectilabrum* (Conrad). Stephenson, Texas Univ. Bull. 4101, p. 276, pl. 50, figs. 1, 6.

1941. *Polinices rectilabrum texanus* Stephenson, idem., p. 276, pl. 50, figs. 7, 8.

1944. *Polinices* (*Euspira*) *halli* (Gabb). Shimer and Shrock, Index fossils of North America, p. 483, pl. 198, figs. 23, 24.

1955. *Polinices rectilabrum* (Conrad). Stephenson, U.S. Geol. Survey Prof. Paper 274-E, p. 125, pl. 21, figs. 10–12.

Diagnosis.—Medium-sized globose shell with impressed suture; surface usually smooth and glazed; inner lip moderately thick, straight, merging above into expanded and thickened pad of callus; umbilicus moderately narrow.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*HB*
1	32.2	24.3	20.8
1	26.8	20.7	18.0
1	27.4	21.0	18.0
1	25.1	20.2	17.5
1	24.7	21.0	16.9
1	22.9	18.6	16.5
1	21.0	16.5	14.6
1	18.4	13.9	12.5
1	17.5	13.5	12.7
1	12.3	10.9	9.0
6	23.3	19.1	16.8
6	23.8	18.5	16.7
6	22.8	17.0	15.8
6	19.7	15.3	13.3
6	16.8	13.2	11.1
6	15.2	12.3	10.5
6	15.3	11.6	10.6
7	28.2	23.2	19.5
7	15.2	12.3	11.9
7	10.7	9.2	8.1
12	29.7	22.5	19.5
12	23.5	19.3	16.4
29	30.0	24.5	19.5
40	20.3	11.0	13.2
46	16.4	12.8	12.0
46	14.0	12.0	10.5

Discussion.—Stephenson (1941, p. 276) has described this species in sufficient detail but assigned it to *Polinices.* The lack of any pronounced ornament makes difficult any attempt at subdivision. In general, with the exception of the growth lines, the surface is smooth, but several specimens in the collections studied show a faint spiral ornament (pl. 17, fig. 14). If present the ornament is strongest on the earlier whorls. Variations in the height of spire and inflation of the body is judged due, at least in part, to sexual differences. As is typical of related modern species, the shell of the female is lower-spired and has more inflated shoulders. (Compare figs. 5 and 7, pl. 17.) Smaller specimens (see pl. 17, fig. 12) show a ridge along the inner lip which evidently filled a corresponding depression in the opercular rim. In general, specimens from the Owl Creek formation are smaller than many of the Ripley specimens. Aside from these minor differences there appears to be no sound basis for the distinction of more than one species throughout the *Exogyra ponderosa* and *E. costata* zones.

Cossmann (1925, p. 135) states; "Dans le" group Ripley," une espece à spire élevé et a sutures canaliculées, mais a ombilic de *Lunatia*: je ne crois pas que ce soit *Gernina Halli* Gabb (*Euspira*) et je la dénomme *Lun. Wadei* nob., ma coll."

Cossmann gives neither further description nor illustration of this form. Although discussing and assigning other naticid species from the Upper Cretaceous of North America, no mention is made of *E. rectilabrum*, and I believe that he was not aware of this species and that the name which he proposed is nude and invalid and further is a probable synonym of Conrad's species.

Polinices rectilabrum texanus Stephenson, from the Navarro group of Texas, is only a minor variation and probably not even a valid subspecies. The holotype of *Lunatia carolinensis* Conrad (1875, app. A, p. 13) has been lost but may be conspecific with *E. rectilabrum.* The specimen figured by Stephenson (1923, pl. 88, figs. 17, 18) from the Snow Hill marl member of the Black Creek formation of North Carolina does not appear to differ significantly from *E. rectilabrum* (Conrad), but the specimen (USNM 31844) from the same locality figured Stephenson (1923, pl. 88, fig. 19) may be a distinct species. This specimen, although incomplete, has growth lines that are more reflected and a less impressed suture; this gives the whorls of the spire and body a more evenly rounded profile. *L. halli* Gabb, from the Matawan and Monmouth groups of New Jersey, is based on specifically indeterminable internal molds. These molds may belong to *Euspira*, and some may even belong to Conrad's species, but one cannot offer sufficient proof because of the state of preservation. The specimen figured by Gardner (1916, pl. 13, figs. 1, 2.) from the Monmouth formation of Maryland and assigned to *Polinices* (*Euspira*) *halli* (Gabb) is close if not conspecific with *E. rectilabrum.* Cossmann (1925, p. 33), on the basis of the elevation of the spire, assigned Gardner's specimen to *Cernina.* Actually the spire is much too high for that genus. Absolute assignment of the species from Maryland is difficult owing to the loss of the characters of the inner lip and umbilicus. *Lunatia concinna* (Meek and Hayden), from the Fox Hills sandstone of the western interior, is close in shape and general features but has a lower spire, less callus on the parietal area, and a more open umbilicus.

The shape and features of *Euspira rectilabrum* are so generalized that it is difficult to find any characters with which to distinguish it from similar forms in the faunas of other regions of outcrop of Upper Cretaceous rocks. *Natica* (*Lunatia*) *multistrata* Baily, from Pondoland, South Africa, is a close analog. *Mammilla carnatica* Stoliczka, from the Arialoor group of India, has a similar arrangement of the inner lip but probably belongs to *Polinices. Lunatia klipsteini* Müller, from the Aachen Cretaceous, differs by being more squat in outline. Comparisons with suggestive forms from other areas is limited by the quality of illustrations. Throughout its range, *E. rectilabrum* is one of the most abundant and well preserved of the gastropods. Many shells of this species are found with the shells of other animals attached to them (bryozoans, worms, oysters), but none have been observed with the countersunk borings so common to the other associated shells. This may be an indication that *E. rectilabrum* was the primary borer in the population.

Types: Holotype not present in ANSP; hypotypes USNM 73074 (Tennessee), USNM 128560–128563 (Mississippi), USNM 31957 (North Carolina).

Occurrences: Mississippi: Owl Creek formation, locs. 41, 43, 44, 45, 46, 47; Ripley formation, locs. 2, 3, 4, 5, 6, 7, 9a, 10, 11, 12, 14, 15, 16, 17, 18, 19, 22, 23, 24, 27, 29, 32, 33, 36, 39; Coffee sand. Tennessee: Clayton formation (reworked Cretaceous material at base), loc. 40; Ripley formation, loc. 1. Texas: San Miguel formation, Neylandville marl, Nacatoch sand, Corsicana marl, and Kemp clay. Alabama: Blufftown formation, Cusseta sand, Ripley formation, Providence sand. Georgia: same range as Alabama.

Euspira cf. E. rectilabrum (Conrad)

Plate 17, figures 10, 11

Discussion.—A number of internal molds from the Prairie Bluff chalk of Mississippi probably belong to Conrad's species *E. rectilabrum*, but owing to their preservation definite specific placement is impossible. Perhaps the name *Euspira halli* (Gabb) should be applied, as that species is also based upon internal molds; but until a direct comparison of the Mississippi material with the holotype from New Jersey can be made, an extension of Gabb's name to include anything other than the type material appears futile.

Internal molds approaching *E. rectilabrum* both in size and in character, although not numerous, occur at a moderate number of localities in both Alabama and Mississippi.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 54, 55, 67, 71, 72, 75, 80, 82, 83, 84, 85, 94. Alabama: Prairie Bluff chalk.

Family AMPULLINIDAE

Under the ruling of the Copenhagen Congress in 1953, the name *Ampullinidae* will have to stand in spite of the general conviction that *Ampullina* is invalid.

Genus GLOBULARIA Swainson, 1840

Type by subsequent designation (Hermannsen, 1847), *Ampullaria sigaretina* Lamarck, 1804.

Diagnosis.—Low-spired globose shell; aperture expanded laterally, outer lip thin; umbilicus narrow to moderately wide and open to constricted; sheath generally with a well-defined rim.

Discussion.—*Globularia* s. s. is probably best developed in the Eocene epoch, but if *Cernina* Grey is considered a synonym, as Cox (1931, p. 38) proposes, the genus ranges into the Recent seas. Wrigley (1946, p. 89) considers *Globularia* gradational to those forms included in *Ampullella* Cox, but the latter seems to have utility as a subgenus including the less expanded and higher spired species. The confusion surrounding the name *Ampullina* is discussed later.

Subgenus AMPULLELLA Cox, 1931

Type by original designation, *Ampullaria depressa* Lamarck, 1804.

Diagnosis.—Cox (1931, p. 38) diagnosed *Ampullella* as follows:

Perforate or virtually imperforate; spire moderately high; siphonal fasciole conspicuous; aperture not expanded laterally; inner lip widely reflected, but frequently only distinctly margined in the middle, owing to the callosity of the parietal and umbilical region.

Discussion.—Cox (1931, p. 38) showed that the old and much used name *Ampullina* Bowdich, 1882, was a nomen nudum and that Dall (1909, p. 90) was unwarranted in assuming the figure given to be that of *Natica depressa* Lamarck. As it stood before reevaluation, the name *Ampullina* had been much abused; and many of the species assigned will not be assignable to *Ampullella*, as diagnosed by Cox, nor to *Globularia* Swainson. Cossmann (1925, p. 18) considered *Globularia* Swainson a synonym of *Ampullina*, but both Stewart (1927, p. 330) and Woodring (1928, p. 391) considered it distinct, because of its lower spire and laterally expanded aperture. Wenz (1941, p. 1020) has not accepted Cox's proposed genus and retains *Ampullina* in the old sense. Wrigley (1946, p. 89) considered *Ampullella* superfluous, but it is here considered a subgenus differing from *Globularia* s. s. by its higher spire and more notably by its lack of lateral expansion.

Species of *Ampullina* have been reported from beds as old as the Lias in France, and Cossmann (1925, p. 20–27) listed numerous Jurassic, Cretaceous, and Tertiary occurrences. No attempt has been made to substantiate all the assignments, but in a cursory examination of literature on the Jurassic, no species bearing a distinct sheath ("siphonal fasciole" of Cox) were noted, and I much doubt that any of the listed Jurassic species belong to *Ampullella*. Similarly, most of the Cretaceous assignments are doubtful, but actual inspection of specimens is needed to verify or discard the assignments of many of the species. *Polinices umbilica* Wade, from the Ripley formation of Tennessee, appears to be the only North American Cretaceous species assignable to *Ampullella*. "*Ampullina*" *potens* Wade, the type of which is figured herein (pl. 17, figs. 24, 25), is a species which would be assigned to the old group *Ampullina* Bowdich. No name now appears to be available for this group.

Globularia (Ampullella) umbilica (Wade)

Plate 18, figures 39, 40

1926. *Polinices umbilica* Wade, U.S. Geol. Survey Prof. Paper 137, p. 163, pl. 56, figs. 6, 10.

Diagnosis.—Shell moderately small; spire of medium height; whorls shouldered and sculptured by faint spirals; growth lines arcuate and opisthocline in trend; siphonal fasciole rugose.

Description.—Shell moderately small; spire about one-third total shell height; suture impressed. Body with a somewhat flattened narrow shoulder and well-rounded sides; surface glazed. Sculpture of closely spaced faint spiral lirae, finest lirae visible only at high magnification and in favorable light. Growth lines arcuate and prosocline in trend. Aperture subovate; outer lip well rounded in profile and moderately prosocline inclined backward from suture; inner lip reflected anteriorly; margin straight over umbilical area and obscured by callus on parietal area. Umbilicus open; siphonal fasciole prominent and rugose.

Measurements.—The holotype is the only specimen available and the height of shell measures 10.4 millimeters; the maximum diameter, 9.3 millimeters; height of aperture, 8.9 milimeters.

Discussion.—*Globularia* (*Ampullella*) *umbilica* (Wade), is known from only one specimen, the holotype, from the Ripley formation at Coon Creek, Tenn. Wade's illustrations (1926, pl. 56, figs. 6, 10) are considerably retouched and fail to render the umbilical features faithfully. The "siphonal fasciole" bordering the anterior part of the columellar lip is incomplete, and the base of the shell is corroded over part of the umbilical margin. Therefore, the full extent of the "fasciole" cannot be determined, but its presence is definite and allies the species to *Ampullella.* The same holds true for the shoulder, which, except for the latter part of the body, is accentuated in acuteness, owing to sutural corrosion, a feature common among fossil ampullinids and naticids. The notch of the inner lip, although not common for the genus, finds an analogy in a similar structure seen on *Natica parisiensis* d'Orbigny, from the Eocene of the Paris Basin.

No other species of this genus are known from the Upper Cretaceous series of the Atlantic or Gulf Costal Plains. *Ampullina recurva* Aldrich, from the Eocene of Alabama, closely approximates this species in proportion and umbilical character but is larger and possesses a stronger shoulder and thicker inner lip.

Types: Holotype USNM 73071.
Occurrence: Tennessee: Ripley formation, loc. 1.

Genus AMAURELLINA Fischer, 1885

Type by monotypy, *Natica spirata* Lamarck, 1804.

Diagnosis.—Shell of medium size; body about two-thirds total height; whorls shouldered; aperture subovate; inner lip anteriorly expanded and reflexed, with umbilical sheath reduced to a rim extending up into the umbilicus.

Discussion.—Cossmann (1925, p. 44), and Wrigley (1946, p. 99) in following Cossmann, used the name *Amauropsella* "Bayle" in Chelot for this group, but Stewart (1926, p. 335) believed *Amaurellina* to have priority, stating: "According to Cossmann (An. Soc. Roy Malac. Belg., vol. 23, 1888, p. 176) Chelot's article appeared first but since it contains a footnote referring to *Amaurellina* as having been already published by Fischer, *Amaurellina* must have priority."

The genus has been reported from the Lower Upper Cretaceous to Oligocene, but many of the species probably belong to other genera.

Natica concinna Meek and Hayden, from the Maestrichtian of the western interior, which Cossmann (1925, p. 45) assigned to this genus, certainly does not belong here nor does *Amauropsis pannucea* Stoliczka, from the Arrialoor group of India, as cited by the same author. The only Cretaceous species which can reasonably be cited as belonging to *Amaurellina* are *Polinices stephensoni* Wade, *Natica cretacea* Goldfuss of Holzapfel (in part), and *Amauropsis holzapfeli* Cossmann, from the Aachen Cretaceous.

Ampullella Cox (=*Ampullina* Bowdich), in its strict usage, differs from *Amaurellina* by possessing a proportionally shorter spire, generally less angulated shoulders, and a broad sheath surrounding the umbilical area rather than the thin ridge extending into the umbilicus, such as is found in *Amaurellina.*

Amaurellina stephensoni (Wade)

Plate 17, figures 15–19, 22

1926. *Polinices stephensoni* Wade, U.S. Geol. Survey Prof. Paper 137, p. 163, pl. 56, figs. 13, 14.
1941. *Polinices stephensoni* Wade. Stephenson, Texas Univ. Bull. 4101, p. 278, pl. 50, figs. 9–11.

Diagnosis.—Medium-sized shell with excavated shoulder, subovate umbilicus that is posteriorly notched and a reflexed inner lip having a ridge extending from the anterior appressed part into the narrow umbilicus.

Description.—Shell of medium size, body two-thirds to three-fourths the total length. Protoconch unknown. Whorls 4–5 in number, suture impressed and bordered by an excavated shoulder of moderate width; whorl sides well-rounded. Surface smooth, glazed and unornamented except for prosocline growth lines that are strongest near suture and on the excavated shoulder, where a very slight, shallow sinus is developed. Aperture subovate, notched posteriorly and broadening anteriorly; outer lip inclined back from suture; inner lip broadened anteriorly, folded and appressed over columellar surface, with sheath reduced to a thin rim extending up into the narrow umbilicus.

Measurements.—Explanation of measurements and symbols used in the following table appear in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*	*HB*	*H:W*
1 (holotype)	27.0	22.0	19.0	1.22
1 Texas (hypotype)	17.0	14.8	12.9	1.08
1 (topotype)	23.7	21.0	18.0	1.12
1 (topotype)	25.0	20.5	17.2	1.16
1 (topotype)	22.5	19.8	17.1	1.13
1 (topotype)	20.5	17.0	14.3	1.20
29 (hypotype)	22.5	17.5	15.2	1.22

Discussion.—The above measurements indicate a relative constancy of the body proportions; variation is more or less restricted to the strength and development of the excavated shoulder. Among specimens from the type locality at Coon Creek, McNairy Co., Tenn., both width and depth of the excavation vary. The specimens from Texas figured by Stephenson (1941, pl. 50, figs. 9–11) are slightly slimmer than typical but compare well with the type material. Only one specimen is known from the Ripley formation of Union County, Miss. (loc. 29). This specimen has a narrower, more deeply excavated shoulder and a stronger bordering ridge than is typical of the type specimens, although the body proportions are normal. In addition, the spire appears proportionally higher. This specimen comes from the upper part of the Ripley formation, considerably above the zone represented at the type locality. However, with only this lone specimen it is impossible to tell whether the differences noted are constant or grade with the more normal specimens, and no new name is proposed for this specimen.

A. stephensoni shows a number of features typical of the genus *Amaurellina.* Like specimens of the type species, *A. spirata* (Lamarck), from the Eocene of the Paris Basin, this form has well-rounded early whorls, with the shoulder developing only in the later stages, and it is accompanied by an increase in the pleural angle. The umbilical characters also agree well with those of the type species, but the latter is faintly spirially striate, has a flat and sloping shoulder, and a much less inclined outer lip. The features displayed by *A. stephensoni* are in some ways different from those typical of the genus and offer the possibility of subgeneric separation. However, this taxon would be monotypic; and until more forms are found which could be assigned, little advantage in the proposal of such a group is seen.

