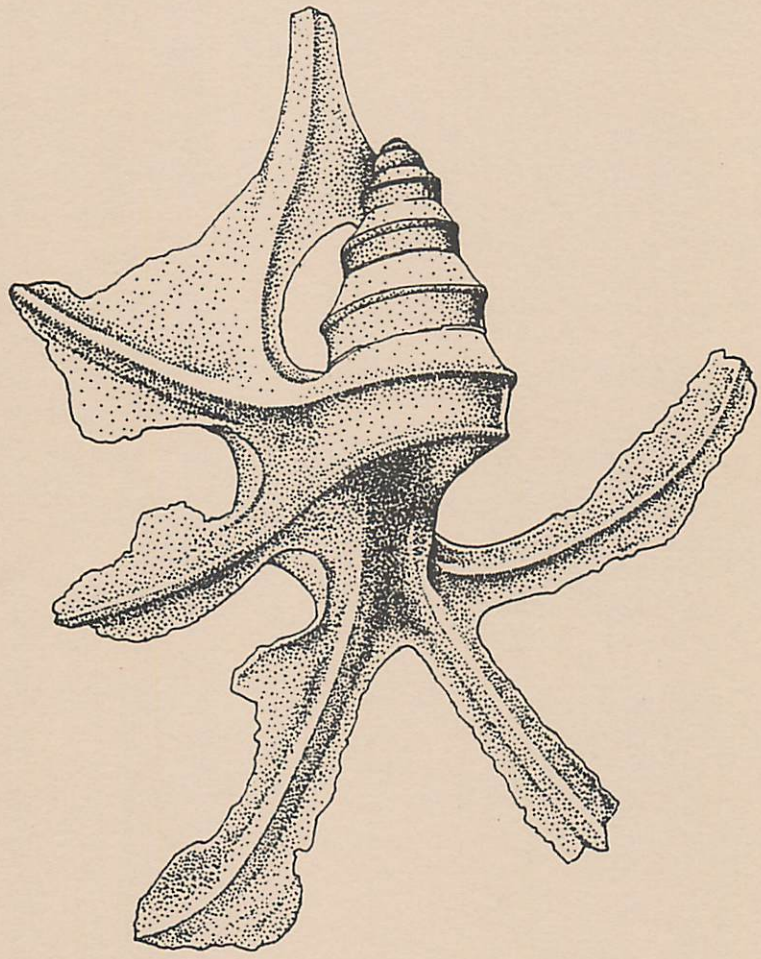
THE STREPTONEURAN GASTROPODS, EXCLUSIVE OF THE STENOGLOSSA, OF THE COFFEE SAND (CAMPANIAN) OF NORTHEASTERN MISSISSIPPI

David T. Dockery III



BULLETIN 129

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF GEOLOGY

S. Cragin Knox
Director

Jackson, Mississippi
1993

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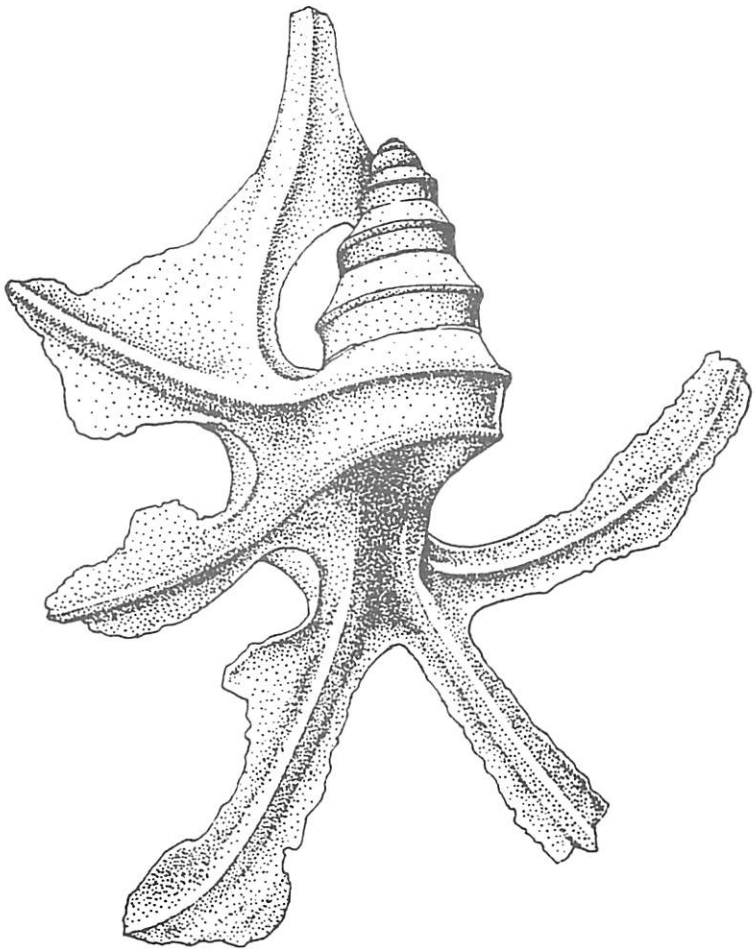

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COVER: *Pterocerella maryea* n. sp. holotype 457000 USNM, dorsal view (x4).

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STATE OF MISSISSIPPI
DEPARTMENT OF ENVIRONMENTAL QUALITY
JAMES I. PALMER, JR.
EXECUTIVE DIRECTOR

March 31, 1993

Mr. Henry W. Weiss, Chairman, and
Members of the Commission
Department of Environmental Quality

Commissioners:

Mississippi lies within the Gulf Coastal Plain Physiographic Province and is a state reclaimed from the sea. Geologic formations that underlie the State's thin veneer of soil often contain fossils of marine animals from the oceans of times past. These fossils are useful in recognizing and mapping formations of the same age and are of interest to professional paleontologists and hobbyists (rock and fossil collectors) worldwide. For certain geologic periods and epochs, Mississippi is world renowned for its marine fossils. This is true of the Upper Cretaceous molluscan faunas of northeastern Mississippi.

This bulletin is a modification and expansion of a Ph.D. dissertation by the writer accepted by the Graduate School of Tulane University on July 18, 1991. It reports on a hundred species of Upper Cretaceous (Campanian Stage) gastropods from the Coffee Sand of Lee County. These are illustrated in 42 plates and are exceptionally well preserved, especially when considering that they are about 81 million years old. Even the tiny larval shells show beautifully preserved details when examined under a scanning electron microscope. According to Klaus Bandel (personal communication), a professor of paleontology at the University of Hamburg, Germany, the Coffee Sand gastropods reported here constitute the best preserved Campanian fauna known anywhere. As such, they are of global interest and contribute to our overall understanding of fossil and living mollusks as well as to the regional geology.

Respectfully submitted,

S. Cragin Knox
Director and State Geologist

OFFICE OF GEOLOGY, P. O. BOX 20307, JACKSON, MS 39289-1307, (601) 961-5500, FAX (601) 961-5521

THE STREPTONEURAN GASTROPODS, EXCLUSIVE OF THE STENOGLOSSA, OF THE COFFEE SAND (CAMPANIAN) OF NORTHEASTERN MISSISSIPPI

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DEDICATED TO NORMAN FREDERICK SOHL
July 14, 1924 - April 14, 1993

Norman F. Sohl contributed greatly to the understanding of Mississippi's Cretaceous stratigraphy and gastropod faunas. He was first to publish the gastropods of the Coffee Sand. Norm worked 39 years with the U. S. Geological Survey before his retirement on April 3, 1993. His retirement party was on April 7, only a week before his death. During his tenure at the Survey, Norm served as Chief of the Paleontology and Stratigraphy Branch (1968-1973) and as Chairman of the Geologic Names Committee (1977-1981). He was recipient of the Paleontological Society Medal for 1991. Fortunately, the Memphis Pink Palace Museum requested an autobiography from Norm to be displayed at their Coon Creek Site. This autobiography was written in 1991 and, with only minor editing, is given below.

D. T. D.

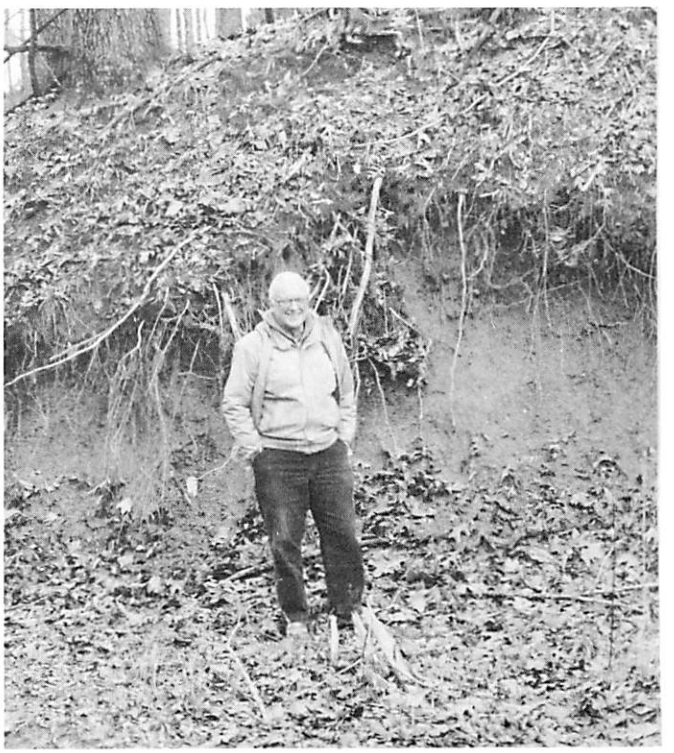
AUTOBIOGRAPHY
NORMAN FREDERICK SOHL

I was born in Oak Park, Illinois, on July 14, 1924, to Florence Wray and Fred John Sohl, a pharmacist, who had graduated from Northwestern University. My early years were spent in Forest Park, Illinois, where I attended elementary school. My first contact with geology came when I read a high school text for a course taken by my older brother Jerry (now a writer in California) at Proviso Township High School.

Although suburban Chicago lies within the glaciated area and offers no nearby rock outcrops, I lived near the main line of the Chicago, Burlington, and Quincy Railroad, extending to the west from Chicago. Most of the road bed rip-rap was composed of Silurian dolomites that commonly bore recognizable remains of corals, brachiopods, or other such fossil treasures. However, these rocks were of secondary interest to me at this stage, as my main passion was playing shortstop in pickup baseball games on the Chicago prairies, our nickname for vacant lots, during the summer. Winter was devoted to playing basketball for the Presbyterian Church, and between ball seasons I boxed for the Catholic Youth Organization, playing no favorites among religions.

My father died when I was fifteen years old, and the course of my life changed greatly. After completing my sophomore year of high school, I drove my mother to southern California where she could be near her family. Early in 1942 I returned to Illinois to live with my brother in Sycamore, Illinois, and finish high school there.

In 1943, like most other young men at the time, I was drafted into the Army and sent to Europe with a rifle company in the First Infantry Division. We landed on Omaha Beach in Normandy on D-Day, June 6, 1944. The course of the war took me through France, Belgium, and into Germany. On 17 October 1944, I was in Aachen, Germany, where General Huebner was preparing his final offensive. To quote *Bloody Aachen* by Charles Whiting, "The battle swayed back and forth. But in the end the Americans had to abandon it to the triumphant young SS men, who immediately started looking



Norm Sohl at roadcut just north of Unity on the road to Friendship in Lee County, Mississippi (MGS locality 130), where most of the Coffee Sand gastropods were collected for his 1964b report. At the time of this photograph (February 22, 1989), the locality was found to be nonfossiliferous due to leaching of shell material in the acid soil.

for American cigarettes and the much prized Hershey chocolate bars. Kicked out into the attack again by their NCO's, they pushed on against the Americans still holding the fringe of the park. But not all the Americans had fled before their wild advance. A lone mortar observer of the forward American company refused to budge although the SS men were only a matter of yards away. Buried at the bottom of a foxhole, he whispered into his phone, giving the co-ordinates of his own position. With an obscene belch the 4.2 mortars opened up." That unnamed lone mortar observer was Norman F. Sohl, and I'm pleased to announce that he survived that mortar fire and received the Bronze Star for his efforts. I managed to stay alive and intact until late November, when I was wounded in the Hurtgen Forest in Germany. That was the end of combat for me, and after recuperation in a military hospital in Tunbridge Wells, England, I was sent back to Germany to serve out the war in Eisenhower's Headquarters ending in Berlin in 1945.

Along with the host of other returning veterans, I took advantage of the G.I. Bill and entered the University of Illinois in 1946. On June 5, 1947, I married Dorothy M. Jansen of Sycamore, Illinois, and, remarkably, we are still together.

My original intention at the university was to major in history and philosophy, but during my junior year I took a beginning course in Geology as an elective. To me the initial major appeal of Geology was that it was a discipline that took all of the earth as its natural laboratory. It was the amalgam of all the other scientific specialties applied to solving problems relating to our immediate surroundings. Because of my interest in history, I found stratigraphy and the chronologic aspects of the science especially appealing.

This was a time of expansion in faculty at Illinois, and young and energetic professors with youthful enthusiasm for their subjects created an exciting atmosphere in which to study. I completed my B.S. in Geology in 1949 with hopes of employment in the oil industry. Hydrocarbon exploration at this time was, unfortunately, in a post-war decline, and no jobs were available. Having still more support obtainable under the G.I. Bill, I accepted the alternative of entering graduate school in Geology. I also found employment as a research assistant with the Industrial Minerals Division of the Illinois Geological Survey. My summer was spent mainly in the field investigating limestone and flourspar resources of southern Illinois. I was encouraged both by the Survey administration and the faculty of the Geology Department to continue work in the industrial mineral field and to eventually do my thesis in this subject area. However, other factors arose to upset these plans.

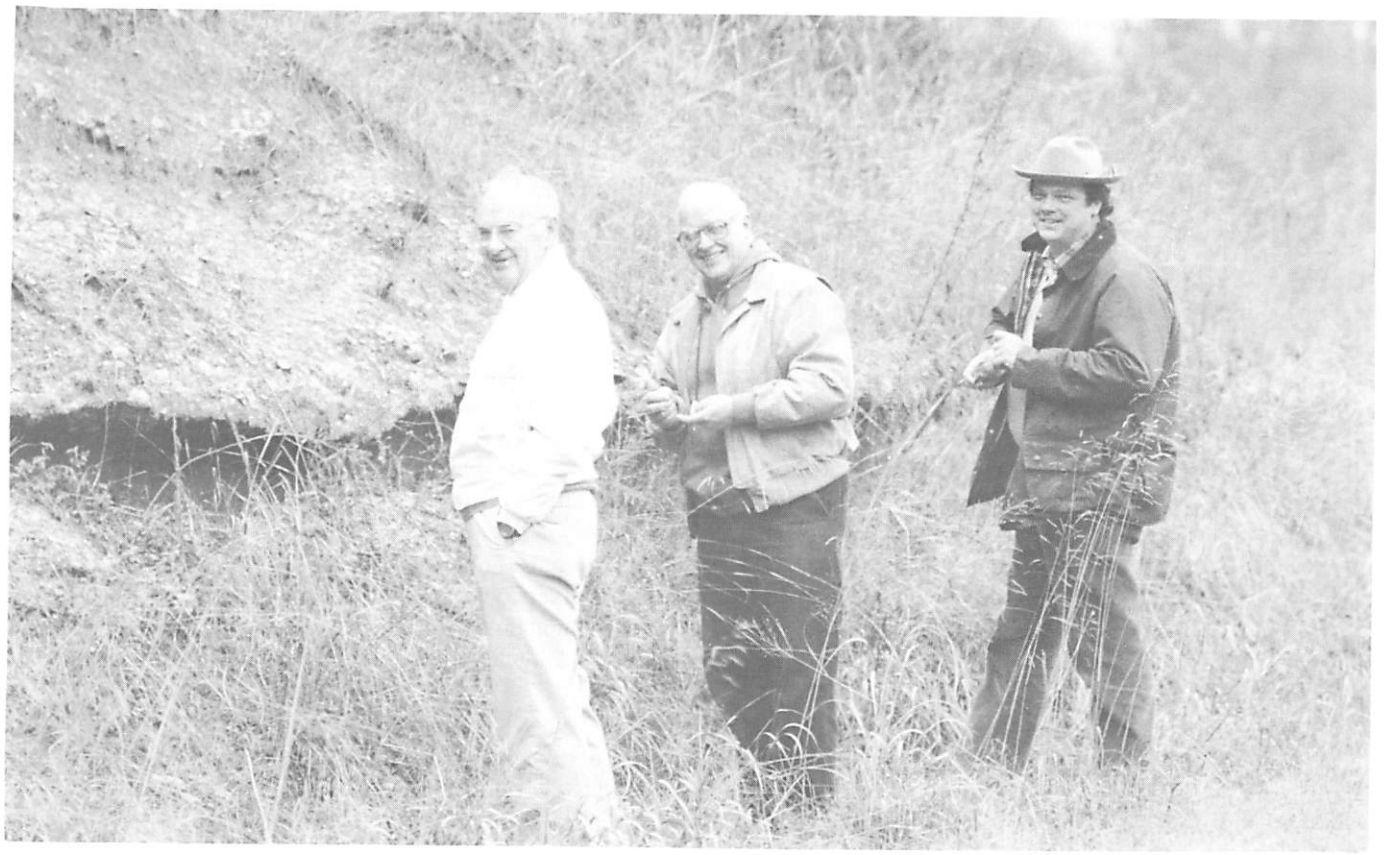
During my first year of graduate work, I fell under the thrall of a young Professor of Paleontology and Stratigraphy, Bernhard Kummel. I signed up for his course in Mesozoic and Cenozoic Stratigraphy, an action that changed my life. The arena that Bernie used as his setting for stratigraphy was the world and not the classical U. S. approach to which I had been accustomed. Emphasis was on global relationships and basin evolution, not the rote memorization of stratigraphic columns. By the end of that year I had decided that I wanted to develop a career in biostratigraphy. I left the Illinois Survey and accepted a position as a teaching assistant with Kummel and the sedimentary petrologist, Jack L. Hough. Both men remained close friends until their deaths, and I owe both a great debt for all the support they gave me in getting started with my career.

As Kummel's assistant I spent the summer of 1950 working with him on the Triassic stratigraphy of northern Utah, southern Idaho and western Wyoming. The work was partially supported by the U. S. Geological Survey and was my first contact with that organization. I had the opportunity to meet Survey men such as Bill Ruby, Preston Cloud, Vince McKelvey and John Reeside, whose names I had only known from papers I had been assigned to read as a student. What a wonderful new world I had fallen into!

Eventually the time came to decide on a topic choice for my thesis. Kummel and I worked up a list of possible areas of study, one of which was work with the Mesozoic Gastropoda, a likely area, because there were no active specialists in this field in the United States at that time. Bernie submitted the list to paleontologists he knew. Among the replies was one from Lloyd W. Stephenson, Ralph Imlay, and John B. Reeside of the USGS at the National Museum, who suggested that I work in the Upper Cretaceous of the Gulf Coastal Plain. Because of the known exceptional state of preservation of mollusks that were contained in the Late Cretaceous of Tennessee and Mississippi, we decided on that as the place to work. A significant contribution to knowledge of Cretaceous Gastropoda lay there waiting to be unearthed.

My first objective was to locate and collect Bruce Wade's fauna from Coon Creek, Tennessee. This may seem an easy task now that the site is so famous and has been developed as a study center by the Memphis Museum Center. However, in 1950 the area was considerably more remote, especially to a young man raised in the wilds of suburban Chicago. The only paved roads in the area were U. S. Route 45 and the new Memphis Highway, U. S. Route 64. Local topographic maps were non-existent; residents did not know of any place called Coon Creek or "Dave Weeks Place". I finally encountered a Mr. Crumby, who remembered Dave Weeks and knew of the shelly exposures in the creek, which he referred to as remnants of the "Great Flood". In fact, Mr. Crumby rather informally kept track of the property, which was no longer being farmed. In subsequent years I always stopped to visit with this old gentleman, and we became friends.

When I first visited the site, the old Weeks house was still there, but deserted, and only an old rutted track running along the field border led down toward the creek. My car, a passenger vehicle, could not manage this passage, and all collections had to be carried up to the old homestead. Coon Creek was a wonderful place to collect when I first saw it. At that time not a scar of



Norm Sohl (middle), James P. Owens (left), and Wayne L. Newell (right) at Coffee Sand - Demopolis Chalk contact (base of ledge formed by lithified oyster biostrome) in a roadcut on north side of the Guntown-Chapelville Road just east of Five County Sportsman Lake in the SW/4, SE/4, Section 26, T. 7 S., R. 6 E., Lee County, Mississippi (photograph taken February 22, 1989).

a previous collector's efforts could be seen, the exposures were washed smooth and the stream banks were steep along the full course of the creek.

During the course of my early trips to the locality, I removed several tons of material. Most blocks were placed in nail kegs, which are no longer available, for shipment. At that time hardware stores sold their nails from such containers, and on each trip I scoured these establishments for them. To seal them one removed the upper steel retainer band, placed burlap across the opening, tapped down the band over the burlap and nailed the keg shut. They were the strongest shipment containers I have ever encountered.

While collecting at Coon Creek, I stayed in Selmer, Tennessee, at the Gooch Hotel, located next to the railroad tracks. Both Mr. and Mrs. Gooch were elderly but very hospitable, and additionally, charged only $2.00 a night for a room, a price a graduate student could almost afford. Seldom did they have another guest while I was there. Mrs. Gooch once showed me the family silver that she maintained had been buried by her forebears at the time of the battle of Shiloh to save it from the "Yankees".

Selmer, at that time, seemed to me a sleepy picturesque little southern farm-market town. I remember coming in from the field one day to find Mrs. Gooch inordinately excited. The town was agog with the news that the drug store had been robbed of several watches the preceding evening. In Mrs. Gooch's view, the perpetrator had to be someone local, because, as she said, only someone local would have known that the back door of the drug store was left open at night just in case someone became ill and needed medicine. Obviously, times have changed.

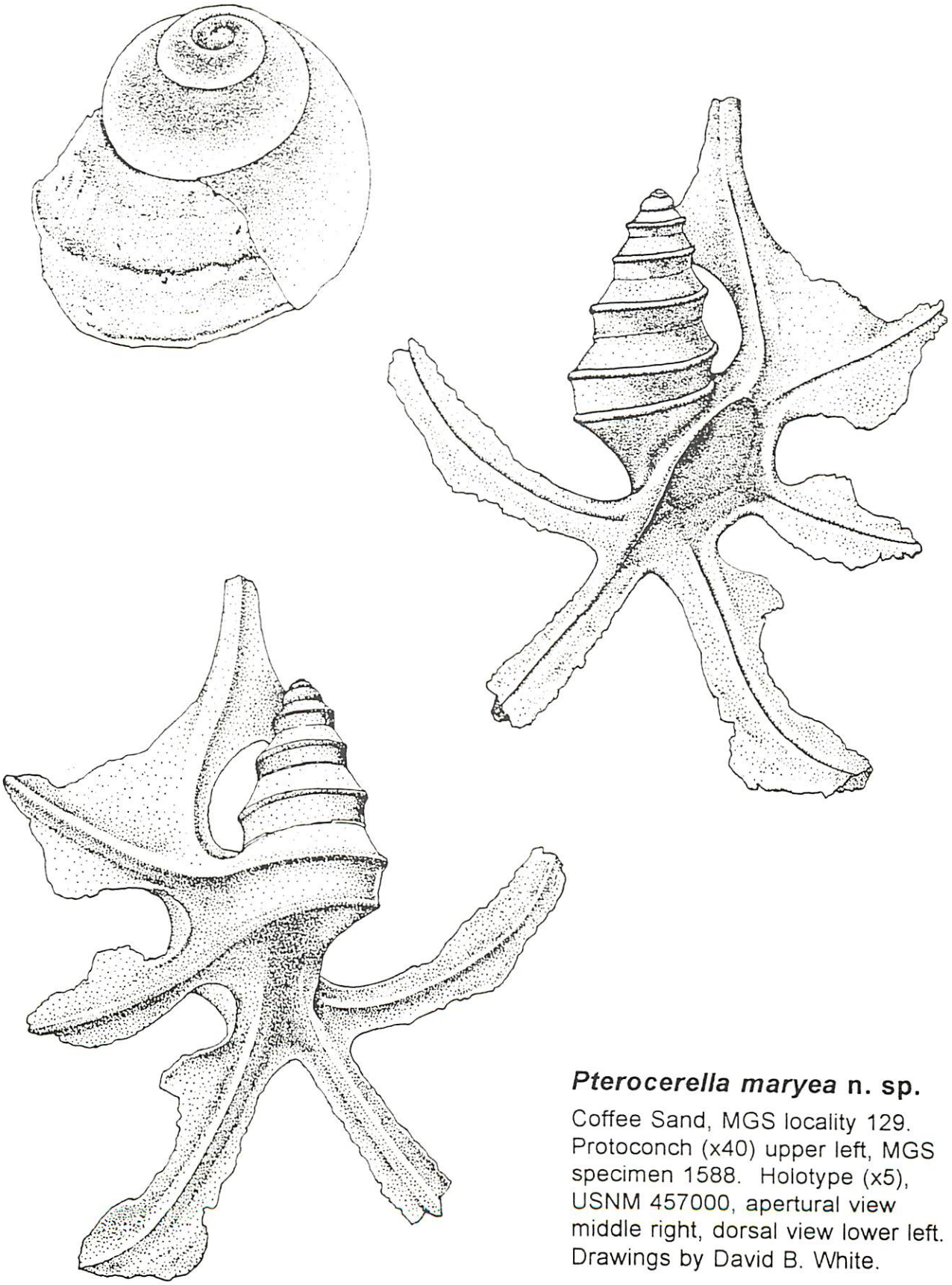
Collecting to the south into Mississippi followed much the same pattern. There were no motels in most towns then. Usually I inquired at a gas station for the location of a rooming house. After finding a place to stay, my next move was to contact the county road commissioner for a county road map. Because topographic maps did not exist for these areas at this time, these blueprint county maps were invaluable for making road traverses and locating outcrops. Such maps served as the basis both here and elsewhere for my work in the Coastal Plains in the early 1950's.

Part way through my thesis work, my major professor, Bernhard Kummel, left the University of Illinois to accept a position with the Department of Geology at Harvard University. I was to follow him there, but found that, because of University residency requirements, I would have had to take an additional year to finish my work. In the interim I was offered an opportunity to replace a faculty member, who was going on a sabbatical, and teach for a year at Bryn Mawr College in Pennsylvania. By accepting, I gained experience teaching historical geology and paleontology, as well as an opportunity to see the collections of type specimens for many of the species I was describing in my thesis in the National Museum in nearby Washington, D. C. It was a most enjoyable year with the challenge of teaching, taking students into the field, and becoming acquainted with the eastern seaboard. While at Bryn Mawr, I received an offer from the geology department at Illinois to return as an Instructor for Historical Geology, Invertebrate Paleontology, and Mesozoic Stratigraphy. This appointment allowed me to finish my thesis while earning a living at the same time for a family that was about to grow in number. Our son, Norman F. Sohl, Jr., was born on January 26, 1954.

My main concern, beside finishing a thesis and carrying my teaching load, was to search for a permanent position after the school year was over. Fortunately, there were many academic positions available at that time, and my sights were set on pursuing a teaching career. At the same time Preston E. Cloud, the Chief of the U.S.G.S. Paleontology and Stratigraphy Branch, was expanding his staff. We met at a Geological Society of America convention and during the interview, I told him of my career research goals. He indicated interest in my joining his group, and eventually a firm offer was forthcoming for employment as a paleontologist with the Survey at the National Museum of Natural History in Washington, D. C. The opportunity to work with such geologists as Lloyd Stephenson, John Reeside, and Ralph Imlay offered a unique opportunity to learn more of Mesozoic paleontology and stratigraphy. In addition there were other renowned workers on fossil and recent mollusks, such as Wendall Woodring, Ralph Stewart, Julia Gardner, Harold Rehder, and J. Brooks Knight on the Survey or Museum Staff, which presented an extraordinary opportunity to tap an incredible reservoir of accumulated knowledge. An offer to join such a group was not to be denied.

In September 1954, upon completion of my Ph.D., I joined the Survey. My initial duties were to continue the Cretaceous coastal plain studies that were begun by Stephenson during the early part of the century. I began by expanding my thesis to include the additional material in the collections in Washington while concurrently carrying on field studies in the Upper Cretaceous of the Chattahoochee River region of Georgia and Alabama. The government's publication mills grind slowly, and the work on Coon Creek and Mississippi was not to appear until 1960-1964 (Professional Paper 331). Meanwhile, my areas of interest had expanded to include work on the Western Interior Jurassic and Cretaceous gastropod faunas (Professional Papers 393 and 502).

Next I began work in the Caribbean region to support the Survey's geologic mapping program of the island of Puerto Rico in cooperation with the Commonwealth Government. Creating a viable biostratigraphy in the Cretaceous of the Antillean islands was a great challenge, because it meant learning the faunas of a new biotic province. It introduced me to those strange, if not bizarre, pelecypods, the rudists that develop reef-like framework structures in the tropical regions of the Cretaceous. Many of the gastropods are equally strange, and in Professional Papers 1125 and 1304 I described a number of these.



***Pterocerella maryea* n. sp.**

Coffee Sand, MGS locality 129. Protoconch (x40) upper left, MGS specimen 1588. Holotype (x5), USNM 457000, apertural view middle right, dorsal view lower left. Drawings by David B. White.

THE STREPTONEURAN GASTROPODS (EXCLUDING STENOGLOSSA) OF THE COFFEE SAND (CAMPANIAN) OF NORTHEASTERN MISSISSIPPI

David T. Dockery III

ABSTRACT

A recently discovered fossiliferous zone, the Chapelville fossiliferous horizon, in the Tupelo Tongue of the Coffee Sand in northern Lee County, Mississippi, contains the best preserved and most diverse molluscan fauna known from the Campanian Stage (Upper Cretaceous). This fauna contains about three hundred molluscan species and is comparable in both preservation and diversity to the well known Maastrichtian fauna of the Coon Creek Tongue of the Ripley Formation at Coon Creek in McNairy County, Tennessee. Thirty families, seventy genera (three of which are new), and one hundred species from the Coffee Sand are discussed in the systematic section of this report and are illustrated in Plates 1-42. All but one of these taxa are streptoneuran gastropods (the Stenoglossa not included). Six species of archaeogastropods are recognized, two of which are new. The Caenogastropoda, exclusive of the Stenoglossa, include ninety-three species, forty-nine (including one subspecies) of which are new. The pulmonate limpet *Anisomyon* is also discussed, and its protoconch is illustrated for the first time by scanning electron microscopy.

Protoconchs of several taxa are described here for the first time. Two genera, *Demasia* and *Lemniscolittorina*, which had previously been assigned to the archaeogastropod Family Neritidae and the caenogastropod Family Littorinidae, respectively, are reassigned to the heterostroph families Amathinidae and Mathildidae based on their protoconchs. *Damesia* is recognized as the larval shell of a pyramidellid limpet related to the extant genus *Amathina*.