In size and in character of the channeled shoulder, this species suggests certain species of *Pseudamaura*, but these forms have obscure umbilical areas that are commonly totally covered. None of the few other Cretaceous species appear to be very closely related to *A. stephensoni*, but all have the common bond of a typical *Amaurella*-like umbilicus.

Types: Holotype USNM 73075 (Tennessee); hypotype USNM 76844 (Texas), 128565 (Tennessee), 128566 (Mississippi).

Occurrences: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1. Mississippi: Ripley formation, locs. 16, 29. Texas: Navarro group. Georgia: Ripley formation.

Genus PSEUDAMAURA Fischer, 1885

Type by monotypy, *Natica bulbiformis* Sowerby, 1832.

Diagnosis.—Medium to large rather high-spired shells with channeled sutures; commonly with spiral ornament; umbilicus either lacking or only a small slit.

Discussion.—*Pseudamaura* Fischer has, in the past, been much misused and frequently ignored. Stewart (1926, p. 333) pointed out that Cossmann (1925, p. 49) "seems to have considered *Pseudamaura* synonymous with *Ampullospira* but for some reason used the latter name although *Pseudamaura* had ten years priority." Stewart took this view because Cossmann listed the type species *N. bulbiformis* and related species as belonging to *Ampullospira.* Cossmann (1925, p. 18) did not consider *Ampullospira* and *Pseudamaura* synonyms but actually listed the name *Pseudamaura* as a synonym of *Ampullina.* This confusion arose as a result of his unsupported view that *N. marcousana* d'Orbigny, which is not a *Pseudamaura*, was the type species. Cossmann, (1925, p. 23) in listing the species of *Ampullina* noted: "Le genotype de *Pseudamaura*, dans la plupart des gisements portlandiens: *N. Marcousana* d' Orb." *N. bulbiformis* Sowerby is unquestionably the type species by monotypy, and Cossmann gave no reasons for his opposite views, except a statement that Sowerby's species has been erroneously assigned to *Pseudamaura.*

The list of species assigned to *Ampullospira* by Cossmann include forms ranging in age from Triassic through Miocene. Many species, such as *Natica occidentalis* Meek and Hayden (preoccupied by *N.? occidentalis* Hall and renamed *Lunatia dakotensis* by Henderson), from the Upper Cretaceous of the western interior, have utterly no relationship to the genus because they lack a channeled suture and have an open umbilicus.

Amauropsis lirata Wade, from the Ripley formation of Tennessee, is here placed in *Pseudamaura* on the basis of the presence of its channeled suture, high spire, and lirate ornament. The species differs from the type species and such typical forms as *Amauropsis bulbiformis* Sowerby of Stanton (1893, p. 137), from his Pugnellus sandstone of the western interior, by its smaller size, more subdued ornament, and the presence of an umbilical chink. Available material is insufficient to determine if the presence of the chink is a constant feature, but indications are it is not. Cox (1931, p. 38) states a narrow umbilicus is present on *Euspira canaliculata* Morris and Lycett, the type species of *Ampullospira*, which here is considered synonymous with *Pseudamaura*. In any event *A. lirata* does not belong to *Amauropsis*. *Amauropsis* Mörch (Oligocene through Recent) is an Arctic and boreal genus whose type, *Natica helicoides* Johnson (=*Nerita islandicus* Gmelin), lacks a reflexed inner lip. All the Cretaceous species assigned to *Amauropsis* belong elsewhere. *Amauropsis compacta* Gardner, from the Monmouth formation of Maryland, is based on an immature and incomplete specimen and is generically indeterminate.

Pseudamaura lirata (Wade)

Plate 17, figures 20, 21, 23

1926. *Amauropsis lirata* Wade, U.S. Geol. Survey Prof. Paper 137, p. 165, pl. 57, figs. 5, 8.

Diagnosis.—Medium-sized shell with high acuminate spire, channeled sutures, impressed spiral lirae, and subovate aperture with reflexed inner lip.

Description.—Shell of medium size; spire proportionally high and acuminate. Protoconch unknown; suture impressed, lies at base of deep, rather narrow channel. Body below channel elongate and broadly rounded. Sculpture of numerous impressed thin spiral lirae which are much narrower than their interspaces but are more closely spaced on base, and tend to become punctate where crossed by growth lines. Growth lines of variable strength and strongly prosocline over channel rim, becoming orthocline over whorl sides. Aperture subovate, somewhat angulated posteriorly, and well rounded anteriorly; outer lip broadly rounded in profile and straight in side view, but flexed forward near suture; inner lip thin, reflected partly or totally, obscuring minute umbilical chink.

Measurements.—The holotype is the only available specimen suitable for measurement. Height of shell, 30.5 millimeters, maximum diameter, 20.5 millimeters, height of body, 18.7 millimeters.

Discussion.—Only three specimens, all from the type locality of Coon Creek, Tenn., are available for study, and two of them preserve only the features of the body whorl. They are, however, sufficient to indicate that the umbilical chink on the holotype is not present on all specimens but may be covered entirely by the reflected inner lip. There seems to be no other species referable to this genus in the Upper Cretaceous series of the gulf coast, but in the western interior one species, *Ampullospira stantoni* Cossmann (=*Amauropsis bulbiformis* Sowerby of Stanton) from the Pugnellus sandstone of Colorado, is present. This form is much larger and has a broader, more appressed inner lip than the younger gulf coast species. *Amauropsis palidunaeformis* (Meek and Hayden), from the upper part of the Pierre shale of South Dakota, is similar but lacks the channeled suture and probably belongs to *Ampullina* s. l.

Type: Holotype USNM 73078.
Occurrence: Tennessee: Ripley formation, loc. 1.

Subfamily AMPULLELLINAE, indet.

Plate 18, figures 26, 27

Discussion.—A number of generically indeterminate internal molds are present in the survey collections from the Prairie Bluff chalk of Mississippi that appear to belong to the subfamily Ampullellinae. They are placed here on the basis of their relatively high spire and general outline. Generic placement is impossible because the apertural and sutural features are not preserved. In size and proportion, as well as stratigraphic level, they are not far from the specimens from the Corsicana marl assigned by Stephenson (1941, p. 278) to *Amauropsis?*.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 67, 87, 90.

Superfamily TONNACEA
Family CYMATIIDAE

Genus CHARONIA Gistel, 1848

Type by original designation, *Murex tritonis* Linné, 1757.

Discussion.—One species from the Ripley formation, described under the name *Tritonium univaricosum* by Wade (1926, p. 147), appears to belong close to the genus *Charonia*. The status of the name *Tritonium* was fully discussed by Cossmann (1904, p. 126), who found it to be preoccupied and substituted *Eutritonium* Cossmann, but he evidently did not realize the availability of *Charonia*.

The Cretaceous species bears either 1 or 2 varices per whorl. In general features, especially the anterior canal, it is closer to forms included in the subgenus *Sassia* than to *Charonia* s. s.

Charonia? univaricosum (Wade)

Plate 18, figure 44

1926. *Tritonium univaricosum* Wade, U.S. Geol. Survey Prof. Paper 137, p. 147, pl. 51, figs. 9, 10.

Diagnosis.—Medium-sized fusiform shells with turriculate spire; ornament of strong varicose to spinose axial ribs that diminish in vigor both near suture and low on body; spirals numerous and strongest on periphery; aperture subovate; outer lip dentate and interrupted at position of low peripheral shoulder.

Measurements.—Explanation of the measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*H*	*MD*
1 (holotype)	46.6+	27.4
1 (topotype)	41.0	17.0
1 (topotype)	40+	20.5
1 (topotype)	[1] 50.0	23.5

[1] Estimated.

Discussion.—This species is known only from its type locality of Coon Creek, McNairy County, Tenn. No perfect specimens are known, and all five available specimens lack the earliest whorls. When adult, all specimens measure disproportionately larger in width, owing to the development on the outer lip of a spinose projection at the intersection of the peripheral shoulder.

The true generic affinities of this species are in doubt. There are no other Cretaceous species which even appear to be closely related.

Types: Holotype USNM 32916; hypotype, USNM 128568.
Occurrence: Tennessee: Ripley formation, loc. 1.

Genus PLESIOTRITON Fischer, 1884

Type by monotypy, *Cancellaria volvutella* Lamarck, 1803.

Diagnosis.—Small- to medium-sized shells with spire more than one-half total shell height. Ornament consists of both axial and spiral elements and two or less varices per whorl. Aperture lanceolate; anterior canal short and twisted; outer lip denticulate within; parietal lip has several teeth, and columellar lip reflected and bears three folds.

Discussion.—This genus has been heretofore known from only a few species, which occur in the lower Tertiary. The type species, *Plesiotriton volvutella* (Lamarck), occurs in the Eocene (Lutetian) of the Paris Basin. *P. cretaceus* from the Ripley formation of Mississippi is the first occurrence of the genus in the Cretaceous system. There appear to be no Tertiary representatives on the gulf coast, but the close resemblance of the Cretaceous species to the type species indicates sufficient relationship to apply the name *Plesiotriton* to the Ripley species.

Plesiotriton cretaceus Sohl, n. sp.

Plate 18, figures 35, 41, 42

Diagnosis.—Shell small; spire high and turriculate; whorls ornamented by sinuous round-topped transverse costae that develop to varices about every two-thirds of a volution; fine spiral lirae with finer spiral threads in their interspaces cover the whorl surfaces and form nodes where they cross the costae. Outer lip of aperture dentate; inner lip has three folds.

Description.—Shell small; spire high, turriculate, three-fifths total shell height. Protoconch proportionally large, consists of 2½–3 smooth round-sided whorls; junction with conch abrupt. Suture impressed. Whorls number 3–4 and are round sided; body whorl slopes steeply below periphery and becomes constricted to short anterior canal. Whorls marked by strong varices every two-thirds of a volution; transverse costae moderately strong, noded, colabral; spiral lirae fine and widely spaced with finer closely spaced spiral threads covering interspaces. Growth lines gently prosocline with shallow sinus on upper third of whorl. Aperture lanceolate, slightly angulated posteriorly, and produced anteriorly to a short, narrow, somewhat twisted anterior canal; outer lip reinforced by a varix with 11 denticles immediately behind edge; inner lip excavated; parietal lip has 2 teeth; columellar lip reflected and free along edge and bears 3 plaits.

Measurements.—The holotype measures 13.5 millimeters in height and 6 millimeters in width.

Discussion.—This species is represented in the collection by only the holotype. The specimen was originally complete, but during photographing the spire was damaged. This is the first report of the genus in the Cretaceous system. *P. cretaceus* is very similar to the type species, *P. volvutella* (Lamarck), from the Eocene of the Paris Basin, but it possesses two teeth on the parietal lip and has stronger axial ornament and growth lines that are more sinuous.

Type: Holotype USNM 128569.
Occurrence: Mississippi: Ripley formation, loc. 6.

Genus TINTORIUM Sohl, n. gen.

Type species, *Tintorium pagodiforme* Sohl.

Etymology.—Anagram from *Tritonium*, a gastropod genus. Gender, neuter.

Diagnosis.—Small- to medium-sized shells with a turriculate spire of more than half total shell height. Body whorl bicarinate, with nodes forming at intersection of carinae and the stronger transverse elements. Aperture broadly angulated posteriorly and anteriorly produced to a short twisted canal; outer lip angulated at junction with body carinae and may be dentate within; inner lip lightly callused; columella bears 1–3 teeth above anterior canal.

Discussion.—This genus is proposed for three species, all from the Upper Cretaceous series. *T. pagodiforme*, the type species, is from the Coon Creek tongue of the Ripley formation of Tennessee; *Lagena nodulosa* Stoliczka and *Lagena secans* Stoliczka are from the Arialoor Group of India. All the species have the typical bicarinate body, but Stoliczka (1868, p. 138) mentioned no teeth as present on the columella of *L. secans*. However, the holotype lacks the anterior part of the shell, and the absence of teeth is thus not assured.

Lagena Klein (not Schumacher) differs from *Tintorium* by its lack of a carinate whorl and by having rounded whorls. In several features *Tintorium* resembles *Serrifusus* Meek. Both genera are bicarinate, but the latter has no teeth on the columella and has a much more elongate anterior canal.

Tintorium pagodiforme Sohl, n. sp.

Plate 18, figures 1, 2

Diagnosis.—Small high-spired shells with bicarinate whorls; ornament of spiral lirae covers shell surface; axial costae strongest between carinae and form coarse spines where they cross the carinae.

Description.—Shell small; spire high, more than one-half total shell length; pleural angle about 35°. Protoconch not preserved. Whorls 4–5 in number; suture impressed. Body whorl bicarinate, but only one carina visible on whorls of spire; body abruptly constricted below lower carina. Ornamentation consists of both axial and spiral elements; axial elements are weak, low; colabral swellings are strongest between carinae and are accentuated to coarse spines where they override carinae. Spirals are thin lirae with wider interspaces and are most closely spaced between the carinae. Growth lines faint and sinuous, being prosocline between suture and upper carina, holocline between carinae, and slightly opisthocline over base. Aperture acute posteriorly and produced anteriorly to short and twisted canal; outer lip incomplete but angulated at junction of carinations and bearing seven denticles interiorly; inner lip with a thin callus over the parietal lip; columellar lip bears three indistinct low nodes immediately above anterior canal. Columella short and stout.

Measurements.—The holotype measures 9.6 millimeters in height and 5.8 millimeters in width.

Discussion.—The species is known only from the holotype, from the Ripley formation on Coon Creek, McNairy County, Tenn. *Lagena secans* Stoliczka (not Walker and Boys) from the Arialoor group of India, approaches this species in shape but differs decidedly in ornament.

Type: Holotype USNM 128570.
Occurrence: Tennessee: Ripley formation, loc. 1.

Order MESOGASTROPODA?
Family MATHILDIDAE

Thiele (1929), Wenz (1939), and others have placed this family within the superfamily Cerithiacea. Thiele (1929, p. 183) diagnosed the family and stated that the soft parts and the type of radula were similar to those considered diagnostic of the cerithiids and their relatives. He does not state where the information was obtained, and no information on the soft parts has appeared since. The shell of the members of this family possesses initial whorls that are not typical of the Cerithiacea and give rise to the speculation that they may better be placed with the opisthobranchs. The initial whorls are generally deviated, ranging from complete heterostrophy in some of the species of *Mathilda* to slightly deviated or even submerged and deviated, as in *Gegania*. Until more detail is known of the soft parts of the living representatives, their classification must be treated as tentative, and they are assigned here to the Mesogastropoda, but with reservation.

Genus MATHILDA Semper, 1865

Type by subsequent designation, *Turbo quadricarinatus* Brocchi, 1814.

Diagnosis.—Medium-sized turriculate to turreted shells with heterostrophic protoconchs; whorl sides usually rounded and basally subcarinate; base broadly arched and may or may not possess umbilical chink; ornament of strong spiral cords and fine axial threads.

Discussion.—Haas (1953, p. 185) has discussed the spelling of *Mathilda*, concluding that Cossmann (1912, p. 2) was in error in using *Mathildia* and Mathildiidae.

Mathilda resembles *Gegania* Jeffreys in gross aspect and was included by Dall (1892, p. 318) in *Tuba* Lea, a synonym of *Gegania*. However, shells belonging to *Mathilda* are slimmer in outline, with flatter bases, less rounded whorls, and a nonimmersed protoconch. The species here placed in *Mathilda* s. s. possess an ornament and profile much like *M.* (*Fimbriatella*) Sacco, a Paleocene to Pliocene subgenus, but are closer to the type species in apertural features.

The genotype is from the Pliocene of Italy, and species have been reported from strata as old as the

Albian. In the Cretaceous system of the gulf coast, two species of *Mathilda* s. s. are known—*M.* (*Mathilda*) *ripleyana* Wade, from the Ripley formation of Tennessee, and *M.* (*M.*) *cedarensis* Stephenson, from Texas and Mississippi. In addition, several species of the subgenus *Echinimathilda* are also present.

Mathilda (Mathilda) ripleyana Wade

Plate 18, figures 13, 18, 20–22

1926. *Mathilda ripleyana* Wade, U.S. Geol. Survey Prof. Paper 137, p. 171, pl. 53, figs. 11, 16, 17.

Diagnosis.—Small- to medium-sized ornate turriculate shells with a basal angulation and a peripheral carination marked by bifid spiral ribbon.

Description.—Medium-sized, moderately thick, turriculate shells with pleural angle of 20°–30°. Protoconch heterostrophic, consisting of 2 smooth raised whorls lying at almost 90° to teloconch axis. Suture impressed. Whorls 10 in number, with peripheral angulation above which whorl sides are straight. Body whorl basally angulated, separating the relatively flat base as a basal disk. Sculpture dominated by flat-topped spiral ribbons of unequal spacing, with peripheral bifid ribbon strongest and forming carination; slightly below peripheral carination on body is a less prominent spiral which marks a basal angulation; spiral lirae thinner and more closely spaced on base. Thin axial threads traverse the whorl with only a slightly sinuous trend and accentuated and raised to sharp granules where they cross spiral ribbons. Aperture incomplete on all known specimens, but as preserved it is slightly angulated at intersections of outer lip and primary spiral ribbons; anterior canal shallow and short; inner lip concave and lightly washed by callus.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*HPW*
1 (holotype)	6	6.5+	3.1	1.1
1 (topotype)	8+	11.3+	4.6	2.15

Discussion.—This species occurs in moderate abundance at its type locality, Coon Creek, McNairy County, Tenn.; but owing to the fragile nature of the shell, specimens are generally found incomplete. The holotype is a younger specimen than the hypotype on plate 18, figure 20, but the two specimens agree well. *M.* (*Mathilda*) *ripleyana* bears a considerable resemblance to a number of Tertiary species but is very distinct from *M. cedarensis* Stephenson, from the Navarro group of Texas, and one wonders if the later species even belongs in *Mathilda* s. s. The protoconch of *M. cedarensis* is unknown, and until specimens are found with the protoconch in position, the issue cannot be resolved.