The systematic section contains a new classification that incorporates parts of the recently proposed gastropod classifications of Ponder and Warén (1988) and Haszprunar (1988a, b). The Chapelville gastropod fauna of the Tupelo Tongue provides a window into the pre-Maastrichtian streptoneuran diversity of the northern Gulf region of the U.S. It contains the earliest geologic record of several Cenozoic taxa and is surprisingly modern in many respects.

ACKNOWLEDGMENTS

Numerous workers have freely assisted in this project and have given valuable constructive criticism of the text. Though these critical reviews were greatly appreciated, all suggested revisions were not necessarily taken. Therefore, those acknowledged here are included in appreciation of their help and should not be blamed for the content in every detail. They are listed below in alphabetical order followed by the area of their contribution in parentheses.

Warren D. Allmon, University of South Florida (cladistics, gastropod phylogeny, and Turritellidae); **Vicky D. Andrews**, Millsaps College (SEM photography); **Klaus Bandel**, University of Hamburg, West Germany (gastropod phylogeny and larval shell morphology); **Alan G. Beu**, New Zealand Geological Survey (Cymatiidae); **Rüdiger Bieler**, Field Museum of Natural History, Chicago (Heterostropha); **Michael B. E. Bograd**, Mississippi Office of Geology (text editing); **Philippe Bouchet**, National Museum of Natural History, Paris, France (Eulimidae and Epitoniidae); **Lyle D. Campbell**, University of South Carolina, Spartanburg (*Urceolabrum*); **William A. Cobban**, U.S. Geological Survey, Denver, Colorado (ammonite biostratigraphy); **James X. Corgan** (Pyramidellidae); **Luc Dolin**, Saint Denis, France (Cypraeoidea); **William P. Elder**, U.S. Geological Survey, Menlo Park, Calif. (Stromboidea); **Christopher L. Garvie**, United Kingdom (*Tundora*); **Lindsey T. Groves**, Natural History Museum of Los Angeles County (Cypraeoidea); **Gerhard Haszprunar**, Innsbruck University, Austria (gastropod phylogeny and systematics); **David Jablonski**, University of Chicago (phylogeny and systematics); **Tomoki Kase**, National Science Museum, Tokyo, Japan (Heteropoda - Carinarioidea); **James Kennedy**, Oxford University Museum, U.K. (ammonite identification and biostratigraphy); **Angel A. Luque**, Autonoma University, Madrid, Spain (Epitoniidae and gastropod larval shell morphology); **Earl Manning**, L.S.U. Museum of Geoscience, Baton Rouge, Louisiana (cladistics); **James H. McLean**, Natural History Museum of Los Angeles County (gastropod phylogeny, Archaeogastropoda, and *Urceolabrum*); **Marcos Montes**, Institute for Technology Development, Jackson, Mississippi (SEM photography of small gastropods and larval shells on the ITD Scanning Electron Microscope); **Ronald L. Parsley**, Tulane University (text review); **Winston F. Ponder**, Australian Museum (gastropod phylogeny and systematics, Neritimorpha, and Truncatelloidea); **Robert Robertson**, Academy of Natural Sciences of Philadelphia (Heterostropha and Epitoniidae); **Kaustuv Roy**, University of Chicago (Aporrhaiidae); **Ernest E. Russell**, Mississippi State University (SEM photography of small gastropods and larval shells on the MSU Scanning Electron Microscope);

LouElla Saul, Natural History Museum of Los Angeles County (Aporrhaiidae); **Hubert C. Skinner**, Tulane University (text review); **Norman F. Sohl**, U.S. Geological Survey, Reston, Virginia (text review); **Steve Tracey**, United Kingdom (*Entomope* and *Streptacis*); **Emily H. Vokes**, Tulane University (text review); **Anders Warén**, Swedish Museum of Natural History (Epitoniidae and Eulimidae); **John B. Wise**, George Washington University (Pyramidellidae).

Special thanks are due **Mr. and Mrs. Cecil Griffin** for graciously allowing the collection of fossils and the drilling of test holes on their property at Chapelville. Thanks are also due **Mr. Ashby Green** for permission to drill the Green Estate Test Hole 1 and Guntown **Mayor Ernest Herring** for permission to drill the Guntown Test Hole 1. Appreciation is also extended to the Mississippi Office of Geology staff who assisted with the drilling program.

INTRODUCTION

The first publication to deal with the well preserved Upper Cretaceous molluscan faunas of the Mississippi Embayment region is that by Conrad (1858), who described a collection made by Dr. Spillman at the classic Owl Creek locality in Tippah County, Mississippi. His report included the description of 56 new species of Maastrichtian age. A second report by Conrad (1860) included additional Maastrichtian species from Tippah County, as well as an equivalent or very slightly younger fauna from Eufaula, Alabama. According to Sohl (1960), Conrad's latter Tippah County species included many taxa known only, or more commonly, from the lower Ripley Formation (= Coon Creek Tongue). At the time Conrad published his reports, Tippah County included the northern part of what today is Union County. It is probable that northern Union County was the source of many of Conrad's (1860) taxa.

A long hiatus followed the works of Conrad in which the Mississippi Embayment's Cretaceous molluscan faunas went unstudied. However, the generally less well preserved Cretaceous faunas of the Atlantic Coastal Plain were the focus of several monographic works at this time, including those for New Jersey (Whitfield, 1892; Weller, 1907), Maryland (Gardner, 1916), and North Carolina (Stephenson, 1923). Also, Stephenson (1914) delineated the *Exogyra* faunal zones of the Gulf and Atlantic coastal plains, an important contribution to the stratigraphy of the upper Mississippi Embayment region. Wade (1917, 1920) contributed short papers on the Cretaceous stratigraphy of Tennessee and in 1926 published the classic monograph "The fauna of the Ripley Formation on Coon Creek, Tennessee." This work cited the occurrence of 350 species at Coon Creek, 174 of which were gastropods. At present, this is the most diverse Cretaceous fauna known from a single locality.

Sohl (1960, 1964a) updated and expanded the systematic studies of Conrad and Wade with his reports on the Maastrichtian gastropods of the Ripley, Owl Creek, and Prairie Bluff formations. In conjunction with these works, Sohl (1964b) also published on a Campanian gastropod fauna from the Coffee Sand in Mississippi. His publication described 63 species that were assigned to 53 genera; 21 of these species were new. A faunal checklist cited the occurrence data for bivalve, scaphopod, and cephalopod species, as well as for the gastropods. This list contained twelve collecting localities in the Coffee Sand in Lee, Prentiss, Alcorn, and Tishomingo counties. However, most of the species cited came from a single locality, locality 6 of that report = USGS localities 17254, 17809, 25483, and 26338 (USGS collections made at different times from the same locality are given different numbers). Though fairly well preserved mollusks were collected from this locality, they were never abundant (Sohl, personal communication). Locality 6 was visited by Sohl, Dockery, and others on February 22, 1989, and found to be unfossiliferous. Shells are often leached from the Coffee Sand due to the development of acid soils on the outcrops (Pettry et al., 1990).

A significant new Coffee Sand locality was discovered in the spring of 1976 during the construction of the Natchez Trace Parkway just south of Twenty Mile Creek in northern Lee County, Mississippi. At this time, it was reported to the Mississippi Geological Survey (now the Mississippi Office of Geology) that the road construction had uncovered numerous concretions containing ammonites. The writer, along with Survey geologist Wilbur Baughman, examined the Parkway roadcuts on May 19, 1976, and found them to be moderately to sparsely fossiliferous. However, one roadcut in a hillside along a service road next to the Parkway contained a richly fossiliferous sequence. The fauna of this locality, MGS locality 128, appears abruptly at the base of an otherwise unfossiliferous gray shale section. The upper bed of this stratigraphic sequence was dominated by the large bivalves *Exogyra ponderosa* Roemer, *E. ponderosa erraticostata* Stephenson, and *Cucullaea (Idonearca) grandis* (Wade). Other beds of concentrated shells occurred in a sandy shale/shaly sand below the upper one. The lower half of this sequence contained a fossiliferous sand with boulder-sized concretions. Ammonites occurring in the concretionary zone and the overlying sandy shale include *Placenticeras, Menabites (Delawarella)*, and *Baculites*. The Natchez Trace locality (MGS locality 128) has been collected sporadically over the past fourteen years and is largely overgrown at the present time.

A second fossiliferous Coffee Sand locality containing beds equivalent to those present at the Natchez Trace site was uncovered in the spring of 1982 in a borrow pit during construction on the Friendship-Pratt Road just south of Twenty

Mile Creek in Lee County (figures 1-2). This borrow pit, MGS locality 129, is owned by Cecil Griffin, who has graciously allowed the writer to collect from it over the past 11 years. Most of the material in the Coffee Sand mollusk collections at the Mississippi Office of Geology, as well as most of the specimens described and figured here, are from this locality. The stratigraphic sequence at the Griffin borrow pit is similar to that at the Natchez Trace locality and is shown in Figure 3. Though this section includes five fossiliferous units, beds A-E, two units stand out because of their diversity and preservation, beds B and E. These latter beds bound a stratigraphic interval that was informally named the Chapelville fossiliferous horizon by Dockery and Jennings (1988). Chapelville is a small community (in Sec. 29, T. 7 S., R. 7 E., Lee County) at a fork in the road leading to the Natchez Trace and Griffin borrow pit localities. Traveling toward the east, the left fork (the continuation of the Friendship-Pratt Road) leads to the Griffin site and the right fork leads to the Natchez Trace site.

Bed B of the Chapelville horizon is a concretionary sand unit containing a fauna of large, well preserved gastropods and bivalves in its lower part. The upper part of the bed contains an abundance of the bivalve *"Ostrea" falcata*, which forms lenticular shell coquinas. Pickup truck loads, about two cubic meters in total, of the lower sand interval have been taken to the Mississippi Office of Geology and sieved for fossils.

Bed E is a 0.3 meter thick, very fossiliferous sandy shale with an abundance of *Exogyra*. Fossils of this bed quickly deteriorate upon exposure and weather due to the acidic nature of the soil. For this reason, bed E was not heavily collected by the writer in the initial stages of this work. It was not until Luc Dolin from St. Denis, France, who was studying cypraeids, and Christopher Garvie, a collector from England, on different occasions, dug back into the outcrop and noted this bed's rich diversity that it was collected in earnest. Since that time, as with bed B, pickup truck loads of sediment, about two cubic meters in total, from this bed have been sieved at the Office of Geology.

Bed E is notable for its exceptionally well preserved microfauna of small gastropods and gastropod larval shells. A similar small fauna is present in bed B, but these shells are often pitted on the surface when observed under high magnification. Bed E is also noted for containing the only cypraeid species known from the well preserved Cretaceous faunas of the Embayment region. Two specimens (the type and paratype) of *Bernaya (Protocypraea) mississippiensis* Groves, 1990, were collected from this bed. Well preserved otoliths from both beds E and B were described by Nolf and Dockery (1990), who noted the presence of 20 teleost fish taxa. This fauna indicates a shallow neritic environment in a tropical or subtropical area.

The Chapelville fossiliferous horizon is a fossil mollusk acme zone overlying a moderately fossiliferous marine interval in the lower part of the Coffee Sand. Most molluscan species range throughout this zone, but differences in the abundance of certain taxa were noted between beds B and E (those beds most studied). Bed B contains an abundance of the bivalves *"Ostrea" falcata* Morton and the small *Trigonia, T. eufaulensis* Gabb. These species are rare in bed E. Bed B is more strongly bioturbated than bed E and contains shell-lined vertical burrows with bivalve shells of the same species often stacked like sets of bowls. The large gastropods of this bed are not common, but when found are often accompanied by others, as if they were buried together. These gastropods are generally well preserved and show little or no distortion due to compaction. Large gastropods in bed E are usually somewhat flattened and fractured due to compaction and require special care during extraction from the matrix. The shells of bed E were probably rapidly buried beneath the fine-grained sediments of the overlying unfossiliferous shale sequence. Most of the abundant Exogyra of this bed have both valves in place and some seem to be in life position.

New species described in this report are listed below as they appear in the systematic text. All types are deposited at the U. S. National Museum.

Nerita reticulirata n. sp. Holotype 456982 USNM
Ataphrus griffini n. sp. Holotype 456983 USNM
Tympanotonus (Tympanotonus) robustus n. sp. Holotype 456984 USNM
Tympanotonus (Tympanotonus) binodosus n. sp. Holotype 456985 USNM
Tympanotonus (Exechocirsus) trilirus n. sp. Holotype 456986 USNM
Turritella chapelvillensis n. sp. Holotype 456987 USNM
Gymnentome unicarinata n. sp. Holotype 456988 USNM
Gymnentome canalis n. sp. Holotype 456989 USNM
Stosicia (s.l.) antiqua n. sp. Holotype 456990 USNM
Hyala fragila n. sp. Holotype 456991 USNM
Ceratia cylindrata n. sp. Holotype 456992 USNM
Entomope ponderi n. sp. Holotype 456993 USNM
Nozeba crassa n. sp. Holotype 456994 USNM
Tornus? planocarinatus n. sp. Holotype 456995 USNM
Perissoptera prolabiata mississippiensis n. subsp. Holotype 456996 USNM
Anchura coffea n. sp. Holotype 456997 USNM
Anchura corniculata n. sp. Holotype 456998 USNM
Anchura chapelvillensis n. sp. Holotype 456999 USNM
Pterocerella maryea n. sp. Holotype 457000 USNM
Lispodesthes amplus n. sp. Holotype 457001 USNM
Colombellina cancellata n. sp. Holotype 457002 USNM
Cerithioderma nodosa n. sp. Holotype 457003 USNM
Gyrineum (s.l.) gwinae n. sp. Holotype 457004 USNM
Sassia (Sassia) carlea n. sp. Holotype 457005 USNM
Cerithiella chapelvillensis n. sp. Holotype 457006 USNM
Cerithiella aequalirata n. sp. Holotype 457007 USNM
Monroea coffea n. sp. Holotype 457008 USNM
Eccliseogyra heliclina n. sp. Holotype 457009 USNM
Eccliseogyra inflata n. sp. Holotype 457010 USNM
Opaliopsis angustocosta n. sp. Holotype 457011 USNM

Figure 1. Chapelville horizon of the Coffee Sand at MGS locality 129 as viewed from the east. This photograph was taken in the summer of 1982 shortly after the borrow pit slope was graded. Mary Dockery is kneeling on bed E of the Chapelville section. Shells can be seen weathering from this bed and from the base of bed D below.

Figure 2. Chapelville horizon at MGS locality 129 as viewed from the south. Mary Dockery is on bed E. Shells can be seen weathering from bed E and the base of beds D and B below.

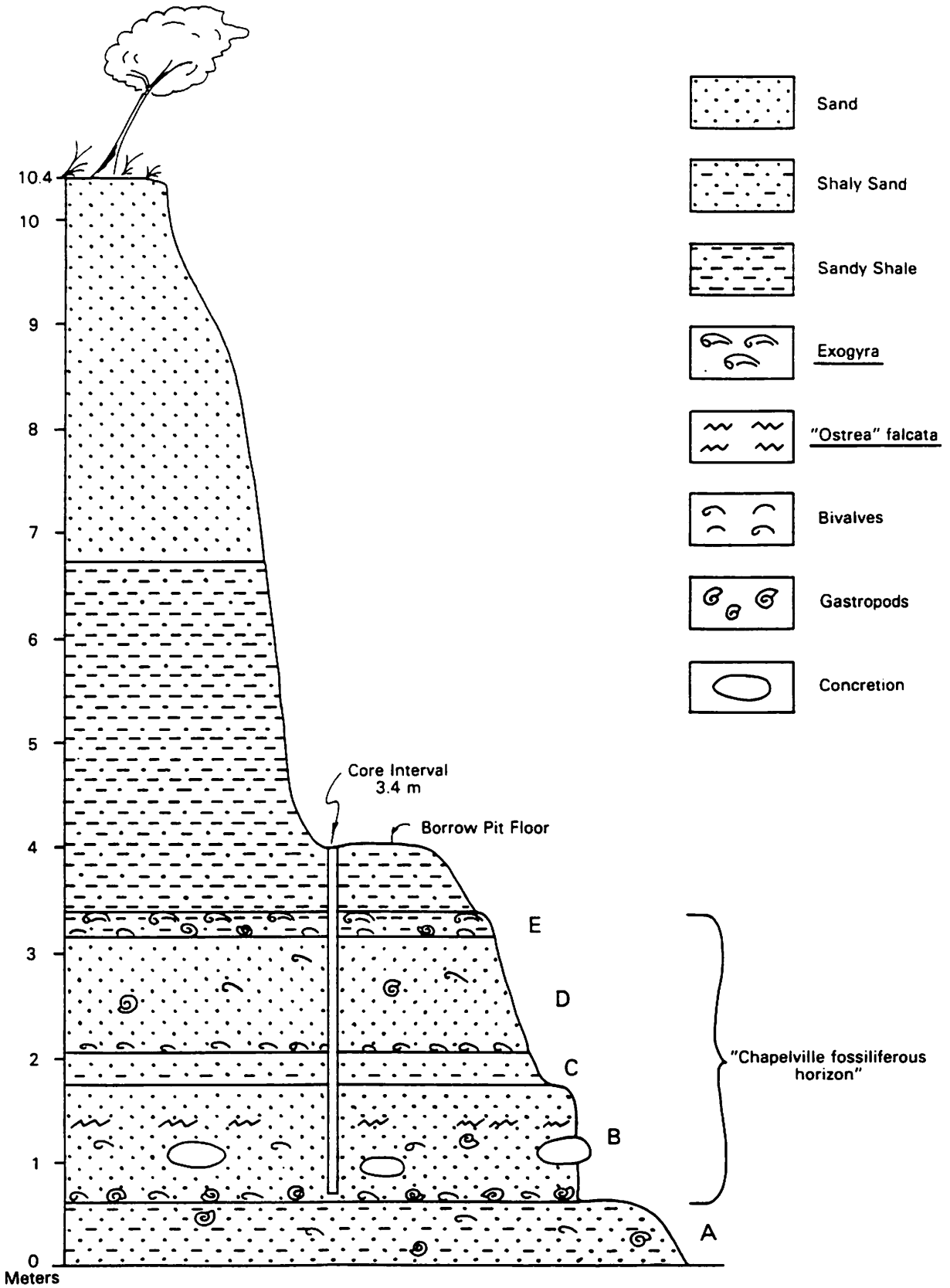


Figure 3. Measured section of Coffee Sand, MGS locality 129.

Pseudoclaviscala laevicosta n. sp. Holotype 457012 USNM
Pseudoclaviscala rugacosta n. sp. Holotype 457013 USNM
Epitonium faearium n. sp. Holotype 457014 USNM
Pauciacirsa simplex n. sp. Holotype 457015 USNM
Punctiscala melaniea n. sp. Holotype 457016 USNM
Striaticostatum griffini n. sp. Holotype 457017 USNM
Striaticostatum micropunctatum n. sp. Holotype 457018 USNM
Belliscala lirata n. sp. Holotype 457019 USNM
Belliscala nodosa n. sp. Holotype 457020 USNM
Aciculiscala coffea n. sp. Holotype 457021 USNM
Eulima coffea n. sp. Holotype 457022 USNM
Eulima spirala n. sp. Holotype 457023 USNM
Mathilda pentalira n. sp. Holotype 457024 USNM
Mathilda hexalira n. sp. Holotype 457025 USNM
Echinimathilda microstriata n. sp. Holotype 457026 USNM
Gegania mississippiensis n. sp. Holotype 457027 USNM
Lemniscolittorina yonkersi n. sp. Holotype 457028 USNM
Heliacus reticulatus n. sp. Holotype 457029 USNM
Neamphitomaria reticulata n. sp. Holotype 457030 USNM
Neamphitomaria planospira n. sp. Holotype 457031 USNM
Streptacis? bogradi n. sp. Holotype 457032 USNM

STRATIGRAPHY

The Coffee Sand is an updip terrigenous facies of the Selma Chalk (Selma Group). At its type locality at Coffee Landing on the Tennessee River in Hardin County, Tennessee, it overlies the Tombigbee Sand Member of the Eutaw Formation (Group) and is the basal unit of the Selma Group. It consists of cross-bedded, non-fossiliferous sands. This lithology persists across the state line into the northern parts of Prentiss and Tishomingo counties in Mississippi. However, the formation becomes progressively more marine toward the south, beginning at its base. Molluscan fossils from the basal part of the Coffee Sand just east of the Tennessee-Tombigbee Waterway divide cut, at the now extinct town of Holcut in Tishomingo County, were figured by Merrill et al. (1988). A similar fauna is exposed in the basal Coffee Sand just above the contact with the underlying Tombigbee Sand in a roadcut on the north side of Highway 30 east of Booneville in Prentiss County. This locality is on the east-facing slope of Martin Creek and was described and illustrated by Parks (1960, figure 11).

The Tupelo Tongue was first described by Stephenson (1917) as a southward extension or tongue of the Coffee Sand into the Selma Chalk sequence. This is the first use of the word "tongue" as a stratigraphic concept and formal term. The Tupelo Tongue overlies the Mooreville Chalk (actually a marl and hereafter referred to as the Mooreville Formation) of the Selma Group and is overlain by the Demopolis Chalk of the Selma Group. It occurs within the *Exogyra ponderosa* Zone of Stephenson (1914) and is of Campanian age. The northern limit of the Tupelo Tongue is in the vicinity of the Lee-Prentiss County line where the Mooreville grades into sands. Electrical logs from wells in this area indicate that the Mooreville may grade into the sands of the upper Tombigbee Sand Member of the Eutaw Formation, as it is mapped in northern Mississippi, rather than those of the lower Coffee Sand. The southern limit of the Tupelo Tongue is just south of Tupelo where the sands and shales of this unit grade into marls of the Demopolis Chalk. Figure 4 is a generalized geologic column of Upper Cretaceous deposits in Mississippi, showing the position of the Coffee Sand and Tupelo Tongue (Dockery, 1981).

Four test holes were drilled in the Guntown-Chapelville area of Lee County to determine the stratigraphic position of the Griffin borrow pit locality within the Coffee Sand sequence. The first test hole, Guntown Test Hole 1, was begun in the Demopolis Chalk to encounter a full section of the Coffee Sand. This hole was drilled on March 12, 1987. It penetrated 3 meters of the Demopolis Chalk (including an oyster biostrome in the lower 1.3 meters of the unit) and 73.5 meters of the Tupelo Tongue, and reached total depth in the Mooreville at 97.5 meters. Though it is difficult to distinguish between the shaly intervals of the Tupelo Tongue and the marls of the Mooreville in the cuttings and drilling characteristics, the resistivity curve of the electrical log clearly shows the presence of the Mooreville shale/marl interval. This finding extends the updip limit of the Mooreville into northern Lee County and differs somewhat with the statement of Stephenson and Monroe (1940, p. 144) that the Mooreville Tongue of the Selma Chalk "loses its identity by merging into and minor intertonguing with the Coffee Sand in central and northern Lee County." A second test hole, Griffin Test Hole 1, was drilled on March 13, 1987, in the floor of the Griffin borrow pit 0.3 meter above bed E at the top of the Chapelville fossiliferous horizon. A 3.4-meter interval including this horizon was cored at the top of the test hole. The hole was then completed to a total depth of 58 meters in the Tombigbee Sand. Only the lower section of this hole including the Tombigbee Sand Member and lower Mooreville Formation was logged due to a malfunction of the electrical logging equipment. A similar malfunction had marred the upper part of the Guntown Test Hole 1 electrical log. Both test holes encountered the Mooreville Formation overlying the Tombigbee Sand Member, thus indicating the Coffee Sand of this area to be technically the Tupelo Tongue.

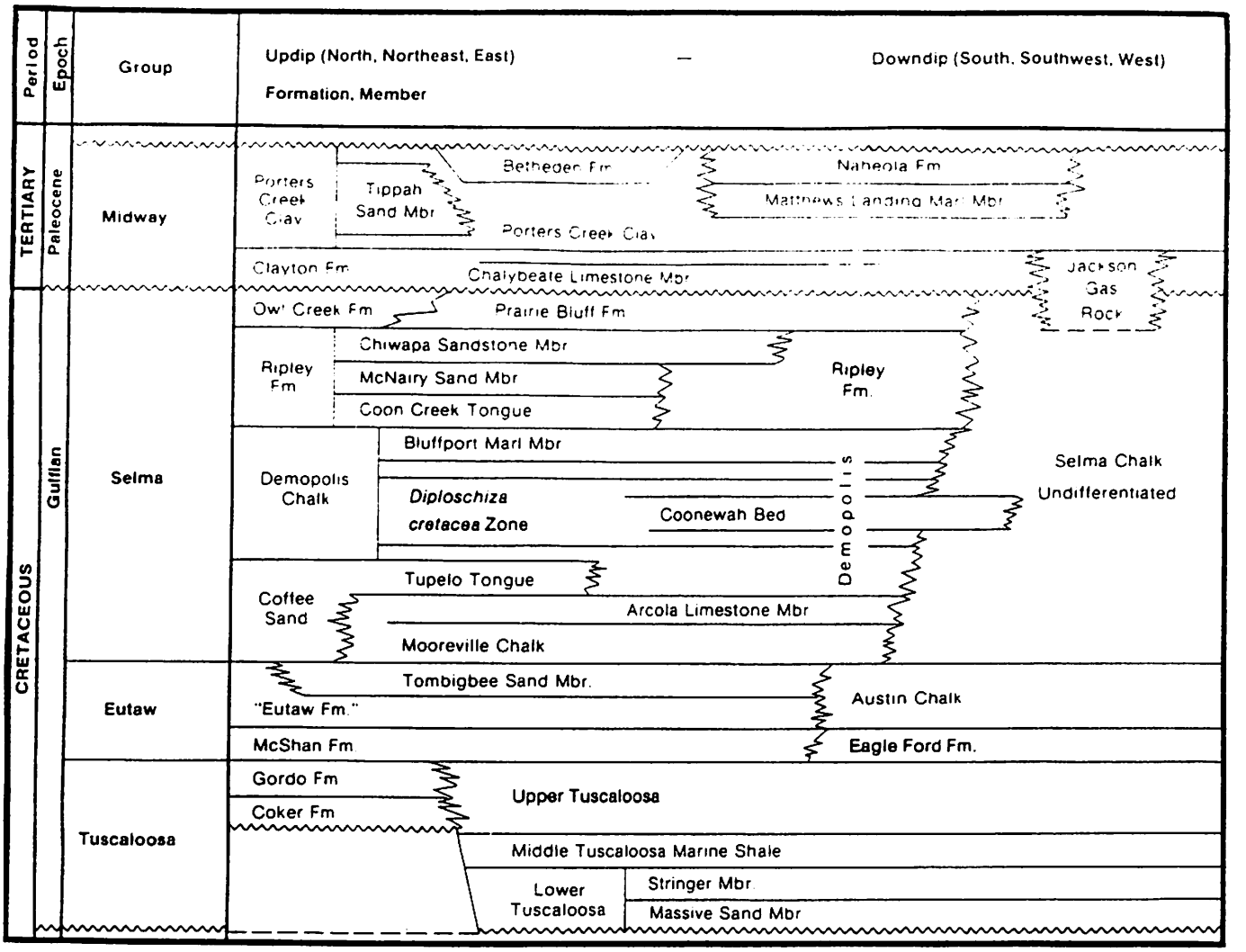


Figure 4. Generalized geologic column of Upper Cretaceous deposits in Mississippi, showing the position of the Coffee Sand and Tupelo Tongue in the overall section (from Dockery, 1981).

Two additional test holes were drilled on May 17 and 18, 1988, and were successfully logged with both multipoint electrical and gamma radiation logging tools. The first of these holes, Griffin Test Hole 2, was begun in the Griffin borrow pit 0.6 meter above the Chapelville horizon (Figure 5). It penetrated 18.3 meters of the Tupelo Tongue, 29.3 meters of the Mooreville Formation, and was drilled to a total depth of 61 meters in the Tombigbee Sand Member. The second hole, Green Estate Test Hole 1, penetrated 4.6 meters of the Demopolis Chalk, 72.3 meters of the Tupelo Tongue, 29.3 meters of the Mooreville Formation, and reached a total depth of 125 meters in the Tombigbee Sand Member. The Tupelo Tongue - Mooreville contact in these holes was determined from the resistivity curve of the electrical log at the last or lowest sand "kick" of the Tupelo Tongue sequence. This resistivity "kick" is a persistent marker in the northern Lee County area as is shown in the cross section of Figure 6. The Mooreville Formation maintained a remarkably uniform thickness of 29.3 meters between the latter two test holes. This along with its electrical log characteristics indicate that the Mooreville has conformable upper and lower contacts.

Figure 6 is an east-west cross section of the Tupelo Tongue, Mooreville, and Tombigbee Sand sequence in northern Lee County and is taken from Dockery and Jennings (1988). The formations depicted on this cross section maintain a rather uniform thickness over the region. However, the sands in both the Tupelo Tongue and Tombigbee Sand Member diminish to the west toward the axis of the incipient Mississippi Embayment, a structural feature that did not fully develop until the Maastrichtian. Several cyclical sand sequences are present in the Tupelo Tongue and are labeled as A-E in Figure 6. Unit A is the persistent small sand unit that marks the base of the Tupelo Tongue and is probably a shelf sand. Units B and C are separated by a thin but persistent shale bed, the base of which

Figure 5. Griffin Test Hole 2 drill site. Stadia rod against bluff (above right headlight of pickup truck at left) is resting on the base of sand unit C of Figure 6. Fossil shells from bed E of the Chapelville horizon are scattered on the slope below the pickup truck at left.

marks the top of the Chapelville horizon. Unit B "coarsens" upward, as is indicated in Figure 6 by the inverted Christmas tree curve, and unit C "fines" upward. The other sand units D and E "coarsen" upward.

Figure 7 is an enlarged cross section showing only the electrical and gamma ray logs for the Green Estate Test Hole 1 and the Griffin Test Hole 2. The oyster biostrome at the base of the Demopolis Chalk is shown, and the top of the Chapelville fossiliferous horizon is indicated. An apparent sand unit is present at the base of the Mooreville Formation on the resistivity log of the Green Estate test hole that does not occur at the Griffin test hole. This unit should not be "picked" as the top of the Tombigbee Sand Member. The Tombigbee-Mooreville contact was easily determined during the drilling of these holes by the increased penetration rate when entering the Tombigbee Sand, the clattering of the drill pipe, and the appearance of large glauconite grains in the drilling mud as well as sand. The increase in radiation shown at the base of the Mooreville on both gamma ray logs confirms "picks" made during drilling.