Types: Holotype USNM 32931; hypotype 128571.

Occurrence: Tennessee: Ripley formation (*E. cancellata* zone), loc. 1.

Mathilda? cedarensis Stephenson

Plate 18, figures 14–16

1941. *Mathilda cedarensis* Stephenson, Texas Univ. Bull. 4101, p. 270, pl. 48, fig. 10.

Diagnosis.—Small, slender, turriculate shells with noncarinate periphery bearing a bifid spiral cord.

Description.—Small thick turriculate shells with pleural angle of about 19°; protoconch not completely preserved, but its scar suggests a deviation from teloconch axis. Suture impressed. Teloconch consists of 9–10 straight-sided whorls, lending spire a rather smooth outline. Body whorl has sharply angulated periphery and flat sloping base. Ornament of two strong spiral ribbons occurs at peripheral angulation; a weak, spiral, threadlike lira, followed nearer suture by a spiral ribbon, occurs above periphery; below periphery two weaker ribbons occur with the lowest one forming an angulation and bounding the base. Spirals are overridden by sharp closely spaced axial riblets that have a sinuous trend on whorl sides but become weaker and closer spaced on base. Aperture unknown, probably subquadrangular in outline.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*HPW*
Texas (holotype)	5+	5+	2.3	----------
Mississippi (hypotype)	6	6.3	2.5	----------
6	4+	(?)	2.25	0.8
16	6.5	3.75+	1.8	.65
16	3+	(?)	2.5	.85
16	7+	4.4	2.0	.75
17	7+	5.75	2.5	.95
17	6.5+	5.75	2.6	1.0
18	8+	6.5	2.5	.85
18	5+	4.8+	2.4	.85

Discussion.—The holotype of *M.? cedarensis* Stephenson, from the Neylandville marl of Texas, is poorly preserved, and the finer details of ornament cannot be seen. Well-preserved specimens from the Ripley formation of Mississippi compare well with the type material in size, shape, and arrangement of the major spiral ribbons and appear to be conspecific.

M.? cedarensis differs from *M.* (*Mathilda*) *ripleyana* by being slimmer, smaller, lacking a peripheral carination, having fewer spiral elements, and possessing a smaller less deviated (?) protoconch. These differences are such as to suggest that the two species are not very closely related and that perhaps *M.*? *cedarensis* belongs with the promathildiids rather than in *Mathilda*. However, until a complete specimen preserving a full protoconch and a complete aperture is found, this species is retained in *Mathilda*.

M.? *cedarensis* is found at a number of localities in the lower part of the Ripley formation and ranges into the lower part of the upper part of the Ripley formation in northern Mississippi. In Texas it is known only from the holotype, from the Neylandville marl in the zone of *E. cancellata*, a range lower than that in Mississippi.

Types: Holotype USNM 76818; hypotype USNM 128573.
Occurrences: Mississippi: Ripley formation, locs. 4 (?), 6, 15, 16, 17, 18, 29.

Subgenus ECHINIMATHILDA Sohl, n. subgen.

Type species, *Mathilda* (*Echinimathilda*) *corona* Sohl, n. sp.

Etymology.—Echinatus (Latin)—spiny, prickly; *Mathilda* a genus of gastropods. Gender, feminine.

Diagnosis.—Small- to medium-sized turriculate shells with a partly submerged and deviated protoconch; whorls shouldered: sides rounded; sculpture of nodose to spiny spiral lirae and ribbons; columellar lip reflected.

Description.—Shell of small to medium size; turriculate; apex generally blunted; first whorl of protoconch submerged and at an angle to teloconch axis; suture impressed. Whorls round sided, shouldered; base flattened. Ornament of strong spiral cords, one of which forms a peripheral subangulation on early whorls and a bifid cord at the basal periphery. Transverse costae override spiral elements and form nodes on whorl sides. Aperture semicircular; columellar lip reflected.

Discussion.—This subgenus is proposed for two distinct species occurring in the Ripley and Owl Creek formations of Mississippi. These species form a group differing distinctly from other subgenera of *Mathilda* but appear to belong in that genus. *Mathilda* s. s. differs by the possession of a raised heterostrophic protoconch. *Acrocoelum* Cossmann and *Gegania* Jeffreys have submerged protoconchs that are not deviated, as in *Echinimathilda*. This subgenus is included in Mathilda primarily on the basis of its protoconch, but also because the peripheral subangulation of the early whorls yields the immature individual a whorl outline very similar to that of *Mathilda* s. s. and the subgenus *M.* (*Fimbriatella*). The later stages of the shell are closer to the Recent species *M.* (*Mathildona*) *euglypta* (Iredale).

Mathilda (Echinimathilda) corona Sohl, n. sp.

Plate 18, figures 10–12

Diagnosis.—Medium-sized slim turriculate shells with broadly rounded, narrowly shouldered whorls; shoulder angulation formed by a spiral cord serrated at its posterior edge where crossed by transverse riblets.

Description.—Shell of medium size, turriculate and slender in outline. Protoconch small, incomplete on holotype, with a scar indicating possible deviation. Apically convex hemispherical septum present in first teloconch whorl of holotype. Suture impressed; whorls number 8–9 with body whorl about one-third total height. Early whorls faintly subangulated peripherally; body rounded on sides, posteriorly narrowly shouldered; base flattened. Sculpture ornate; early whorls of spire have four raised strong round-topped spiral cords, of which the third is strongest and forms a peripheral subangulation. Secondary spiral lirae are interpolated on later whorls and increase in strength until they almost equal the primaries. Penultimate whorl has 10 spiral cords; lower 3 cords weaker than upper 7. Body whorl bears, in addition, two strong cords that form a basal angulation separating the spirally striated flattened base from the rounded whorl sides. Transverse elements of sharp-crested riblets have fine sinuous prosocline growth lines in their interspaces; transverse riblets accentuated to nodes where they cross spiral cords of whorl sides but on cord of shoulder form apically projecting sharp spines lending the shoulder angulation a coronate rim. Aperture subcircular; outer lip broadly arched, notched at intersection of shoulder and basal angulations and bearing on interior of lip grooves that reflect position of exterior spiral cords; inner lip tends to flare anteriorly and is reflexed, covering umbilical fissure.

Measurements.—The holotype measures 10 millimeters in height and 3.7 millimeters in diameter and has a pleural angle of 20°.

Discussion.—*Mathilda* (*E.*) *corona* is known only from the holotype, a well-preserved specimen from the Owl Creek formation at Owl Creek, Tippah County, Miss.

M. (*Echinimathilda*) *unionensis*, from the Ripley formation, is closely related to *M.* (*E.*) *corona* but is smaller, more obese, and lacks the distinct shelflike shoulder of the Owl Creek species, as well as differing in details of ornament.

Type: Holotype USNM 128574.
Occurrence: Mississippi: Owl Creek formation, loc. 46.

Mathilda (Echinimathilda) unionensis Sohl, n. sp.

Plate 18, figures 3–9

Diagnosis.—Small apically blunted turriculate shells with round-sided whorls and a moderately steeply sloping ramp below the suture.

Description.—Shells small, turriculate, somewhat blunted apically; pleural angle varying from 17° at maturity to 45° on earlier whorls. Protoconch consists of about 1¾ smooth-surfaced whorls having a circular whorl cross section; first protoconch whorl submerged in part and resting at a high angle to teloconch axis, but it expands rapidly and becomes normally coiled in late stages; junction with conch gradual, with addition of ornament, and accompanied by a profile change from roundsided to peripheraly subangulate. Whorls of teloconch 4–5; body whorl almost one-half the total shell height, possessing well-rounded sides and highly inclined ramp between suture and first primary spiral cord; base broadly rounded to flattened. Early whorls peripherally angulated by a strong spiral cord, but angulation disappears on body. First teloconch whorl bears three prominent spiral cords, with a fourth appearing on second whorl; on later whorls, secondary spiral lirae appear between major cords but always remain weaker; in addition, on the body a bifid cord forms a basal angulation, and the base has numerous closely spaced but lower spiral lirae. On whorl sides transverse costae are accentuated to nodes where they override spiral cords but weaken on posterior ramp and basal cords. Aperature incompletely known, subcircular in outline with columellar lip reflected over umbilical chink.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*H*	*MD*	*HB*
6	3+	4.1+	2.45	1.25
17	3+	3.6+	2.3	1.3
17	4+	4.2+	2.3	1.25

Discussion.—This small species occurs rarely but well preserved at a number of localities in the Ripley formation of Tippah and Union County, Miss. It is consistently small and exhibits moderate variation in shape, especially affecting the convexity of the whorl profile. Ornamentation varies in strength, and the spacing of axials varies from closely spaced and thin to widely spaced and broad costae.

M. (*E.*) *corona*, from the Owl Creek formation is closely related but is slimmer, has a shouldered whorl and more numerous spirals.

Types: Holotype USNM 128577; paratypes USNM 128575, 128576, 128578.

Occurrence: Mississippi: Ripley formation, locs. 6, 16, 17, 23, 24.

Genus PROMATHILDA Andreae, 1887

Type by original designation, *Cerithium biserta* Münster, 1841.

Diagonsis.—Slim, turriculate, multiwhorled shells, with flat to convex whorl sides that are sculptured by coarse spirals and finer colabral transverse riblets.

Discussion.—The genus is common in the Triassic and Jurassic systems, but Cretaceous occurrences are unknown except for two species from the Upper Cretaceous series of the gulf coast. Both species appear to be assignable to the subgenus *Clathrobaculus* Cossmann (1912, p. 71), which ranges into the Tertiary.

Subgenus CLATHROBACULUS Cossmann, 1912

Type by original designation, *Cerithium ziczac* Deslongchamps, 1842.

Diagnosis.—Small- to medium-sized promathildid of exceedingly thin outline and numerous whorls; whorl sides and base flat and sculptured by coarse spiral cords that are generally overridden by thin axial riblets of sinuous trend.

Cossmann (1912, p. 7) in proposing this subgenus included several species from the Jurassic and one from the Eocene. Wenz (1939, p. 661) limited the subgenus to the Jurassic system. In spite of the lack of any known Lower Cretaceous clathrobaculas, *P.* (*Clathrobaculus*) *cretacea* (Wade) is so remarkably similar to the type species, *Cerithium ziczac*, that any separation would be only arbitrary. The species *Clathrobaculus bacillaris* Cossmann, from the Eocene of the Paris Basin, likewise is similar and should be retained in this group. Unfortunately the protoconch of the type species is unknown, and the retention of *Clathrobaculus* in the genus *Promathilda* is thus open to some doubt.

Promathilda (Clathrobaculus) cretacea (Wade)

Plate 18, figure 19

1926. *Promathilda cretacea* Wade, U.S. Geol. Survey Prof. Paper 137, pl. 53, fig. 18.

Diagnosis.—Shell small, thin, turriculate; suture impressed; three spiral cords visible on penultinate whorl, with a fourth obscured by suture but visible on body and forming an angulation above the flattened base; fine colabral axial riblets, visible in interspiral spaces.

Measurements.—The incomplete holotype measures 3.4 millimeters in height and 0.8 millimeters in diameter.

Discussion.—The holotype (USNM 32934) and paratype (same number), from the *Exogyra cancellata* zone of Coon Creek McNairy County, Tenn., are the only specimens known. Unfortunately, both specimens are incomplete, lacking both apex and aperture.

The basal angulation formed by the fourth spiral almost segregates the base as a disk and lacks the fine axial riblets of the whorl sides. This feature, as well as the size, is typical of *Clathrobaculus* Cossmann. This species differs from P. (*Clathrobaculus*) *parvula* by its possession of five spiral cords.

Types: Holotype and paratype USNM 32934.
Occurrence: Tennessee: Ripley formation, loc. 1.

Promathilda (Clathrobaculus) parvula Sohl, n. sp.

Plate 18, figures 17, 29–31

Diagnosis.—Shell small, thin, and turriculate and bears five spiral ribbons on the broadly convex whorl sides of spire.

Description.—Thin small turriculate shells with numerous whorls. Protoconch unknown; suture impressed. Whorl sides broadly convex and basally angulated; base flat and sloping. Penultimate whorl sculptured by five prominent spiral ribbons of almost equal strength and spacing; on mature body whorl a sixth spiral appears, forming a basal angulation; base with up to 10 spirals that diminish in strength toward center of disk. Fine colabral axial riblets override spiral ribbons of whorl sides and continue onto base with diminished vigor. Aperture incomplete, subovate as preserved; parietal and upper columellar lip thinly washed with callus that spreads out for a short distance over parietal wall.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48); all specimens incomplete.

Loc.	*H*	*MD*	*HB*
15 (holotype)	6.3+	2.7	1.9
6 (paratype)		3.2	2.1

Discussion.—*Promathilda* (*Clathrobaculus*) *parvula* is rare and known only from two localities in the Ripley formation of Mississippi. This species differs quite distinctly from *P. cretacea* Wade by having a greater number of spiral ribbons on the whorl sides, stronger transverse riblets which override the spirals, and strong basal ornament. The analagous basal ribbon on *P.* (*C*) *parvula* is covered by the overlap of succeeding whorls but does occur at the suture, as in *P.* (*C.*) *cretacea.*

Types: Holotype USNM 128579; paratypes USNM 128580, 128581.
Occurrences: Mississippi: Ripley formation, locs. 6 and 16.

Genus ACROCOELUM Cossmann, 1888

Type by original designation, *Mathilda bouryi* Cossmann, 1888.

Diagnosis.—Small thin turriculate shells with initial protoconch whorl sunken; teloconch whorls round sided; spiral sculpture stronger than transverse; umbilical fissure commonly present; aperture subcircular.

Discussion.—*Acrocoelum* is a rare form occurring primarily in the Paleocene and Eocene of the Paris Basin. The Cretaceous form here included in the genus has the typical shape and ornament of *Acrocoelum*, but differs from the type species by having the first protoconch whorl flush with the second whorl rather than distinctly submerged. No topotypes of the *Mathilda bouryi* were available to the author and existing figures are not of the best quality; thus some doubt exists as to the assignment of *A.? cereum* described below to *Acrocoelum.*

Acrocoelum? cereum Sohl, n. sp.

Plate 18, figures 23, 24

Diagnosis.—Very small turriculate shells with round whorl sides marked by five sharp-topped spiral lirae.

Description.—Shell very small, turriculate. Protoconch smooth, coiled about two times, the first half turn lying at a slight angle to shell axis and in some shells may be faintly submerged; in other shells either flush or somewhat raised. Whorls of conch number about five and are round sided, with last whorl about one-half total height. Suture impressed. Sculpture dominated by sharp-topped spirals that are much thinner than their interspaces and number six on the penultinate whorl of larger specimens. Axial threads faint, appear in interspiral spaces. Aperture ovoid in outline; outer lip arched and simple; inner lip callused, somewhat flexed over umbilical region.

Measurements. — The holotype from locality 29, measures 1.7 millimeters in height and 0.85 millimeters in diameter.

Discussion.—Although the shell is very small, the constancy of the features exhibited and the uniformity of size displayed by specimens from various localities leads one to assume that these specimens are mature and not a juvenile stage of some larger species. Their assignment to *Acrocoelum* is questionable as they display features, such as protoconch and inner lip, that differ from the type species; but they do appear to belong in the Mathildidae and lie closest to *Acrocoelum.*

A.? cereum is rather rare and easily overlooked because of its size, although at some localities it occurs with moderate frequency. The species ranges through the lower part of the Ripley (post-*Exogyra cancellata* beds) up into the lower part of the upper part of the Ripley of Mississippi. No other Cretaceous species of this genus are known.

Types: Holotype USNM 128582; paratypes USNM 128583.

Occurrences: Mississippi: Ripley formation, locs. 15, 17, 27, 29.

Genus GEGANIA Jeffreys, 1884

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

Diagnosis.—Medium-sized turriculate shells with globose roundsided whorls marked by numerous strong spiral lirae that are overridden by thinner axial elements; protoconch blunted and initially somewhat sunken; aperture subovate; inner lip callused, reflected back over columellar lip and commonly obscures umbilical fissure.

Discussion. — Gegania is distinguished from *Mathilda* by having a less deviated protoconch, a more obese outline, and a reflected columellar lip. *Acrocoelum* is closer in protoconch characters but again is slimmer in outline and usually lacks the reflected columellar lip and growth-line trend of *Gegania.*

Tuba Lea, 1833, has been applied to the species here included in *Gegania* by both European and American authors, but *Tuba* Lea is preoccupied by *Tuba* Renier, 1804, a polycheate worm, as well as by *Tuba* Fabricus, 1823.

The type species *G. pinguis* Jeffreys is a Recent species, but the earliest representatives of the genus occur in the Senonian. Cretaceous species, although not numerous, are present in widely scattered areas. Several species are rather well represented in the fauna of the *Exogyra costata* zone of the gulf coast. *Gegania* became more common in the Tertiary and maintained a foothold in the gulf region with Eocene species such as *Tuba alternata* Lea, the type species of *Tuba* Lea, from Alabama. The Tertiary species show few differences from the Cretaceous species.

Gegania parabella (Wade)

Plate 18, figures 25, 43

1927. *Tuba parabella* Wade, U.S. Geol. Survey Prof. Paper 137, p. 171, pl. 53, figs. 9, 10.

Diagnosis.—Highly ornate turriculate shells of medium size; whorls convex, subangulated at periphery and tend to flatten basally.

Description.—Shell of medium size, turriculate; pleural angle 34° in adult to 45° + in earlier stages; protoconch unknown; suture impressed. Whorls 7–10 in number, increasing rapidly in size, subcircular in cross section, with well-rounded whorl sides in early stages but becoming subangulated at periphery on later whorls. Body rounded below peripheral subangulation; base becomes flattened near center and subangulated at margin of the narrow umbilicus. Immature specimens have well rounded base and lack an umbilical marginal subangulation. Sculpture strong; early whorls with 3 strong flat-topped spiral cords that continue as the dominant spiral elements, although 11 cords in all are present on the penultinate whorl; these primary spiral cords are peripherally located, with middle one forming a peripheral subangulation; finer spiral lirae are found in interspiral spaces and on base; on largest available specimen the major cords are expanded at their tops and slightly overhang spiral interspaces. Closely spaced flat-topped colabral axial riblets form slight apically projecting spines and thicken as they override the spiral cords. Aperture subcircular, with parietal lip lightly callused and columellar lip reflexed, partly covering narrow umbilical fissure.

Measuremenis.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*PA* (degrees)	*H*	*MD*	*HB*
1 (holotype)	8	34	25.6	14.2	14.0
1 (topotype)	(?)	34	(?)	17.5	16.6
1 (topotype)	7	41	18.7	11.1	10.8
1 (topotype)	5½	47	(?)	(?)	9.9

Discussion.—The available topotype material shows a constancy in the major distinctive morphologic features. All specimens develop the typical peripheral subangulation. The ornament develops in the same way on all specimens examined, but the number and strength of the spirals on the body varies. The variance in pleural angle noted above is to a considerable degree a function of the stage of growth.

This species differs from *Gegania bella* (Conrad) and the variety of that species found in the Ripley formation primarily in adult features. Both species in their early stages are much alike, but *Gegania parabella* develops a subangular periphery and a flattened base, whereas *G. bella* retains a rounded whorl profile. The species is restricted to the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tenn., where it is moderately rare.

Types: Holotype USNM 32930; hypotypes USNM 128584, 128585.

Occurrence: Tennessee: Ripley formation, loc. 1. Mississippi: Ripley formation questionably, loc. 22.

Gegania bella prodiga Sohl, n. subsp.

Plate 18, figures 28, 32, 33

Diagnosis.—Highly ornamented, medium-sized, turriculate shells with convex whorl sides and rounded base.

Description.—Shell of medium size, turriculate; pleural angle 30° in mature specimens to 44° in immature forms. Protoconch consists of 1¼ smooth surfaced whorls, with the initial stage immersed. Suture impressed. Whorls 7–8 in number, subcircular in cross section and round sided; body whorl rounding down to a broadly convex base. Teloconch sculpture initiated by thin low spiral lirae that increase in strength, becoming high, broad, somewhat round-topped spiral cords. Middle two cords strongest, with upper cord forming edge of a shoulder. Shoulder flat and narrow on early whorls, begining to slope on fifth whorl and is lost on body whorl. Secondary cords and subsidiary lirae form on shoulder surface between primary cords of penultimate whorl and cover base of body whorl. Transverse sculpture present on first teloconch whorl, consisting of numerous arcuate colabral thin raised sharp-crested threads which coarsen and broaden where they override spiral elements. Aperture not completely known, subcircular in outline as preserved and slightly angulated posteriorly; inner lip with a thin parietal callus and a reflected columellar lip that partly obscures a narrow umbilical fissure.

Measurements.—Explanation of measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	No. *W*	*PA* (degrees)	*H*	*MD*	*HB*
16 (holotype)	8.0	32	28.9	14.7	16.1
18 (paratype)	6.5	36	19.0	11.2	11.1
18 (paratype)	5.5	47	10.0	7.5	7.3
18 (paratype)	(?)	36	24.6+	15.4	15.5
16 (paratype)	6+	42	15.8	9.5	9.3
Alabama (*G. bella*)	6+	30	23.7	13.2	13.0
Texas (*G. manzanetti*)	(?)	41	14+	10.5	9.4+

Discussion.—The type of *Gegania bella* (Conrad) unfortunately is lost, but a topotype (?) in the U.S. National Museum (USNM 21162) from the Ripley formation at Eufaula, Barbour County, Ala., is well preserved and could serve as a neotype. The dimensions of this specimen are given in the preceding table, and it is figured on plate 18, figures 37, 38. The subspecies here under discussion differs from the Chattahoochee River specimens only to a minor degree, having coarser transverse threads that are less closely spaced, a lower apical angle, and spiral costae that are higher and flattertopped on both the whorl sides and the base. These differences seem to merit no more than subspecific rank. Neither the figure nor the description of the holotype by Conrad (1860, p. 289, pl. 46, fig. 38) is sufficient for close comparison. *Tuba? manzanetti* Stephenson, from the Nacatoch sand of Texas, also appears to be closely related, if not conspecific. The Texas species differs by having somewhat more obese whorls and lacking the shouldering of the early whorls, and although the spiral cords are similar, it does not have them sharply defined to four primary cords. The significance of these differences may lessen when better preserved material is available, as *T.? manzanetti* is based on a specimen preserving only about three whorls and lacking both apex and aperture.

This variety is restricted to the lower part of the Ripley formation above the *E. cancellata* zone and has close relatives in both Alabama, Georgia, and Texas strata of equivalent age.

Types: Holotype USNM 128586; paratypes USNM 128587, 128588, 128589.

Occurrences: Mississippi: Ripley formation, locs. 6, 14, 15, 16, 18, 27, 29.

Gegania? sp.

Plate 18, figures 34, 36

Discussion.—Two internal molds from the Prairie Bluff chalk of Mississippi exhibit features typical of *Gegania* and may indicate the presence of this genus higher in the Cretaceous section than previously known. Both specimens possess rather plump shells with subcircular whorl cross sections. An umbilical fissure is present, and a reflection of rather strong spiral ornament is present on the surface of the molds. Both specimens are incomplete, lacking the apex.

Measurements.—Explanations of the measurements and symbols used in the following table appears in the section "Measurements of specimens" (p. 48).

Loc.	*PA* (degrees)	*MD*	*HB*
71	34	15.4	17+
87	40	15.7	16.8

These measurements indicate a size typical of the species from the Ripley formation and in conjunction with the previously mentioned characters make the assignment of these molds to *Gegania* a reasonable possibility.

Type: Hypotype USNM 128590.

Occurrences: Mississippi: Prairie Bluff chalk, locs. 71 and 87.

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PLATES 3–18

PLATE 3

FIGURE 1. Massive dark silty sand of the Coon Creek tongue of the Ripley formation on Coon Creek, McNairy County, Tenn., overlain by valley fill. Line of concretions above head of S. H. Patterson forms a small falls in creekbed upstream. April 1952.

2. Fossiliferous reworked silty sand of the Owl Creek formation underlying limestone of the basal part of the Clayton formation in a roadcut of Tennessee State Route 57 (loc. 40), Hardeman County, Tenn. February 1952.

3. Unconformable contact between the Ripley formation, below, and Prairie Bluff chalk, above, Mississippi State Route 6, 3 miles east of Pontotoc (loc. 57), Pontotoc County, Miss. July 1951.

4. Near view of 3 showing limestone of the Keownville limestone member of Ripley formation underlying impure Prairie Bluff chalk. Fragments on surface are phosphatic molds of fossils weathered from Prairie Bluff chalk. Hammer marks contact.

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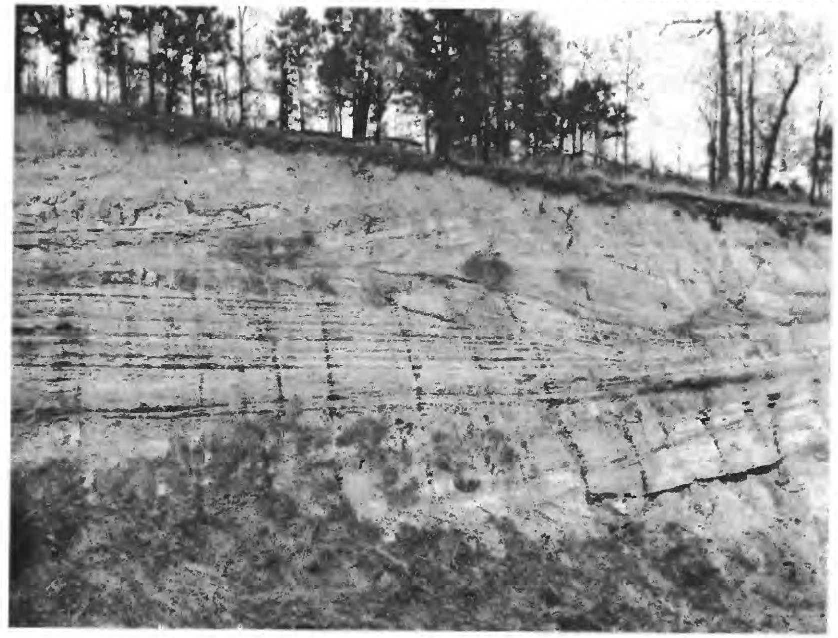
4

VIEWS OF THE RIPLEY, OWL CREEK, AND PRAIRIE BLUFF FORMATIONS

1



2

3

4

McNAIRY SAND MEMBER AND COON CREEK TONGUE OF THE RIPLEY FORMATION

PLATE 4

FIGURE 1. Irregularly bedded sands and ferruginous sandstone ledges of the McNairy sand member in a roadcut of Tennessee State Route 57, near Pocahontis, Hardeman County, Tenn. July 1951.

2. Another view of the preceding roadcut showing the lenticularity of the sand beds. July 1951.
3. Dark, carbonaceous clays of the McNairy sand member in a roadcut of U.S. Highway 72, 14.7 miles west of Corinth, Alcorn County, Miss. July 1951.
4. Fossiliferous concretions from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tenn. February 1951.

PLATE 5

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3, 5. Front and back views of a specimen (× 3) from the Ripley formation at loc. 16. USGS 25409, USNM 128386.

4, 6, 7. Front basal, and back views of a specimen (× 3) from the Ripley formation at loc. 18. USGS 25411, USNM 128387.

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12–14. *Calliomphalus* (*Planolateralus*) *conanti* Sohl, n. sp. (p.).
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15. Enlargement of a selected area of a topotype (× 6) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 10198, USNM 128391.

29–31. Basal, back, and front views of the same specimen (× 3).

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37, 38. *Damesia keownvillensis* Sohl, n. sp. (p. 63).
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40, 41. *Weeksia amplificata* (Wade) (p. 51).
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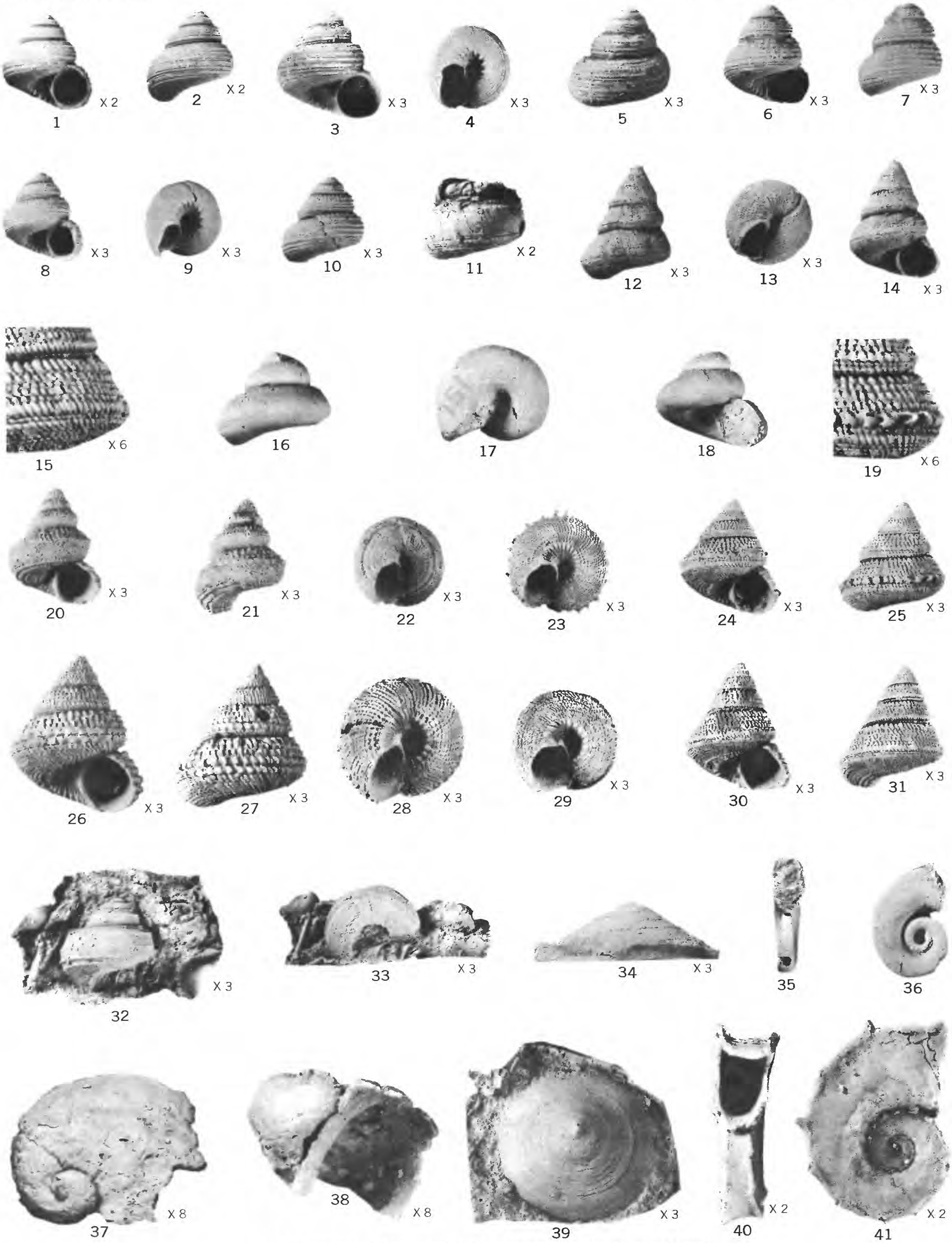
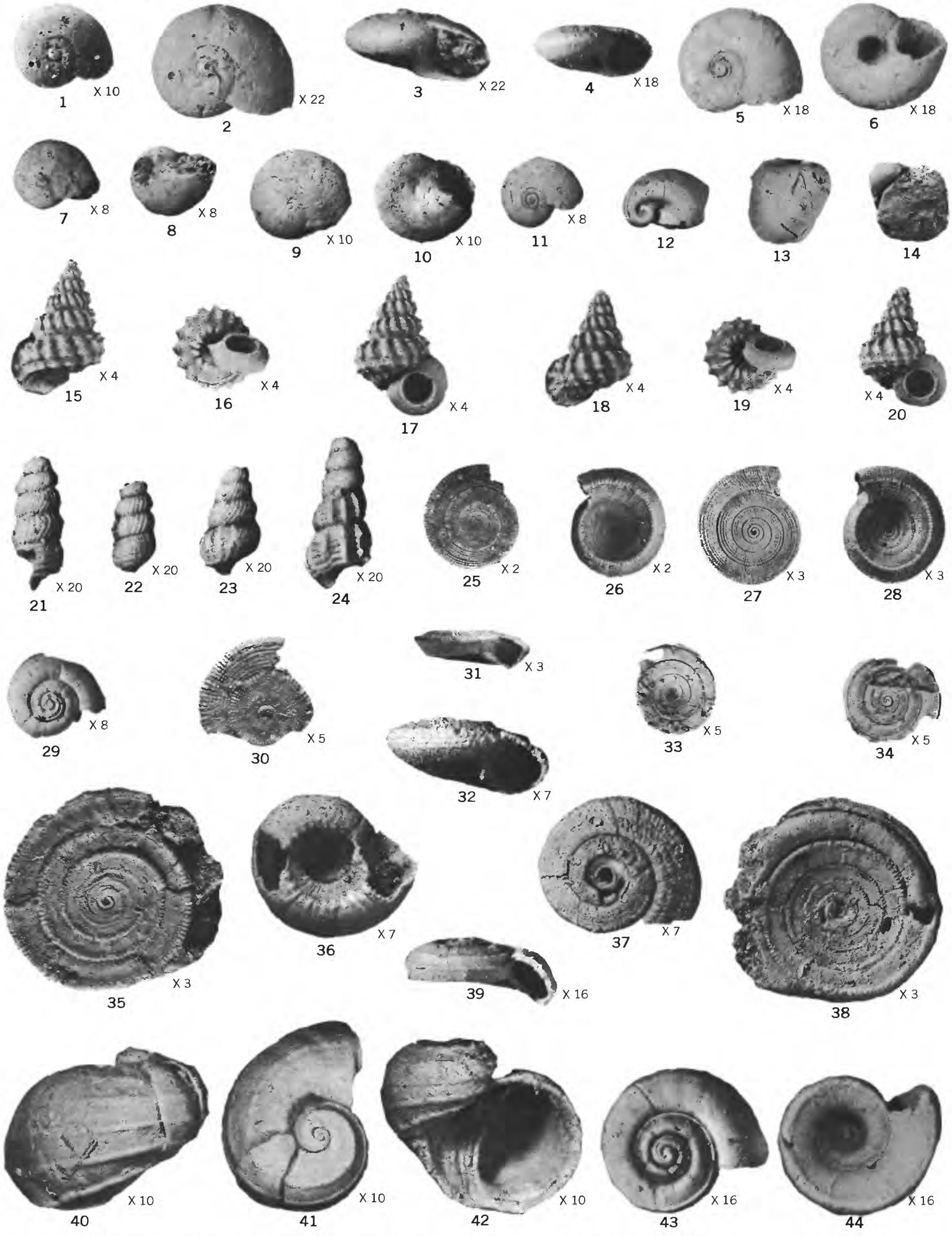


CALLIOMPHALUS, ACMAEA, WEEKSIA, AND *DAMESIA*



TEINOSTOMA, NERITINA, URCEOLABRUM, LOXONEMATID TYPES, *PSEUDOMALAXIS,* AND *DAMESIA*

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15, 22. Basal and side view of a topotype (× 1) from the Owl Creek formation at loc. 46 showing the striated base and the profile of the outer lip. USGS 707, USNM 128429.