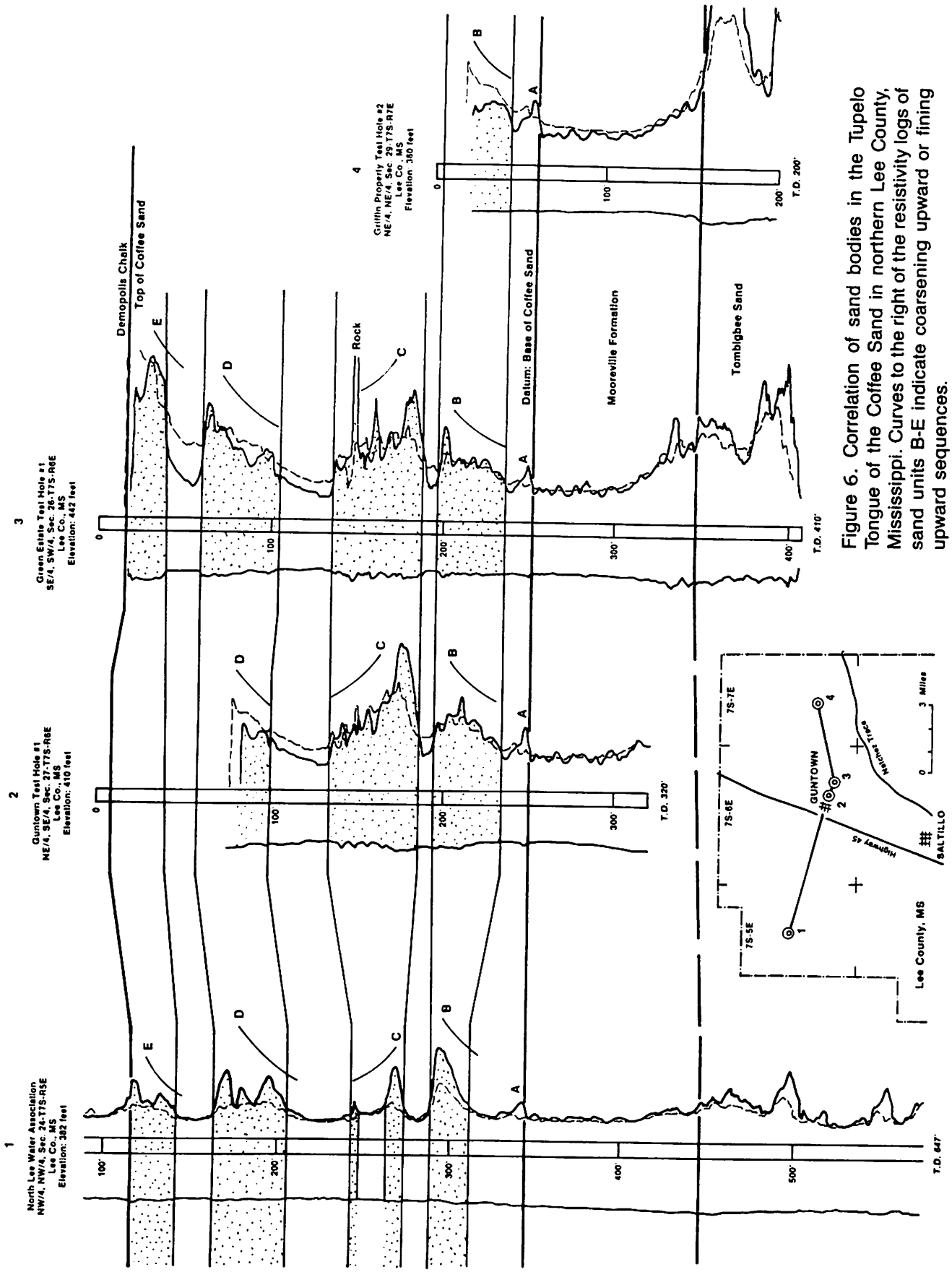


Figure 6. Correlation of sand bodies in the Tupelo Tongue of the Coffee Sand in northern Lee County, Mississippi. Curves to the right of the resistivity logs of sand units B-E indicate coarsening upward or fining upward sequences.

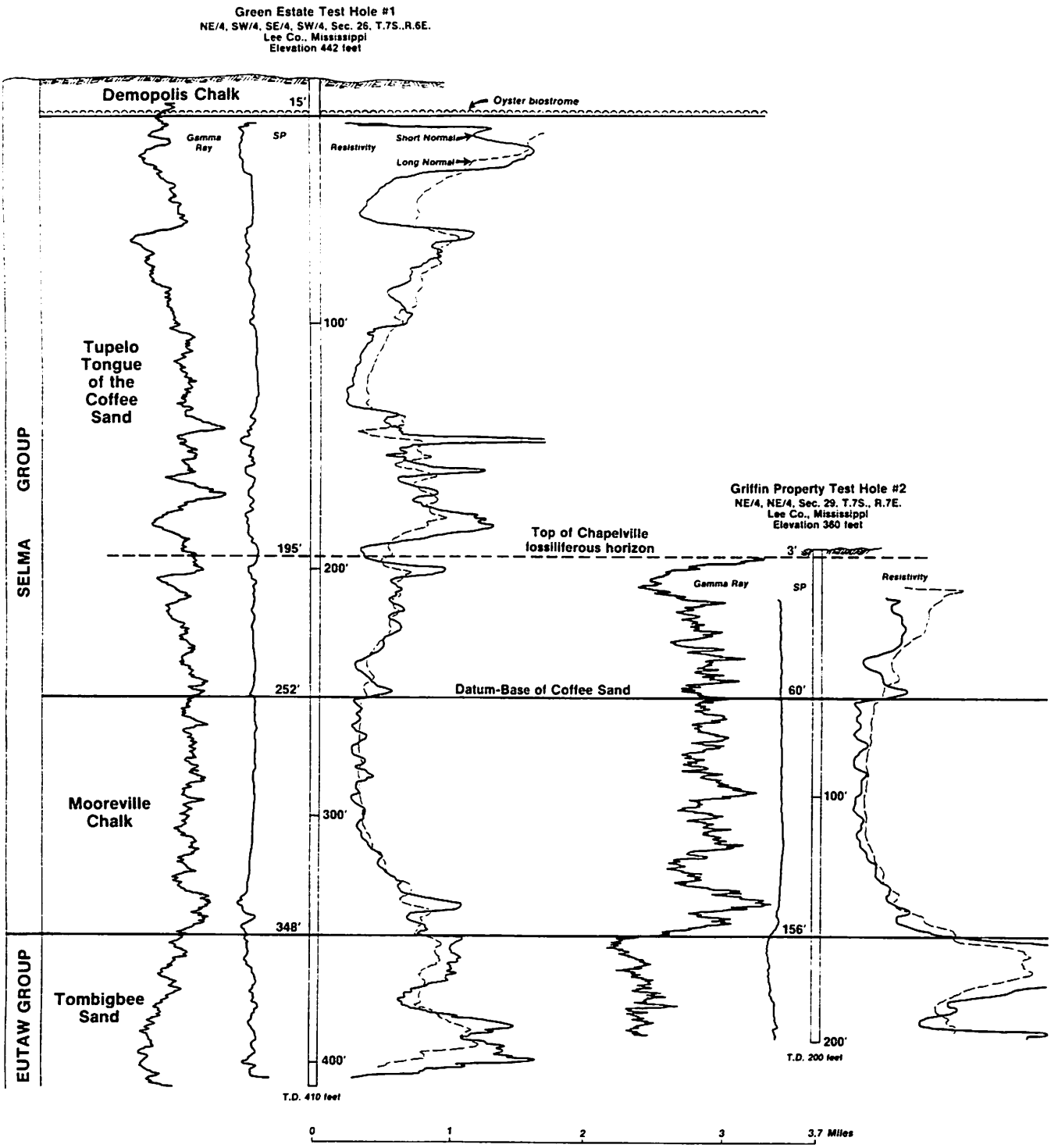


Figure 7. East-west cross section of the Tupelo Tongue, Mooreville, and Tombigbee sequence between Guntown and MGS locality 129 showing the position of the Chapelville horizon within the Tupelo Tongue (from Dockery and Jennings, 1988).

DEPOSITIONAL ENVIRONMENTS

Sand units within the Tupelo Tongue are interpreted as shelf sand bodies deposited in front of prograding delta systems. The unfossiliferous, organic-rich, shale unit overlying the Chapelville fossiliferous horizon above sand sequence B is possibly a prodelta clay preceding the next depositional cycle - sand unit C. Clay components of the Tupelo Tongue - Coffee Sand interval decrease to the north as sands increase. Russell (1975) attributed the Coffee Sand in western Tennessee to shelf deposition associated with barrier bars and sandy lagoons. Webb (1984) recognized Coffee Sand sequences northeast of the Sharkey Platform in the subsurface of western Mississippi as barrier island, offshore bar, and surge channel deposits. A region of fine-grained shelf muds in central Mississippi separates the western sand units from those in Lee County. Webb identified this area as a carbonate mud lagoon. He recognized two source areas for the Coffee sands, the Sharkey Platform to the southwest and the Appalachian Mountains to the east. Delta systems that supplied sands to the Lee County area were fed from Appalachian river systems. The presence of the estuarine gastropod *Gymnentome* in the Chapelville fauna indicates close proximity to a river mouth (Sohl, 1987, p. 1094-1095). All specimens of this estuarine gastropod collected from the Chapelville horizon are abraded and were probably transported before being incorporated into the sedimentary sequence.

The Chapelville horizon's diverse molluscan fauna is indicative of an open marine, shallow shelf environment. The occasional occurrence of echinoids agrees with this interpretation, as does the fish (otolith) fauna reported by Nolf and Dockery (1990). The frequent occurrence of *Teredo*-bored lignitized wood, the estuarine gastropod *Gymnentome*, and the cerithid gastropod *Tympanotonus* indicate that the shoreline was nearby. Terrestrial vertebrates in the Chapelville horizon include a hadrosaur rib and a pterosaur wing bone.

AGE OF THE CHAPELVILLE MOLLUSCAN FAUNA

Sohl (1964b) placed the Coffee Sand in the lower and middle parts of the *Exogyra ponderosa* Zone up to and including beds equivalent to the *Diploschiza cretacea* Zone. He equated this interval with the lower and middle Campanian of Europe (Sohl, 1964b, p. 345, abstract). Sohl divided the Coffee Sand into upper and lower divisions for the purpose of indicating the relative positions of his collecting localities within the formation. The lower division was projected to occur below the position of the Arcola Limestone Member of the Mooreville Formation and to be equivalent to marls of the Mooreville interval downdip, and the upper division was correlated with the lower part of the Demopolis Chalk. Localities 1-7 of Sohl are within the lower division, with localities 1-5 at the base of the unit and localities 6-7 in the middle part of the lower half at approximately the same position as the Chapelville horizon. Based on the occurrence of the ammonite *Menabites (Delawarella) danei* Young in the lower division at locality 3, Sohl was able to correlate this interval with the Ozan Formation of Arkansas and the Gober Tongue of the Austin Chalk in Texas.

Ammonites from the Chapelville horizon were taken to the U.S. Geological Survey National Center in Reston, Virginia, to be examined by James Kennedy of the Oxford University Museum during his visit there in October of 1989. This material included two species of *Placenticeras*. The largest of these was *P. placenta* (De Kay) with a specimen 42 cm in diameter. A smaller unnamed species was characterized by a noded umbilical margin, noded flanks, and nodes along the keel margins. A moderately large *Baculites* species with ribbed flanks was identified as *Baculites* sp. of the *B. haresi* Reeside group. Most important was the occurrence of *Menabites (Delawarella) danei* Young and *M. (D.) delawarensis* (Morton). The range zone containing both of these taxa is of post-*Scaphites hippocrepis* III Zone age (Cobban, 1969). *Scaphites hippocrepis* III is widely distributed in the Western Interior, Texas, New Jersey, the Netherlands, France, and Germany and is associated with *M. (D.) delawarensis* in northwestern Texas and New Jersey. *Menabites (D.) danei* occurs with the latter species in younger rocks in northeastern Texas, but the associated *Scaphites* are not *S. hippocrepis* (Cobban, personal communication).

The *Menabites (Delawarella) delawarensis / M. (D.) danei* concurrent-range Zone of the Coffee Sand is probably equivalent to some or all of the zones of *Baculites* sp. (smooth), B. sp. (weak flank ribs), and *B. obtusus* (Cobban, personal communication). The latter two zones were radiometrically dated in Obradovich and Cobban (1975) as 78.2 and 77.5 Ma, respectively, and approximate the lower and middle Campanian boundary as defined in the U.S. (= the lower/upper Campanian boundary of Europe).

Salomon (1984) studied the calcareous nannoplankton of the Tupelo Tongue of the Coffee Sand in the vicinity of Tupelo, Mississippi. He assigned the uppermost Mooreville Formation and the basal part of the Tupelo Tongue to the *Bukryaster hayi* Subzone (= CC-19b of Sissingh, 1977). This range is above the last occurrence of *Marthasterites furcatus* and within the range of *Bukryaster hayi* and is of late early Campanian age. The middle and upper parts of the Tupelo Tongue were assigned to the *Ceratolithoides aculeus* Zone (= CC-20 of Sissingh, 1977) of early late Campanian age in the

European sense. The top of this zone corresponds roughly to the Coffee Sand - Demopolis Chalk contact.

Although Salomon's study did not extend as far north as the outcrops of the Chapelville horizon studied here, it is probable that this horizon falls near the boundary between the previously mentioned zones (the CC-19b/20 boundary). The northern limit of Salomon's sample area was the Highway 78 bypass north of Tupelo, where he sampled from the Mooreville Formation, through the Tupelo Tongue, and into the lower Demopolis Chalk. Here he records a thickness of the Tupelo Tongue of only about 49 meters with the CC-19b/20 contact about 7.6 meters above the lower contact with the Mooreville Formation. The Tupelo Tongue expands to a thickness of 73 meters in the Chapelville area at the expense of both the Mooreville below and the Demopolis above; thus the CC-19b/20 contact should occur proportionately higher within the unit in this area.

Dowsett (1989) studied the planktonic foraminifers, calcareous nannofossils, and ostracods in a composite section of the Eutaw-Mooreville-Demopolis sequence at Plymouth Bluff on the Tombigbee River in Lowndes County and at Tibbee Creek in Clay County, Mississippi. These localities are in an offshore facies of the Selma Group south of the southern limit of the Tupelo Tongue clastic facies. Here, Dowsett placed the CC-19b/20 boundary within the Mooreville Formation, in a covered interval between the highest exposure at Plymouth Bluff and the lowest exposure at Tibbee Creek. This boundary falls within the lower part of the *Globotruncanita elevata* planktonic foraminiferal Zone and was equated with the Austinian-Tayloran Stage boundary of the provincial Gulf Coast sequence.

Both the Chapelville ammonite fauna and calcareous nannofossil floras of nearby areas indicate that the molluscan fauna of the Chapelville horizon of the Tupelo Tongue is near the lower/middle Campanian boundary in the North American sense and the lower/upper Campanian boundary in the European sense.

PHYLOGENY AND CLASSIFICATION OF THE MARINE GASTROPODS

Cladistics and Gastropod Systematics

The study of gastropod phylogeny and systematics has been greatly influenced within the last few years by the application of Hennig's (1966) cladistic method of phylogenetic analysis. Recent gastropod classifications proposed by Ponder and Warén (1988) and Haszprunar (1988a, b) have been based on both cladistic analysis and new anatomical data. It is evident that the Thiele-Wenz gastropod classification (see later discussion), which has been widely used for the last forty years, will be supplanted in the coming years by a classification that more closely reflects recent concepts in gastropod phylogeny. The classification used in this text is a modification and combination of the classifications proposed by Haszprunar (1988a, b) and Ponder and Warén (1988). As this classification marks a significant change from those previously used in monographs on Mississippi's Coastal Plain gastropod faunas (e.g., Sohl, 1960, 1964a, 1964b, Dockery, 1977, 1980, and MacNeil and Dockery, 1984), it is appropriate here to include a brief discussion of cladistics and gastropod phylogeny.

Malacology has lagged behind other fields (i.e., entomology and vertebrate systematics) in the use of cladistics in phylogenetic reconstructions. Phyletic studies of fossil gastropods have generally followed the phenetic systematic methods of Simpson (1961), Mayr (1969), and others. These studies grouped similar-looking organisms together and made often untestable statements of phylogenetic relationships based largely on the succession of similar taxa in the rock record, an incomplete record at best. One problem with phenetic systematics is that taxa do not always resemble each other because they are closely related (i.e., part of a monophyletic taxon). They may look alike for two other reasons: (1) they have derived similar characters independently in response to similar selection pressures (convergence, parallelism), or (2) they represent the beginning parts of separate lineages with a common origin and, thus, share common primitive characters.

The patelloidean and fissurelloidean limpets illustrate the first condition (convergence). According to Haszprunar (1988a, b), the low, conical, limpet shaped shell of the patelloideans represents the archetype of the primitive gastropod shell (an idea disputed by Lindberg, 1988), but this same shape in the fissurelloidean shell is said to be secondarily derived from a coiled ancestor, as is indicated by the group's anatomy and by its coiled juvenile shell. A taxon defined with a limpet shaped shell as a taxobase would not only include the archaeogastropod superfamilies Patelloidea and Fissurelloidea but would also include the pulmonate limpet *Siphonaria*, and others. Such a taxon would be polyphyletic, as it contains unrelated lineages, and, thus, would not reflect gastropod phylogeny.

The gastropod taxon Archaeogastropoda is an example of the second condition. Archaeogastropoda, as traditionally recognized, includes several primitive lineages with different hypothesized ancestors. These lineages represent early branches on the gastropod phyletic tree and share certain primitive characters or symplesiomorphies. They comprise a phyletic

grade or a paraphyletic taxon (see Hickman, 1988). Although such high level taxa form convenient categories in classification schemes for housing a diversity of lower level taxa, they are of minimal use in reflecting gastropod phylogeny. In cladistic classifications, paraphyletic taxa may be so designated by being enclosed in asterisks (as is done by Haszprunar, 1988a, b). The goal of a cladistic purist is to include only monophyletic taxa within a classification scheme.

The cladistic method of phylogenetic analysis, as proposed by Hennig (1966), differs from the phenetic approach in that not all shared characters are used in the construction of a phylogeny. First, outgroup comparisons are made to determine character polarity; that is, which condition (state) of a character is primitive (plesiomorphic) and which is derived (apomorphic). The outgroup is a closely related taxon not included within the monophyletic taxon under study. Those homologous characters shared by both the outgroup and study group are said to be primitive for the study group (shared primitive or symplesiomorphic for both groups) and those shared only by the members of the study group are said to be shared derived (synapomorphic) characters of the group. The shared derived characters (synapomorphies) of the study group are used to show the monophyletic nature of the group. Such monophyletic groups based on shared derived characters are called "clades" in cladistic studies. Monophyletic clades include all known descendant species of a hypothetical common ancestor and include taxa of any rank that fulfill this requirement.

Cladistic studies place emphasis on comparative morphology rather than stratigraphic sequence in phylogenetic analysis. The stratigraphic record is an important consideration in providing hypotheses of character polarity for testing, but it cannot play a role in determining character polarity for phylogenetic analysis (which is done by outgroup comparisons). Stratophenetic studies (e.g., Gingerich, 1976) generally assume a straight-forward ancestor-descendant relationship between successive morphologically similar species in the rock record. This practice, when misused, requires only that one "connect the dots" between succeeding taxa so that the ancestor is always on the bottom and the descendant on top. Such hypotheses name specific ancestors (something that a cladist would never claim to know) based on stratigraphic position and are largely untestable (unfalsifiable). An exception to the latter point of testability is the ill fated stratophenetic work of Otto Meyer (1885) on the Tertiary mollusks of the Gulf Coastal Plain. His "genealogies" of molluscan species proved to be backward (at best) when it was demonstrated that he had reversed the stratigraphic sequence of the Claiborne, Jackson, and Vicksburg groups.

Allmon (1989) suggested that the selection of a stratophenetic method of phylogenetic analysis may be appropriate depending on the quality or completeness of the available fossil record. Where the record is poor, cladistic methods would be preferable; if it is good, stratophenetic methods may be valid. Using eight measures of paleontological completeness, Allmon estimated the Tertiary molluscan record of the Gulf Coastal Plain (an exceptional record in its completeness) to be only 30-50% complete. Here, he stated that the record, "is probably not complete enough to trust purely stratophenetic approaches to phylogenetic analysis, but is too complete to ignore the record in favor of a purely atemporal, cladistic approach." Thus, in the Gulf Coast Tertiary (and probably Cretaceous as well), Allmon favors a cladistic approach.

A cladistic analysis is depicted by a branching diagram, a cladogram, that shows the distribution of shared derived characters within a monophyletic group. Phylogenetic relationships among taxa are shown in terms of relative recency of common ancestry. Ancestors are considered to be hypothetical and appear at the nodes, or branching points, on the diagram. Each node is defended by one or more shared derived characters. All taxa are shown at terminal positions on the diagram's branches.

Cladograms differ from phylogenetic trees in that they illustrate only the distribution of shared derived characters. They may be translated into proposed trees when the dimension of time is placed upon them. Also, cladograms do not specify the exact nature of the phylogenetic relationship between two taxa (i.e., do not state that one taxon is the ancestor of another) as is often done in phylogenetic trees. Thus, they make a simpler and more general statement concerning phylogeny (Eldredge, 1979).

Figure 8 is a cladogram of gastropod higher taxa. This figure is modified from Haszprunar (1988a, b) and lists derived characters where they first appear at nodes along the main stem. Although these characters are apomorphies (derived characters) for the adjacent node, they are plesiomorphies (primitive characters) for higher level nodes. Apomorphies that are unique to the individual branches (that do not occur as plesiomorphies in higher taxa) are not included in this figure but are given in Haszprunar's original figure. Monophyletic higher gastropod taxa appear at the end of the diagram's branches. Gastropod subclasses (according to Haszprunar, 1988b), as given in the left hand column of Figure 8, include the Streptoneura as the stem group (a paraphyletic group) and the Euthyneura as the crown group (a monophyletic group). Subclasses and orders given in quotation marks in the second column to the right are taxa of the Thiele-Wenz classification (see later discussion). Of these, only the Archaeogastropoda is continued in the classification of Haszprunar (1988b). The Order "Mesogastropoda" is shown to be split into two groups that appear below and above the "Neogastropoda." Paraphyletic taxa are indicated with asterisks.

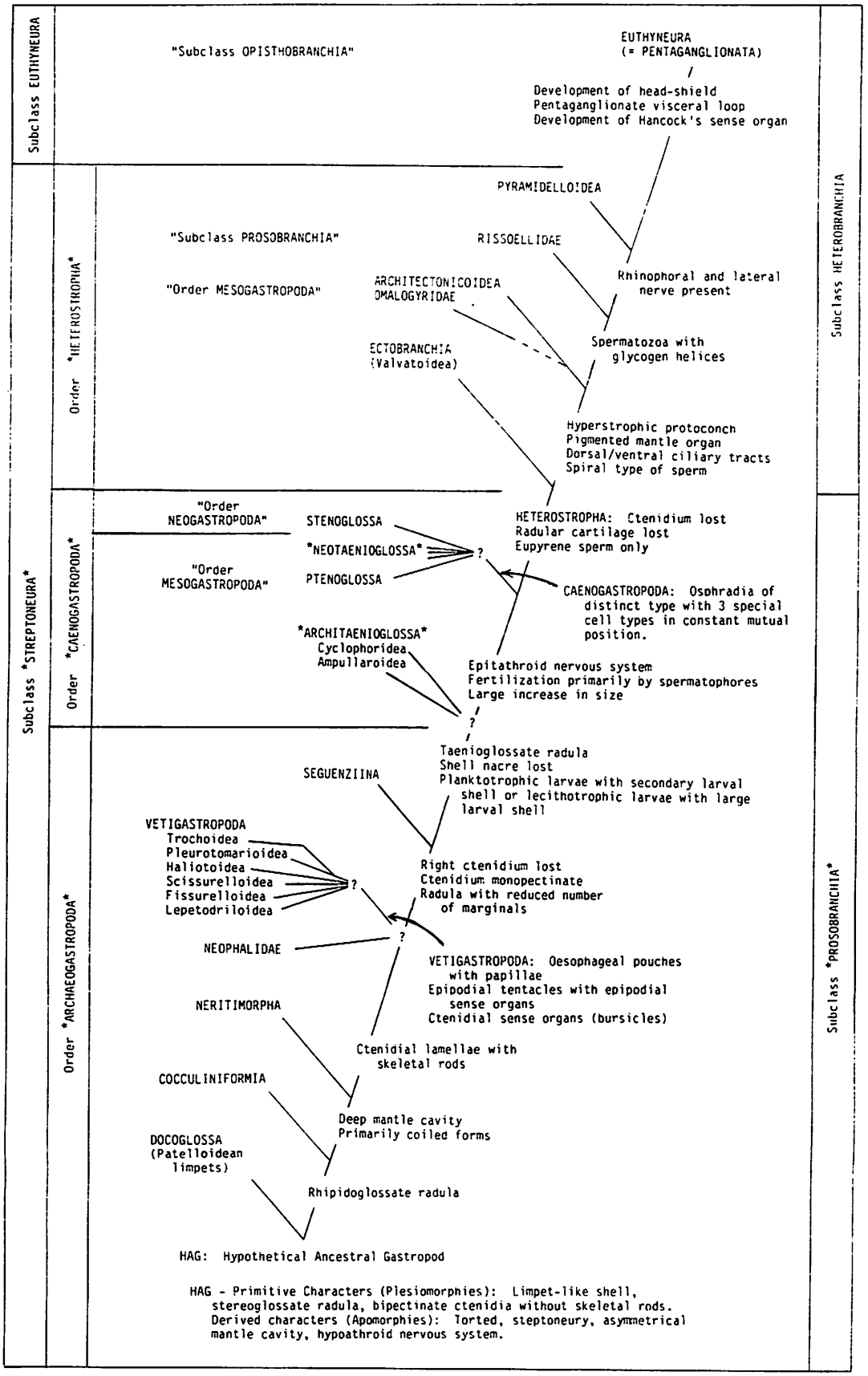


Figure 8. Cladogram of gastropod higher taxa.

Classical Systematics

The classification of marine gastropods for over one hundred years has been based largely on the organism's anatomy, radula, and shell. Anatomical features used as taxobases for the highest level taxa (subclasses) include the form and location of the ctenidia (gills) and the nervous system.

Ctenidia. Schweigger (1820) named the Ctenobranchiata for those gastropods having true ctenidia or comblike gills, and Gray (1840) named the Heterobranchia for those with reduced and otherwise modified gills. Milne Edwards (1848) recognized two groups of marine gastropods based on the position of the ctenidia. Those with "primitive" forwardly-located ctenidia were placed in the Prosobranchia; those with the "derived" posteriorly located ctenidia were placed in the Opisthobranchia. These two divisions of Milne Edwards are widely used as subclasses today. The Heterobranchia of Gray (1840) has recently been revived in the classifications of Haszprunar (1985c) and Ponder and Warén (1988).

Nervous System. Spengel (1881) noted the effect of torsion on the gastropod nervous system. Torsion occurs during larval development and is the 180° rotation of the shell and viscera with respect to the head and foot. The primitive prosobranch-grade gastropods, in which torsion is evident, have the intestinal and pleural ganglia of the visceral loop twisted into a Figure 8. Spengel named this group the Streptoneura for the crossover of the pleural ganglia. In most opisthobranchs, the nerve cords of the visceral loop do not cross, a more derived condition. These Spengel named the Euthyneura. Although the Streptoneura and Euthyneura are roughly equivalent to the Prosobranchia and Opisthobranchia respectively, the latter terms have been more widely used. The Prosobranchia and Opisthobranchia are recognized as subclasses in the work of Thiele (1929 1935), the invertebrate fossil textbook of Moore et al. (1952), the first gastropod volume of the *Treatise on Invertebrate Paleontology* (Moore, ed., 1960), the widely used invertebrate zoology text of Barnes (1974), and the volumes on Recent American marine mollusks by Keen (1971) and Abbott (1974). The Streptoneura and Euthyneura appear as subclasses in the classification systems of Wenz (1938-1944), Taylor and Sohl (1962), and Haszprunar (1988a, b).

Radula. The radula is a band or ribbon-like structure in the buccal cavity that bears rows of teeth. Troschel (1856 1863) suggested that the radula was as important as the shell in the natural classification of the Gastropoda. It was Dall (1871), however, who proposed the first taxon, the Docoglossa, based solely on radular characters. The radular type thought to be primitive in the Gastropoda is the stereoglossate condition (Haszprunar, 1988a, b), in which the radula does not bend longitudinally. This condition occurs in the patelloidean limpets (Docoglossa) and is similar to that found in other primitive mollusks, such as monoplacophorans and polyplacophorans. Other primitive gastropods of the archaeogastropod grade are characterized by a derived rhipidoglossate radula. This radular type has numerous teeth in each row, including a median tooth flanked on each side by five admedians and by very numerous marginal teeth. The marginal teeth are long, narrow, hooked and arranged in a fan like manner (thus the name *rhipido*: Greek for fan, and *glossa*: Greek for tongue).

Primitive members of the caenogastropods (= Mesogastropoda in part) are characterized by a taenioglossate radula. This radular type has a considerable reduction in the number of teeth per row over that of the rhipidoglossate form. These teeth include a median tooth bearing a number of cusps flanked on each side by one cuspidate admedian and two narrow hook-like or cuspidate marginals. The taenioglossate condition is named for the elongate ribbon-like form of the radula (*taenia*: Latin for ribbon). Two other radular forms occur within the higher caenogastropods. The first of these, the ptenoglossate condition, occurs in the Triphoroidea, Janthinoidea, and Eulimoidea and is characterized by an indefinite number of long, hooked teeth of which the outermost are the longest. Haszprunar (1985a, b) proposed the suborder Heteroglossa to include the ptenoglossate taxa with their modified radulae. Ponder and Warén (1988) recognized the Ptenoglossa (= Ctenoglossa of Gray, 1853, in part) as a suborder, and rejected the Heteroglossa of Haszprunar as a homonym of Heteroglossa Gray, 1857 (= Docoglossa + Polyplacophora + Scaphopoda).

The higher caenogastropods, the Neogastropoda of Wenz (1938a), comprise a large group that is characterized by a stenoglossate radula. This radular type is named for its narrowness (*stenos*: Greek for narrow) and includes two subtypes, the Rachiglossa and Toxoglossa. The rachiglossate condition is found in the Muricoidea and consists of a median tooth bearing from one to 14 sharp cusps flanked on each side by (when present) a single, broad, rack like admedian. The toxoglossate condition is found in the Conoidea and consists of a pair of long marginals, which may be associated with a poison gland. The cancellarids have a third radular type consisting of a single row of elongated blade-like teeth, each of which is an aggregate of rectangular tubes that transverse the whole length of the radular filament (Garrard, 1975).

Shell: The gastropod shell provides the space to house the animal when retracted (with the exceptions of those having reduced shells). Its form reflects, to some degree, the internal organization of the organism. Although the shell is often useful in identifying taxa at generic and specific levels, convergence is a major problem when using the shell form alone as a taxobase at higher levels. The limpet like shell of the primitive patelloidean limpets has been convergently derived in higher taxa. Columellar folds, an internal shell structure, occur convergently within the Stenoglossa (Neogastropoda),

Pyramidelloidea, Euthyneura, some Neotaenioglossa, and some Trochoidea. Many other examples of convergence exist.