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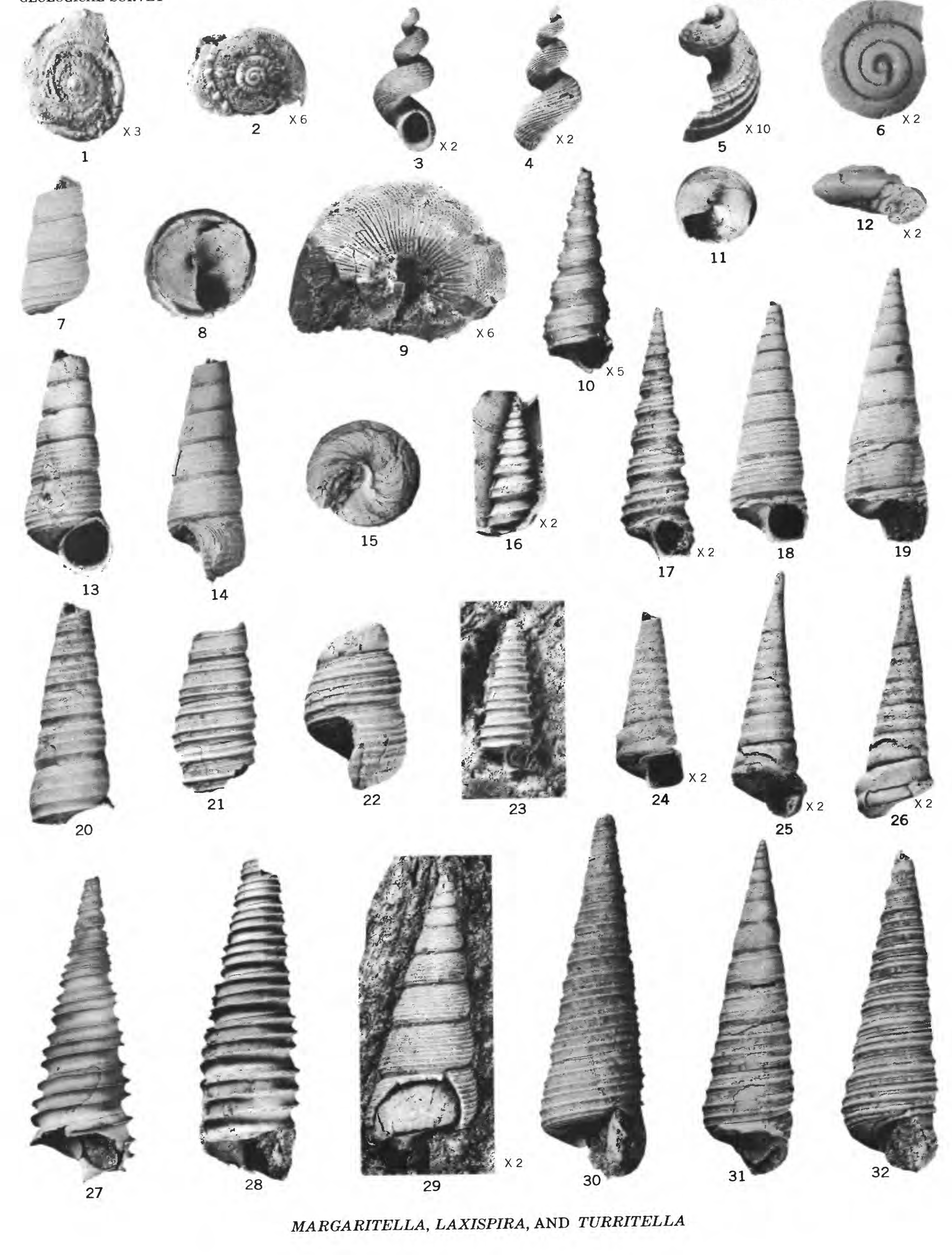
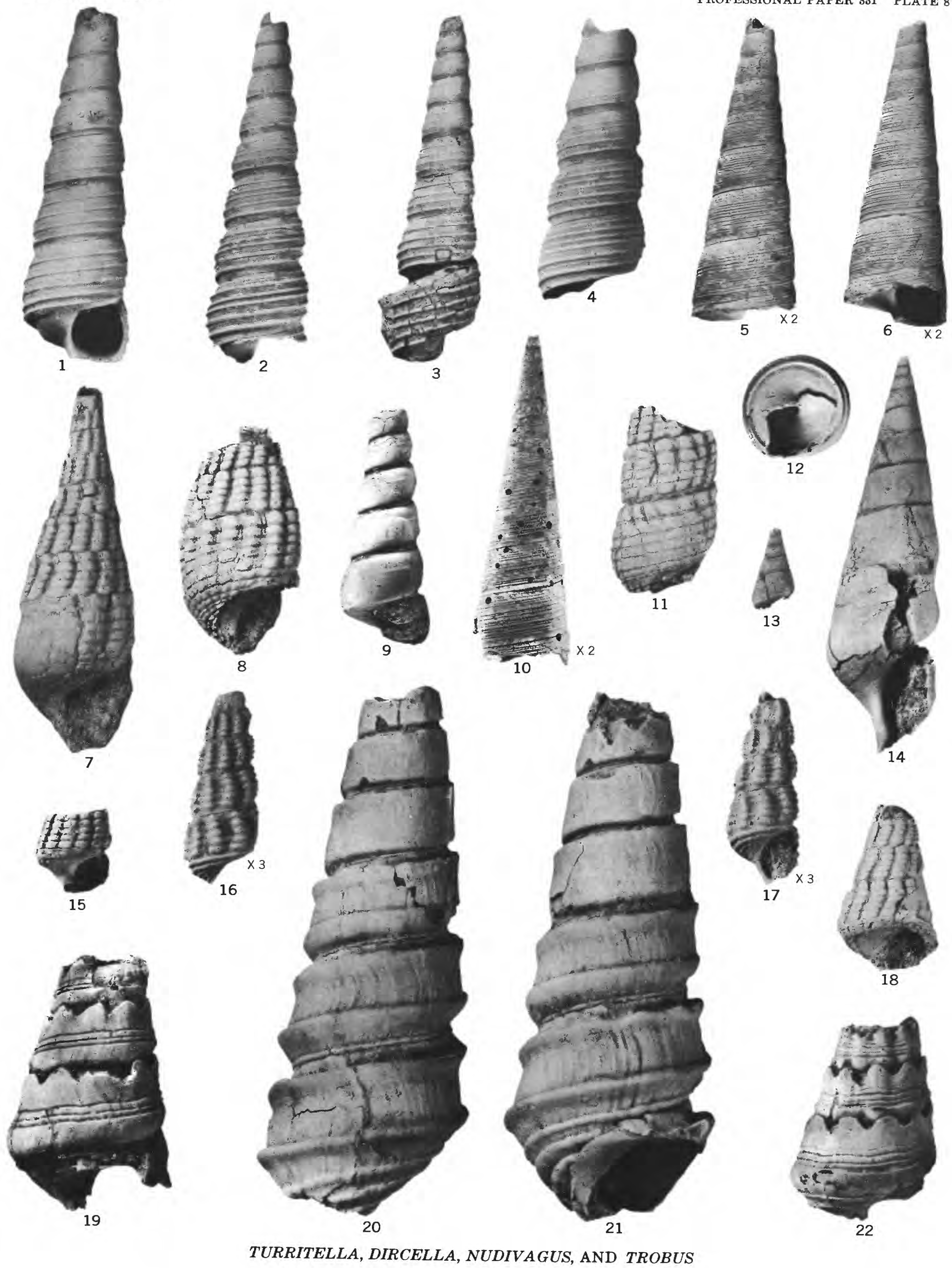
29. *Turritella macnairyensis* Wade (p. 76).

Back view of a topotype (× 2) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 10198, USNM 128440.



MARGARITELLA, *LAXISPIRA*, AND *TURRITELLA*



TURRITELLA, DIRCELLA, NUDIVAGUS, AND *TROBUS*

PLATE 8

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10. Back view of the holotype (× 2) also from loc. 18. USGS 25411, USNM 128445.

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20, 21. *Trobus buboanus* Stephenson (p. 78).

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PLATE 9

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25, 26. *Turboella costata* (Wade) (p. 87).
Back and front views of the holotype (× 20) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 32941.

27, 35. *Seila quadrilirata* (Wade) (p. 84).
27. View of protoconch and early whorls of a specimen (× 10) from loc. 29. USGS 25485, USNM 128471.
35. Back view of the holotype (× 5) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 32943.

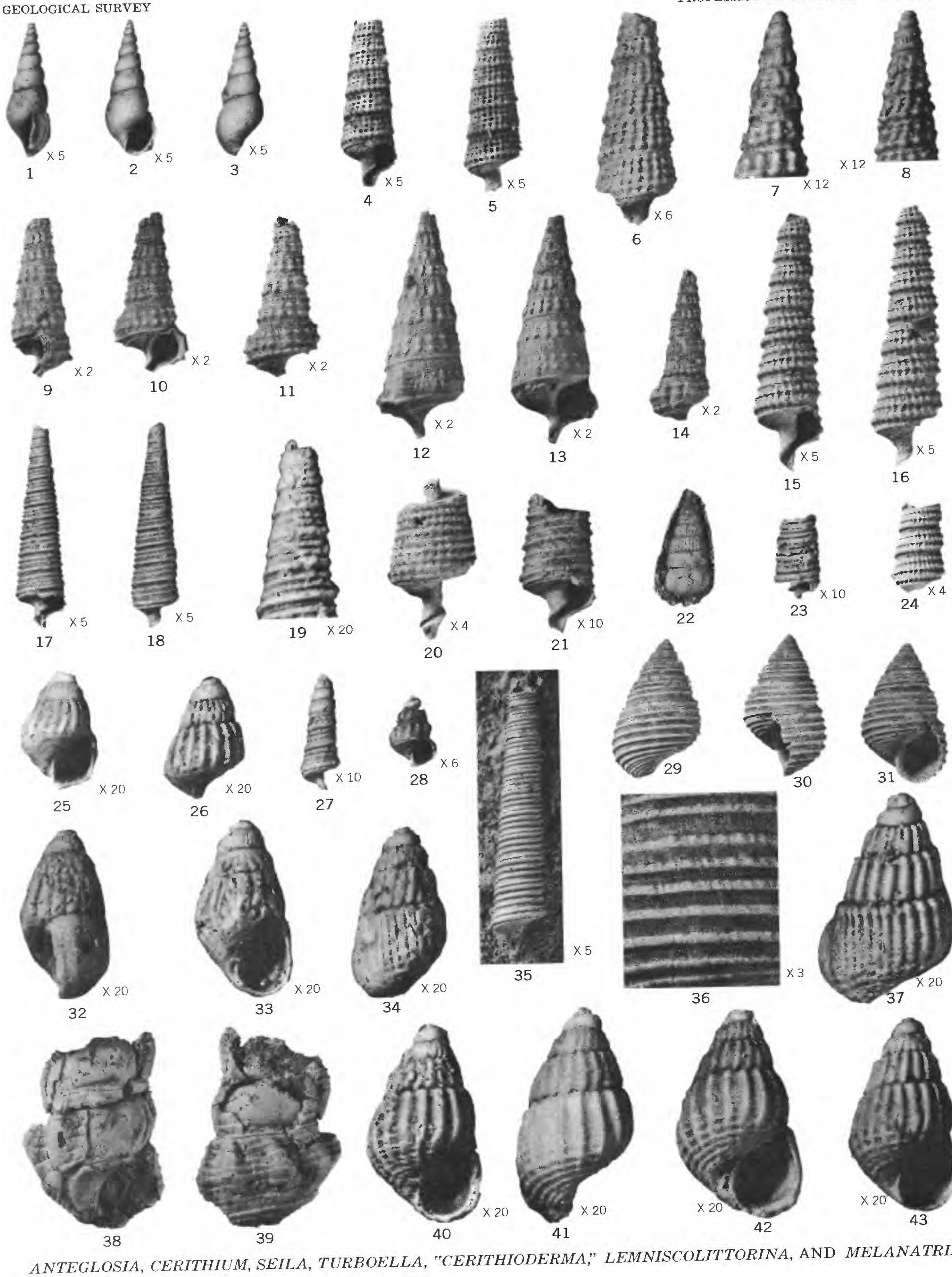
28. *Cerithioderma? americana* (Wade) (p. 92).
Front view of the holotype (× 6) from the Coon Creek tongue of the Ripley formation at loc 1. USGS 25406, USNM 32939.

29–31, 36. *Lemniscolittorina berryi* (Wade) (p. 85).
29–31. Front, side, and back (× 1) views of the holotype from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 73083.
36. Enlargement of ornament of the holotype (× 3).

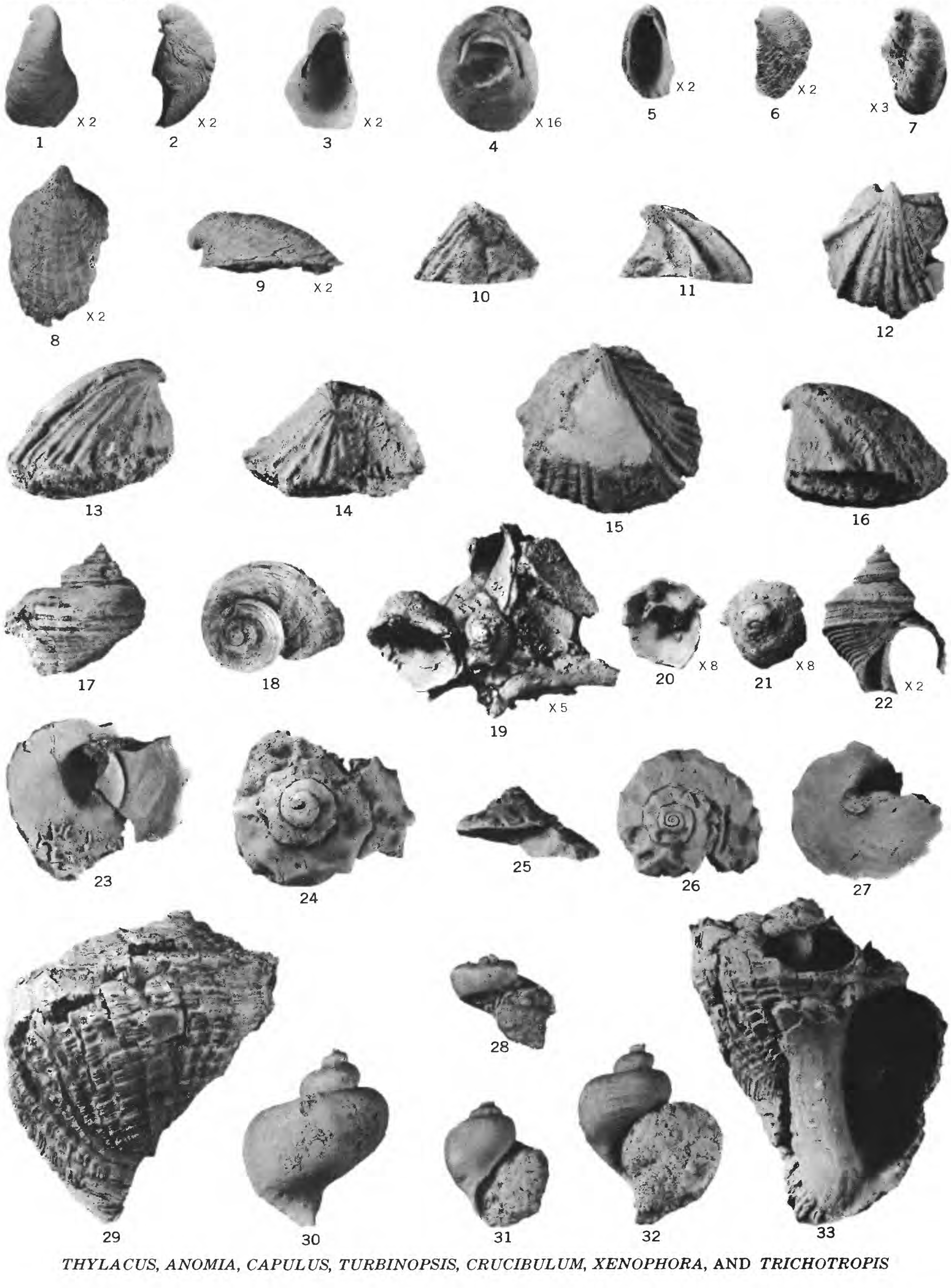
32–34. *Turboella crebricostata* n. sp. (p. 88).
Back, front, and side views of the holotype (× 20) from the Ripley formation at loc. 29. USGS 25485, USNM 128788.