In general, the caenogastropod shell is distinguished from that of the archaeogastropod grade (a group loosely united by the possession of certain derived and primitive characters) by the presence of an anterior siphonal canal (though many caenogastropods lack this feature) that houses the inhalent siphon. One function of the inhalent siphon is that it assists in protecting the mantle cavity from being fouled with fine sediment, an advantage that allows the caenogastropods to live on and in soft substrates. The siphonal canal is particularly prominent in the Stenoglossa and in a large part of the Tonnoidea. Four other shell innovations appear on the cladogram in Figure 8. Given in the successive order in which they appear, these include: (1) the appearance of spacious coiled shells (includes all but the primitive Docoglossa and Cocculiniformia), (2) the loss of shell nacre (this includes all gastropods above the Vetigastropoda as shown in Figure 8, though many archaeogastropod groups lack shell nacre), (3) the appearance of planktotrophic larval shells that produce a protoconch II and of lecithotrophic larvae with large larval shells of few whorls (those above the Archaeogastropoda and not including the Neritimorpha, which have independently derived planktotrophic larval shells; most caenogastropod families and some genera exhibit multiple developmental strategies), and (4) the appearance of hyperstrophic larval shells (includes the Heterostropha and Euthyneura).

Nacreous shells occur exclusively within the archaeogastropod grade. In this feature, the primitive gastropod shell is like that of primitive bivalves and the nautiloid cephalopods.

Planktotrophic larvae. The development of planktotrophic larvae, in which the veliger larva swims and feeds in the plankton, seems to have occurred independently in the archaeogastropod Neritimorpha and in the higher caenogastropods (Haszprunar, 1988a, b). Those gastropods which have planktotrophic larvae have both a protoconch I and II, the protoconch II having developed in the planktotrophic larval stage (see Jablonski and Lutz, 1983). The juncture of the protoconch II and the teleoconch is usually clearly defined, and the protoconch II generally has its own sculptural pattern. Another larval type found in the Caenogastropoda is the lecithotrophic larva, a larva that completes its development within the egg. In this case, the embryonic shell is enlarged and the ornamentation is altered so that the protoconch II stage is sometimes not clearly distinguishable from the teleoconch. Most caenogastropod families exhibit both strategies of larval development. Possession of planktotrophic larvae is a plesiomorphic character for the caenogastropods; lecithotrophic and similar forms of development have been independently derived numerous times.

Hyperstrophy. The adult shell of the archaeogastropods and caenogastropods coils in the same general direction (downward from the apex orthostrophic) as that of the larval shell. In some taxa the protoconch may be tilted, and in the extreme case of *Weeksia* (a neogastropod according to Bandel, 1988), a helically coiled larval shell develops into a planispiral adult. In the Heterostropha, however, an order (as used here) that includes the Pyramidelloidea and certain taxa once placed in the Mesogastropoda (of Thiele), the larval shell coils upward from the shell's apex, a condition called hyperstrophy. At metamorphosis to the adult shell, the direction of coiling is reversed to a downward coil. If both the larval and adult shells are oriented with the apex up, the larval shell appears to be left-handed (aperture on the left side of coiling axis) or sinistrally coiled, although the adult shell is right-handed or dextrally coiled. *Mathilda*, an architectonicid, and the pyramidellids have a slightly different condition called heterostrophy, in which the change in coiling direction at metamorphosis is about 90°. In these groups, the larval shell is generally elevated at the apex as opposed to being enveloped or emerged within the subsequent whorl. Heterostrophy also occurs in primitive members of the Euthyneura (Opisthobranchia), indicating that they were derived from hyperstrophic ancestors.

The architectonicids and *Gegania* show a more extreme rotation of the larval shell at metamorphosis and exhibit the condition called anastrophy, a 180° rotation. In the architectonicid shell, the larval and adult coils share a common coiling axis but coil in opposite directions. The adult shell coils down around the larval shell so that the larval shell is embedded in the apex.

Thiele-Wenz Classification. The previously mentioned shell and anatomical elements have formed the major taxobases for gastropod classifications over much of the 20th Century. The classification most widely accepted during this period was that of Thiele (1929 1935) as modified by Wenz (1938 1944). This classification was utilized in the first gastropod volume (including only the archaeogastropods) of the *Treatise of Invertebrate Paleontology*, Part I, Mollusca 1 (Moore, ed., 1960) and has been used in major monographs on the Cretaceous and Tertiary gastropods of the Gulf Coastal Plain (e.g., Harris and Palmer, 1946 1947, Sohl, 1960, 1964a, 1964b, Dockery, 1977, and MacNeil and Dockery, 1984).

Thiele's original classification recognized three subclasses: the Prosobranchia and Ophisthobranchia of Milne Edwards (1848) and the Pulmonata (mostly air-breathing land snails) of Cuvier (1817). The Prosobranchia of this classification contained the following three orders: the Archaeogastropoda, Mesogastropoda, and Stenoglossa. The first two orders were named respectively for primitive and intermediate grades of prosobranch development. Thiele adopted the Stenoglossa of Bouvier (1887) for the most advanced order. Wenz (1938a) later named this order the Neogastropoda, a name that recognized both the order's advanced position within the Prosobranchia and its great diversification during Cretaceous and Cenozoic times.

Revision of the Classical Gastropod Systematics

The Thiele Wenz classification has not only served as a convenient means to organize systematic studies and to provide pigeonholes for genera and species, but also has influenced evolutionary models and thinking. The prefixes of the prosobranch orders *archaeo*, *meso*, and *neo* suggest a continuous evolutionary progression from the old grade to the new. This succession does not necessarily espouse a gradualism, as opposed to a punctuated view of evolution (as described by Eldredge and Gould, 1972). Most malacologists follow Hickman's (1988) opinion that phylogeny, not classification, should be the main goal of the systematist, and there has been much doubt recently as to how well the Thiele-Wenz classification portrays gastropod phylogeny. Hickman (1988) argued that use of the terms Archaeogastropoda, Mesogastropoda, and Neogastropoda should be discontinued if these orders are taken to connote a transformation series from the "poorly adapted" primitive organization of the archaeogastropods to the "well adapted" advanced organization of the neogastropods. Each group is adequately adapted and organized for its mode of life as is indicated by their long geologic history and their abundance and diversity in the modern marine environment.

The Thiele-Wenz system has remained in wide use despite numerous revisions that have been proposed over the last thirty years. Part of this popularity stems from the conservative desire of many workers to continue with the system's widely used prosobranch orders rather than change to the newly proposed or resurrected old taxon names contained within various revisions. The reader of a malacological work is more likely to know what a mesogastropod is than to know the meaning of such terms as Caenogastropoda (Cox, 1960) or Heterostropha (Fischer, 1885; Ponder and Warén, 1988). Each revision of classification, however, was an attempt to portray gastropod phylogeny more adequately. Cox (1960), for example, proposed the Caenogastropoda as a clade to include related mesogastropod and neogastropod taxa. Kosuge (1966) placed two major mesogastropod groups, the Ptenoglossa and Architectonicoidea, in a new taxon Heterogastropoda. Golikov and Starobogatov (1975) proposed a more drastic revision by reintroducing long forgotten taxobases and taxon names from the previous century. Haszprunar (1985c, d) introduced the taxon Allogastropoda to unite the Architectonicoidea and Pyramidelloidea within a grade, a phyletic unit with certain derived characters in common and lacking others that characterize a "higher" related unit but without a single common ancestor. Ponder and Warén (1988) reintroduced the term Heterostropha of Fischer (1885) to replace Allogastropoda as the name for this group (see Figure 8). A review of recent concepts in gastropod phylogeny and systematics is given in Bieler (1992).

New areas of molluscan research have provided additional taxobases that further undermine the soundness of the Thiele-Wenz system as a phylogenetic system. Some of these areas, as outlined by Haszprunar (1988b), include: (1) the discovery of new groups that appear to represent new higher taxa (i.e., *Neomphalus*/Neomphaloidea), (2) new anatomical studies of species that were previously known only from the shell and radula, (3) new techniques such as semi-thin sectioning that provide the means for anatomical research of tiny species, (4) ultra-structural methods for studying sense organs and sperm morphology, and (5) cladistic analysis, which provides a more precise method for studying phylogeny.

New Taxa. New groups and heretofore little-known groups representing high taxonomic categories include the "symmetrical" hot vent limpets, Cocculiniformia, Neomphalidae (McLean, 1981, 1985), and Valvatidae. The first three of these are of the Archaeogastropoda grade, while the latter is of the Heterostropha grade. The "symmetrical" hot vent limpets resemble the Docoglossa in retaining a primitive stereoglossate radula. These two groups resemble the Cocculiniformia in their primitive shape, divided shell muscles, and shallow mantle cavity. These groups cannot be united in a single clade, however, as the Cocculiniformia share the rhipidoglossate radula of the more derived archaeogastropods. Haszprunar (1988a, b) placed the Docoglossa and Cocculiniformia respectively as the first and second (most primitive/least derived) offshoots of the archaeogastropod grade (see Figure 8). The Neomphalidae are similar to the Vetigastropoda in having a bipectinate ctenidium with skeletal rods. The Neomphalidae, however, do not have bursicles or epipodial sense organs. As shown in Figure 8, this group is placed in trichotomy with the vetigastropods and the more derived gastropods. The Valvatidae have traditionally been placed in an intermediate position between the archaeogastropods and caenogastropods. Rath (1988), however, found a significant gap between the Valvatidae and the Archaeogastropoda based on the valvatid genital condition, modifications in the alimentary tract, and the lack of a true ctenidium (its gill is of secondary origin). The absence of ciliary tracts in the mantle cavity indicates a position between the Caenogastropoda and the Heterostropha. Figure 8 follows Ponder and Warén (1988) in placing the Valvatoidea as the first offshoot of the Heterostropha even though this group does not have a heterostrophic protoconch.

Osphradium. Histological studies of the osphradium (Haszprunar, 1985a), a sensory organ situated on the left side of the mantle flap below the ctenidia, have provided a new taxobase for gastropod phylogeny. Aberrant osphradial characters were found to link the Haliotidae of the Zeugobranchia with the Trochoidea. These groups are shown to branch from a common point on the vetigastropod stem in Figure 8. In the Architaenioglossa, the fine structure of the freshwater Ampullarioidea osphradium and that of the terrestrial Cyclophoridea possesses entirely different cell types from that of other taenioglossate groups. The Architaenioglossa em-

bryo, however, has lecithotrophic development similar to that found within the caenogastropods, indicating that it was derived from a planktotrophic ancestor (Bandel, personal communication). For this reason, Figure 8 follows Ponder and Warén (1988) in placing the Architaenioglossa as the first offshoot of the caenogastropods even though this placement alters the status of the Caenogastropoda from a clade united by similar osphradial characters to a grade. Apart from the Architaenioglossa, the caenogastropods are united by a distinctive derived type of osphradium that has three specialized cell types in constant mutual position.

Another exception to the caenogastropod osphradial type is an aberrant family in the Cerithioidea, the Campanilidae. The biology of this family is known only from the relict species *Campanile symbolicum* Iredale (Houbrick, 1981, 1989). According to Haszprunar (1988b), unpublished fine-structural studies on the osphradia of this species revealed an osphradial epithelium that was entirely different from those of caenogastropod groups. Based on similarities in the genital system and reproductive biology of *Campanile* and the Architectonicoidea, Haszprunar (1988b) suggested that the former presents the first step towards the opisthobranch level of evolution. However, Ponder and Warén (1988) noted that the sperm morphology of *Campanile* is unlike that of any heterobranch (including the heterostrophs and opisthobranchs) and that the opisthobranchs occur in the fossil record long before the first *Campanile*-like gastropod. Therefore, they regarded *Campanile* as an aberrant cerithioidean rather than having anything to do with heterobranch evolution. Houbrick (1981) stated that the shell, operculum, and radula unequivocally referred *Campanile* to the superfamily Cerithiacea, but later (Houbrick, 1989) placed this taxon in its own superfamily Campaniloidea and suggested its systematic position as an early offshoot of the stem that gave rise to the Cerithiacea and Caenogastropoda.

Spermatozoa. Ultrastructural studies of gastropod spermatozoa by Healy (1988) have shown their structure to be useful in indicating phylogenetic relationships. The archaeogastropods, apart from the Neritoidea, possess a primitive type of spermatozoa with relatively simple cells. A modification of this type occurs in the Opisthobranchia and Pulmonata. The Neritoidea along with the mesogastropods and neogastropods have dimorphic (or sometimes polymorphic) sperm. In these groups, fertilizing spermatozoa (typical or euspermatozoa) coexist with non fertilizing spermatozoa (atypical or paraspermatozoa). Though Nishiwaki (1964) favored inclusion of the Neritoidea within the Caenogastropoda because of the group's dimorphic sperm, sperm ultrastructure suggests that these groups were derived from separate archaeogastropod ancestors. The shared feature of dimorphic sperm is most likely due to convergence related to the development of internal fertilization (Haszprunar, 1988b).

Euspermatozoan morphology indicates a two-part division of the Caenogastropoda: one group consisting of the Cerithioidea, Viviparoidea, and Cyclophoroidea, and one group including the remainder of the mesogastropods and the neogastropods. Certain families previously placed in the Cerithioidea (e.g., Triphoridae, Cerithiopsidae, and Vermetidae) have euspermatozoa similar to that of the latter group. These data, along with anatomical evidence, support the removal of these families from the Cerithioidea. The morphology of paraspermatozoa generally reinforces the systematic conclusions reached from the study of euspermatoza. Paraspermatozoa show an affiliation of the Cerithioidea, Viviparoidea, and Cyclophoroidea as well as between the Epitonioidea, Cerithiopsoidea and Triphoroidea and show close similarity between the Cypraeoidea, Tonnoidea, and Neogastropoda.

The Opisthobranchia and Pulmonata, which comprise the Euthyneura, have the same sperm morphology and features of spermatogenesis. According to Healy (1988), it is unlikely that the combination of sperm characters present in these groups evolved more than once, and the pulmonates were probably derived from the opisthobranchs. Also, certain groups within the Heterostropha, including the Pyramidelloidea, Rissoellidae, and Omalogyridae, have spermatozoa that more closely resemble the euthyneuran condition than that of the prosobranch grade. The architectonicids have some unique sperm characters that distinguish them from both the Euthyneura and Prosobranchia. It is possible that the Architectonicidae and Omalogyridae are the surviving derivatives of a group that gave rise to the primitive opisthobranchs (Healy, 1988).

Biochemical Analysis. Current technology has provided additional avenues of study that will have impact on the future understanding of gastropod phylogeny. One of these avenues, which has enormous potential, is the use of biochemical analysis of DNA and RNA to determine relationships. Such an analysis was successfully utilized in the development of an allozyme-based phylogeny for an endemic group of 27 species of land snails belonging to three genera discovered in the isolated Ningbing Range of northwestern Australia by Woodruff and Solem (1990).

Cladistic Software. Another current technology is the use of desktop computers to handle sophisticated cladistic software. Software programs such as PAUP can analyze large data sets and search for cladograms based on varying assumptions or initial conditions. These programs use sophisticated search algorithms to find the most parsimonious or shortest trees that fit the data. Parsimony, an economy-related term for frugality (simplicity) or thriftiness, is used in cladistics for cladograms that require the fewest ad hoc assumptions of convergence, parallelism, and reversal, terms which are collectively referred to as homoplasy. Recent cladistic studies of gastropods involving computer analyses include those of Lindberg (1988) on the Patellogastropoda using PHYLIP, Houbrick (1988) on the Cerithioidea using PHYSYS, Ponder (1988) on the Truncatelloidea (= Rissoacea) using PAUP, and Bieler (1988) on the Architectonicidae using PAUP and PHYSYS.

CLASSIFICATION SYSTEM OF THIS REPORT

The classification system used in this report utilizes paraphyletic taxa and thus must be considered as an authoritarian biological taxonomic system, such as the classical systems of Thiele (1929-1935) and Wenz (1938-1944), rather than a purely cladistic classification. Though not exclusively used here, cladistic methodology is recognized as a valuable tool in the study of gastropod phylogeny and strongly influences the classification adopted in this text. It has forced the rejection of polyphyletic taxa such as the widely used Mesogastropoda of Thiele (1925). Table 1 is a "cladogram" that outlines the classification and higher taxa of the following systematic section. Apomorphies that defend the various nodes of this "cladogram" are given in Table 2.

Though cladistics has prompted revisions that more closely follow gastropod phylogeny, a purely cladistic classification can be cumbersome as it requires that all taxa are clades. This requirement would reject the Archaeogastropoda as a grade and replace it with at least five orders (seven orders according to Haszprunar, 1988b, Table 5a) as shown by the branching nodes of Figure 8. Bandel (1982) recognized only two archaeogastropod clades, the Archaeogastropoda *s.s.* and the Neritimorpha. Also, a purely cladistic methodology leads to an increase in the taxonomic levels available for recognition and forces decisions concerning the inflation of taxa and expansion of the hierarchy (Hickman, 1988). The classification system given in Table 1 follows the cladogram of Figure 8 only to the extent that the higher divisions comprise paraphyletic grades and not polyphyletic units. To this degree, it is a portrayal of gastropod phylogeny even though it is not a cladistic classification.

The clado-evolutionary system favored by Haszprunar (1988b, Table 5a) recognizes divisions that are paraphyletic grades as well as clades and so is also a mixture of cladistics and authoritarian biological taxonomy. Such a mixture is unsatisfactory to mainstream cladists, as is evidenced by the critique of Bieler (1990). It proposes many useful revisions to the currently used Thiele-Wenz classification, however. The Archaeogastropoda of this classification is used here with some modifications such as the removal of the Architaenioglossa. The Caenogastropoda and Heterostropha of this classification are taken from that of Ponder and Warén (1988) with the modification that both are placed as orders along with the Archaeogastropoda in the Subclass Streptoneura. Ponder and Warén recognize the subclasses Prosobranchia and Heterobranchia. The former includes the Archaeogastropoda and Caenogastropoda and the Heterobranchia includes the Heterostropha and Opisthobranchia, as shown in the right column of Figure 8.

Archaeogastropoda

The Archaeogastropoda is the most primitive gastropod order and is the only streptoneuran/prosobranch order of the Thiele-Wenz classification that is continued in this report. The "radical" classification proposed by Golikov and Starobogatov (1975) eliminated the Archaeogastropoda as a polyphyletic taxon and raised its constituent clades in rank to replace it. Haszprunar (1988b, Table 5a) recognized the Archaeogastropoda as a grade that included six clades (the "Hot-Vent Group-C" clade is not shown in the cladogram of Figure 8, but is placed by Haszprunar between the Docoglossa and Cocculiniformia). The paraphyletic suborder Architaenioglossa is included in the Archaeogastropoda by Haszprunar based on its hypoathroid nervous system, which he states is the only symplesiomorphic character that unites all the archaeogastropods. He also noted that coinciding with the appearance of the epiathroid nervous system was the appearance of planktotrophic larvae. However, the Architaenioglossa have a taenioglossate radula as do the more advanced caenogastropods and have a lecithotrophic larval shell. Many caenogastropod families included both planktotrophic and lecithotrophic larval developmental strategies. The lecithotrophic larvae develop to juvenile adults within a yolk rich egg (or egg with nurse cells, abundant albumen, etc.) rather than having a planktotrophic stage. It is probable that the lecithotrophic Architaenioglossa larvae were derived from a planktotrophic caenogastropod ancestor.

Bandel (1982) recognized the Archaeogastropoda exclusive of the Neritimorpha as a clade set apart from other gastropods by its mode of direct larval development. In this mode of development, mineralization of the shell occurs after the initially bilaterally symmetrical organic shell is deformed into a trochospiral shape. This deformation is independent of the torsion of the soft body, as is seen in patelloid gastropods in which the bilaterally symmetrical shell is produced by a normally torted animal. Bandel (1982) recognized the Neritimorpha as an independent group differing from both archaeogastropods and caenogastropods in its convolute larval shell. This group has a long geologic record and includes the Ordovician platyceratids.

Hickman (1988) proposed that the Archaeogastropoda be restricted to a holophyletic clade including only the fissurelloid-pleurotomarioid-trochoid clades. This revision would make the Archaeogastropoda equivalent to the Vetigastropoda, the first archaeogastropod clade with the plesiomorphic character of ctenidia with skeletal rod supports. Such a revision would rescue a taxon with powerful traditional appeal from "extinction" (disuse) by making it satisfy cladistic criteria. It would also maintain the Archaeogastropoda in the

Table 1. Cladogram of streptoneuran systematics as followed here. Broadly distributed derived characters are given in short form where they first appear along the cladogram's main stem. Each node is numbered, and the corresponding apomorphy that defends it, if present, is given in Table 2.

Subclass **EUTHYNEURA** - Gastropods having a euthyneural nervous system.

Superfamily **Pyramidelloidea** _____15_/
Rhinophoral and lateral nerve present
Superfamily **Rissoelloidea** _____14_/
Spermatozoa with glycogen helices
Superfamily **Architectonicoidea** _____13_/
Superfamily **Omalogyroidea** _____/ /
Hyperstrophic protoconch
Superfamily **Valvatoidea** _____12_/

Order **HETEROSTROPHA** - Streptoneural gastropods that have lost both the ctenidium and the radular cartilage. Most have planktotrophic larvae with hypostrophic shells.

Suborder **Neogastropoda** __11_
Suborder **Ptenoglossa** _____10_\
Suborder **Heteropoda** _____9_\
Suborder **Neotaenioglossa** _____8___7_/
Epitathroid nervous system
Suborder **Architaenioglossa** _____6_/

Order **CAENOGASTROPODA** - Streptoneural gastropods having planktotrophic larvae with an orthostrophic larval shell or having secondarily derived lecithotrophic larvae (or a similar development) with a large larval shell.

Suborder **Seguenziina** _____5_/
Monopectinate ctenidium; right ctenidium lost
Suborder **Vetigastropoda** _____4_/
Ctenidial lamellae with skeletal rods
Suborder **Neritimorpha** _____3_/
Primarily coiled shells
Suborder **Cocculiniformia** 2_/
Rhipidoglossate radula
Suborder **Docoglossa** ___1_/

Order **ARCHAEOGASTROPODA** - Streptoneural gastropods with direct development and a small embryonic shell or with specialized planktotrophic larvae with a convolute shell.

Subclass **STREPTONEURA** - Gastropods having a streptoneural nervous system.

Table 2. Apomorphies, as taken from Haszprunar (1988b, p. 425) or elsewhere, numbered in Table 1.

1. DOCOGLOSSA: Compact salivary glands with ducts; reduced hypobranchial glands; distinct osphradium close to the "wart-organ." The Nacelloidea retain only the left ctenidium, and the Patelloidea have subpallial gills replacing the ctenidia.

2. COCCULINIFORMIA: Reduction of right pallial organs; primarily wood-feeding with a typical oesophageal pattern. The Cocculinoidea have a pseudoplicate gill, and the Lepetelloidea have secondary gill-leaflets.

3. NERITIMORPHA: Planktotrophic larvae with unique convolute larval shells (Bandel, 1982); specialization and hypertrophy of genital organs; osphradium of distinct type.

4. VETIGASTROPODA: Oesophageal pouches with papillae; epipodial tentacles with epipodial sense organs; ctenidial sense organs (bursicles).

5. SEGUENZIINA: Distinct radula type; true gonoduct, internal fertilization; oesophague with ventral mucous pockets and lacking posterior longitudinal folds; anterior nerve ring concentrated.

6. ARCHITAENIOGLOSSA: This group is distinguished by a unique combination of characters including a hypoathroid or dystenoid nervous system and a taenioglossate radula; however, there is no known synapomorphy that connects the group's two superfamilies. The Ampullarioidea are fresh-water gastropods, and the Cyclophoroidea are terrestrial gastropods, which have a lung formed from the mantle cavity instead of a ctenidium.

7. "HIGHER" CAENOGASTROPODS: Osphradium of distinct type with three specialized cell types in constant mutual position and shared fine-structure of euspermatozoa and paraspermatozoa.

8. NEOTAENIOGLOSSA: No known apomorphy unites the members of this group. It has a taenioglossate radula and various plesiomorphic characters, as given in number 7.

9. HETEROPODA: Derived foot modified for swimming: shell reduced.

10. PTENOGLOSSA: Specialized ptenoglossate radula; acrembolic proboscis; spermatozeugmata.

11. NEOGASTROPODA: Distinct stenoglossate radula; proboscis.

12. VALVATOIDEA: Fresh-water gastropods with secondary gills in the mantle cavity; pallial tentacle; osphradium of a distinct type.

13. OMALOGYROIDEA and ARCHITECTONICOIDEA: Ovary and testis separated; ciliary tract at the left side.

14. RISSOELLOIDEA: Head bilobed; operculum with peg.

15. PYRAMIDELLOIDEA: Radular reduction; jaw apparatus hypertrophied or modified or lacking; parasitic.

systematic position it has long held as being the stem group for all the higher (more derived) gastropods (which also have skeletal rods supporting ctenidial leaflets). As Archaeogastropoda is recognized as a paraphyletic grade by both Haszprunar and Ponder and Warén and, as the present classification is not cladistic, Hickman's revision is not followed here.

The Coffee Sand archaeogastropods consist of neritids (Neritimorpha) and trochoids (Vetigastropoda). The Neritimorpha, as previously mentioned, are peculiar among the archaeogastropods in that they have a multispiral planktotrophic larval shell (Plate 2, figures 1-2). The Vetigastropoda have the characteristic archaeogastropod larval shell with less than one whorl (Plate 2, figure 4, and Plate 3, figures 1-3, 6-7). Two Coffee Sand taxa previously included as archaeogastropods are removed based on new information concerning their larval shells. *Damesia* is now placed in the Heterostropha as a pyramidellid rather than in the Neritimorpha. The larval shell of this taxon (Plate 2, figures 5-9), is of 1 1/2 whorls and is inclined with respect to the teleoconch. *Urceolabrum* is placed near *Sansonia*, a caenogastropod of uncertain position placed in the family Pickworthiidae (Ponder, 1985, p. 104), and is removed from the Family Turbinidae of the Trochoidea. This taxon has a high spired larval shell of between two and three whorls (Plate 2, figure 3).

Caenogastropoda

The Caenogastropoda are the most diverse order of marine gastropods. This order includes both the largest part of the Mesogastropoda (those with orthostrophic larval shells) and all of the Neogastropoda of the Thiele-Wenz system. Due to the large number of neogastropods in the Coffee Sand, this group will be treated in a later volume along with the Euthyneura. Haszprunar (1988a, b) recognized the Caenogastropoda as a holophyletic clade, with the exclusion of the Architaenioglossa, that possesses the apomorphic character of a distinct osphradium with three special cell types in constant mutual position. This group is also characterized by a taenioglossate radula, nonnacreous shell, and planktotrophic or lecithotrophic larval shell. The classification used here follows that of Ponder and Warén (1988) in including the Architaenioglossa within the Caenogastropoda, thus making the order paraphyletic according to the cladogram of Haszprunar (1988a, b). Also, as this classification is not a hybrid classical and cladistic classification, the paraphyletic order Apogastropoda of Haszprunar (1988a, b), which includes those streptoneuran gastropods above the archaeogastropod grade that have planktotrophic larvae, is not needed. Therefore, the Archaeogastropoda and Caenogastropoda are recognized as paraphyletic orders of equal taxonomic rank.

The classification of the Caenogastropoda used here is that of Ponder and Warén (1988) with the modification that this group is placed as an order rather than a superorder, and the Architaenioglossa, Neotaenioglossa and Neogastropoda are suborders rather than orders. The superfamily designations remain the same.

Architaenioglossa. The Architaenioglossa include the fresh-water snails of the Ampullarioidea and air breathing terrestrial snails of the Cyclophoroidea. These groups are united in having the unique combination of the archaeogastropod-type hypoathroid or dystenoid nervous system (plesiomorphic characters) and the derived caenogastropod taenioglossate radula. No synapomorphy uniting the Ampullarioidea and Cyclophoroidea is known. However, no synapomorphy (with the exception of the groups' euspermatozoa: Healy, 1988) is known to connect either of these groups with any higher gastropod taxa, thus the status of the Architaenioglossa remains uncertain (Haszprunar, 1988b). This group is not represented in the Coffee Sand fauna.

Neotaenioglossa. The Neotaenioglossa of Ponder and Warén (1988) is equivalent to the largest part of the Mesogastropoda of Thiele (1925) and includes 21 superfamilies in three suborders. The largest suborder (section) is the Discopoda, which contains 17 superfamilies. Haszprunar's (1988a, b) classification included only extant taxa and records 11 superfamilies in the Neotaenioglossa, which he placed as a section in the Suborder Caenogastropoda. These superfamilies are largely the same as those included in the Discopoda of Ponder and Warén with two major exceptions. Haszprunar (1988b) believed the caenogastropod archetype to resemble the cerithioid groundplan and recognized the Cerithiomorpha as the first section or stem group of the Caenogastropoda. Also, Haszprunar (1988a, b) placed the Heteropoda in the Neotaenioglossa between the superfamilies Cypraeoidea and Naticoidea, but Ponder and Warén place this group as the second suborder within the Neotaenioglossa after the Discopoda.

The third neotaenioglossate suborder of Ponder and Warén is the Ptenoglossa, which includes the superfamilies Triphoroidea, Janthinoidea, and Eulimoidea. Haszprunar (1988b, p. 417) recognized the Ctenoglossa (=Ptenoglossa) as a taxon of equal rank with the Neotaenioglossa, as is shown in the cladogram of Figure 8. Earlier (1985a-c) he had used the term Heteroglossa for this group but later dropped the term because it was preoccupied (Gray, 1857 = Docoglossa, Polyplacophora, and Scaphopoda). Heteroglossa appears as a suborder of the Order Mesogastropoda in the recent classification of Vaught (1989).

The Order Neotaenioglossa includes most of the Coffee Sand taxa of this report. The Coffee Sand Neotaenioglossa fauna includes the discopod superfamilies Cerithioidea,

Truncatelloidea, Stromboidea, Calyptraeoidea, Xenophoroidea, Vermetoidea, Cypraeoidea, Naticoidea, and Tonnoidea, and the ptenoglossate superfamilies Triphoroidea, Janthinoidea, and Eulimoidea. In the early phase of this work, certain specimens were tentatively identified as the heteropod taxon *Brunonia*, a supposed relative of the extant genus *Carinaria* according to Kase (1988). These specimens (Plate 17, figures 8-10) were later classified as a pulmonate limpet in the genus *Anisomyon* due to its sinistrally coiled (hyperstrophic) juvenile shell. However, the thin shell and adult form of this species resemble the Lower Cretaceous taxon *Brunonia annulata* (Yokoyama, 1890) closely enough to warrant further comparisons as new Coffee Sand material is found.

Neogastropoda. Neogastropoda is the third prosobranch order of the Thiele-Wenz system and is still widely used as such today. This system conveniently divided the Prosobranchia into subequal groups of similar diversity and complexity. Recent studies indicate that the mainline mesogastropods having orthostrophic larval shells, the Neotaenioglossa, are more closely related to the neogastropods than to hyperstrophic members of their own order. Haszprunar (1988a, b) showed these mesogastropods (Neotaenioglossa) and the neogastropods to be members of the same clade. With the merger of these groups into one giant order, the Caenogastropoda, the subdivisions of the Prosobranchia (Streptoneura of this report) are uneven in their levels of diversity. However, classifications with higher taxa of similar diversity levels are not the goal of phylogeny-based systematics. The Coffee Sand neogastropod fauna is quite diverse and will be treated in a separate report.

Heterostropha

The Heterostropha unites the largely hyperstrophic mesogastropods of the Architectonicoidea and the pyramidellids into the third streptoneuran order. This order is equivalent to the Allogastropoda of Haszprunar (1985b) and equivalent in part to the Heterogastropoda of Habe and Kosuge (1966). The latter combines the Ptenoglossa and the Architectonicoidea into a group with similar feeding habits (body tissue of coelenterates) and feeding structures (acrembolic proboscis). Both the Heterostropha (=Allogastropoda) and the Heterogastropoda include mesogastropod taxa thought to be transitional between the streptoneuran and euthyneuran levels of organization. Although the ptenoglossate taxa are similar to the architectonicids in their feeding habits and structures, they have typical mesogastropod gills and osphradial characters. For these reasons, they are omitted from the Heterostropha and its equivalent taxon Allogastropoda. Bandel (personal communication) prefers to use the term Heterostropha as a taxon containing all heterostrophic forms, including the Euthyneura. Used in this way, the Heterostropha is equivalent to the Heterobranchia of the Ponder and Warén (1988) classification.

Robertson (1985) noted four characters shared between the transitional mesogastropod taxa and the opisthobranchs that he believed to be homologous and to reflect phylogeny. These include pigmented mantle organ, ciliated strips, chalazae connecting egg cocoons, and heterostrophy. Only one of these, the pigmented mantle organ, occurs in the Ptenoglossa, but all four characters occur in the Architectonicoidea and Pyramidelloidea of the Heterostropha, as well as in the primitive opisthobranch group Bullomorpha. The latter character cited, heterostrophy, is a feature that can be identified in well preserved fossil shells, such as those of the Coffee Sand.

Ponder and Warén (1988) included six superfamilies in the Order Heterostropha: Valvatoidea, Architectonicoidea, Rissoelloidea, Omalogyroidea, Nerineoidea, and Pyramidelloidea. Though not all of these groups possess a hyperstrophic larval shell as do the euthyneurans, all do have some euthyneuran characters that might indicate a transitional position between the Caenogastropoda and Euthyneura. The Pyramidelloidea is the most derived of the heterostrophid superfamilies and is also closest to the euthyneuran condition. This group has been placed near the Eulimidae (Ptenoglossa) in the Streptoneura (Wenz, 1938-1944) and with the Nerineoidea in the most primitive euthyneuran order Entomotaeniata (Taylor and Sohl, 1962). The Architectonicoidea is placed by Haszprunar (1988a, b) and Ponder and Warén (1988) among the most primitive of the heterostrophid superfamilies. Both the Architectonicoidea and Pyramidelloidea have a hyperstrophic larval stage and are represented in the Coffee Sand fauna: the Pyramidelloidea by two and the Architectonicoidea by nine genera.

The diversity of the Coffee Sand heterostrophid fauna sheds new light on the early history of this group. The presence of both primitive and derived heterostrophid taxa in the Campanian deposits of Mississippi indicates that the major radiation of the Heterostropha occurred before Late Cretaceous time. Bieler (1988, p. 227, fig. 24) showed the architectonicoidean family Mathildidae to occur as early as the Triassic. Yoo (1988) showed an early heterostrophid/euthyneuran radiation in and before the early Carboniferous. With its early geologic occurrence, the mathildid shell should preserve some of the primitive shell characters of the Heterostropha as well as the Architectonicoidea. Shell characters of the "primitive" genus *Mathilda* include a heterostrophic protoconch that is tilted at about a 90° angle to the teleoconch and a high spired nonumbilicate shell with an apical angle of less than 35°.

The primitive nature of these characters is corroborated in an outgroup comparison with the pyramidellid genus *Pyramidella*, a taxon characterized by its heterostrophic protoconch, high-spired, smooth-sided teleoconch, and colu-

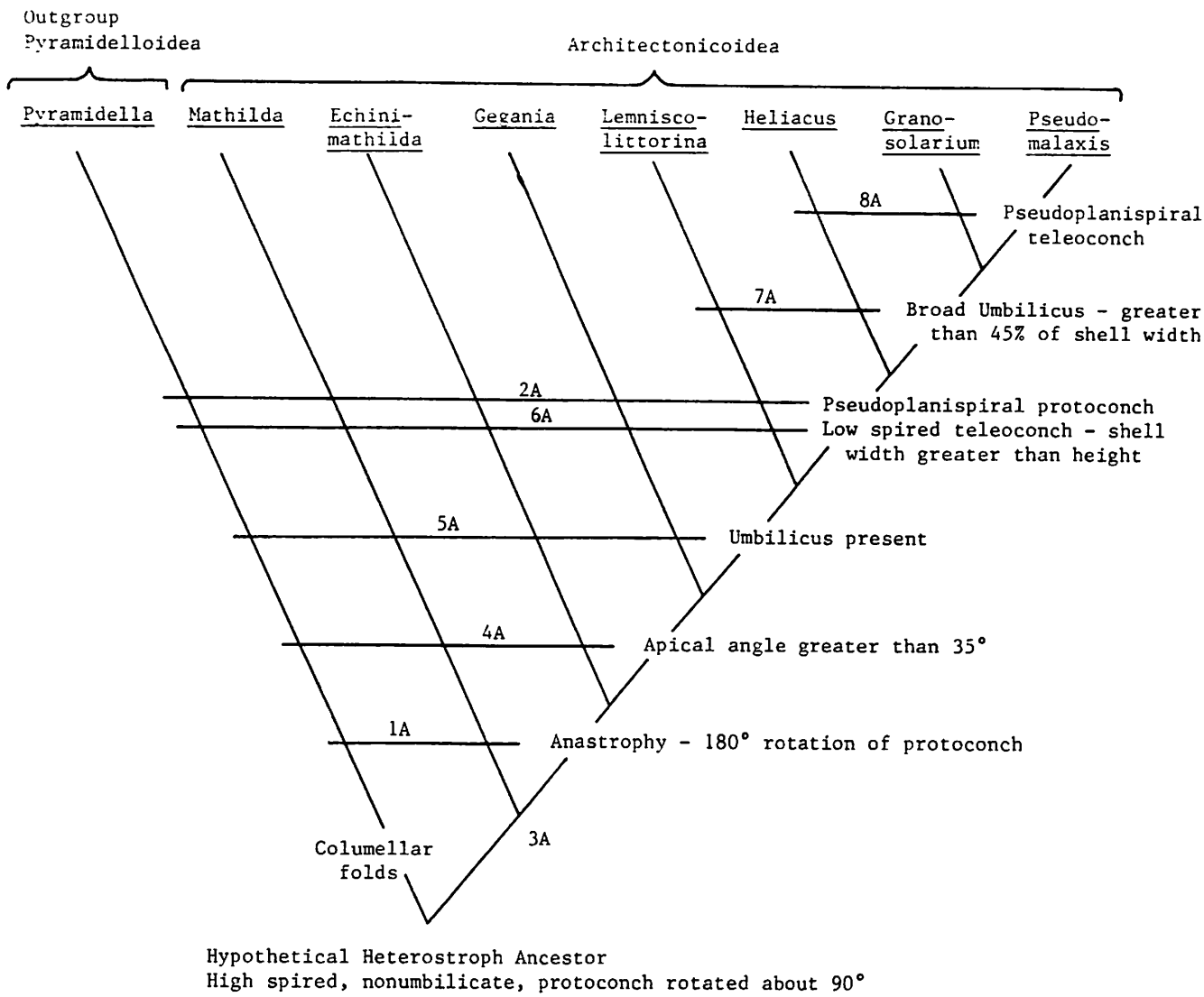


Figure 9. Cladogram of Coffee Sand Heterostropha.

mellar folds. A more primitive pyramidellid taxon, *Streptacis*, is present in the Coffee Sand. This genus is distinguished from *Pyramidella* by the absence of columellar folds and by its sinuous growth lines.

The cladogram in Figure 9 shows seven architectonicoidean genera present in the Coffee Sand in an outgroup comparison with *Pyramidella*. These genera include the extant taxa *Mathilda*, *Gegania*, *Heliacus*, *Granosolarium*, and *Pseudomalaxis*, and the extinct taxa *Echinimathilda* and *Lemniscolittorina*. Protoconchs of the latter two taxa are illustrated here for the first time and are shown to be anastrophic. Eight bi-state shell characters are used in the cladogram with the first state of each character (designated as A) being the primitive condition and the second state (designated as B) being the uniquely derived condition.

Derived character states are written out along the diagram's main stem and outgroup branch, and the distributions of corresponding primitive states are indicated by labeled bars. The heterostrophic shell of *Mathilda* with its protoconch tilted at 90° and its narrow and high spired nonumbilicate teleoconch is shown to be most primitive by the outgroup comparison. Seven apomorphies shown along the diagram's main stem subdivide the other six architectonicoidean genera into a series of increasingly derived taxa. The first apomorphic character (1B) is a change in the angle of rotation of the hyperstrophic larval shell from 90° (heterostrophy) to 180° (anastrophy) at metamorphosis. In this case, the coiling axis of the protoconch becomes concordant with that of the teleoconch but with the two coiling in opposite directions. At metamorphosis, the teleoconch coils back down around the larval shell,

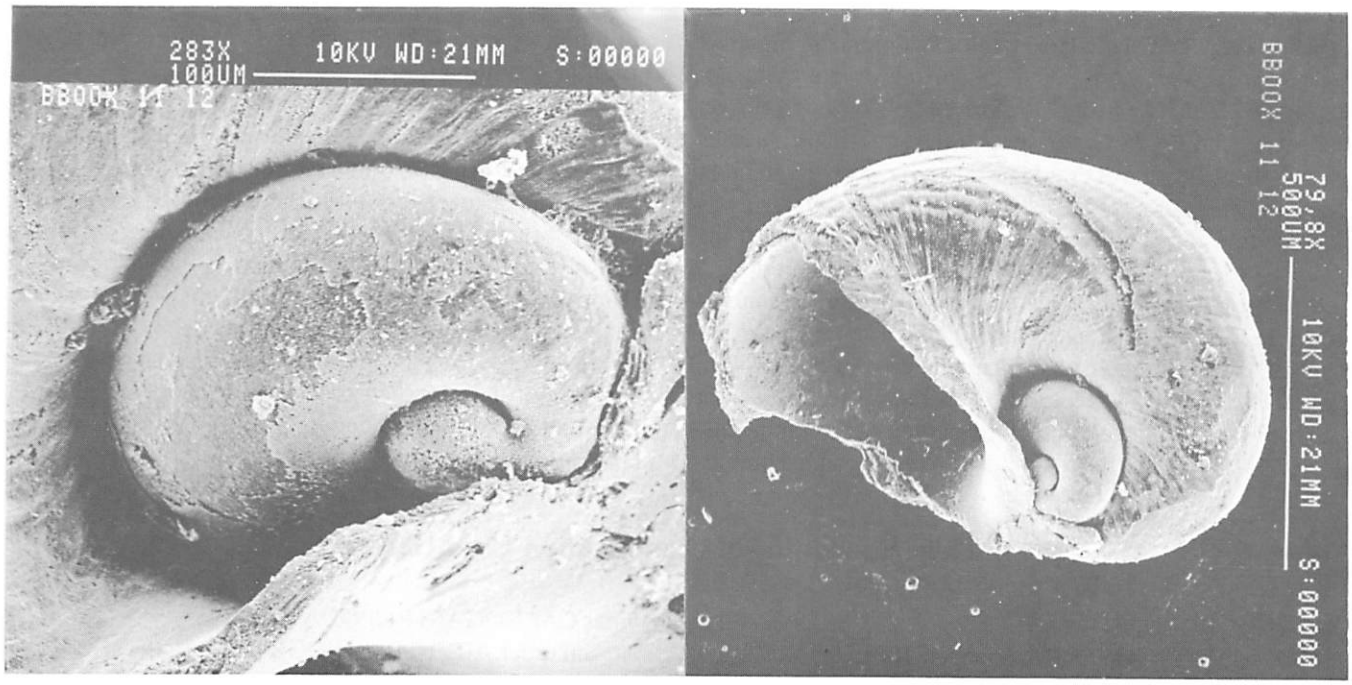


Figure 10. *Echinimathilda* protoconch in oblique view (x283 on left and x79.8 on right) from below apex of teleoconch showing its true anastrophic character. This specimen is from the Providence Sand in a roadcut and ditch of U. S. Route 82 on the north-northwest facing slope of Pataula Creek valley and immediately southeast of a bridge over Pataula Creek, 2.5 miles northwest of Morris and 2 miles west-northwest of junction with Georgia State Route 29, Quitman County, Georgia, U. S. Geological Survey locality 25992. The specimen was collected in 1955 when the roadcut was fresh. When the site was revisited in 1984 all the shell material had been leached out and only impressions remained (Sohl, personal communication). SEM photographs provided by N. F. Sohl.

leaving it embedded in the apex. *Echinimathilda* is the most primitive Cretaceous genus with this derived character (for the other more derived genera this character is a plesiomorphy). This genus is known only from the Upper Cretaceous of the northern Gulf Coastal Plain. Figure 10 shows the transformation from the larval to adult stage of a young *Echinimathilda*.

The second derived character (4B) first appears in *Gegania* and is an increase in the apical angle to greater than 35°. This increase reflects a change to a broader and larger shell with a more spacious body whorl. Though none of the architectonicoideans are particularly large, *Mathilda* and *Echinimathilda* species are generally small for the size of the group as a whole.

The third derived character (5B) is the appearance of an umbilicus, a character that first appears in *Lemniscolittorina*. This genus was originally placed in the caenogastropod family Littorinidae because of its turbinate *Littorina*-like shell (Sohl, 1960). Well preserved specimens from the Coffee Sand, such as the one illustrated in figures 1-4 of Plate 5, show the protoconch to be anastrophic and similar to that of *Gegania*. *Lemniscolittorina* nicely bridges the morphological gap between the high spired nonumbilicate *Gegania* and the low spired umbilicate *Architectonica*-like forms.

The fourth and fifth derived characters first appear together in the *Architectonica*-like genus *Heliacus*. They are a change in the protoconch morphology to a pseudoplanispiral form (2B) and a shortening of the teleoconch spire to the extent that the shell's width is greater than its height (6B). *Heliacus* represents the first taxon to have the discoid shaped form that characterizes a number of *Architectonica*-related genera. The Coffee Sand species is rather spindle shaped and has a narrow umbilicus when compared to Recent *Heliacus* species. These conditions probably represent primitive character states for the genus. However, the spindle shaped shell character may only represent the juvenile form as all the Coffee Sand specimens are small. The pseudoplanispiral protoconch is a unifying plesiomorphic character for other *Architectonica*-like taxa that have varying teleoconch morphologies. This protoconch is characterized by a flat or depressed apical surface, which produces a nearly planispiral coil. The coil is called pseudoplanispiral as it is not perfectly symmetrical about the plane of coiling (the top and bottom sides are not mirror images).

Bieler (1988, p. 223, fig. 22) listed "5 basal field ribs, expanding towards umbilicus" as a plesiomorphic shell character that distinguished a clade including *Heliacus*, *Architectonica*, and four other groups. This character is present in the Coffee Sand *Heliacus* species. Sculptural

elements were not included in the cladogram of Figure 9 because they were considered to be too variable and not homologous between taxa. The presence of five basal ribs on one of the earliest *Heliacus* species, however, corroborates Bieler's identification of the character as a primitive condition. It also indicates that the Miocene-Recent *Architectonica* was derived from the *Heliacus* clade of Figure 8 rather than the *Granosolarium* clade, another *Architectonica*-like group.

The sixth derived character is an increase in the umbilical width to a broadly conical umbilicus greater than 45% of the shell's width. This character distinguishes *Granosolarium*. Some Tertiary-Recent species of the *Heliacus-Architectonica* clade show convergence in the broadening of the umbilicus. However, *Granosolarium* maintains its broad conical umbilicus to the Recent. A small umbilicus is considered to be the primitive condition for *Heliacus* and its kin.

The seventh derived character is a pseudoplanispiral teleoconch, as exhibited by *Pseudomalaxis*. This character is well represented in the Upper Cretaceous species *Pseudomalaxis pateriformis* Stephenson, a species that is very close in form to the Recent species *Pseudomalaxis centrifuga* Monterosato from the Gulf of Mexico and eastern North Atlantic. With the inclusion of this most derived architectonicoidean genus, the major shell morphologies of the Architectonicoidea were present by Campanian time. In fact, morphological diversity in Recent architectonicoideans is less than that of the Cretaceous due to the extinction of *Lemniscolittorina*.

General Outline of Classification Used Here

Class GASTROPODA Cuvier, 1797
- Subclass STREPTONEURA Spengel, 1881
  - Order ARCHAEOGASTROPODA Thiele, 1925
    - Suborder DOCOGLOSSA Troschel, 1866
    - Suborder COCCULINIFORMIA Haszprunar, 1987
    - Suborder NERITIMORPHA Golikov and Starobogatov, 1975
    - Suborder VETIGASTROPODA Salvini- Plawen, 1980
    - Suborder SEGUENZIINA Salvini-Plawen and Haszprunar, 1987
  - Order CAENOGASTROPODA Cox, 1959
    - Suborder ARCHITAENIOGLOSSA Haller, 1892
    - Suborder NEOTAENIOGLOSSA Haller, 1882
    - Suborder HETEROPODA Lamarck, 1812
    - Suborder PTENOGLOSSA Gray, 1853
    - Suborder NEOGASTROPODA Thiele, 1929
  - Order HETEROSTROPHA Fischer, 1885
- Subclass EUTHYNEURA Spengel, 1881
- Order BASOMMATOPHORA A. Schmidt, 1855

OUTLINE OF SYSTEMATICS

Class GASTROPODA Cuvier, 1797
Subclass STREPTONEURA Spengel, 1881
Order ARCHAEOGASTROPODA Thiele, 1925
Suborder DOCOGLOSSA Troschel, 1866
Superfamily PATELLOIDEA Rafinesque, 1815
Family ACMAEIDAE Carpenter, 1857
Genus ACMAEA Eschscholtz, 1830

Acmaea sp.

Suborder NERITIMORPHA Golikov and Starobogatov, 1975
Superfamily NERITOIDEA Rafinesque, 1815
Family NERITIDAE Rafinesque, 1815
Subfamily NERITINAE Rafinesque, 1815
Genus NERITA Linné, 1758

Nerita reticulirata n. sp.

Genus NERITINA Lamarck, 1816

Neritina sp.

Suborder VETIGASTROPODA Salvini Plawen, 1980
Superfamily TROCHOIDEA Rafinesque, 1815
Family TROCHIDAE Rafinesque, 1815
Subfamily ANGARIINAE Thiele, 1924
Genus CALLIOMPHALUS Cossmann, 1888
Subgenus CALLIOMPHALUS Cossmann, 1888

Calliomphalus (Calliomphalus) paucispirilus Sohl, 1964

Subgenus PLANOLATERALUS Sohl, 1960

Calliomphalus (Planolateralus) tuberculosus Sohl, 1964

Family ATAPHRIDAE Cossmann, 1918
Genus ATAPHRUS Gabb, 1869

Ataphrus griffini n. sp.

Order CAENOGASTROPODA Cox, 1959
Suborder NEOTAENIOGLOSSA Haller, 1882
Section DISCOPODA Fischer, 1884
Superfamily CERITHIOIDEA Ferrussac, 1819

Family POTAMIDIDAE H. and A. Adams, 1854
Genus TYMPANOTONUS Schumacher, 1817
Subgenus TYMPANOTONUS Schumacher, 1817

Tympanotonus (Tympanotonus) cretaceus Wade, 1926
Tympanotonus (Tympanotonus) robustus n. sp.
Tympanotonus (Tympanotonus) binodosus n. sp.

Subgenus EXECHOCIRSUS Cossmann, 1906

Tympanotonus (Exechocirsus) cowickeensis (Sohl, 1964)
Tympanotonus (Exechocirsus) trilirus n. sp.

Family TURRITELLIDAE Loven, 1847
Subfamily TURRITELLINAE Loven, 1847
Genus TURRITELLA Lamarck, 1799

Turritella trilira Conrad, 1860
Turritella quadrilira Johnson, 1898
Turritella vertebroides Morton, 1834
Turritella chapelvillensis n. sp.

Subfamily VERMICULARIINAE Faustino, 1928
Genus LAXISPIRA Gabb, 1877

Laxispira lumbricalis Gabb, 1877

Family GLAUCONIIDAE Pchelintsev, 1953
(= CASSIOPIDAE Kollmann, 1979)
Genus GYMNENTOME Cossmann, 1909

Gymnentome unicarinata n. sp.
Gymnentome canalis n. sp.

Superfamily TRUNCATELLOIDEA Gray, 1840
(= RISSOACEA Gray, 1847)
Family RISSOIDAE Gray, 1847
Subfamily RISSOINAE Gray, 1847
Genus ALVANIA Risso, 1826

Alvania (s.l.) tallahatchiensis (Sohl, 1960)

Subfamily RISSOININAE Stimpson, 1865
Genus STOSICIA Brusina, 1870

Stosicia (s.l.) antiqua n. sp.

Genus COSSMANNIA Newton, 1891

Cossmannia tennesseensis (Wade, 1926)

Family IRAVADIIDAE Thiele, 1928
Genus HYALA H. and A. Adams, 1852

Hyala fragila n. sp.

Genus CERATIA H. and A. Adams, 1852

Ceratia cylindrata n. sp.

Genus ENTOMOPE Cossmann, 1888

Entomope ponderi n. sp.
Entomope sp.

Genus NOZEBA Iredale, 1915

Nozeba crassa n. sp.

Family TORNIDAE Sacco, 1896
Genus TORNUS Turton and Kingston, 1830

Tornus? planocarinatus n. sp.

Family ADEORBIDAE Monterosato, 1884
(= CIRCULIDAE Fretter and Graham, 1962)
Genus SOLARIORBIS Conrad, 1865

Solariorbis clara (Sohl, 1960)

Genus TEINOSTOMA A. Adams, 1851

Teinostoma prenanum Wade, 1926

INCERTAE SEDIS
Family PICKWORTHIIDAE Iredale, 1936
Genus URCEOLABRUM Wade, 1916

Urceolabrum mantachieensis Sohl, 1964

Superfamily STROMBOIDEA Rafinesque, 1815
Family APORRHAIDAE Mörch, 1852
Genus PERISSOPTERA Tate, 1865

Perissoptera prolabiata mississippiensis n. subsp.

Genus LATIALA Sohl, 1960

Latiala ? sp.

Genus GRACILIALA Sohl, 1960

Graciliala johnsoni (Stephenson, 1923)

Genus ANCHURA Conrad, 1860

Anchura coffea n. sp.
Anchura corniculata n. sp.

Anchura chapelvillensis n. sp.

Genus PTEROCERELLA Meek, 1864

Pterocerella maryea n. sp.

Genus TUNDORA Stephenson, 1941

Tundora tuberculata Stephenson, 1941

Genus GYMNARUS Gabb, 1868

Gymnarus abnormalis (Wade, 1926)

Genus LISPODESTHES White, 1876

Lispodesthes amplus n. sp.

Genus PUGNELLUS Conrad, 1860

Pugnellus densatus (Conrad, 1858)

Family COLOMBELLINIDAE Fischer, 1884
Genus COLOMBELLINA d'Orbigny, 1842

Colombellina cancellata n. sp.

Superfamily CALYPTRAEOIDEA Lamarck, 1809
Family CALYPTRAEIDAE Lamarck, 1809
Genus THYLACUS Conrad, 1860

Thylacus cretaceus Conrad, 1860

Family CAPULIDAE Fleming, 1822
Genus CAPULUS Monfort, 1810

Capulus? sp.

Genus TRICHOTROPIS Broderip and Sowerby, 1829

Trichotropis squamosa (Gabb, 1876)

Genus CERITHIODERMA Conrad, 1860

Cerithioderma nodosa n. sp.

Superfamily XENOPHOROIDEA Troschel, 1852
Family XENOPHORIDAE Troschel, 1852
Genus XENOPHORA Fischer von Waldheim, 1807
Subgenus XENOPHORA Fischer von Waldheim, 1807

Xenophora (Xenophora) leprosa (Morton, 1834)

Superfamily CYPRAEOIDEA Rafinesque, 1815
Family CYPRAEIDAE Rafinesque, 1815
Subfamily BERNAYINAE Schilder, 1927
Genus BERNAYA Jousseaume, 1884
Subgenus PROTOCYPRAEA Schilder, 1927

Bernaya (Protocypraea) mississippiensis Groves, 1990

Superfamily NATICOIDEA Forbes, 1838
Family AMPULLINIDAE Cossmann, 1918
Genus AMPULLINA Bowdich, 1882

"Ampullina" cf. *"A." potens* Wade, 1926

Genus AMAURELLINA Fischer, 1885

Amaurellina stephensoni (Wade, 1926)

Genus PSEUDAMAURA Fischer, 1885

Pseudamaura lepta Sohl, 1964

Family NATICIDAE Forbes, 1838
Subfamily GYRODINAE Wenz, 1941
Genus GYRODES Conrad, 1860
Subgenus GYRODES Conrad, 1860

Gyrodes (Gyrodes) major Wade, 1926

Subgenus SOHLELLA Popenoe, Saul, and Susuki, 1987

Gyrodes (Sohlella) spillmani Gabb, 1861

Subfamily POLINICINAE Finlay and Marwick, 1937
Genus EUSPIRA Agassiz *in* Sowerby, 1842

Euspira rectilabrum (Conrad, 1858)

Superfamily TONNOIDEA Suter, 1913
Family RANELLIDAE Gray, 1854
Subfamily RANELLINAE Gray, 1854
Genus GYRINEUM Link, 1807

Gyrineum (s.l.) gwinae n. sp.
Gyrineum (s.l.) gwinae var.?

Subfamily CYMATIINAE Iredale, 1913
Genus SASSIA Bellardi, 1872

Sassia carlea n. sp.

Suborder HETEROPODA Lamarck, 1812
Superfamily CARINARIOIDAE Blainville, 1818
Genus BRUNONIA Blainville, 1818
(discussion only)

Suborder PTENOGLOSSA Gray, 1853
Superfamily TRIPHOROIDEA Gray, 1847
(=CERITHIOPSOIDEA H. and A. Adams, 1853)
Family TRIFORIDAE Jousseaume, 1884
Genus CERITHIELLA Verrill, 1882

Cerithiella nodoliratum (Wade, 1926)
Cerithiella chapelvillensis n. sp.
Cerithiella aequalirata n. sp.
Cerithiella sp.

Genus MONROEA Stephenson, 1952

Monroea coffea n. sp.

Genus BITTIUM Leach, 1847

Bittium? sp.

Genus VARISEILA new genus

Variseila meeki (Wade, 1926)

Superfamily JANTHINOIDEA Lamarck, 1810
(=EPITONACEA Berry, 1910)
Family EPITONIIDAE S. S. Berry, 1910
Subfamily NYSTIELLINAE Clench and Turner, 1952
Genus ECCLISEOGYRA Dall, 1892

Eccliseogyra heliclina n. sp.
Eccliseogyra inflata n. sp.

Genus OPALIOPSIS Thiele, 1928

Opaliopsis angustocosta n. sp.

Genus PSEUDOCLAVISCALA new genus

Pseudoclaviscala laevicosta n. sp.
Pseudoclaviscala rugacosta n. sp.

Subfamily EPITONIINAE S. S. Berry, 1910
Genus EPITONIUM Roding, 1798

Epitonium faearium n. sp.

Genus ACIRSA Morch, 1857

Acirsa gravida Sohl, 1964
Acirsa culmosa Sohl, 1964

Genus PAUCIACIRSA new genus

Pauciacirsa simplex n. sp.

Genus PUNCTISCALA de Boury, 1890

Punctiscala melaniea n. sp.

Genus STRIATICOSTATUM Sohl, 1963

Striaticostatum griffini n. sp.
Striaticostatum micropunctatum n. sp.

Genus BELLISCALA Stephenson, 1941

Belliscala lirata n. sp.
Belliscala nodosa n. sp.

Genus ACICULISCALA Sohl, 1963

Aciculiscala coffea n. sp.

Superfamily EULIMOIDEA H. and A. Adams
Family EULIMIDAE Troschel, 1853
Genus EULIMA Risso, 1826

Eulima gracilistylis Sohl, 1964
Eulima coffea n. sp.
Eulima spirala n. sp.
Eulima sp.

Suborder NEOGASTROPODA Thiele, 1929
(Not included in this report)

Order HETEROSTROPHA Fischer, 1885
Superfamily ARCHITECTONICOIDEA Gray, 1840
Family MATHILDIDAE Dall, 1889
Genus MATHILDA Semper, 1865

Mathilda ripleyana Wade, 1926
Mathilda pentalira n. sp.
Mathilda hexalira n. sp.

Genus ECHINIMATHILDA Sohl, 1964

Echinimathilda corona Sohl, 1960 var.
Echinimathilda microstriata n. sp.
Echinimathilda parvula (Sohl, 1960)

Genus ACROCOELUM Cossmann, 1888

Acrocoelum? cereum Sohl, 1960

Genus GEGANIA Jeffreys, 1884

Gegania mississippiensis n. sp.

Genus LEMNISCOLITTORINA Sohl, 1960

Lemniscolittorina yonkersi n. sp.

Family ARCHITECTONICIDAE Roding, 1798
Genus HELIACUS d'Orbigny *in* Sagra, 1842

Heliacus reticulatus n. sp.

Genus GRANOSOLARIUM Sacco, 1892

Granosolarium coffea Sohl, 1964

Genus PSEUDOMALAXIS Fischer, 1850

Pseudomalaxis pateriformis Stephenson, 1955

Family OMALOGYRIDAE G. O. Sars, 1878
Genus NEAMPHITOMARIA Bandel, 1988

Neamphitomaria stantoni Sohl, 1960
Neamphitomaria reticulata n. sp.
Neamphitomaria planospira n. sp.

Superfamily PYRAMIDELLOIDEA Gray, 1840
Family STREPTACIDIDAE Knight, 1931
Genus STREPTACIS Meek, 1872

Streptacis? bogradi n. sp.

Family AMATHINIDAE Ponder, 1987
Genus DAMESIA Holzapfel, 1888

Damesia keownvillensis Sohl, 1960

Subclass EUTHYNEURA Spengel, 1881
Order BASOMMATOPHORA A. Schmidt, 1855
Superfamily SIPHONARIOIDEA Gray, 1840
Family SIPHONARIIDAE Gray, 1840
Genus ANISOMYON Meek and Hayden, 1860

Anisomyon sp.

SYSTEMATICS

Descriptions of species included in this section were made from specimens collected from the Coffee Sand unless otherwise noted. Types are deposited in the Natural History Building of the U.S. National Museum. This repository is abbreviated in the following text as USNM. Figured specimens not designated as types are deposited in the Figured Specimen Collection of the Mississippi Office of Geology. This repository is abbreviated as MGS, an abbreviation of the agency's former name, Mississippi Geological Survey, when the collection was begun.