37, 40–43. *Turboella tallahatchiensis* n. sp. (p. 88).
37. Back view of a specimen (× 20) from loc. 29 showing closely spaced axial ribs. USGS 25485, USNM 128784.
40. Front view of a paratype (× 20) from the Ripley formation at loc. 15, showing thick well-spaced axial ribs and few spirals. USGS 25408, USNM 128786.
41, 42. Back and front views of the holotype (× 20) from the Ripley formation at loc. 24. USGS 13122, USNM 128787.
43. Back view of a paratype (× 20) from the Ripley formation from loc. 24. USGS 13122, USNM 128785.

38, 39. *Melanatria?* sp. (p. 79).
Front and back views of a specimen (× 1) from the Owl Creek formation at loc. 45. USGS 25422, USNM 128455.



ANTEGLOSIA, CERITHIUM, SEILA, TURBOELLA, "CERITHIODERMA," LEMNISCOLITTORINA, AND *MELANATRIA*



THYLACUS, ANOMIA, CAPULUS, TURBINOPSIS, CRUCIBULUM, XENOPHORA, AND *TRICHOTROPIS*

PLATE 10

FIGURES 1–4, 7. *Thylacus cretaceus* Conrad (p. 94).

1, 2, 3. Back, side, and front views of a specimen (× 2) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128483.

4. Front view of a juvenile specimen (× 16) from the Owl Creek formation enlarged to show the early development of the muscle supports. USGS 6875, USNM 128484.

7. Oblique view of a specimen (× 3) from the Ripley formation at loc. 15. USGS 25408, USNM 128485.

5, 6. *Anomia perlineata* Wade (p. 95).

Front and side views of a specimen (× 2) from the Coon Creek tongue of the Ripley formation at loc. 1 which simulates the *Thylacus* growth habit. USGS 25406, USNM 128486.

8, 9. *Capulus monroei* Sohl, n. sp. (p. 93).

Back and side views of the holotype (× 2) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128479.

10–12. *Capulus corrugatus* Wade (p. 93).

Front, side, and apical views (× 1) of a topotype from the Ripley formation at loc. 1. USGS 25406, USNM 128481.

13–16. *Capulus cuthandensis* Stephenson? (p. 93).

Right side, anterior, back, and left side views of a specimen (× 1) from the Prairie Bluff chalk at loc. 87. USGS 6844, USNM 128482.

17, 18. *Turbinopsis hilgardi* Conrad (p. 91).

Back and apical views of the holotype (× 1) from the Ripley formation of Mississippi. ANSP 14956.

20, 21. *Crucibulum* sp. (p. 95).

Front and back views of a specimen (× 8) from the Ripley formation at loc. 29. USGS 25485, USNM 128487.

19, 23–27. *Xenophora leprosa* (Morton) (p. 96).

19. Apical view of a specimen (× 5) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128488.

23, 24. Basal and apical views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 57 showing the basal ridge of *Endotygma*. USGS 25425, USNM 128489.

25–27. Front, base, and apical views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 88. USGS 25438, USNM 128490.

22. *Trichotropis mississippiensis* Sohl, n. sp. (p. 89).

Front view of the holotype (× 2) from the Ripley formation at loc. 18. USGS 25411, USNM 128474.

29, 33. *Trichotropis imperfecta* Wade (p. 90).

Back and apertural view of the holotype (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 32936.

28. *Turbinopsis?* cf. *T. depressa* Gabb (p. 91).

Front view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 94. USGS 25440, USNM 128477.

30, 32. *Turbinopsis?* sp. (p. 91).

Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 82. USGS 25435, USNM 128478.

31. *Turbinopsis?* cf. *T. curta* Whitfield (p. 91).

Front view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 80. USGS 25434, USNM 128476.

PLATE 11

FIGURES 1–4, 6. *Graciliala calcaris* (Wade) (p. 98).

1, 2. Front and back views of a specimen (× 2) from the Ripley formation at loc. 6. USGS 25407, USNM 128491.

3, 4. Back and front views of a specimen (× 2) also from loc. 6. USGS 25407, USNM 128492.

6. Back view of a topotype (× 1½) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128493.

5, 11. *Graciliala decemlirata* Conrad (p. 99).

5. Front view of a specimen (× 2) from the reworked Cretaceous beds at the base of the Clayton formation at loc. 40. USGS 25420, USNM 128494.

11. Back view of a specimen (× 3) from the Owl Creek formation at loc. 45. USGS 25422, USNM 128495.

7, 8. *Drepanochilus* sp. (p. 101).

Front and back views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 94. USGS 6480, USNM 128498.

9, 13–15. *Arrhoges* (*Latiala*) *lobata* Wade (p. 101).

9. View of the apex of a topotype (× 3) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128501.

13, 14. Front and back views of a topotype (× 1) from loc. 1. USGS 10198, USNM 128501.

15. Back view of a specimen (× 1) from the Ripley formation at loc. 5. USGS 708, USNM 128502.

10. *Arrhoges* (*Latiala*) sp. (p. 103).

Back view of a specimen (× 1) from the Owl Creek formation at loc. 42. USGS 713, USNM 128506.

12. *Drepanochilus triliratus* Stephenson (p. 100).

Back view of a fragmentary specimen (× 2) from the Ripley formation at loc. 6. USGS 25407, USNM 128497.

16. *Arrhoges* (*Latiala*) sp. (p. 103).

Back view of a specimen (× 1) from the Owl Creek formation at loc. 42. USGS 713, USNM 128505.

17. *Arrhoges* (*Latiala*) cf. *A. plenocosta* Stephenson (p. 103).

Back view of an internal mold (× 1) from the reworked Cretaceous beds at the base of the Clayton formation at loc. 60. USGS 26088, USNM 128504.

18–20, 24, 25. *Helicaulax formosa* Stephenson (p. 104).

18. Front view of a topotype (× 1) from the Owl Creek formation at loc. 46. USGS 707, USNM 20434.

19. View of a topotype (× 1) from locality 46 showing the external impression of the inner surface of the extended outer lip. USGS 707, USNM 20434.

20. Back view of a specimen (× 1) from the reworked Cretaceous beds at the base of the Clayton formation at loc. 40. USAGS 25420, USNM 128507.

24. Back view of the holotype (× 1½), from the Owl Creek formation at loc. 46. USGS 707, USNM 128192.

25. Back view of a specimen (× 1) from the reworked Cretaceous beds at the base of the Clayton formation at loc. 40. USGS 25420, USNM 128508.

21. *Arrhoges* (*Latiala*) cf. *A. lobota* (Wade) (p. 102).

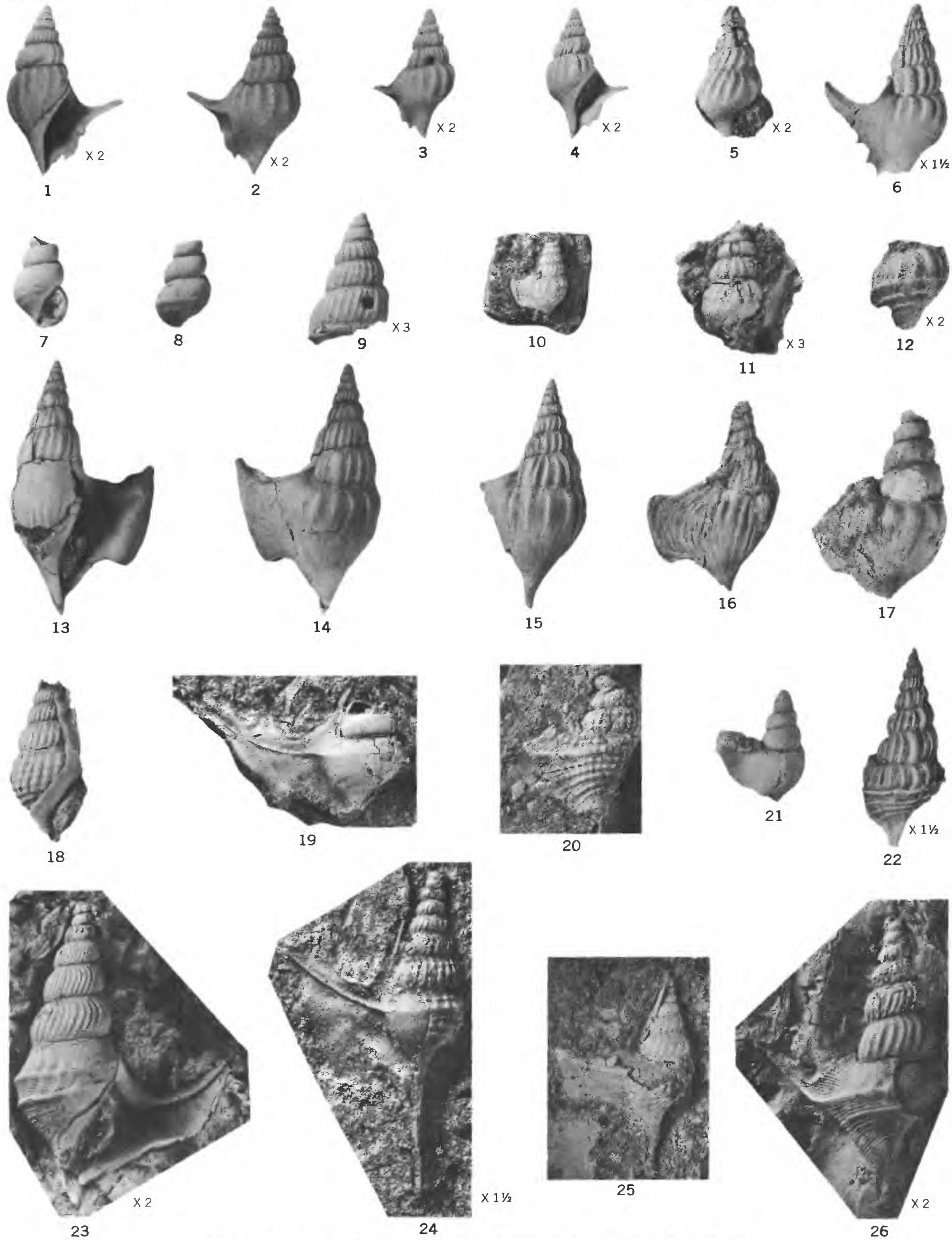
Back view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128503.

22. *Drepanochilus quadriliratus* (Wade) (p. 99).

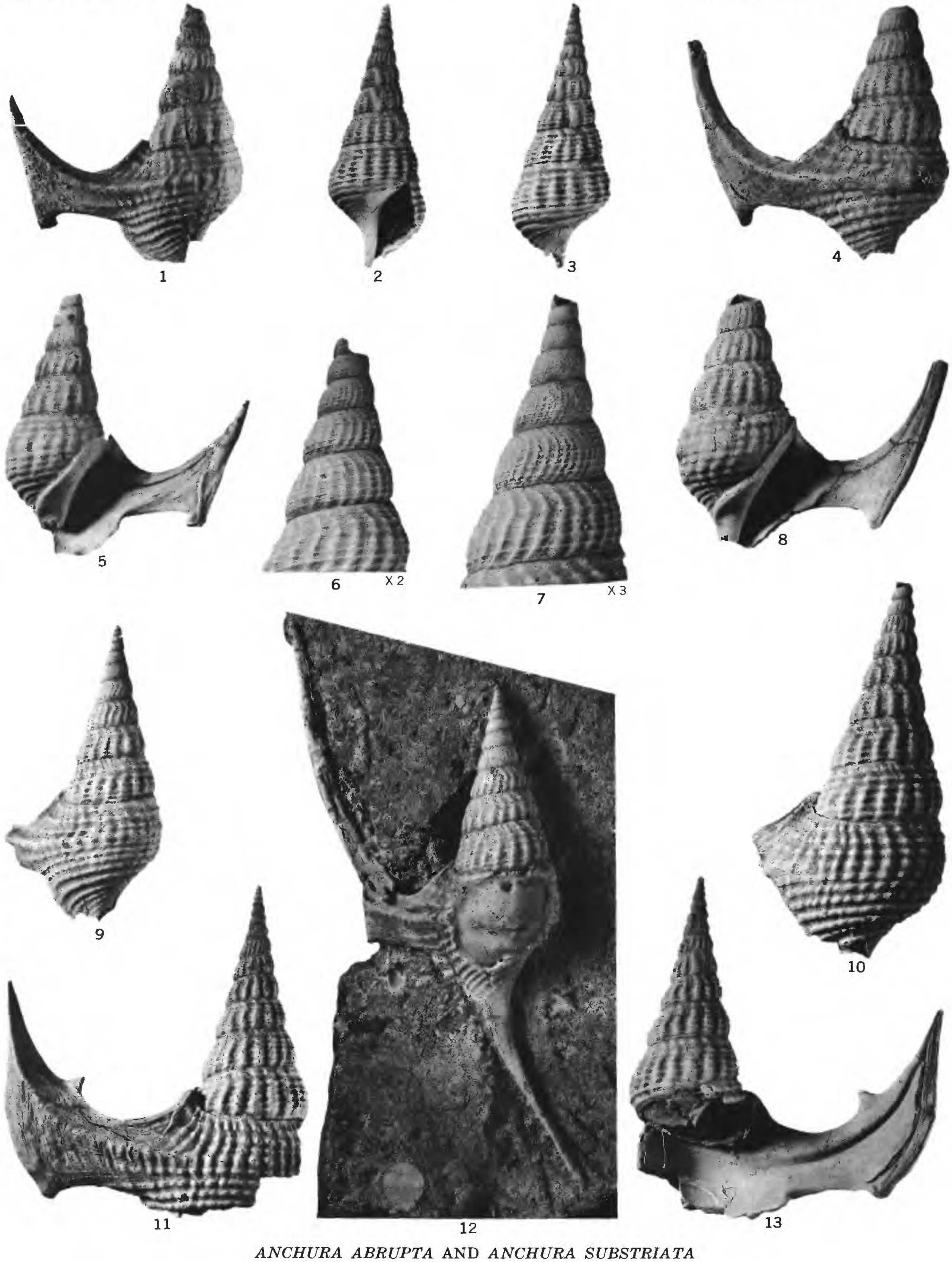
Back view of a topotype (× 1½) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128496.

23, 26. *Drepanochilus evansi* Cossmann (p. 100).

Front and back views of the two specimens (× 2), figured by Meek (1876, pl. 32, figs. 8a and 8b) from the Fox Hills sandstone of the western interior. The back view is the holotype. USNM 273.



GRACILIALA, DREPANOCHILUS, ARRHOGES, AND *HELICAULAX*



ANCHURA ABRUPTA AND *ANCHURA SUBSTRIATA*

PLATE 12

FIGURES 1, 4–9, 12. *Anchura abrupta* Conrad (p. 105).

1, 5. Back and front views of a specimen (× 1) from the Ripley formation at loc. 18. USGS 25411, USNM 128509.

4, 8. Back and front views of a specimen (× 1) from the Ripley formation at loc. 6. USGS 25407, USNM 128510.

6. Enlarged view of the spire of a specimen (× 2) from the Ripley formation at loc. 18, showing the fine spiral ornament of the early whorls. USGS 25411, USNM 128511.

7. Enlarged view of the spire of a specimen (× 3) from the Ripley formation at loc. 6, showing the arcuate trend of the axial ribs of the early whorls. USGS 25407, USNM 128512.

9. Back view of a specimen (× 1) also from locality 6 bearing an almost complete spire. USGS 25407, USNM 128513.

12. Back view of a specimen (× 1) from the Ripley formation at loc. 5 showing the full extent of the anterior canal and the upward curved spike of the outer lip. USGS 708, USNM 20559.

2, 3, 10, 11, 13. *Anchura substriata* Wade (p. 106).

2, 3. Front and back views of a topotype (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1 showing a constricted basal slope of the immature individual. USGS 10198, USNM 128514.

10. View of a topotype (× 1) from locality 1 showing the rounded basal slope of the last whorl. USGS 25406, USNM 128515.

11, 13. Back and front views of a topotype (× 1) from locality 1 preserving the outer lip. USGS 10198, USNM 128516.

PLATE 13

FIGURES 1, 2. *Pterocerella poinsettiformis* Stephenson (p. 109).

1. Back view of a specimen (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 10198, USNM 128524.

2. Back view of a specimen (× 1) from the Ripley formation at loc. 7. USGS 709, USNM 20530.

3, 5, 19. *Pterocerella tippana* Conrad (p. 109).

3. Back view of a topotype (× 1) from the Owl Creek formation at loc. 46. USGS 25423, USNM 128525.

5. Front view of a topotype (× 1) from locality 46. USGS 707, USNM 20435.

19. Back view of a topotype (× 1) same locality 46. USGS 707, USNM 20435.

4, 12. *Pterocerella pontotocensis* Sohl, n. sp. (p. 110).

4. Front view of a rubber cast of the holotype (× 2) from the Prairie Bluff chalk at loc. 57. USGS 25425, USNM 128527.

12. Back view of the paratype (× 1), an internal mold from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128528.

6, 23–27. *Anchura noakensis* Stephenson? (p. 107).

6. View of a rubber cast (× 1) of a portion of a spire from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128517.

23. Back view of a specimen (× 1) from reworked Cretaceous beds at the base of the Clayton formation at loc. 40. USGS 25420, USNM 128518.

24. Back view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 72. USGS 25429, USNM 128519.

25. View of a rubber cast (× 1) of an external impression from the reworked Cretaceous beds at the base of the Clayton formation at loc. 69. USGS 4053, USNM 128520.

26. Front view of an internal mold (× 1) from the Prairie Bluff formation at loc. 71, which bears the outlines of its surface ornament preserved by fillings of the borings of the sponge *Cliona*. USGS 25428, USNM 128521.

27. Back view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 87. USGS 6844, USNM 128522.

7, 8, 9. *Pterocerella* sp. A. (p. 110).

7, 8. Back and front views of a specimen (× 2) from the Owl Creek formation at loc. 46. USGS 25423, USNM 128529.

9. Back view of a specimen (× 1½) from the Ripley formation at loc. 16. USGS 25409, USNM 128530.

10, 11. *Pterocerella* sp. B. (p. 110).

Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128532.

13, 14. *Anchura?* sp. (p. 108).

Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 87? USNM 28340.

15, 16. *Anchura convexa* Wade (p. 107).

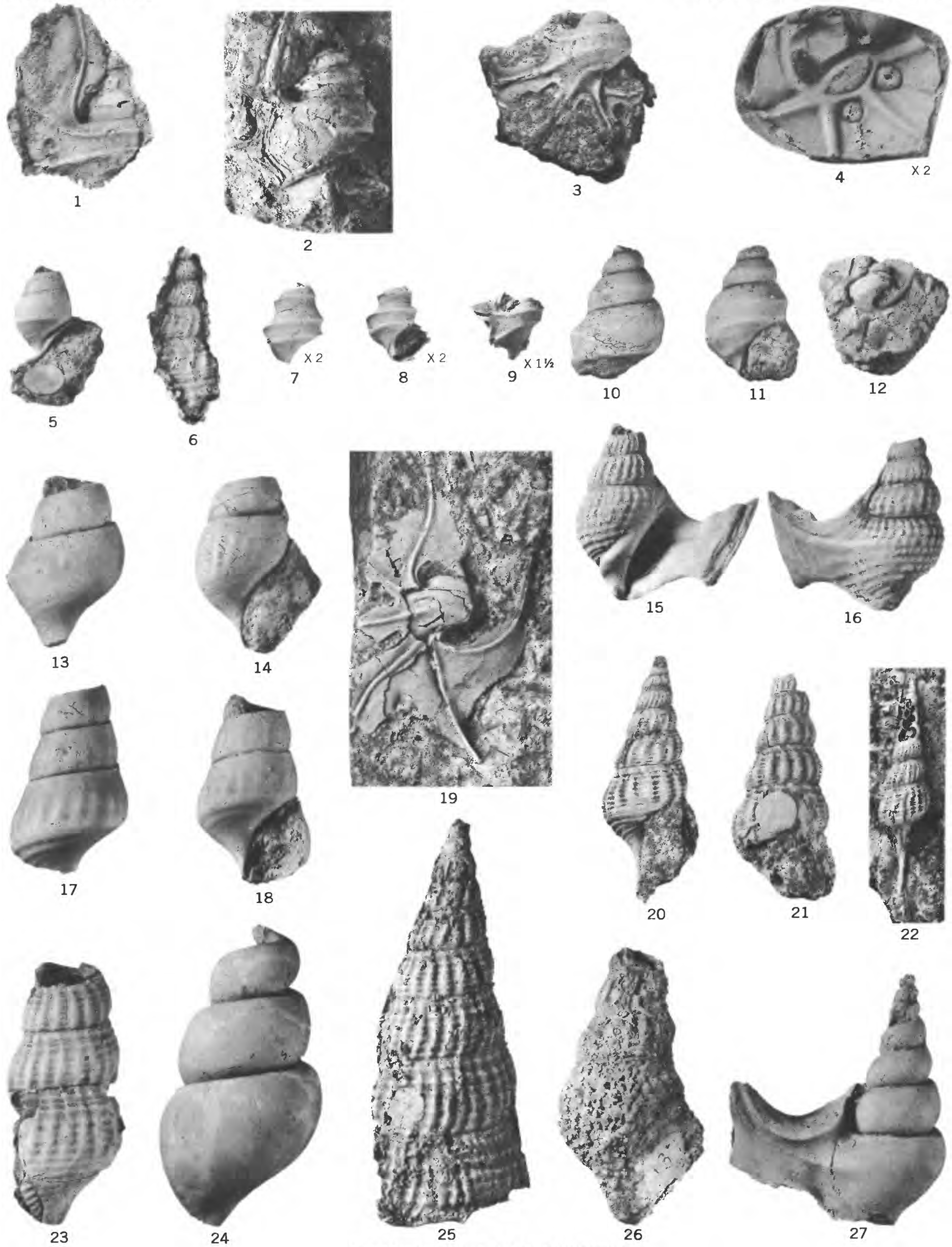
Front and back views of the holotype (× 1), from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 32923.

17, 18. *Anchura* sp. (p. 108).

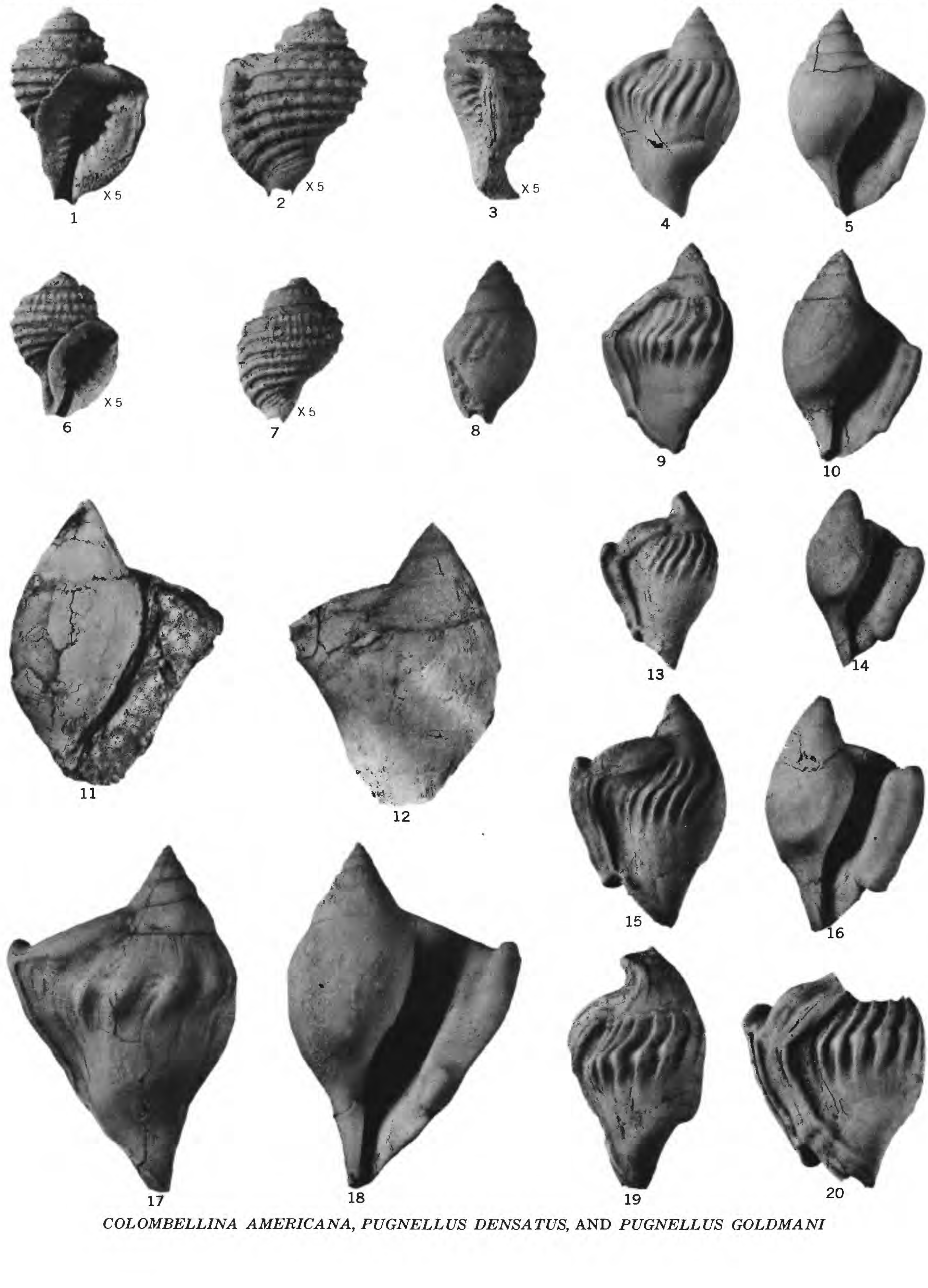
Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 87. USGS 6843, USNM 128523.

20–22. *Anchura* sp. (p. 108).

Views of three specimens (× 1) from the Owl Creek formation at loc. 46. USGS 707; fig. 20 is USNM 20445a; fig. 21 is 20445b; and fig. 22 is 20434.



PTEROCERELLA AND *ANCHURA*



COLOMBELLINA AMERICANA, PUGNELLUS DENSATUS, AND *PUGNELLUS GOLDMANI*

PLATE 14

FIGURES 1–3, 6, 7. *Colombellina americana* Wade (p. 111).

1–3. Front, back, and side views of a topotype (× 5) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128533.

6, 7. Front and back views of a specimen (× 5) from the Ripley formation at loc. 6. USGS 25407, USNM 128534.

4, 5, 9, 10, 13–16, 19, 20. *Pugnellus* (*Pugnellus*) *densatus* Conrad (p. 112).

Specimens represent the growth sequence of the species with the early mature stage at the top grading to the late mature stage at the base of the plate.

4, 5. Back and front views of a speciman (× 1) from the Ripley formation at loc. 6. USGS 25407, USNM 128535.

9, 10. Back and front views of a topotype (× 1) from the Owl Creek formation at loc. 46. USGS 707, USNM 128536.

13, 14. Back and front views of a specimen (× 1) from the Ripley formation at loc. 16. USGS 25409, USNM 128537.

15, 16. Back and front views of a specimen (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128538.

19–20. Back view of two topotypes (× 1) from the Owl Creek formation at loc. 46. USGS 25423, USNM 128539, 128540.

8. *Pugnellus* (*Pugnellus*) *densatus* Conrad? (p. 114).

Back view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 57. USGS 25425, USNM 128541.

11, 12, 17, 18. *Pugnellus* (*Pugnellus*) *goldmani* Gardner (p. 114).

11, 12. Front and back views of the holotype (× 1) from the Monmouth formation of Maryland. USNM Gardner collection.

17, 18. Back and front views of a specimen (× 1) from the Ripley formation at loc. 6. USGS 25407, USNM 128542.

PLATE 15

FIGURES 1, 6, 9, 13. *Pugnellus* (*Gymnarus*) *abnormalis* Wade (p. 115).

1, 6. Front and back views of the holotype (× 1), from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 32922.

9. Front view of the incomplete holotype (× 1), of *Pugnellus levis* Stephenson from the Peedee formation of North Carolina. USNM 73466.

13. Back view of a specimen (× 1) from the Ripley formation at loc. 13. USGS 712, USNM 20492.

2–5. *Gyrodes petrosus* (Morton) (p. 120).

Top, base, back, and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128554.

7, 8. *Gyrodes abyssinus* (Morton) (p. 120).

Views of the umbilical filling of an internal mold from (× 1) the Prairie Bluff chalk at loc. 71. Figure 8 is a rubber cast of the top of the specimen in figure 7. USGS 25428, USNM 128553.

10, 11, 15, 16. *Pugnellus* sp. (p. 115).

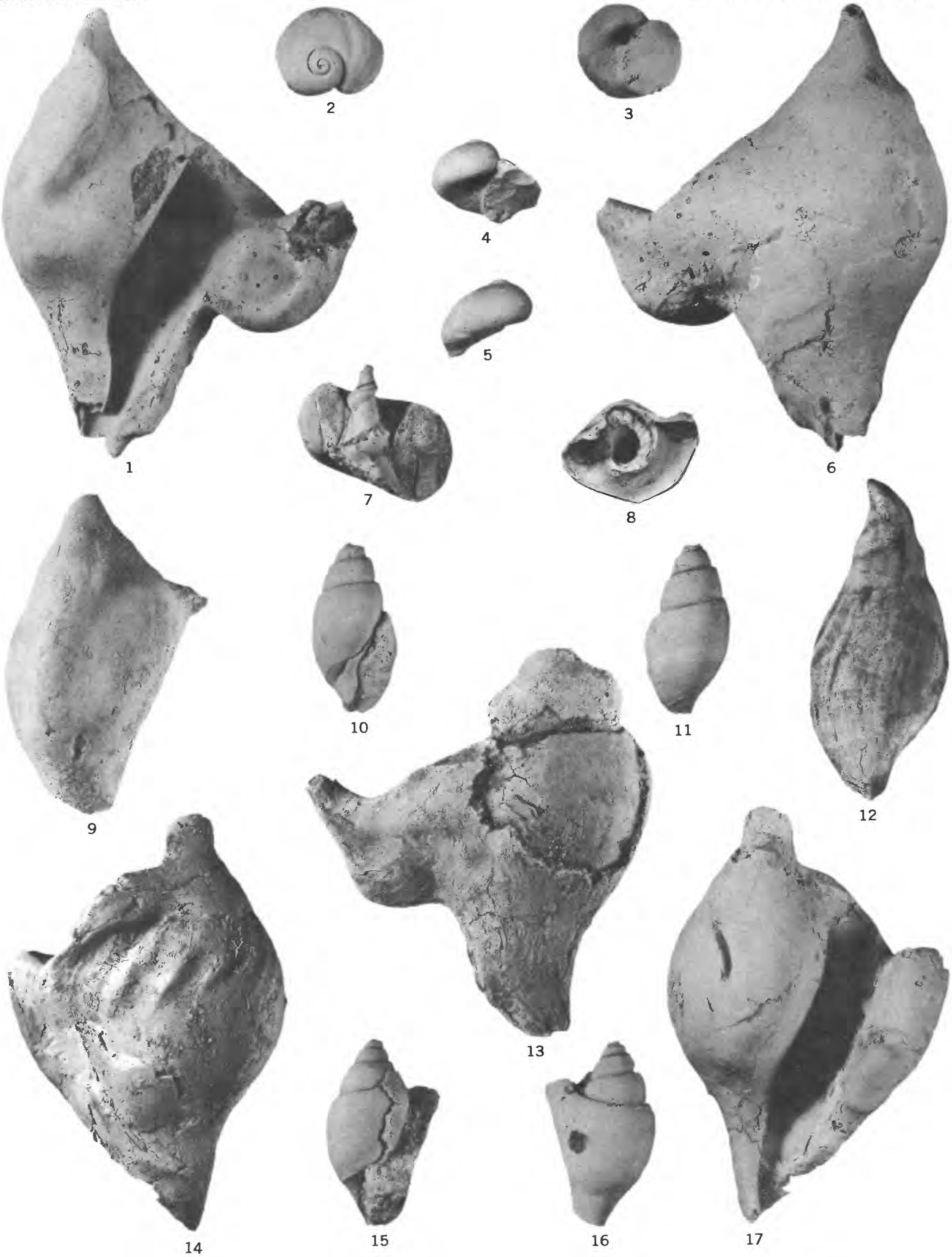
10, 11. Front and back views of an internal mold (× 1), from the Prairie Bluff chalk at Starkville, Oktibbeha County, Miss., USNM 28335a.

15, 16. Front and back views of an internal mold (× 1) from the same locality. USNM 28335b.

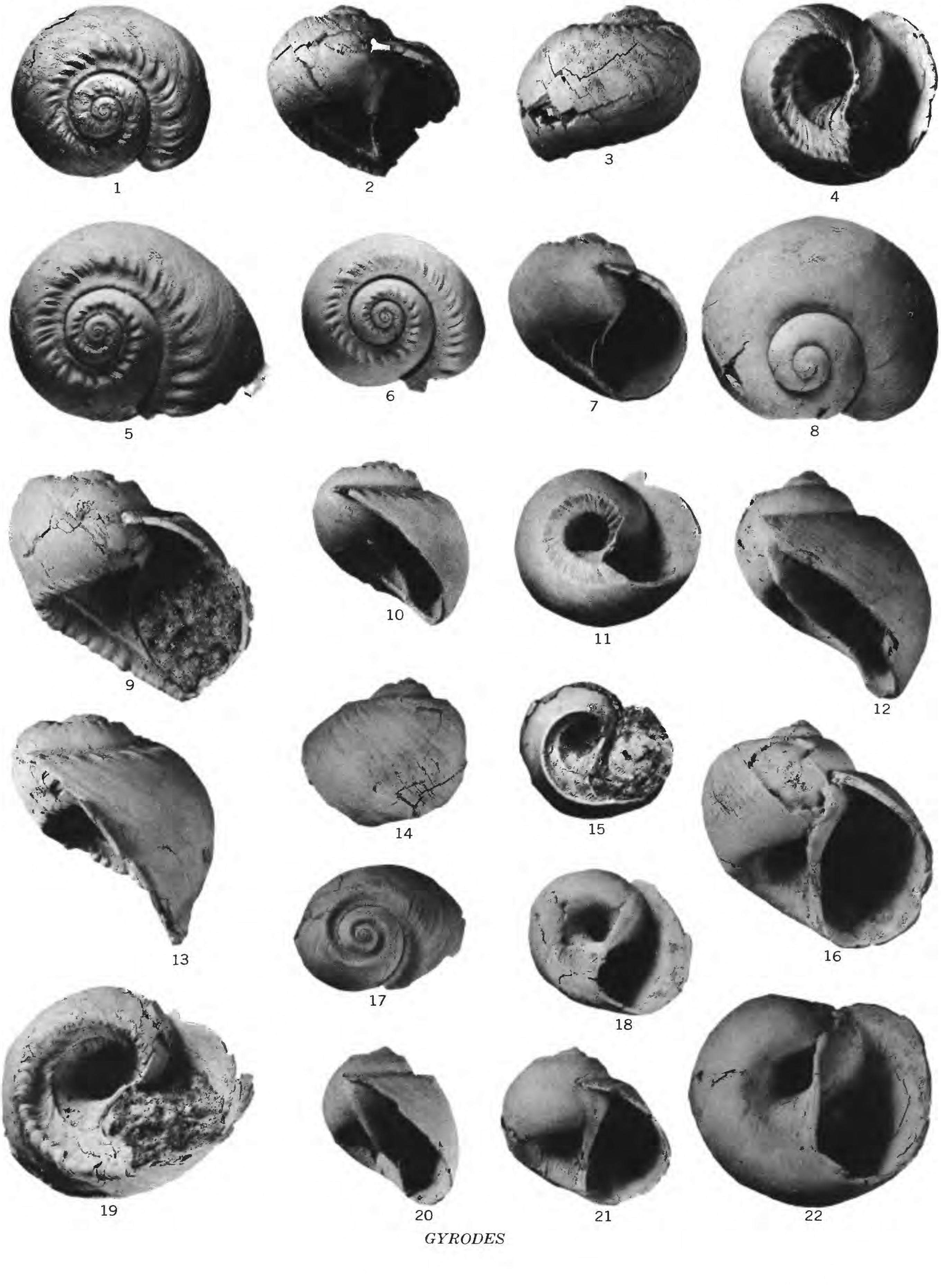
12, 14, 17. *Pugnellus* (*P.*) *goldmani* Gardner (p. 114).