Class GASTROPODA Cuvier, 1797
Subclass STREPTONEURA Spengel, 1881
Order ARCHAEOGASTROPODA Thiele, 1925
Suborder DOCOGLOSSA Troschel, 1866
Superfamily PATELLOIDEA Rafinesque, 1815
Family ACMAEIDAE Carpenter, 1857

Genus ACMAEA Eschscholtz, 1830

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

Diagnosis: Porcelaneous, conical shell with apex central or near anterior margin; protoconch conical; exterior with radial ornament or smooth (after Davies, 1971, p. 291).

Range: Upper Cretaceous (Cenomanian) - Recent.

Acmaea sp.

1964b. *Acmaea* sp. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 357, pl. 53, fig. 18.

Diagnosis: A small sized *Acmaea* with subcentral apex, steep anterior slope, and smooth surface (after Sohl, 1964b, p. 357).

Discussion: A small incomplete specimen of *Acmaea* is discussed and figured in Sohl (1964b). No additional specimens were found in the course of this study.

Types: Figured specimen 131492 USNM.

Occurrence: Coffee Formation, MGS locality 130.

Suborder NERITIMORPHA Golikov and Starobogatov, 1975
Superfamily NERITOIDEA Rafinesque, 1815
Family NERITIDAE Rafinesque, 1815
Subfamily NERITINAE Rafinesque, 1815

Genus NERITA Linné, 1758

Type, *Nerita peloronta* Linné, 1758.

Diagnosis: Ovate to hemispherical shell with low spire and enveloping body whorl and with inner walls resorbed; protoconch multiwhorl, globose, and involute; aperture semicircular with denticulate columellar septum; exterior smooth or with spiral sculpture (after Davies, 1971, p. 300).

Range: Upper Cretaceous (Cenomanian) - Recent.

Nerita reticulirata n. sp.
Plate 1, figures 18-20; Plate 2, figures 1-2

Diagnosis: A small sized *Nerita* with smooth protoconch, strongly lirate teleoconch, and semicircular aperture with a single denticle on the upper part of the inner lip.

Description: The protoconch (as shown in Plate 2, figures 1-2) consists of about two smooth whorls with fine, closely spaced growth laminations. Spiral lirae appear abruptly on the teleoconch. These lirae number twenty or more in the adult and form a reticulate pattern with fine, prosocline, raised, growth laminae that are most prominent in the interspaces. Lirae above the shoulder become increasing nodiferous toward the upper suture with the upper five or six having a strongly beaded appearance. The aperture is semicircular with rounded anterior and posterior margins. The inner lip septum is well developed and bordered by a single denticle at the terminus of an internal lira at the base of the parietal lip. The outer lip is crenulate with the crenulations marking the termini of the exterior lirae and interspaces.

Discussion: This species has an aperture like that of *Nerita* but has a sculpture similar to that of *Neritopsis* (Ponder, personal communication). Several specimens of *Neritopsis radula* from New Caledonia and the New Hebrides were borrowed from the Australian Museum for comparison. Both *Nerita reticulirata* and *Neritopsis radula* have a sculpture of closely spaced, nodose, spiral lirae. However, *Neritopsis* is readily distinguished from *Nerita* by its peculiar character of resorbing the interior shell walls, thus leaving a void within the exterior walls. *Nerita reticulirata* has interior shell walls and can be assigned to *Nerita* without question. It is closely related to *Nerita ornata* Stephenson, 1952, from the Lewisville Member of the Woodbine Formation of Texas. It differs from this species in being smaller in size and in having nodose lirae only above the shoulder rather than covering the entire shell. *Nerita reticulirata* is also similar to *Nerita nodosa* Stephenson, 1947, and *Nerita denticulata* Stephenson, 1947. Both of the latter species are from a core of late Austin age (= Eutaw Group) in the Avent No. 1 well in Grenada County, Mississippi, at depths between 2730 and 2750 feet. *N. reticulirata* differs from *N. nodosa* in having less prominent nodes on the spiral lirae and from *N. denticulata* in having a single denticle rather than three on the inner lip.

Material: Several specimens.

Measurements: The holotype, which is not figured, measures 3.0 mm in height and 3.0 mm in width. The largest complete specimen collected measures 4.0 mm in height and

4.0 mm in width.

Types: Holotype 456982 USNM.

Etymology: The species is named for its reticulate sculpture with fine growth laminae and spiral lirae.

Occurrence: Coffee Formation, MGS locality 129.

Genus NERITINA Lamarck, 1816

Type by subsequent designation (Kennard et al., 1931, p. 24), *Nerita pulliger* Linné, 1767.

Diagnosis: Ovate shell like that of *Nerita*, but with thinner shell and weak teeth on the inner lip; exterior smooth (after Abbott, 1974, p. 64, in part).

Range: Upper Cretaceous (Maastrichtian) - Recent.

Neritina sp.
Plate 4, figures 3-4

Diagnosis: A large sized *Neritina* with color pattern of light spots and non-denticulate, rounded, columellar septum.

Discussion: The *Neritina* specimen figured here is from the Coon Creek Tongue of the Ripley Formation in Union County, Mississippi (MGS locality 127). It may prove to be *Neritina densata* Conrad, 1858, a species attributed to the Owl Creek Formation, the type of which is lost. Though the publication of the Ripley molluscan fauna of Mississippi is planned for a future work, this species is included here to show the excellent preservation of its color pattern. This color pattern is similar to extant species of *Neritina* such as *N. punctulata* Lamarck, 1815.

Material: Two specimens from MGS locality 127.

Removed from the Neritidae

Discussion: *Damesia* Holzapfel, 1888, is placed here with *Amathina* in the Superfamily Pyramidellacea, Family Amathinidae Ponder, 1987. Sohl (1960, p. 63) followed Holzapfel (1888, p. 168) in placing this genus in the family Neritidae, though he stated that this placement was in doubt. *Damesia* is represented in Campanian-Maastrichtian sediments of the Gulf Coastal Plain by the species *D. keownvillensis* Sohl, 1960. Specimens of this species illustrated in figures 8 and 9 of Plate 2 clearly show the protoconch not to be involutely coiled as in the Neritidae, but to be heterostrophic and minute like that described by Ponder (1987, p. 19) for the pyramidellacean limpet *Amathina*.

Suborder VETIGASTROPODA Salvini-Plawen, 1980
Superfamily TROCHOIDEA Rafinesque, 1815
Family TROCHIDAE Rafinesque, 1815
Subfamily ANGARIINAE Thiele, 1924

Genus CALLIOMPHALUS Cossmann, 1888

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

Diagnosis: Trochiform shell with nacreous inner layer; protoconch small and less than one whorl; aperture round to subround; exterior with beaded or spinose spiral sculpture; base striated; umbilicus wide and with noded margin (after Sohl, 1960, p. 53).

Range: Upper Cretaceous (Coniacian) - Eocene.

Discussion: Ten species of the genus *Calliomphalus* are present in the Upper Cretaceous deposits of the Gulf and Atlantic Coastal Plain. These species are placed in two subgenera, each of which is represented in the Coffee Sand by one species. The subgenus *C. (Calliomphalus)* is characterized by a stair-step spire with a flat subsutural ramp, by prominent spiral cords that are generally nodose on the spire and upper half of the body whorl, and by a moderately large umbilicus. This subgenus, though generally larger in size, resembles certain Gulf Coastal Plain Paleogene species of *Solariella*, such as *S. cancellata* (Conrad, 1833) of the Middle Eocene Gosport Sand.

The subgenus *C. (Planolateralis)* Sohl, 1960, is characterized by nodose sculpture rather than spiral lirae with the nodes arranged in spiral rows. The spire is more flat-sided and lacks a stair-step appearance, and the umbilicus is narrow. The difference in the umbilicus of these two subgenera is especially prominent in the juvenile stage. *C. (Calliomphalus)* as shown in Plate 3, figure 5, and Plate 4, figure 2, has a large funnel shaped umbilicus while *C. (Planolateralis) tuberculosus* shown in Plate 3, figure 4, and Plate 4, figure 1, has a narrow umbilicus with sides that are nearly vertical to the base.

Subgenus CALLIOMPHALUS Cossmann, 1888

Calliomphalus (Calliomphalus) paucispirilus
Sohl, 1964
Plate 1, figures 1-4; Plate 3, figures 5-7;
Plate 4, figure 2

1964b. *Calliomphalus (Calliomphalus) paucispirilus* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 357-358, pl. 53, fig. 23-24.

Diagnosis: Moderately small sized, trochiform shell with a stair-step spire and with rounded whorls, which lack a basal keel.

Description: The spire has a stair-step appearance due to a flat subsutural ramp and is sculptured with nodose spiral cords. The periphery of the body whorl has coarse, lightly nodose, spiral cords, and the base is covered with fine, closely spaced, spiral threads. The umbilicus is moderately large and bordered by coarse nodes. The protoconch consists of one smooth whorl and is sharply set off from the teleoconch as show in Plate 3, figure 6. Early whorls of the teleoconch have strong longitudinal ribs which become nodose below the suture and at the shoulder. Four spiral threads occur on the

periphery. Later whorls have two or three coarse, strongly nodose, spiral ribs on the subsutural ramp and three spiral cords on the periphery with a fourth fine cord closely spaced below the third. The base has fine impressed spiral lines and a large umbilicus with a strongly nodose margin. The aperture is subrounded in outline, and its profile is oblique to the shell axis. The interior is smooth and nacreous.

Discussion: The exterior shell of this species has a sculptured porcelaneous layer, which readily spalls off to reveal the underlying smooth nacreous layer.

Material: Numerous specimens.

Measurements: The holotype measures 8.8 mm in height and 8.2 mm in width. An incomplete paratype (131683 USNM) has a maximum diameter of 9.8 mm.

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

Occurrence: Coffee Sand, MGS localities 128, 129, and 130 (type locality).

Subgenus PLANOLATERALUS Sohl, 1960

Type by original designation, *Calliomphalus argenteus* Wade, 1926.

Diagnosis: Trochoid shell with flat-sided whorls and angulate basal margin; protoconch of 3/4 whorl; shell higher than wide and with a less flaring umbilicus than *Calliomphalus s.s.* (after Sohl, 1960, p. 55).

Range: Upper Cretaceous (Campanian) - Eocene.

Calliomphalus (Planolateralus) tuberculosus
Sohl, 1964
Plate 1, figure 5; Plate 3, figures 1-4; Plate 4, figure 1

1964b. *Calliomphalus (Planolateralus) tuberculosus* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 358, pl. 53, fig. 26-28, 30-31, 35.

Diagnosis: Small sized trochiform shell with moderately elevated spire and strongly nodose (tuberculous) surface; umbilicus narrow with a rounded margin bordered by a modest spiral row of nodes.

Description: The protoconch consists of one half smooth whorl and is sharply set off from the teleoconch as shown in Plate 3, figure 1. The first two whorls of the teleoconch have a flat subsutural ramp with well defined, spoke-like ribs that terminate at the ramp's peripheral margin. Some space below the ramp's margin on the shell's rounded periphery are eight or so spiral threads. The base is smooth except for elongate nodes radiating outward from the umbilical margin. The adult shell is sculptured on the spire, shell margin, and base with spiral rows of nodes or tubercules. Whorls of the spire generally have six strong, spiral rows of nodes with some intervening rows of secondary strength. Of these rows, the most prominent occurs below the suture. Figure 3 of Plate 3 shows the sequence in which the nodose rows form. The subsutural and peripheral rows form first with the intervening four forming in sequence from the second subsutural row to the fourth. The base is covered with fine nodes in spiral rows and with a row of coarse nodes on the umbilical margin. The aperture is subrounded and, in profile, is oblique to the shell axis. Three shell layers are exposed just inside the aperture where they form concentric bands. These include an outer porcelaneous layer, a central nacreous layer, and an inner porcelaneous layer. The inner layer has fine spiral lirae that terminate in fine nodes at the junction with the nacreous layer.

Material: Numerous specimens.

Measurements: The holotype (131594 USNM) measures 6 mm in height and in width. A larger topotype measured by Sohl (1964b, p. 358) is 7.2 mm in height and 7 mm in width.

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

Occurrence: Coffee Sand, MGS localities 128, 129, and 130 (type locality).

Family ATAPHRIDAE Cossmann, 1918

Genus ATAPHRUS Gabb, 1869

Type by monotypy, *Ataphrus crassus* Gabb, 1869.

Diagnosis: Trochiform, non-umbilicate shell with rounded sides, subcircular to ovate aperture, and generally a smooth exterior; protoconch of less than one whorl.

Range: Lower Jurassic - Cretaceous (Maastrichtian).

Ataphrus griffini n. sp.
Plate 1, figures 6-12; Plate 2, figure 4

Diagnosis: A moderately small sized *Ataphrus* with a low, modestly shouldered spire and rounded body whorl.

Description: The protoconch (as shown in Plate 2, figure 4) consists of one half, smooth whorl. The teleoconch has a shoulder just above the suture that begins after the first three-fourths whorl (of the teleoconch) and continues for three whorls before becoming obsolete on the fourth whorl or body whorl. Low, prosocline nodes form below the suture after the first one and one half whorls of the teleoconch and continue for little more than one whorl before fading out. Where these nodes occur, the ramp between the nodes and the shoulder is slightly concave. The body whorl is smooth and evenly rounded. The shell base is smooth and with a semicircular callus pad extending from the parietal lip of the adult. Juvenile shells lack this callus pad and have a small umbilicus. The aperture is subcircular and has a prosocline margin. The interior is smooth with a thin porcelaneous layer covering the nacreous layer.

Discussion: The only other species attributed to this genus in the Gulf-Atlantic Coastal Plain Region is *Ataphrus kerri* Gabb, 1876, which occurs in the Snow Hill Member of the Black Creek Formation in North Carolina. The Snow Hill

Member is in the upper part of the *Exogyra ponderosa* zone and is roughly equivalent in age to the Coffee Sand. *A. kerri* differs from the Coffee Sand species in having fine spiral sculpture on the spire and base and in having a tubercule on the columellar lip.

Ataphrus griffini has a variable color pattern as is shown by two specimens in Plate 1. The first of these consists of zigzag longitudinal stripes as shown in figures 6 and 7. The second consists of prosocline longitudinal stripes and an overriding spiral band just below the periphery as shown in figures 9 and 10.

Material: Several specimens.

Measurements: The holotype measures 3.0 mm in height and 4.0 mm in width.

Types: Holotype 456983 USNM.

Etymology: Named in honor of the property owner of the type locality, Cecil Griffin.

Occurrence: Coffee Sand, MGS locality 129.

Removed from the Turbinidae

Discussion: *Urceolabrum* is placed here in the Pickworthiidae, a caenogastropod tentatively placed as *incertae sedis* in the Superfamily Truncatelloidea based on the protoconch morphology. See that section for details.

Order CAENOGASTROPODA Cox, 1959
Suborder NEOTAENIOGLOSSA Haller, 1882
Section DISCOPODA Fischer, 1884
Superfamily CERITHIOIDEA Ferrussac, 1819
Family POTAMIDIDAE H. and A. Adams, 1854

Genus TYMPANOTONUS Schumacher, 1817

Type by monotypy, *Tympanotonus fluviatilis* Schumacher.

Diagnosis: Turreted-conical shell with subquadrangular aperture and straight columellar lip; labrum with hood-like anterior projection; ornament variable and changing with growth consisting of crenulated spiral threads with or without nodes and/or spines (after Davies, 1971, p. 318).

Range: Upper Cretaceous (Campanian) - Recent.

Discussion: Extant species of *Tympanotonus* inhabit mangrove swamps and lagoons along the African West Coast. Taxa attributed to this genus from the Coffee Sand are also considered to be nearshore, shallow water indicators.

Subgenus TYMPANOTONUS Schumacher, 1817

Discussion: Three Coffee Sand species are assigned to *Tympanotonus s.s.* based on the sculpture. This placement was suggested by Klaus Bandel, University of Hamburg (personal communication), and largely agreed with by Richard Houbrick, U.S. National Museum (personal communication). The sculpture of these three species shows a gradation from strong axial nodes in *T. cretaceus*, to axial nodes that become binodose on the penultimate and body whorls in *T. robustus*, to axial nodes that become binodose on the last four whorls in *T. binodosus*. None of these species has been found with a complete aperture so their generic placement cannot be made with certainty.

Houbrick (personal communication) suggested that the sculpture of *T. cretaceus* as shown in Plate 7, figure 4, might be that of *Pyrazus*, *Terebralia*, or *Potamides*. However, due to the similarity of this sculpture with that of the early whorls of the other two species, all three are considered to be generically related. Wenz (1940) placed a group of European Cenomanian to Maastrichtian cerithids of Cossmann's (1906) taxon *Echinobathra* as a subgenus of *Pyrazus*. The type of this subgenus, *Cerithium simonyi* Zekeli, is a medium sized shell with strong axial ribs. It is possible that this subgenus is congeneric with the Gulf Coast taxa included in *Tympanotonus s.s.*

Tympanotonus (Tympanotonus) cretaceus
Wade, 1926
Plate 6, figure 1; Plate 7, figure 4

1926. *Melanatria cretacea* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 158, pl. 55, fig. 1a, 1b, 2.
1960. *Melanatria cretacea* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 79.

Diagnosis: A *Tympanotonus* with strong, widely spaced axial ribs that extend from suture to suture on the early whorls and prominent axial nodes on the latter whorls that terminate at a subsutural sulcus.

Description: The protoconch, earliest juvenile whorls, and the apertural margin of this species are unknown. The first five known whorls have prominent, broadly spaced axial ribs that extend from suture to suture and which are covered with eight (on the first three whorls) to nine (on the fourth and fifth whorls) spiral lirae. On the sixth and seventh whorls the axial sculpture is constricted by a shallow subsutural sulcus. This constriction produces axial nodes that slope gently toward the lower suture and steeply where truncated by the subsutural sulcus. Spiral lirae on the latter whorls consist of one lira adjacent to the upper suture, one in the sulcus, two on the adapical slope of the axial nodes, six broad lirae separated by narrow grooves on the node crests and interspaces, and a prominent lira adjacent to the lower suture. Nine nodes are present on the fifth whorl. The growth lines are opisthocyrtic and indicate the presence of a shallow apertural sinus centered along the shoulder. The base is covered by broad lirae with narrow interspaces.

Discussion: Wade (1926, p. 158) placed this species as *Melanatria* based on comparisons with two Paris Basin Paleogene species - *Melanatria dufresnei* (Deshayes) from the Thanetian to the Cuisian stages and *Melanatria cuvieri* (Deshayes) from the Sparnacian to Lutetian stages. However,

these species have a prominent posterior canal located in the outer lip just below the suture in the subsutural sulcus, a common character for the genus. The opisthocyrtic growth lines of *Tympanotonus cretaceus* suggest a broad apertural sinus at the shoulder.

Material: Several specimens.

Types: Holotype 32947 USNM; paratype 32947a USNM.

Occurrence: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County, Tennessee (type locality).

Tympanotonus (Tympanotonus) robustus n. sp.
Plate 7, figure 1

Diagnosis: A large sized *Tympanotonus* sculptured on the early whorls with axial ribs noded at intersections with five or six spiral lirae; penultimate and body whorls sculptured with bispinose axial ribs.

Description: The protoconch and early whorls are unknown. Only five whorls including the body whorl are present on the most complete specimen. The first two whorls have nine axial ribs per whorl. These ribs extend from suture to suture and are noded at intersections with five to six spiral lirae, which are better developed on the ribs than in the interspaces. The third whorl has eight ribs and becomes bispinose. Nodes associated with the first and third lirae above the suture strengthen to spines as the nodes of other lirae diminish. The fourth and fifth whorls have seven bispinose axial ribs with the spines more prominent than the ribs themselves. Growth lines are opisthocyrtic and indicate an apertural sinus centered along the upper row of spines. The base has five rows of closely spaced nodes. The aperture is incompletely known, but an anterior canal is present.

Discussion: This species is characterized by the bispinose ribs of the penultimate and body whorls. It is closely related to *T. (T.) binodosus*, which has a similar but more subdued sculpture. Both species are similar to *T. (T.) cretaceus* in the axial sculpture of the early whorls.

Materal: Several specimens.

Measurements: The incomplete holotype measures 69.9 mm in height and 38.2 mm in width.

Types: Holotype 456984 USNM.

Etymology: The species is named for its large size and robust nodes (spines).

Occurrence: Coffee Sand, MGS locality 129.

Tympanotonus (Tympanotonus) binodosus n. sp.
Plate 7, figures 2-3

Diagnosis: A large sized *Tympanotonus* with a prominent binodose sculpture that appears early in the shell's ontogeny.

Description: The earliest whorls and apertural margin of this species are unknown. Adults may have eight or more whorls. The first three whorls have six axial ribs per whorl and five spiral lirae, the lower one being the most prominent; the latter whorls are binodose with seven binoded axial ribs per whorl. The base has four rows of closely spaced nodes. Growth lines are opisthocyrtic and indicate the presence of a broad and shallow apertural sinus.

Discussion: The sculpture of this species resembles that of the recent fresh-water thaiarid species *Pachymelania byronensis* (Wood, 1828) as figured in Bernard (1984, pl. 8, fig. 37), from the west coast of Africa. It is possible that shells of such a fresh-water taxon were transported into near-shore Coffee Sand environments as were shells of the estuarine cassiopid *Gymnentome*. However, shells of *T. (T.) binodosus* are not abraded and have a more prominent anterior canal than that of *Pachymelania*, so the similarity in sculpture is attributed to convergence.

Material: Several specimens.

Measurements: The incomplete holotype measures 66.7 mm in height and 29.0 mm in width.

Types: Holotype 456985 USNM.

Etymology: The species is named for its binodose sculptural pattern.

Occurrence: Coffee Sand, MGS locality 129.

Subgenus EXECHOCIRSUS Cossmann, 1906

Type by original designation, *Cerithium cingillatus* Zekeli.

Diagnosis: A small to medium sized cerithid sculptured with spiral rows of nodes and with varical swellings (after Wenz, 1940, p. 741).

Range: Upper Cretaceous (Turonian-Maastrichtian).

Discussion: Houbrick (personal communication) suggested the placement of two small cerithid species in the genus *Tympanotonus*. The apertures of these species are unknown, but the sculpture is like that of *T. cingillatus* (Zekeli), the type species for the subgenus *Exechocirsus*. This subgenus occurs in the Turonian to Maastrichtian beds of Europe and is recognized here in the North American Gulf sequence for the first time. One of the Coffee Sand species attributed to *Exechocirsus*, *T. (E.) cowickeensis* (Sohl), was originally placed in the genus *Potamides* based largely on the similarity of its sculpture with that of the subgenus *Ptychopotamides*. This subgenus occurs in the Paris Basin Eocene and has a sculpture of noded spiral lirae that become spiral rows of nodes on the latter whorls. *Exechocirsus* has a similar sculpture but has convex whorls rather than flat-sided or basally carinate whorls as does *Ptychopotamides*. The whorl profile of *T. (E.) cowickeensis* is like that of *Exechocirsus*.

Tympanotonus (Exechocirsus) cowickeensis
(Sohl, 1964)
Plate 6, figures 2-4; Plate 24, figures 13-15, 17

1964b. Potamides cowickeensis Sohl, U. S. Geol. Survey, Prof. Paper 331 C, p. 363, pl. 53, fig. 10-16.

Diagnosis: A small sized *Exechocirsus* with a variable nodose sculpture consisting of five to seven primary spiral lirae noded at intersections with collabral swellings and with a rounded basal margin.

Description: The protoconch consists of three smooth whorls, the second of which has a modest carina, and the third of which is more strongly carinate with a spiral thread above and below the carina. The juncture between the protoconch and teleoconch is abrupt with the protoconch exhibiting a sinus in the apertural margin above the carina. The teleoconch consists of ten or more whorls sculptured by strongly noded lirae and has an apical angle of 20°. Whorls one through four are bilirate with the lirae strongly noded at the junctions with collabral ribs or swellings. This sculpture appears abruptly on the first whorl with the two spiral lirae stemming from the carina and upper spiral thread of the protoconch. A third spiral lira appears just below the suture on the fourth or fifth whorl, and secondary lirae appear above and below the middle lira on the seventh whorl. On the typical variety of this species, the secondary lirae become subequal or equal to the primaries on the eighth whorl and three spiral threads appear in a sulcus below the lower lira. These threads become finely noded on the ninth whorl, and the upper and lower threads increase in strength to become subequal with the spiral lirae. Tertiary lirae may appear on the eighth or ninth whorl. By the tenth whorl, the typical variety has five to seven (sometimes eight) prominent nodose spiral lirae and additional lirae of lesser strength. Growth lines are opisthocyrtic, and irregularly spaced varical swellings are generally present. The apertural form is incompletely known, but an anterior canal is present. The basal margin is rounded and bordered by two finely noded spiral lirae with an intervening thread. The upper of these lirae is derived from the lowest of the three threads that lie in the sulcus above the suture. The base is covered by four to five finely crenulate threads.

Discussion: This species is common in the Chapelville horizon of the Coffee Sand and is believed to be an indicator of a shallow water, nearshore environment. Though most specimens have between five and eight noded spiral lirae, one variety has only three primary lirae. This variety is otherwise like the typical form in its apical angle and strength of its nodose sculpture.

Material: Numerous specimens.

Types: Holotype 131606 USNM; paratype 131607 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130. Alabama: Blufftown Formation, Cowickee Creek 3 miles southwest of Glenville on the county line between Russell and Barbour counties (type locality).

Tympanotonus (Exechocirsus) trilirus n. sp.
Plate 6, figures 5-10; Plate 24, figure 16

Diagnosis: A small sized *Exechocirsus* sculptured with three primary spinose or nodose spiral lirae and with a strongly bicarinate and angular basal margin.

Description: The protoconch and earliest juvenile whorls are unknown. The teleoconch has 11 or more nodose, trilirate whorls and an apical angle of 21° to 24°. The first three whorls are coarsely sculptured with spiral lirae and axial ribs forming nodes at their intersections. Spiral threads appear in the interspaces between lirae on the fourth whorl, and three spiral threads appear in a sulcus above the lower suture on the fifth whorl. Interliral threads become finely noded between the fifth and eighth whorls. Growth lines are opisthocyrtic, and irregularly spaced varical swellings are present. The apertural form is incompletely known, but an anterior canal is present. The basal margin is angular and bicarinate with two, finely noded spiral lirae. Twelve spiral threads of varying strength are present on the base.

Discussion: This species is much less common than *T. (E.) cowickeensis* and can be distinguished from that species by the coarseness of its sculpture, its greater apical angle, its strongly angular and bicarinate basal margin and generally by being trilirate. Only six specimens of this species are currently in the MGS collections. All six are illustrated in Plate 6. Four of these specimens shown in figures 6-9 are coarsely noded to spinose, and two specimens shown in figures 5 and 10 are more finely noded.

Material: Six specimens.

Measurements: The holotype measures 17.0 mm in height and 6.0 mm in width.

Types: Holotype 456986 USNM.

Etymology: Named for the three coarsely noded lirae that are characteristic of the species' sculpture.

Occurrence: Coffee Sand, MGS locality 129.

Family TURRITELLIDAE Loven, 1847
Subfamily TURRITELLINAE Loven, 1847

Genus TURRITELLA Lamarck, 1799

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

Diagnosis: Slender turreted-conical shell having numerous whorls and sculptured with spiral threads or costae and curved growth lines; aperture rounded or quadrate and not large; labrum thin, arcuate, prosocline at the suture; columella smooth and concave (after Davies, 1971, p. 309).

Range: Lower Cretaceous - Recent.

Discussion: Sohl (1964b) placed a group of three distinctive and widespread turritellid species, *T. quadrilira*, *T. trilira*, and *T. bilira*, in the genus *Haustator* based on the

ontogenetic development of their sculpture and on the conformity of their growth lines to that of the type species as defined by Marwick (1957). Wenz (1940) recognized *Haustator* only as a subgenus of *Turritella*. Serna (1979) proposed a new subgenus *Sohlitella* to include those species recognized as *Haustator* by Sohl (1964b). Several genera have been proposed within the turritellids, but, as defined, these taxa often lack characters that consistently distinguish them from other groups. Allmon (1988, p. 252), in his work on the Paleogene turritelline gastropods of the Gulf and Atlantic coastal plains, recognized "species groups" rather than formal supraspecific taxa even though several of these groups could have been placed in *Haustator* based on their apical sculpture formula and the form of their lateral sinus. *Turritella* is used here in a broad sense to include all turritelline species, and other supraspecific taxa are not recognized.

Turritella trilira Conrad, 1860
Plate 8, figures 1-4.

1860. *Turritella trilira* Conrad, Philadelphia Acad. Nat. Sci. Jour., 2nd 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.
1907. *Turritella trilira* Conrad. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 699, pl. 79, fig. 4-5.
1923. *Turritella trilira* Conrad. Stephenson, North Carolina Geol. and Econ. Survey, v. 5, p. 360, pl. 90, fig. 2-9.
1926. *Turritella trilira* Conrad. Wade, U. S. Geol. Survey, Prof. Paper 137, p. 161, pl. 56, fig. 3.
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, fig. 1-5.
1944. *Turritella trilira* Conrad. Shimer and Shrock, Index Fossils of North America, p. 493, pl. 201, fig. 13.
1960. *Turritella trilira* Conrad. Sohl, U. S. Geol. Survey, Prof. Paper 331 A, p. 71-73, pl. 7, fig. 8, 10, 17, 20, 27-28.
1964b. *Haustator trilira* (Conrad). Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 361-362, pl. 54, fig. 15.
1979. *Turritella (Sohlitella) trilira* Conrad. Serna, Bol. Geologia, v. 13, no. 27, p. 23.

Diagnosis: A large sized turritellid with moderately convex whorls characterized by three shelf-like spiral carinae, the lower two of which originate at the inception point of the teleoconch and the upper of which originates as a spiral thread between the upper two lirae of the fifth whorl.

Description: The protoconch is mammillate and consists of about three whorls. The juvenile whorls of the teleoconch have a narrow apical angle of about 13° (see Plate 8, figure 1). This angle begins an incremental increase at the twelfth whorl (see Plate 8, figure 2) until it reaches 20° to 21° on the adult whorls. Two spiral lirae appear below the midline of the first whorl at the teleoconch's inception, and a third lira just below the upper suture before the second whorl. The next three whorls are trilirate and slightly carinate about the middle lira. An additional lira (which is not well developed in some specimens) forms a subsutural collar on the fifth or sixth whorl and a spiral thread develops between the second and third lirae above the lower suture. This spiral thread increases in strength to form a lira on the subsequent whorl so that next six whorls (whorls seven through twelve) have five spiral lirae with the second one above the suture being the most prominent. After whorl twelve, the lower three lirae become stronger than the two above with the lowest of these surpassing the second lira above the suture in prominence. A spiral thread appears in each of the interspaces between the lower suture and the first lira and between the lower four lirae on the thirteenth whorl. Other spiral threads form on subsequent whorls, and, by the eighteenth whorl, three primary lirae and a secondary upper lira are present with two to three spiral threads in the interspaces. The secondary lira and interliral threads diminish on whorls twenty to twenty-four. These whorls have three shelf-like carinae and smooth interspaces with the exception of strongly ophisthocyrtic growth lines and fine spiral striations. A fourth shelf-like carina borders the basal margin on the body whorl. The base is smooth. The aperture is not complete on the specimens at hand but appears to be subcircular to quadrate.

Discussion: The type locality for *Turritella trilira* was given by Conrad (1860) only as Tippah County, Mississippi, which may be either Tippah or northern Union County by present boundaries. The type horizon is assumed to be the Coon Creek Tongue of the Ripley Formation. Juvenile specimens from this horizon in the type area figured by Stephenson (1941, pl. 52, fig. 4) and Sohl (1960, pl. 7, fig. 10) differ considerably from the Coffee Sand juvenile illustrated here in Plate 8, figure 1. The Coffee Sand juveniles develop five spiral lirae rather than three and have a more narrow apical angle. None of the Coffee Sand juveniles have been found attached to fully grown adult specimens, but they can be traced to the adult shell through forms of intermediate size such as that illustrated in Plate 8, figure 2. The Coffee Sand adults develop the same characteristic three shelf like carinae as do those from the Coon Creek Tongue.

Sohl (1960) pointed out that *T. trilira* was "one of the most abundant, widely distributed, and long-ranging gastropod species in the Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plains." He also noted differences in size and in the strength of ornament of this species but attributed these to infraspecific variations. It is possible that this species may

be a form taxon that includes multiple species with a convergent adult sculpture. Otherwise the early sculptural ontogeny of this species is even more variable than the adult form.

Material: Several specimens.

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

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130. For other occurrences in the Ripley (type horizon), Prairie Bluff, and Owl Creek formations of Mississippi as well as in equivalent units in Texas, Arkansas, Tennessee, Alabama, Georgia, North Carolina, Maryland, and New Jersey, see Sohl (1960, p. 72-73).

Turritella quadrilira Johnson, 1898
Plate 8, figures 6-13

1898. *Turritella quadrilira* Johnson *in* Woolman, New Jersey Geol. Survey, Ann. Rept. for 1897, p. 264.
1898. *Turritella quadrilira* Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 50, p. 463.
1905. *Turritella quadrilira* Johnson. Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 57, p. 21.
1907. *Turritella quadrilira* Johnson. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 695, pl. 78, fig. 7.
1923. *Turritella quadrilira* Johnson. Stephenson, North Carolina Geol. and Econ. Survey, v. 5, p. 363, pl. 90, fig. 10-11.
1940. *Turritella quadrilira* Johnson. Stephenson and Monroe, Mississippi Geol. Survey, Bull. 40, pl. 4, fig. 61.
1964b. *Haustator quadrilira* (Johnson). Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 362, pl. 54, fig. 34, 14.
1979. *Turritella (Sohlitella) quadrilira* Johnson. Serna, Bol. Geologia, v. 13, no. 27, p. 23.

Diagnosis: A medium sized turritellid with convex whorls characterized by four primary spiral lirae.

Description: The protoconch is mammillate and consists of three smooth convex whorls (see Plate 8, figure 8). The juvenile whorls of the teleoconch are trilirate and carinate at the middle lira (see Plate 8, figures 6-7). The middle lira or carina is always the most prominent, but the upper and lower lirae vary as to which is the second strongest. All three lirae appear very early on the first whorl, though the carina and lower lira seem to appear slightly before the upper one. A fourth lira appears between the carina and upper lira on the sixth whorl, and a fifth one appears between the carina and lower lira on the seventh whorl. By the eighth whorl, these newly formed lirae are stronger than the upper lira and along with the carina and lower lira form a series of four primary lirae. The second lira above the suture, the carina of the previous whorl, is reduced on the ninth whorl so that it is of equal strength with the lira above and below, and the whorl is no longer carinate. The upper lira of this whorl is of lesser strength than the lower three. Whorls nine through eleven are quadrilirate, strongly convex, and rapidly expanding with an apical angle of about 27° (see Plate 8, figure 11). Whorls twelve through seventeen are as before but with a smaller apical angle of 18°. No specimen has been found with the body whorl intact.

Discussion: *Turritella quadrilira* and *T. trilira* are the most common turritellids in the Coffee Sand. While the adult whorls of these species differ by only one primary lira, the juvenile whorls are considerably different as can be seen in figures 1 and 6 of Plate 8. The early juvenile whorls of *T. quadrilira* have a greater apical angle and are more strongly carinate than *T. trilira*. The latter juvenile whorls are strongly convex, while the whorls of *T. trilira* are imbricate (compare figures 3 and 9 of Plate 8).

The upper lira of one variety of *T. quadrilira* illustrated in Plate 8, figure 13, is not developed so that the specimen is trilirate as is *T. trilira*. This variety shows convergence between the two species. However, it can be clearly placed in *T. quadrilira* based on the morphology of its early whorls.

Material: Several specimens.

Types: Cotypes 690 (New Jersey) ANSP; hypotypes 31894 (North Carolina), 76243 and 131602 (Mississippi) USNM.

Occurrence: Mississippi: Eutaw Formation; Coffee Sand, MGS localities 128, 129, and 130. Arkansas: Brownstown Marl. Alabama: Eutaw and Blufftown formations. Georgia: Eutaw and Blufftown formations. North Carolina: Black Creek Formation. New Jersey: Magnothy Formation and Woodbury Clay.

Turritella vertebroides Morton, 1834
Plate 8, figure 5

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, fig. 13-18.
1907. *Turritella vertebroides* Morton. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 293, pl. 78, fig. 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. Survy, Prof. Paper 137, p. 160, pl. 56, fig. 5.
1941. *Turritella vertebroides* Morton. Stephenson, Texas Univ. Bull. 4101, p. 290-291, pl. 53, fig. 5-13.
1944. *Turritella vertebroides* Morton. Shimer and Shrock, Index Fossils of North America, p. 491, pl. 202, fig. 9-12.
1955. *Turritella vertebroides* Morton. Stephenson, U. S. Geol. Survey, Prof. Paper 274-E, p. 126, pl. 22, fig. 16-19.
1960. *Turritella vertebroides* Morton. Sohl, U. S. Geol.

Survey Prof. Paper 331 A, p. 75-76, pl. 8, fig. 1-4, 12.

Diagnosis: A large sized turritellid with convex whorls bearing four spiral lirae with fine spiral striations in the interspaces.

Description: The protoconch and juvenile whorls from the Coffee Sand are unknown. Adult specimens have convex whorls with four widely spaced spiral lirae, the upper one being weaker than the lower three. The whorls meet flush at the suture to form a broad and shallow sulcus between the lower lira of the upper whorl and the upper lira of the lower whorl. This sulcus and the interspaces between lirae are covered by spiral striations. The growth lines are ophisthocyrtic. A fifth lira is present along the angulate basal margin of the body whorl. The base is smooth except for adapically convex growth lines. The aperture is incompletely known.

Discussion: This species includes the largest turritellid specimens found in the Coffee Sand. The largest specimen at hand consists of twelve whorls (the early whorls are missing) and is 91 mm high and 25 mm wide. *Turritella vertebroides* is easily distinguished from the other large Coffee Sand turritellid, *T. trilira*, by its fourth spiral lira and by having lirae of more modest relief. These species are illustrated side by side at actual size in figures 4 and 5 of Plate 8.

The Coffee Sand specimens differ from other forms that occur stratigraphically higher, including the four varieties (i.e., *T. vertebroides tenuispira, T. vertebroides jonesi, T. vertebroides longi*, and *T. vertebroides leoni*) named by Stephenson (1941, p. 290-291) from the Navarro Group of Texas, in lacking secondary lirae. The primary lirae of the Coffee Sand forms are strong and regularly spaced. Only microscopically fine striations are present in the interspaces, which otherwise appear to be smooth to the unaided eye.

Material: Several specimens.

Types: Holotype 2287 (Mississippi) ANSP; hypotypes 32955 (Tennessee), 21128 (Alabama), 128181 (Mississippi) USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129. For other occurrences in the Ripley, Prairie Bluff, Owl Creek, and Clayton (reworked) formations of Mississippi as well as in Texas, Arkansas, Missouri, Tennessee, Alabama, and Georgia, see Sohl (1960, p. 76).

Turritella chapelvillensis n. sp.
Plate 9, figures 1-2

Diagnosis: A medium sized turritellid with flat-sided whorls bearing six primary lirae with a seventh sometimes appearing above the suture.

Description: The protoconch and earliest juvenile whorls are unknown. Both the late juvenile and adult whorls have six primary lirae with a seventh lira of modest strength exposed just above the suture. The whorls are flush at the suture to the point that the suture is not readily distinguishable among the spiral lirae. The lirae have a characteristic sequence that consists of three strong lirae on the whorl's lower half followed by a weak fourth middle lira and upper lirae including a strong fifth and modest sixth lira. This sequence gives the whorls a doubly imbricated appearance (two imbrications per whorl) with the weak lira partially exposed above the suture forming a set with the upper two primaries of the subsequent whorl and the weak middle lira forming a set with the lower three. In each set the lirae generally increase downward (toward the aperture) in strength. Weak secondary lirae develop in the interspaces between lirae three through six (one per interspace) and are joined by microscopically fine spiral striations on the adult whorls. Interspaces between lirae one through three of the adult whorls have only microscopically fine spiral striations. Overprinted on the spiral ornamentation are closely spaced, microscopically fine, sinuous, growth laminations. The apical angle varies between 17° and 20°. None of the specimens on hand has a complete body whorl. The basal margin (known only from a fragment on the holotype) is bordered by two spiral lirae, the upper of which projects beyond the lower and is the lira partially exposed above the suture on the spire. The base is covered with spiral lirae with microscopically fine striations in the interspaces.

Discussion: This species is closely related to *Turritella tippana* Conrad, 1858, from the Ripley and Owl Creek formations. A topotype from the Owl Creek Formation at Owl Creek shows the same sinuous growth lines and closely spaced growth laminations, flat sided whorls with a doubly imbricated appearance, and spirally sculptured base. Sohl (1960, p. 76) stated that the sculpture of *T. tippana is* variable with the exception of three dominant spiral cords of almost equal strength, two occupying the whorl's lower half and one near the upper suture. In *T. chapelvillensis*, there are three dominant spirals (primary lirae one through three) on the lower half and two below the upper suture (primary lirae four and six).

Material: Several specimens.

Types: Holotype 456987 USNM.

Measurements: The incomplete holotype measures 31.7 mm in height and 8.8 mm in width. The largest specimen on hand has a broken apex and no body whorl and measures 31 mm in height and 11 mm in width.

Etymology: The species is named for the community of Chapelville near which it was found.

Occurrence: Coffee Sand, MGS locality 129, in the lower sand bed of the Chapelville horizon.

Subfamily VERMICULARIINAE Faustino, 1928

Genus LAXISPIRA Gabb, 1877

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

Diagnosis: Adult shell loosely but regularly coiled, so that whorls are not in contact; exterior sculptured with spiral lirae; aperture round to drop-shaped (after Sohl, 1960, p. 69).

Range: Upper Cretaceous (Campanian-Maastrichtian).

Laxispira lumbricalis Gabb, 1877
Plate 9, figures 4-9

1877. *Laxispira lumbricalis* Gabb, Acad. Nat. Sci. Philadelphia, Proc. for 1876, p. 301, pl. 17, fig. 6-7.
1883. *Laxispira lumbricalis* Gabb. Tryon, Structural and Systematic Conchology, v. 2, p. 309, pl. 76, fig. 14.
1892. *Laxispira lumbricalis* Gabb. Whitfield, U. S. Geol. Survey, Monograph 18, p. 148, pl. 18, fig. 25.
1892. *Laxispira lumbricalis* Gabb. Dall, Wagner Free Inst. Sci. Trans., v. 3, pt. 2, p. 307.
1907. *Laxispira lumbricalis* Gabb. Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 706, pl. 81, fig. 1-2.
1912. *Vermicularia lumbricalis* (Gabb). Cossmann, Essais Paleoconchologie comparee, v. 9, p. 143.
1926. *Laxispira lumbricalis* Gabb. Wade, U. S. Geol. Survey, Prof. Paper 137, p. 159, pl. 55, fig. 5, 8.
1939. *Vermicularia (Laxispira) gabbi* Wenz, Handbuch der Palaozoologie, Gastropoda, pt. 3, p. 679.
1960. *Laxispira lumbricalis* Gabb. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 69-70, pl. 7, fig. 3-5.
1964b. *Laxispira lumbricalis* Gabb. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 361, pl. 53, fig. 25, 34.

Diagnosis: A loosely and generally regularly coiled high spired gastropod with the coils touching only in the larval shell and with a sculpture of closely spaced spiral lirae.

Description: The protoconch is trochoid in shape and consists of three convex whorls, the second of which has rows of very fine punctae. The terminus of the protoconch shows the outline of a subsutural sinus. After this terminus, the shell becomes widely uncoiled. The teleoconch consists of three or three and one half broadly uncoiled whorls sculptured with closely spaced spiral lirae that are slightly beaded where crossed by faint growth lines. The inner side of the whorls opposite the axis of coiling is smooth. Growth lines of the juvenile shell indicate a sinus that follows the whorl's upper surface. The aperture is circular.

Discussion: This species is common in the Coffee Sand. According to Sohl (1964b, p. 361), the Coffee Sand is at about the same stratigraphic position as that of the species' type horizon in the Woodbury Clay of New Jersey. Sohl (1964b) assigned the more tightly coiled and strongly beaded forms in the Ripley Formation of Mississippi and Tennessee to a new species, *Laxispira monilifera*. He illustrated the inclined protoconch of this species at an enlargement ten times the actual size (1960, pl. 7, fig. 5). The SEM photographs illustrated here in figures 4 and 8-9 of Plate 9 are the first published figures of the protoconch of the type species.

Material: Numerous specimens.

Measurements: The largest Coffee Sand specimen figured here is missing the apex and measures 14.5 mm in height and 7.0 mm in width.

Type: Holotype ANSP lost; hypotypes 131599-131600 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130. New Jersey: Woodbury (type horizon) and Merchantville Clays. Delaware: Crosswicks Clay.

Family GLAUCONIIDAE Pchelintsev, 1953
(= CASSIOPIDAE Kollmann, 1979)

Discussion: Sohl (1987) stated that this family is especially abundant in low diversity or marginal marine assemblages of Cretaceous age. The Glauconiidae first appeared in the Barremian Stage and reached its maximum geographic distribution and diversity during mid-Cretaceous times. The distribution of this family falls within a pan-tropic belt that Sohl (1987) called the core-Tethys. Thus, the presence of Glauconiidae taxa in the Coffee Sand is indicative of both estuarine and tropical environments. All specimens of this family found in the Coffee Sand to date are abraded, suggesting that they were transported from marginal marine settings onto the open marine shelf.

Genus GYMNENTOME Cossmann, 1909

Type by original designation, *Turritella renauxiana* D'Orbigny, 1842.

Diagnosis: A large sized, turreted, rather thick shell with whorls somewhat vertically compressed and sculptured with spiral ribs or smooth; aperture rounded; base rounded.

Range: Upper Cretaceous (Cenomanian-Campanian).

Gymnentome unicarinata n. sp.
Plate 7, figures 5, 8-10

Diagnosis: Large sized, turreted shell with unicarinate early whorls and slightly imbricate or flat-sided latter whorls that are tightly joined at the suture.

Description: The protoconch and earliest juvenile whorls are unknown. The first five known whorls of the teleoconch are unicarinate with a prominent carina just above the suture and have an apical angle of 36° to 42°. The latter five whorls are smooth and flat-sided when the suture covers the basal margin of the previous whorl and slightly imbricate when the suture is just below the margin. These whorls have an apical angle of 24°. Growth lines are ophisthocyrtic with the axis of concavity about one third the whorl's height above the suture. The basal margin is broadly rounded, and the base is smooth. The aperture is subcircular with a projecting lip around the entire outer margin.

Discussion: This species is closely related to *Gymnentome valida* Stephenson (1952) from the Woodbine Formation of Texas. It differs in having unicarinate early whorls rather than bilirate early whorls as in *G. valida*. All specimens of this

species on hand are abraded and are believed to have been transported from a marginal marine environment to the open shelf.

Material: Several specimens.

Measurements: The incomplete holotype measures 92 mm in height and 41 mm in width at the aperture (rotated normal to the page in Plate 7, figure 8).

Types: Holotype 456988 USNM.

Etymology: The species is named for its unicarinate early whorls.

Occurrence: Coffee Sand, MGS localities 128 and 129 (type locality).

Gymnentome canalis n. sp.
Plate 7, figures 6-7

Diagnosis: A large sized, turreted shell with compact whorls that are bilirate in the juvenile stage and smooth in the adult and with an incised suture below the basal angulation of the previous whorl.

Description: The protoconch and earliest juvenile whorls are unknown. The first whorl of the teleoconch is bilirate with two broadly spaced lirae of low relief. The other four whorls are smooth except for growth lines. All whorls with the exception of the body whorl have an angulate basal margin which is exposed just above the suture. This angulation in combination with the incised suture form a prominent spiral channel at the suture. The growth lines are ophisthocyrtic. The basal margin of the body whorl is rounded, and the base is smooth. The complete aperture is unknown.

Discussion: This species differs from both *Gymnentome unicarinata* and *G. valida* in its sutural channel and compact whorls. It is like *G. valida* in having bilirate early whorls. As is the case for *G. unicarinata*, the specimens of *G. canalis* on hand are abraded and are believed to have been transported from marginal marine environments onto the open marine shelf.

Material: Three specimens.

Measurements: The incomplete holotype measures 64.3 mm in height and 33 mm in width.

Types: Holotype 456989 USNM.

Etymology: This species is named for its sutural channel (*canalis* = Latin channel, groove, trench).

Occurrence: Coffee Sand, MGS locality 129.

Superfamily LITTORINOIDEA Gray, 1840

Removed from the Littorinidae

Discussion: Specimens of *Lemniscolittorina* from the Coffee Sand include well preserved protoconchs which are anastrophic. Thus, in this paper, *Lemniscolittorina* is placed next to *Gegania* in the Family Mathildidae.

Superfamily TRUNCATELLOIDEA Gray, 1840
(= RISSOACEA Gray, 1847)
Family RISSOIDAE Gray, 1847
Subfamily RISSOINAE Gray, 1847

Genus ALVANIA Risso, 1826

Type, *Alvania europea* Risso, 1826 (= *Turbo cimex* Linné, 1758) by subsequent designation (Nevill, 1885).

Diagnosis: Minute to small sized, elongate to turbiniform shell with axial and spiral sculpture; protoconch of one and one third to more than two and a half whorls and sculptured with raised dots to a few strong spiral keels, often with irregular raised lines and dots in combination; aperture simple in most species, with or without weak posterior sinus; outer lip opisthocline to prosocline, with or without varix (after Ponder, 1985, p. 36).

Range: Upper Cretaceous (Campanian) - Recent.

Discussion: Ponder (1985) tentatively placed several North American Upper Cretaceous taxa in *Alvania*, including *Turboella tallahatchiensis* Sohl, 1960, *Turboella crebricostata* Sohl, 1960, and *Mesostoma costatum* Wade, 1926. Of these species, only *Turboella tallahatchiensis* Sohl has been found in the Coffee Sand.

Alvania (s.l.) **tallahatchiensis** (Sohl, 1960)
Plate 10, figure 10; Plate 40, figure 3

1960. *Turboella tallahatchiensis* Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 88, pl. 9, fig. 37, 40-43.

1985. *Alvania (s.l.) tallahatchiensis* (Sohl). Ponder, Records of the Australian Museum, Supplement 4, p. 40, fig. 92E, F (p. 141).

Diagnosis: Minute sized (2 mm or less in height), ovate-conic shell with strong axial ribs and spiral lirae on the body whorl in the rib interspaces.

Description: The protoconch is dome shaped with one and a half smooth whorls. The teleoconch consists of two and one half to three axially ribbed whorls. Twelve spiral lirae are present on the body whorl, the upper of which forms a subsutural collar that is noded where it crosses the axial ribs. Seven spiral lirae lie between the subsutural collar and the posterior margin of the aperture. These lirae do not cross the ribs and are visible only in the interspaces. The basal margin is gently rounded. Axial ribs diminish across this margin and fade out on the base. The base is sculptured with four spiral lirae. Young shells with a teleoconch of two and one half whorls such as the one illustrated here in Plate 10, figure 10, have a narrow umbilicus, while shells of two or more whorls have a narrow umbilical chink. The aperture is ovate.

Discussion: Ponder (1985, fig. 92E, p. 141) included an SEM photograph of this species' protoconch taken of a specimen from the Ripley Formation of Tennessee. It shows the protoconch to have spiral grooves as do other specimens from

this horizon in the MGS collections. This sculpture is only faintly visible on the Coffee Sand specimens, which are nearly smooth.

Material: Several specimens.

Types: Holotype 128787 USNM; paratypes 128784-128786 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Ripley Formation (type horizon), Tippah and Union counties, MGS locality 127. Georgia: Ripley Formation.

Subfamily RISSOININAE Stimpson, 1865

Genus STOSICIA Brusina, 1870

Type by monotypy, *Rissoa buccinalis* Grateloup, 1828.

Diagnosis: Small sized, ovate-conic, solid shell with spiral cords or clathrate sculpture; protoconch multispiral or paucispiral, dome-shaped to conical, smooth; aperture ovate with shallow posterior channel and an anterior channel that is generally broad and deep; outer lip orthocline to slightly opisthocline with prominent varix; columella simple or with prominent angulation (after Ponder, 1985, p. 92).

Range: Upper Cretaceous (Campanian), Miocene-Recent.

Discussion: Ponder (1985, p. 93) stated that *Stosicia* could be distinguished from other related taxa such as *Rissoina*, *Schwarziella*, and *Zebina* by its "broad, deep, anterior apertural channel." The Coffee Sand rissoid species described below resembles *Rissoina* in some respects but is placed in *Stosicia* based on the form of its anterior apertural channel. According to Ponder, Australian Museum (personal communication), this species is not a typical *Stosicia*, but its tentative assignment to this genus is reasonable.

Ponder (1985, p. 92 96) recognized two subgenera of *Stosicia*. The first, *Stosicia s.s.*, is characterized by a conical multispiral protoconch and a sculpture consisting of strong spiral cords. The second, *Isseliella*, is characterized by a dome shaped protoconch of about one and one half whorls and a clathrate sculpture with strong axial and spiral ribs. *Stosicia (s.l.) antiqua* has a protoconch like that of *Stosicia s.s.*, while its sculpture more closely resembles that of *Isseliella* though it lacks strong spiral elements. The Coffee Sand species has a strongly notched, anterior, apertural channel like that of species of *Stosicia*, but doesn't fit into the presently defined subgenera.

Stosicia (s.l.) **antiqua** n. sp.
Plate 10, figures 1-2

Diagnosis: Minute sized, elongate-conic shell sculptured with axial ribs, aperture ovate with a deeply notched anterior channel that obliquely truncates the columella, outer lip thickened and with fine denticles inside.

Description: The protoconch is smooth, conical, and consists of about three whorls with the suture impressed. The junction of the protoconch and teleoconch is sharp with the protoconch terminating in a sinuous lip. The axial ribs of the teleoconch begin immediately after this junction and continue to the body whorl. The teleoconch consists of three and one half to four and one half whorls and is sculptured with closely spaced, round-crested, axial (collabral) ribs. The suture is impressed above a weak subsutural collar that is noded at intersections with the axial ribs. A narrow incised spiral line is present at about one third of the whorl's height below the suture. Interspaces between the collabral ribs have fine spiral striations. The collabral ribs of the body whorl are sinuous and fold backward and fade out across the neck. They also are finer and more closely spaced adjacent to the shell's varicate outer lip. This lip is thickened on the exterior and interior and has a thin median apertural flange. The thinned interior of the outer lip is denticulate with the largest denticle being adjacent to the narrow posterior apertural channel. The denticles terminate at the broad, deeply notched, anterior channel. This channel truncates the columella and opens behind it. The inner lip has a callus deposit that folds back over the columella adjacent to the anterior channel and continues to the posterior channel. The neck has a low rounded fasciole produced by the notched anterior channel and is sculptured with fine spiral lirae.

Discussion: This species has shell characters in common with both *Stosicia* and *Rissoina*. Based on its sculpture and protoconch it would be placed as *Rissoina s.s.* However, its broad, deep, anterior, apertural channel has characters in common with both *Stosicia* and *Rissoina*. The position of the channel adjacent to (and even truncating) the columella is like that of *Rissoina*, while the channel's deeply notched form is like that of *Stosicia*.

Material: A few specimens.

Measurements: The holotype measures 3.3 mm. in height and 1.5 mm in width.

Types: Holotype 456990 USNM.

Etymology: Named for its early occurrence in the geologic record (*antiquus*: Latin for old, of antiquity). The previously known range of this genus was Miocene-Recent (Ponder, 1985, p. 93).

Occurrence: Coffee Sand, MGS locality 129.

Genus COSSMANNIA Newton, 1891

Type by original designation, *Rissoina expansa* Deshayes, 1861.

Diagnosis: Medium size, shiny, elongate-conic shell with angled periphery; sculpture of spiral and axial threads of equal strength with pits in the interspaces on upper spire whorls, remainder of teleoconch smooth, shiny; protoconch of nearly three whorls and smooth; aperture pyriform with weak subangulation; outer lip prosocline and varicate with a narrow posterior channel and no anterior channel; columella deeply excavated (after Ponder, 1985, p. 92).

Range: Upper Cretaceous (Campanian-Maastrichtian) - Eocene.

Cossmannia tennesseensis (Wade, 1926)
Plate 10, figures 7-9; Plate 19, figures 1-2

1926. *Rissoina tennesseensis* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 167, pl. 58, fig. 26, 27.
1948. *Anteglosia tennesseensis* (Wade). Vokes, Maryland Dept. Geology, Mines and Water Bull. 2, p. 147.
1960. *Anteglosia tennesseensis* (Wade). Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 86-87, pl. 9, fig. 1-3.

Diagnosis: Small, elongate conic, smooth shell with an ovate aperture having a notched anterior canal and a thickened outer lip.

Description: The protoconch is conical with an impressed suture and consists of about three convex whorls sculptured on the lower half with spirally arranged, microscopically fine granules. The teleoconch consists of six or more convex whorls, which may be smooth or microscopically pitted. Growth lines are slightly opisthocline on the spire and sinuous on the body whorl. The suture is impressed and a weak subsutural collar is present. The aperture is ovate with a small posterior channel or notch and a broad, deeply notched, anterior channel. The outer lip is thickened along its exterior margin and a thin callus is present along the inner lip.

Discussion: Sohl (1960, p. 86) noted that the spire of this species has a typically pitted surface. Specimens from the Coffee Sand also show this sculpture, but the pits are microscopically fine and some specimens appear to be smooth. This species resembles the Recent species *Folinia histia* (Bartsch), as figured by Ponder (1985, figure 142F), from the Pacific coast of Central America. A primary diagnostic shell feature of *Folinia* is its deep posterior apertural notch; however, only a small and shallow posterior notch is present on the Coffee Sand specimens. The pitted microsculpture and smooth shell indicate a closer relationship with *Cossmannia* (Ponder, personal communication).

Material: Several specimens.

Types: Holotype 73096 USNM; hypotype 128472 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Ripley Formation, Tippah and Union counties, MGS locality 127. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality).

Family IRAVADIIDAE Thiele, 1928

Genus HYALA H. and A. Adams, 1852

Type by monotypy, *Hyala vitrea* (= *Turbo vitreus* Montagu, 1803).

Diagnosis: Small sized, thin shell with microscopic spiral threads or smooth; protoconch of two and a half smooth whorls; aperture simple, oval; outer lip strongly prosocline and without varix; weak posterior angulation present but no posterior sinus (after Ponder, 1984, p. 52).

Range: Upper Cretaceous (Campanian), Upper Oligocene - Recent.

Discussion: The previous record for *Hyala* includes the Upper Oligocene of the North Sea Basin and the Recent of the Coast of Europe, the Mediterranean Sea, and possibly the Sea of Japan (Ponder, 1984, p. 52).

Hyala fragila n. sp.
Plate 4, figure 9

Diagnosis: Minute sized, pupiform, fragile shell with impressed suture, whorls convex and smooth except for fine growth lines and spiral threads on the base.

Description: The protoconch is dome-shaped with two convex whorls that are smooth with the exception of faint sinuous growth lines. The teleoconch consists of one and one half convex whorls that expand gradually along the axis of coiling so that the shell has a cylindrical or pupiform aspect. The body whorl is smooth with the exception of faint, slightly prosocline (nearly orthocline) growth lines and spiral threads on the base. The aperture is ovate.

Discussion: This species is similar to *Hyala vitrea* (Montagu), a Recent Mediterranean species, and the type species for the genus. It differs in that it has more gradually expanding volutions, which, in combination with its blunt-topped protoconch, gives the shell an almost cylindrical form.

Material: One largely complete specimen and a few fragments of others.

Measurements: The holotype measures 1.3 mm in height and 0.65 mm in width.

Types: Holotype 456991 USNM.

Etymology: Named for the shell's fragility.

Occurrence: Coffee Sand, MGS locality 129.

Genus CERATIA H. and A. Adams, 1852

Type by monotypy, *Rissoa proxima* (Alder Ms).

Diagnosis: Shell like that of *Hyala* but with fine spiral striae; protoconch of about two smooth whorls with the first whorl slightly elevated and the nucleus depressed (after Ponder, 1984, p. 54).

Range: Upper Cretaceous (Campanian) - Recent.

Ceratia cylindrata n. sp.
Plate 4, figures 7-8; Plate 42, figure 4

Diagnosis: Minute sized, pupiform shell with impressed sutures and convex whorls; teleoconch sculptured with spiral rows of punctae and slightly prosocline growth lines.

Description: The protoconch is dome-shaped with an impressed suture and consists of two smooth, convex whorls.

The teleoconch consists of two convex whorls sculptured with spiral rows of punctae and slightly prosocline (nearly orthocline) growth lines. When the growth lines are strong (see Plate 4, figure 7), the teleoconch has a cancellate sculpture. The teleoconch's apical angle is so narrow that the shell has a nearly cylindrical or pupiform aspect. The aperture is ovate.

Discussion: This species is similar to *Ceratia proxima* (Forbes and Hanley), a Recent Mediterranean species, and type species for the genus. It differs in having less rapidly expanding volutions and a nearly cylindrical form. *Ceratia cylindrata* n. sp. and *Hyala fragila* n. sp. both have a pupiform shell but differ in their sculpture and perhaps shell thickness.

Ponder (personal communication) first recognized this species as belonging to *Ceratia*. The previous record for this genus includes possible occurrences in the Paris Basin Eocene, the Miocene of the Dominican Republic, the Pliocene of Italy and England, the Pleistocene of Italy, and the Recent of the southern British Isles and the Mediterranean (Ponder, 1984, p. 54).

Material: A few specimens.

Measurements: The holotype measures 1.5 mm in height and 0.7 mm in width.

Types: Holotype 456992 USNM.

Etymology: Named for the shell's cylindrical form.

Occurrence: Coffee Sand, MGS locality 129.

Genus ENTOMOPE Cossmann, 1888

Type by original designation, *Litiopa klipsteini* Cossmann from the middle Eocene (Lutetian), Calcaire Grossier, Villers-Saint-Frédéric, France.