12. Back view of an incomplete specimen from the Owl Creek formation at loc. 46, USGS 707, USNM 128543.

14, 17. Back and front views of a specimen (× 1) from the reworked Cretaceous beds of the Clayton formation at loc. 40. USGS 25420, USNM 128544.



PUGNELLUS AND *GYRODES*



GYRODES

PLATE 16

FIGURES 1–5, 9, 13, 19. *Gyrodes supraplicatus* Conrad (p. 117).

1–4. Top, front, back, and basal views of a specimen (× 1), from the Ripley formation at loc. 18. USGS 25411, USNM 128545.

5, 9, 19. Top, front, side, and basal views of a topotype (× 1), from the Owl Creek formation at loc. 46. USGS 25423, USNM 128546.

6, 7, 10, 11, 15. *Gyrodes major* Wade (p. 118).

6, 7, 10, 11. Top, front, side, and basal views of a topotype (× 1), from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 16951, USNM 128547.

15. Basal view of a topotype (× 1) from locality 1 showing a sharp umbilical carinae. USGS 16951, USNM 128548.

8, 12, 16, 22. *Gyrodes americanus* (Wade) (p. 119).

Top, side, front, and basal views of the holotype (× 1), from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 73078.

14, 17, 18, 20, 21. *Gyrodes spillmani* Gabb (p. 118).

Back, top, base, side, and front views of a topotype from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 16951, USNM 128550.

PLATE 17

FIGURES 1–4, 8, 9. *Polinices kummeli* Sohl, n. sp. (p. 121).

1–3. Back, front, and side views of a paratype (× 5) from the reworked Cretaceous beds at the base of the Clayton formation at loc. 40. USGS 25420, USNM 128556.

4. Front view of a paratype (× 1½) from locality 40. USGS 25420, USNM 128557.

8, 9. Back and front views of the holotype (× 1½) from the Owl Creek formation at loc. 46. USGS 707, USNM 128555.

5–7, 12–14. *Euspira rectilabrum* (Conrad) (p. 122).

5. Back view of a specimen (× 1) from the Ripley formation at loc. 18. USGS 25411, USNM 128560.

6, 7. Front and back views of a specimen (× 1) from the Ripley formation at loc. 6 which shows a broader, lower spired outline than figure 5 which may be a sexual difference. USGS 25407, USNM 128561.

12, 13. Side and front views of a specimen (× 1½) also from loc. 6 with a complete aperture. USGS 25407, USNM 128562.

14. Back view of a specimen (× 1½) from the Ripley formation loc. 6 which bears faint spiral ornament on the body whorl. USGS 25407, USNM 128563.

10, 11. *Euspira* cf. *E. rectilabrum* (Conrad) (p. 124).

Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 80. USGS 25434, USNM 128564.

15–19, 22. *Amaurellina stephensoni* (Wade) (p. 125).

15, 22. Back and apical views of a specimen (× 1½) from the Ripley formation at loc. 29. USGS 25485, USNM 128566.

16–19. Side, back, front, and apical views of a topotype (× 1½) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 16951, USNM 128565.

20, 21, 23. *Pseudamaura lirata* (Wade) (p. 127).

Front, side, and apical views of the holotype (× 1½), from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 73078.

24, 25. "*Ampullina*" *potens* Wade (p. 124).

Back and front views of the holotype (× 1), from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 73081.

26, 29, 30, 33. *Gyrodes abyssinus* (Morton) (p. 120).

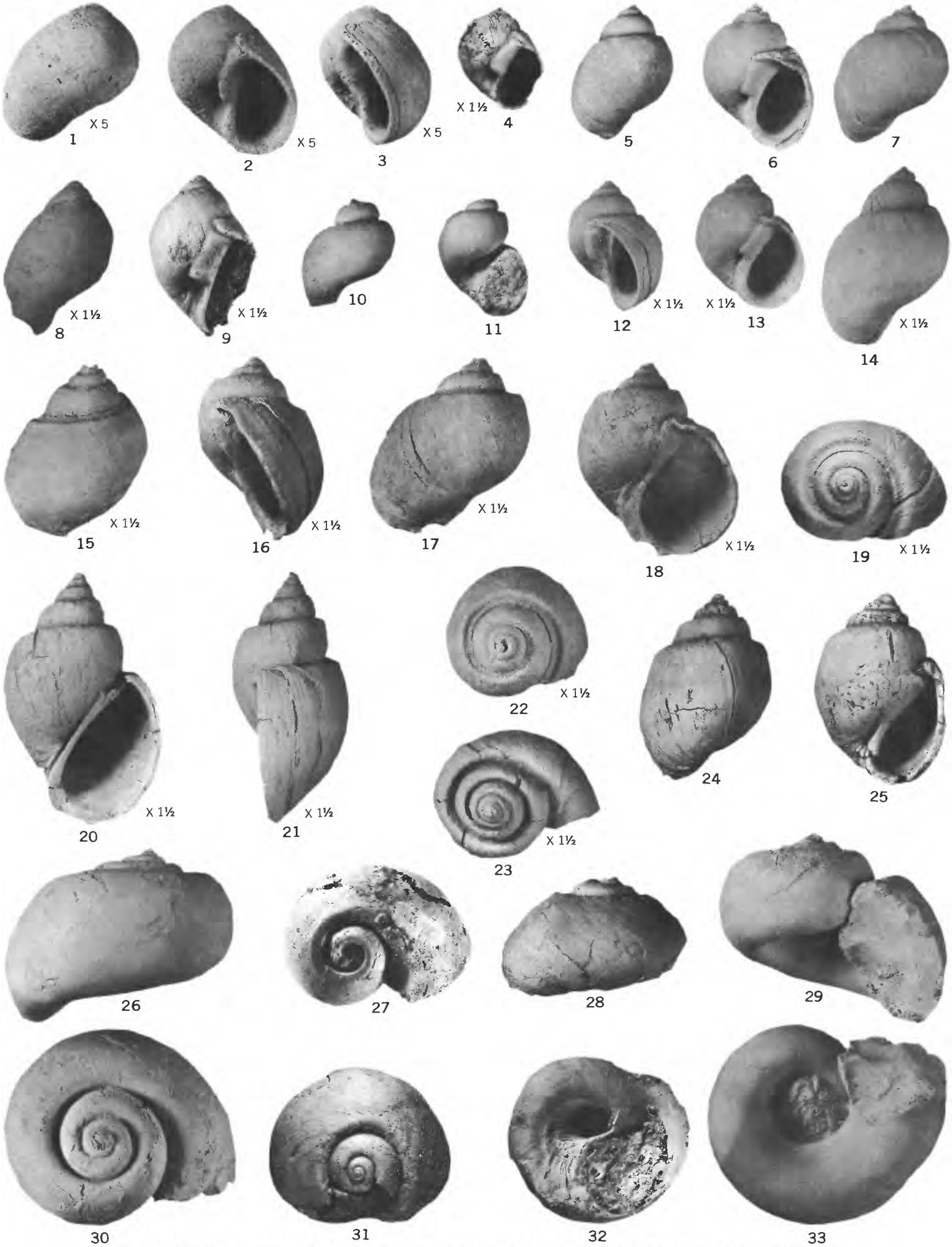
Back, front, top, and basal views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 71. USGS 25428, USNM 128552.

27. *Gyrodes spillmani* Gabb (p. 118).

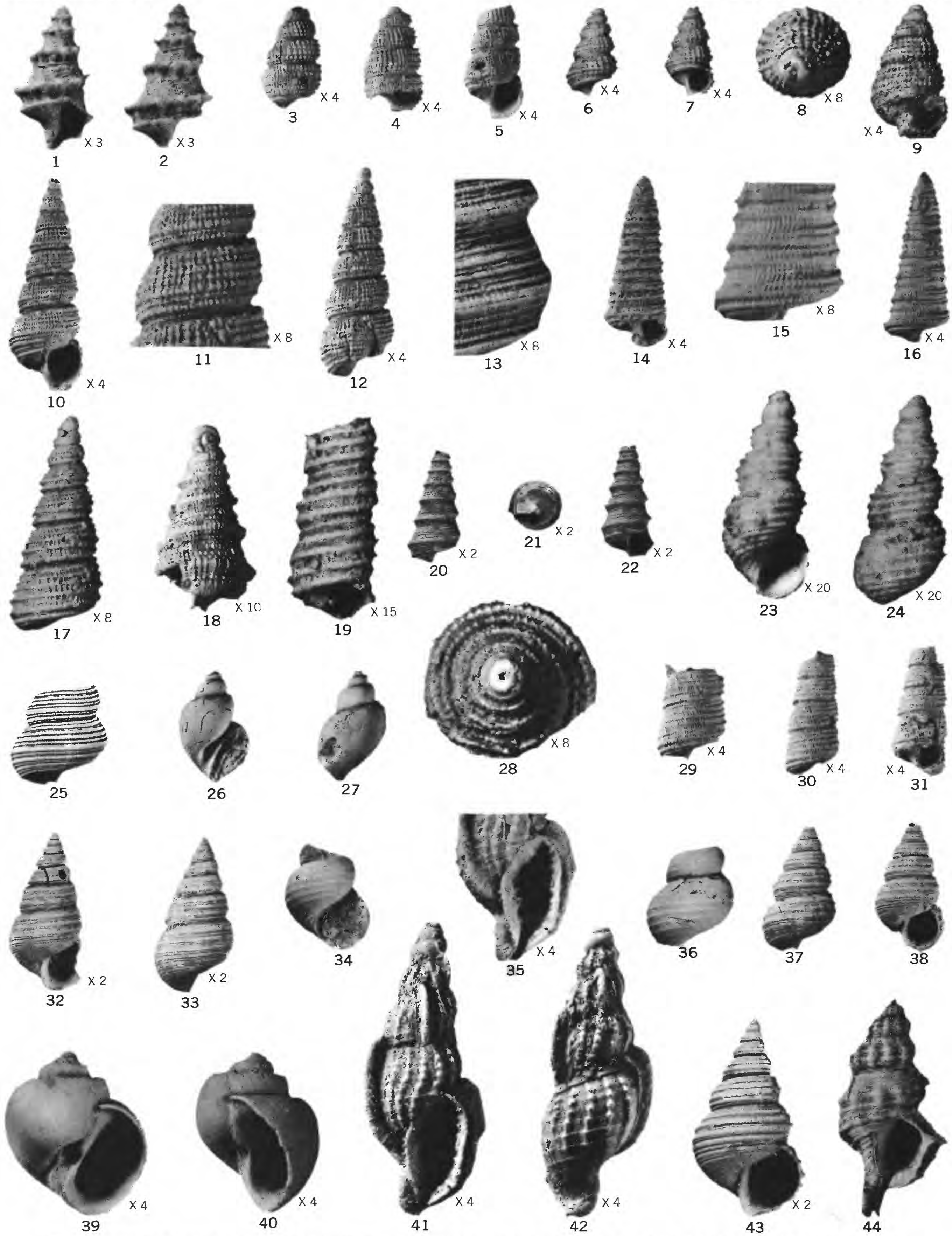
Apical view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 83. USGS 25436, USNM 128551.

28, 31, 32. *Gyrodes americanus* (Wade) (p. 119).

Back, apical, and basal views of a specimen (× 1) from the Ripley formation at loc. 6. USGS 25407, USNM 128550.



POLINICES, EUSPIRA, AMAURELLINA, PSEUDOMAURA, "*AMPULLINA,*" AND *GYRODES*



TINTORIUM, MATHILDA, PROMATHILDA, ACROCOELUM, GEGANIA, "AMPULLININAE," PLESIOTRITON, GLOBULARIA, AND *CHARONIA*

PLATE 18

FIGURES 1, 2. *Tintorium pagodiforme* Sohl, n. sp. (p. 129).

Front and back views of the holotype (× 3), from the Ripley formation at loc. 6. USGS 25407, USNM 128570.

3–9. *Mathilda* (*Echinimathilda*) *unionensis* Sohl, n. sp. (p. 132).

3, 4. Back and front views of a paratype (× 4) from the Ripley formation at loc. 17. USGS 25410, USNM 128575.

5. Front view of a paratype (× 4) from the Ripley formation at loc. 6. USGS 25407, USNM 128576.

6, 7. Back and front views of the holotype (× 4), also from loc. 6. USGS 25407, USNM 12877.

8. Apical view of the holotype (× 8), enlarged to show the protoconch.

9. Front view of a paratype (× 4) from loc. 24. USGS 13122, USNM 128578.

10–12. *Mathilda* (*Echinimathilda*) *corona* Sohl, n. sp. (p. 131).

11. Enlargement of a selected portion of the holotype (× 8), from the Owl Creek formation at loc. 46. USGS 541, USNM 128574.

10–12. Front and back views of the holotype (× 4), from loc. 46.

13, 18, 20–22. *Mathilda* (*Mathilda*) *ripleyana* Wade (p. 130).

20–22. Back, basal, and apertural views of a topotype (× 2) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128571.

13. Enlargement of a selected portion of a topotype (× 8) from loc. 1 to show the character of the sculpture.

18. View of the protoconch and early whorls of a topotype (× 10) from the same locality. USGS 25406, USNM 128572.

14–16. *Mathilda? cedarensis* Stephenson (p. 130).

14, 16. Front and back views of a specimen (× 4) from the Ripley formation at loc. 16. USGS 25409, USNM 128573.

15. Enlargement of selected portion of same specimen to show details of sculpture (× 8).

17, 29–31. *Promathilda* (*Clathrobaculus*) *parvula* Sohl, n. sp. (p. 133).

17. View of a paratype (× 8) from the Ripley formation at loc. 15. USGS 25408, USNM 128581.

29. Back view of a paratype (× 4) from the Ripley formation at loc. 6. USGS 25406, USNM 128580.

30, 31. Back and front view of the holotype (× 4), from the same locality. USNM 128579.

19. *Promathilda* (*Clathrobaculus*) *cretacea* (Wade) (p. 132).

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23, 24. *Acrocoelum cereum* Sohl, n. sp. (p. 133).

Front and back views of the holotype (× 20), from the Ripley formation at loc. 29. USGS 25485, USNM 128582.

25, 43. *Gegania parabella* (Wade) (p. 134).

25. Back view of a topotype (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128584.

43. Front view of a topotype (× 2) from loc. 1. USGS 25406, USNM 128585.

26, 27. "Ampullinae" indet. (p. 127).

Back and front views of an internal mold (× 1) from the Prairie Bluff chalk at loc. 67. USGS 8306, USNM 128567.

28, 32, 33. *Gegania bella prodiga* Sohl, n. subsp. (p. 135).

28. Apical view of a paratype (× 8) from the Ripley formation at loc. 6. USGS 25406, USNM 128587.

32, 33. Front and rear views of the holotype (× 2) from the Ripley formation at loc. 14. USGS 17277, USNM 128586.

34, 36. *Gegania?* sp. (p. 135).

Front and back view of an internal mold (× 1) from the Prairie Bluff chalk at loc. 87. USGS 6843, USNM 128590.

35, 41, 42. *Plesiotrition cretaceus* Sohl, n. sp. (p. 128).

Views of the holotype (× 4) from the Ripley formation at loc. 6. USGS 25407, USNM 128569.

37, 38. *Gegania bella* (Conrad) (p. 135).

Back and front views of a topotype (× 1) from the Ripley formation at Eufaula, Ala. USNM 21162.

39, 40. *Globularia* (*Ampullella*) *umbilica* (Wade) (p. 125).

Back and front views of the holotype (× 4) from the Coon Creek tongue of the Ripley formation at loc. 1. USNM 73071.

44. *Charonia? univaricosum* (Wade) (p. 128).

Front view of a topotype (× 1) from the Coon Creek tongue of the Ripley formation at loc. 1. USGS 25406, USNM 128568.

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