Diagnosis: Small, ovate to elongate-conical, slightly umbilicate shell with a glossy surface sculptured with spiral incised lines or punctae; protoconch with two to two and a quarter convex, smooth whorls, flattened on top; aperture ovate, excavated anteriorly and sharply angulate posteriorly; posterior corner of aperture turned forward slightly, rest of outer lip approximately orthocline and thin; inner lip partially disconnected from parietal wall in some species; columella concave.

Discussion: The writer is indebted to Steve Tracey for pointing out the similarities of the following two species with an undescribed species, listed as "*Lacuna fasciata* Edwards MS" by Newton (1891) from the middle Eocene of the United Kingdom. *Entomope* was not discussed in Ponder's (1984) work on the iravadiid genera. It differs from *Nozeba* in possessing a slight umbilicus and in its thin outer lip.

Range: Upper Cretaceous (Campanian) - Middle Eocene.

Entomope ponderi n. sp.
Plate 10, figures 4-5; Plate 41, figures 1-2

Diagnosis: Minute sized, glossy, ovate-conic, umbilicate shell with a narrow funicle, base sculptured with spiral rows of punctae.

Description: The protoconch is dome-shaped with a flattened top and consists of two and a fourth smooth whorls. The teleoconch consists of about two convex, smooth and glossy whorls. Growth lines are prosocline. The aperture is drop-shaped with an angulate posterior and a rounded anterior with a broad sulcus. On adult specimens, the inner lip is detached from the parietal wall and base, while, on juveniles, the inner lip is detached only from the base. The base has a narrow umbilicus and is channeled adjacent to the inner lip with a narrow funicle in the channel. The base is sculptured with spiral rows of punctae.

Discussion: This and the following species were originally placed in *Nozeba* in the unpublished dissertation of Dockery (1991). As pointed out by Steve Tracey (personal communication), *Entomope ponderi* most closely resembles an undescribed species, listed as "*Lacuna fasciata* Edwards MS" by Newton (1891) from the middle Eocene of England. It differs from that species in having a smooth and glossy shell with spiral rows of punctae generally restricted to the base and sometimes below the suture on the spire. The undescribed English species is covered with incised spiral lines. Apart from being umbilicate, *E. ponderi* resembles the type species of *Nozeba, N. emarginata* (Hutton) of the Plio-Pleistocene and Recent of New Zealand. However, this species is sculptured on the base with spiral threads rather than with spiral rows of punctae.

One specimen of *E. ponderi* has the spire and body whorl covered with spiral rows of punctae. Punctae also occur on a second species of *Entomope* from the Coffee Sand though this sculpture has not been previously described for *Entomope* and was not included in the diagnosis of *Nozeba* by Ponder (1984).

Material: Several specimens.

Measurements: The holotype (Plate 41, figure 2) measures 1.9 mm in height and 1.3 mm in width. The specimen figured in Plate 10, figure 5, measures 1.9 mm in height and 1.3 mm in width.

Types: Holotype 456993 USNM.

Etymology: Named for the malacologist Winston F. Ponder, Australian Museum, who has contributed significantly to the understanding of the Truncatelloidea as well as to gastropod systematics as a whole.

Occurrence: Coffee Sand, MGS locality 129.

Entomope sp.
Plate 10, figure 6

Diagnosis: Minute sized, glossy, ovate conic, umbilicate or nonumbilicate shell sculptured with two to three spiral rows of punctae on the middle region of the body whorl.

Description: The protoconch is dome-shaped and flat-topped, consisting of two whorls. The teleoconch consists of two moderately convex, smooth and glossy whorls. Growth

lines, which are only faintly visible, are prosocline. The aperture is drop-shaped with an angulate posterior and a rounded anterior with a broad sulcus. On adult specimens, the inner lip may be either attached or detached to the parietal wall and base. Those with the lip detached have a narrow umbilicus. The body whorl is sculptured with two to three spiral rows of punctae on the whorl's midsection at and just below the top of the aperture and spiral suture.

Discussion: In the unpublished dissertation of Dockery (1991), this species was named *Nozeba elegans*, a name not continued here due to breakage of the type and only good specimen. This species differs from *Entomope ponderi* in being more slender, in its less prominent umbilicus, in lacking a funicle, and in having spiral rows of punctae on the whorl's midsection rather than base. Twelve unfigured specimens of *Entomope* in the MGS collections are from the basal sand bed (bed B) of the Coffee Sand's Chapelville horizon and thirty-two are from the upper clay bed (bed E) of that horizon. Of these, half of those from the sand bed are *E. ponderi*, while the other half are *E.* sp. All of those from the clay bed are *E. ponderi*.

Material: Several incomplete specimens.

Measurements: The figured specimen measures 2.1 mm in height and 1.2 mm in width.

Occurrence: Coffee Sand, MGS locality 129.

Genus NOZEBA Iredale, 1915

Type by original designation, *Rissoa emarginata* Hutton, 1885.

Diagnosis: Ovate to elongate-conical, rather solid shell with a glossy surface sculptured with spiral threads or smooth; protoconch with two to two and a quarter convex, smooth whorls, flattened on top with apex partially immersed; aperture rounded to distinctly excavated anteriorly, sharply angulate posteriorly but not channeled; posterior corner of aperture turned forward slightly, rest of outer lip approximately orthocline; inner lip partially disconnected from parietal wall in some species (after Ponder, 1984, p. 54).

Range: Upper Cretaceous (Campanian) - Recent.

Discussion: The *Nozeba* species described here differs from those of *Entomope* in its thick outer lip and nonumbilicate shell. Ponder (1984, p. 56) noted the occurrence of *Nozeba* in the "Upper Cretaceous (Ripley Formation) of the U.S.A." but did not elaborate. His definition of *Nozeba* probably included those forms placed here in *Entomope*. Undescribed species of *Entomope* occur in the Coon Creek Tongue of the Ripley Formation at MGS locality 127 and the type locality at Coon Creek in McNairy County, Tennessee.

Nozeba crassa n. sp.
Plate 10, figure 3

Diagnosis: Minute, rather solid, glossy, ovate-conic shell with subrounded aperture and thick inner and outer lip; base sculptured with fine spiral grooves.

Description: The protoconch is dome-shaped and consists of two whorls. The teleoconch consists of two and a half slightly convex whorls. The aperture is subrounded with comma-like angulation at the posterior end. The inner and outer lips are thickened. The base is nonumbilicate and sculptured with fine spiral grooves.

Discussion: This species is similar to *Nozeba emarginata* (Hutton, 1885) in its thickened inner and outer lip and solid shell but differs in having spiral sculpture only on its base. It differs from the previously described species of *Entomope* in its more circular aperture and thickened inner and outer lip, and in the lack of punctae and an umbilicus.

Material: Two specimens.

Measurements: The holotype measures 2.3 mm in height and 1.24 mm in width.

Types: Holotype 456994 USNM.

Etymology: Named for its solid shell and the thickened inner and outer lips of the aperture (*crassus*: Latin for thick, stout).

Occurrence: Coffee Sand, MGS locality 129.

The Vitrinellid Group

Discussion: The family Tornidae was previously included in the Family Vitrinellidae. Ponder and Warén (1988) stated that there was some evidence to suggest that this family is distinct, and their classification is followed here. Ponder (personal communication) doubts the assignment of the following species to *Tornus*. This tentative assignment is based largely on the close resemblance of this Coffee Sand "vitrinellid"-like taxon to the Gulf Coast Paleogene species *Tornus infraplicatus* (Johnson, 1899). If this Coffee Sand "vitrinellid" assignment is incorrect, then the Gulf Coast Paleogene "vitrinellid" assigned to *Tornus* is also probably in need of revision.

Family TORNIDAE Sacco, 1896

Genus TORNUS Turton and Kingston, 1830

Type by subsequent designation (Sacco, 1896, p. 88), *Tornus subcarinatus* (Montagu).

Diagnosis: Low turbinate shell with rather flattened base and a few spiral threads; last whorl large; umbilicus limited by a keel; peristome continuous (after Davies, 1971, p. 309).

Range: Upper Cretaceous (Campanian-Maastrichtian) ?, Paleocene - Recent.

Tornus? planocarinatus n. sp.
Plate 11, figures 6-7

Diagnosis: Minute sized, circular shell with flattened spire, moderately broad flat-topped peripheral carina, and strongly convex and umbilicate base.

Description: The protoconch (as shown in Plate 11, figure 6) consists of two and one fourth smooth whorls. The first one and one half whorls of the teleoconch have an elevated shoulder just above the suture so that the subsutural ramp is slightly concave. This ramp has a punctate appearance due to the well defined interspaces between spiral and axial elements. Spiral lirae dominate over axial ribs on the body whorl where the shoulder becomes more rounded. A moderately broad flat-topped carina occurs on the shell periphery. This carina is formed by the shell's folded margin rather than merely a thickening of the shell's outer surface. It is sculptured with fine spiral threads on all sides. The shell base is strongly convex with punctae occurring between axial and spiral elements on the elevated central region surrounding the umbilicus. Axial elements do not continue over the sloping outer margin of this region where the sculpture consists of spiral threads.

Discussion: This species resembles *Tornus infraplicatus* (Johnson, 1899) of the upper Eocene Moodys Branch Formation in its general shell form. This form consists of a flattened spire and convex umbilicate base. The spire has a prominent convex subsutural ramp sculptured with axial ribs and spiral lirae and bordered by an elevated shoulder. The shell surface slopes downward from the shoulder to the peripheral carina. The shell base has an elevated central region around the umbilicus with axial ribs and finer spiral lirae.

Tornus? planocarinatus differs from *T. infraplicatus* in being about half its size, in having less prominent axial ribs on the subsutural ramp and base, and in the form of its peripheral carina. In *T.? planocarinatus*, the carina is broad and flat topped with rounded upper and lower shoulders and is covered with closely spaced spiral threads. The carina of *T. infraplicatus* is crenulate and has an upturned upper shoulder, which produces a sulcus between the shoulder of the body whorl and that of the carina. Below its flattened crest, the carina slopes evenly onto the base and has no lower shoulder.

Material: A few specimens.

Measurements: The holotype measures 2.4 mm in diameter.

Types: Holotype 456995 USNM.

Etymology: The species is named for its flat-topped peripheral carina.

Occurrence: Mississippi: Coffee Sand, MGS locality 129. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (three specimens in the Mississippi Office of Geology collections).

Family ADEORBIDAE Monterosato, 1884

(= CIRCULIDAE Fretter and Graham, 1962)

Genus CYCLOSTREMISCUS Pilsbry and Olsson, 1945

Type by original designation, *Vitrinella panamensis* C. B. Adams, 1852.

Diagnosis: Small sized, solid, discoidal shell sculptured with several spiral angles or carinae and axial ribs; protoconch with one to two smooth whorls; base umbilicate (after Abbott, 1974, p. 84).

Discussion: The type and, at the time, only known specimen of a species named *Cyclostremiscus? reticulatus* n. sp. in the unpublished dissertation of Dockery (1991) was assigned questionably to this genus. A smaller second specimen has been found with its protoconch intact (see figures 1-2 of Plate 37). Based on this protoconch, this species is here moved to the genus *Neamphitomaria* in the Family Omalogyridae.

Range: Eocene - Recent.

Genus SOLARIORBIS Conrad, 1865

Type by subsequent designation (Dall, 1892, p. 412, 414), *Delphinula depressa* I. Lea, 1833.

Diagnosis: Small sized, discoid shell sculptured with fine spiral grooves, which may be punctate; protoconch minute, smooth, and depressed; aperture rounded; inner lip thickened at base and impinging on umbilicus.

Range: Upper Cretaceous (Campanian) - Recent.

Solariorbis clara (Sohl, 1960)
Plate 11, figures 8-9

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

1964b. *Teinostoma* cf. *T. clara* Sohl. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 359, pl. 53, fig. 4-6.

Diagnosis: Minute sized, discoidal, umbilicate shell with rounded periphery and sculptured with impressed spiral lines.

Description: The protoconch consists of one and one half smooth whorls, and the teleoconch consists of one and one half whorls sculptured with impressed spiral lines. These lines continue onto the shell's base, which is umbilicate.

Discussion: This species is similar to both *Solariorbis subangulatus* (Meyer, 1886) from the upper Eocene Moodys Branch Formation and *S. depressus* (I. Lea, 1833) from the middle Eocene Gosport Sand. However, it is only about half the size of the former and a third the size of the latter species.

Material: Several specimens.

Measurements: The holotype and the largest specimen figured here measure 1.9 mm in diameter.

Types: Holotype 128780 USNM; paratype 128781 USNM.

Occurrence: Coffee Sand, MGS localities 129 and 130; Ripley Formation (type horizon), Tippah and Union counties, Mississippi.

Genus TEINOSTOMA A. Adams, 1851

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

Diagnosis: Small sized, discoidal, glossy shell sculptured with extremely fine spiral striae or smooth; umbilicus covered by a broad, flat callus (after Davies, 1971, p. 309).

Range: Jurassic - Recent.

Teinostoma prenanum Wade, 1926
Plate 11, figures 2-5

1926. *Teinostoma prenanum* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 178, pl. 59, fig. 16, 20-21.

1960. *Teinostoma prenanum* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 62, pl. 6, fig. 9-10.

Diagnosis: Minute sized, discoidal shell with smooth glossy surface faintly sculptured with growth lines on the adult and spiral rows of punctae on the base and margins of the juvenile.

Description: The shell of the adult is largely involute so that only the body whorl and about one fourth of the penultimate whorl are visible in the apical view. A juvenile specimen (Plate 11, figure 3) shows the first three-fourths whorl of the teleoconch enveloping the protoconch. The protoconch apparently consists of about two smooth whorls. The first whorl of the teleoconch has faint growth lines on the upper surface and spiral rows of punctae on the periphery and base. A smooth umbilical plug occupies the central region of the base.

Discussion: Species of *Teinostoma* are conservative in their morphology. They have involute, subdiscoidal, glossy shells without prominent sculpture. In this sense, *T. prenanum* is similar to most other species of the genus. The spiral rows of punctae noted on juvenile species of this species are similar to those illustrated by Dockery and Zumwalt (1986) on a juvenile specimen from the upper Eocene Yazoo Formation.

Material: Several specimens.

Measurements: The holotype measures 0.8 mm in height and 1.7 mm in diameter. The largest specimen figured here measures 2.0 mm in diameter.

Types: Holotype 73101 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality); Clayton Formation (reworked), USGS locality 25420.

INCERTAE SEDIS

Family PICKWORTHIIDAE Iredale, 1936

Genus URCEOLABRUM Wade, 1916

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

Diagnosis: Small sized, trochiform shell with prominent nodose axial costae and circular, heavily reinforced aperture; protoconch trochiform, smooth, and multiwhorl; base umbilicate (after Sohl, 1960, p. 59).

Range: Upper Cretaceous (Campanian-Maastrichtian).

Discussion: Sohl (1960, 1964b) placed *Urceolabrum* in the archaeogastropod family Turbinidae as did Wenz (1938b) and others. However, this genus lacks a nacreous layer and has a conical and multispiral protoconch (Plate 2, figure 3), a morphology that places it as a caenogastropod and excludes it from the Archaeogastropoda. Hickman and McLean (1990, p. 42) cited the placement of *Urceolabrum* in the Turbinidae as "highly suspect."

The Recent genus *Sansonia* is similar to *Urceolabrum* in its general shell morphology (this similarity was pointed out to the writer by L. D. Campbell). This genus has also been placed as an archaeogastropod, though the soft parts have never been studied. Ponder (1985, p. 104) reported that the radula of a similar and probably related taxon *Lophocochlias minutissimus* (Pilsbry) was not that of an archaeogastropod but was typical of the Vitrinellidae. Thus, in this report, *Urceolabrum* is placed with *Sansonia* in the family Pickworthiidae, a family of uncertain position that for the present is placed after the vitrinellids.

Urceolabrum mantachieensis Sohl, 1964
Plate 1, figures 13-17; Plate 2, figure 3

1964b. *Urceolabrum mantachieensis* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 359, pl. 53, fig. 1-3.

Diagnosis: A small sized, high spired, trochiform, umbilicate shell with spiral lirae coarsely noded at intersections with axial ribs and with a heavily reinforced flaring aperture.

Description: The protoconch is conical and consists of three smooth and convex whorls. The teleoconch consists of four and one half to five and one half whorls. It is sculptured on the spire with two centrally located spiral lirae that are coarsely noded at intersections with prosocline axial ribs. These ribs fade toward the upper suture. The body whorl has two spiral lirae at the shoulder and two at the basal margin, all of which are noded at intersections with the axial ribs. The axial ribs are muted or absent on the base but reemerge to produce coarse nodes on the umbilical margin. The aperture is circular and reinforced by a flaring lip with a flange projecting from the apertural margin.

Discussion: This species is smaller than the type species *Urceolabrum tuberculatum* Wade from the Coon Creek Tongue of the Ripley Formation and has four rather than five spiral lirae on the body whorl.

Material: Numerous specimens.

Measurements: The holotype measures 5 mm in height and 4 mm in width. The largest specimen figured here (Plate 1, figure 14) measures 6.0 mm in height and 5.2 mm in width.

Types: Holotype 131589 USNM; paratypes 131588 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130 (type locality). Texas: Wolf City Sand Member of the Taylor Marl.

Superfamily STROMBOIDEA Rafinesque, 1815

Discussion: The superfamily Stromboidea contains seven families according to the recent classification of Ponder and Warén (1988). Two of these families, the Aporrhaidae and Colombellinidae, are represented in the Coffee Sand fauna. The Aporrhaidae was the most diverse of these families during the Jurassic and Cretaceous periods but suffered the loss of most of its taxa, including all those present in the Coffee Sand, at the terminal Cretaceous extinction event. After this event, it was the Strombidae that underwent the greatest diversification. This family, as broadly defined by Abbott (1960, p. 37), includes five extant genera (*Strombus, Lambis, Terebellum, Tibia*, and *Rimella*) and 75 to 100 species depending on the inclusion of strong subspecies. The Aporrhaidae is represented by only two extant genera, *Aporrhais* and *Arrhoges*, and about five species, only one of which belongs to *Arrhoges*. In addition to the previously mentioned extant strombid genera, several other taxa were common during various epochs of the Tertiary Period, including *Hippochrenes, Calyptraphorus, Platyoptera, Dientomochilus*, and *Orthaulax*. With the exception of *Dientomochilus*, the other taxa are characterized by a spire that is partially or completely coated by callus. A callus-coated spire is also present in the Cretaceous stromboid taxon *Pugnellus*. This character along with the sinuous form of the basal lip (suggesting the presence of a strombid eye notch) may have been contributing factors in leading Conrad and subsequent writers to include *Pugnellus* within the Family Strombidae. *Pugnellus* and related taxa are placed here in the Family Aporrhaidae as was done by Popenoe (1983), and no representatives of the Strombidae are recognized from the Coffee Sand.

Family APORRHAIDAE Mörch, 1852

Discussion: Popenoe (1983) proposed two subfamilies for the Aporrhaidae, the Aporrhainae and Arrhoginae, based on the two living genera. He also recognized the presence of these subfamilies in the Mesozoic and subdivided between them certain Cretaceous aporrhaid genera as well as taxa previously placed in the Strombidae. In his classification, Popenoe emphasized the form of the outer lip and placed particular emphasis on the presence and position of incurrent and excurrent sinuses. He also placed emphasis on whether or not the anterior canal was straight (Aporrhainae) or bent toward the ventral surface (Arrhoginae). Cretaceous aporrhaids with features identifiable as anterior and posterior sinuses at the top and base of the outer lip, respectively, and with straight anterior canals/rostra were placed in the Subfamily Aporrhainae. Those with ventrally reflected rostra and quadrate and thickened outer lips as in Arrhoges were placed in the Subfamily Arrhoginae. These subfamily divisions are not followed here.

Genus PERISSOPTERA Tate, 1865

Type by original designation, *Rostellaria reussi* Tate.

Diagnosis: Medium sized, high spired, axially ribbed shell with outer lip having a broad central lobe and an upper, posteriorly directed, long and narrow spur; anterior canal long and straight.

Discussion: *Anchura (Drepanocheilus) prolabiata* White, 1876, from the late Cenomanian Tropic Shale of southern Utah should be included in this genus (as advised by Kaustuv Roy, University of Chicago). Stanton (1893) assigned this species to *Aporrhais (Perissoptera?)* and noted that it occurred about 350 feet above the base of the Cretaceous section in the upper Kanab valley. He also recorded the ammonite *Acanthoceras? kanabense* Stanton, 1893, [= *Euomphaloceras septemseriatum* (Cragin)] from this locality and position. According to Cobban, U.S. Geological Survey, Denver (personal communication), this ammonite is restricted to the upper Cenomanian ammonite zone of *Sciponoceras gracile* (Shumard). A new subspecies of *Perissoptera, P. prolabiata mississippiensis*, is described below from the Coffee Sand.

Range: Cretaceous - Paleocene (Danian).

Perissoptera prolabiata mississippiensis n. subsp.
Plate 14, figure 1

Diagnosis: Medium sized, axially ribbed, turriculate aporrhaid with a glossy shell and a broad bilobate outer lip with upper lobe long, narrow, and posteriorly directed.

Description: The protoconch is large and conical, consisting of five convex, smooth and glossy whorls and a varix at its terminus. The teleoconch has five and one half glossy whorls that are axially ribbed on the spire and smooth on the body whorl. Axial ribs are slightly opisthocline and extend from suture to suture; fifteen are present on the penultimate whorl. The outer lip is smooth except for low growth ridges and is bilobate along the posterior margin with both lobes having posteriorly extended projections. The base is thin shelled and is incomplete on both specimens at hand.

Discussion: This species differs from *Perissoptera prolabiata s.s.* (= *Anchura prolabiata* White, 1876) in having fewer whorls (teleoconch with five rather than nine or ten whorls), in lacking a deep sinus at the base of the outer lip, and in having a smooth rather than axially ribbed body whorl.

Material: Two specimens.

Measurements: The holotype, which has an incomplete base, measures 37.5 mm in height (incomplete) and 28.5 mm in width including the outer lip. The greatest diameter of the body whorl is 13.3 mm.

Types: Holotype 456996 USNM.

Etymology: Named for the State of Mississippi.

Occurrence: Coffee Sand, MGS localities 128 and 129.

Genus LATIALA Sohl, 1960

Type by original designation, *Anchura lobata* Wade, 1926.

Diagnosis: Medium sized, high spired shell with broad, thick outer lip that 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 slightly callused (after Sohl, 1960).

Discussion: *Latiala* has been previously placed as a subgenus of *Arrhoges* (Sohl, 1960, and Popenoe, 1983) based in part on the shape of the outer lip. This lip is somewhat quadrate and has its greatest length along its slightly thickened distal edge. The shell of *Latiala* is thinner and more fragile than *Arrhoges* and it lacks the fine spiral lirae of the body whorl. *Latiala* has a high spire that is sculptured with round crested axial ribs. The helicocone of this genus is similar to that of *Graciliala*.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Latiala ? sp.
Plate 13, figures 3-4

1964b. *Arrhoges (Latiala?)* sp. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 367, pl. 54, fig. 19, 24-26.

Diagnosis: Medium sized, axially ribbed, turriculate aporrhaid with a channeled suture and a varicate outer lip that is only slightly extended.

Description: The protoconch is conical with three convex, smooth whorls, the terminus of which is not distinct. The teleoconch consists of about six or seven more flat-sided whorls with a channeled suture. The early whorls have narrow, closely spaced, opisthocline ribs and fine spiral threads. The opisthocline ribs broaden on the latter whorls and are more widely spaced. They fade out in the vicinity of the juncture of the penultimate and body whorls. The spire has irregularly spaced varical swellings. The outer lip has been observed intact on only a few specimens from the Chapelville horizon and consists of a varicate, sinuous, slightly extended shell margin.

Discussion: Sohl (1964b, p. 367) assumed that the modest outer lip of this species was only the early development of the mature stage. However, since this is the only lip known for the species, it may be that the mature lip does not project to a great degree.

Material: Several specimens.

Measurements: A small specimen with complete outer lip measures 16.2 mm in height, 9.5 mm in width including the outer lip, and with a greatest diameter, excluding the lip, of 7.0 mm. A larger but incomplete figured specimen (Plate 13, figure 3) measures 21.8 mm in height and 10.2 mm in diameter.

Occurrence: Coffee Sand, MGS localities 128, 129, and 130.

Genus GRACILIALA Sohl, 1960

Type by original designation, *Anchura (Drepanochilus) calcaris* Wade, 1926.

Diagnosis: Medium sized, high spired, turriculate shell with generally six to eight whorls; whorls well rounded and sculptured with fine spiral threads and curved transverse ribs that die out below periphery; aperture elongate and lenticular with a short, narrow, anterior canal; outer lip expanded with a long, narrow, tapering spur having an internal groove and corresponding external ridge that dies out on the body; inner lip with moderately heavy, well defined callus over the entire length (after Sohl, 1960, p. 97).

Range: Upper Cretaceous (Campanian-Maastrichtian).

Graciliala johnsoni (Stephenson, 1923)
Plate 13, figures 7-10; Plate 15, figures 5-6

1875. *Anchura rostrata* Morton. Conrad, *in* Kerr, North Carolina Geol. Survey Rept., v. 1, appendix A, p. 12, pl. 2, fig. 28.
1877. *Anchura pennata* Morton. Conrad, Acad. Nat. Sci. Philadelphia, Proc. 1876, p. 275.
1898. *Anchura* sp. Johnson, Acad. Nat. Sci. Philadelphia, Proc., v. 50, p. 463, text fig. 3.
1923. *Anchura johnsoni* Stephenson, North Carolina Geol. Survey, v. 5, p. 370, pl. 92, fig. 1, 4.
1960. *Graciliala johnsoni* (Stephenson). Sohl, U. S. Geol. Survey, Prof. Paper 331 A, p. 47, 97.
1964b. *Graciliala johnsoni* (Stephenson)? Sohl, U. S. Geol. Survey, Prof. Paper 331 C, p. 367, pl. 54, fig. 23.

Diagnosis: A medium sized, axially ribbed, turriculate aporrhaid with an anterior spine and canal, a rostrate, slightly upturned upper digit on the outer lip, and three secondary digits below the upper one and before the anterior canal.

Description: The teleoconch consists of nine axially ribbed whorls. The first four whorls are strongly convex and with modest axial ribs, while the latter whorls of the spire are more flat sided and have coarse, opisthocline, axial ribs. These ribs fade out on the base of the body whorl and toward the outer lip. Crossing these ribs on the body whorl are two subsutural spiral threads. The aperture is elongate with a narrow anterior canal located on a basal spine. The outer lip has a prominent, rostrate projection that is slightly upturned and is reinforced

with a median rib on the exterior side. At the base of this projection is a modest secondary digit followed by a sinus and a pair of secondary digits. The latter digits are separated from the basal spine by a prominent basal sinus. The inner lip has a strong parietal callus which expands on the shell's base and covers the ventral side of the basal spine.

Discussion: This species is the most common aporrhaid in the Chapelville horizon of the Coffee Sand. It is often well preserved with the outer lip intact. Figure 6 of Plate 15 is illuminated from the right side to show the successive growth lines (stages) leading up to the formation of the outer lip. There is a large size range in specimens with fully developed outer lips. Small specimens with well developed outer lips may be half the size of larger specimens, with a continuum of sizes in between.

Material: Numerous specimens.

Measurements: The holotype measures 32 mm in height and 11 mm in greatest diameter. One specimen reported by Stephenson (1923) from the Black Creek Formation measured 40 mm in height. Adult specimens from the Coffee Sand that have well formed outer lips range between 16 mm and 31 mm in height.

Types: Holotype 31858 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130. North Carolina: Snow Hill Marl Member of the Black Creek Formation (type horizon).

Genus ANCHURA Conrad, 1860

Type by monotypy, *Anchura abrupta* Conrad, 1860.

Diagnosis: Medium to large, high spired shell with ornate sculpture of strong axial and spiral elements, commonly noded; aperture lenticular with long and narrow anterior rostrum, straight or bent to the left; outer lip expands into an anterior-posteriorly extended lateral edge with a upper, posteriorly directed spine and a lower, anteriorly directed lobe or blunt spine; some taxa with a medial, secondary spine on the posterior margin of outer lip and sometimes also a proximal spine adjacent to the spire (revised from Sohl, 1960, p. 104).

Discussion: Conrad's generic name for this taxon is probably derived from a combination of the Latin (*ancora*) and Greek (*ankyra* or *ankura*), words for hook. This name refers to the hook or anchor like process of the outer lip that characterizes the genus. Other characterizing features include the shell's high and busily sculptured spire with both spiral lirae and axial ribs and its long anterior canal and spine.

The anchor-like outer lip of *Anchura* is subdivided here into the following elements: a shank extending laterally from the body whorl, a posterior arm extending posteriorly as a long spine or spur from the terminus of the shank's posterior margin, and an anterior arm, which is generally no more than a modest lobe or a short spur extending anteriorly from the terminus of the shank's anterior margin (terminology for these elements follows that of an anchor and was suggested by LouElla Saul). The anterior arm may be in line with the posterior one so that the outer lip's distal margin is straight, or it may be bent away from the shell's axis so that the distal margin is concave. The posterior arm is reinforced by a median rib extending from the body whorl and may be as tall as the shell's spire. In the type species *Anchura abrupta* (see Plate 15, figure 2), the posterior arm is inclined at a 21° angle to the axis of the spire as viewed along the shank's axis. The arms are often in line in this species and bring to mind a skewed outrigger extending from a boat.

The type horizon of the type species *A. abrupta* is probably the Coon Creek Tongue of the Ripley Formation in either Tippah or Union County, Mississippi. This species is characterized by an outer lip with a relatively narrow shank, a spur-like anterior arm, and the absence of a proximal spine and (with the exception of one specimen) a median spine along the shank's posterior edge. A closely related species, *A. substriata*, occurs in an older phase of the Coon Creek Tongue than that of *A. abrupta* and is common at the unit's type locality. It is similar to *A. abrupta* in its spire and body whorl, but differs in the form of its outer lip. This lip is characterized by a wider shank bearing (at least in most specimens) a median spine and a lobe-like anterior arm. The posterior arm is broader and shorter than that of *A. abrupta*. One complete specimen of *A. substriata* at hand from the Coon Creek type locality lacks a secondary spine, though its outer lip is typical for the species in other respects.

Three new species of *Anchura* are reported here from the Coffee Sand. Of these, one species, *A. coffea*, is closely related to *A. abrupta* and *A. substriata* judging from the form of its outer lip. The relationship of the other two, *A. corniculata* and a smaller species *A. chapelvillensis*, is uncertain. These species bear a proximal spine on the shank similar to that found in the genus *Helicaulax*. The proximal spine in *Helicaulax* differs in being curved away from and partly attached to the spire, while this spine is free and curved toward the spire in *A. corniculata* and *A. chapelvillensis*.

The specimen of *Anchura abrupta* illustrated in figures 1-3 of Plate 15 is the first complete specimen of the type species to be figured. It is from the species' type horizon and area (Union County, Mississippi) and is in a private collection. Though the species is variable, this specimen shows the long anterior rostrum to be bent to the left, and the posterior arm of the outer lip to be at a 21° angle to the spiral axis. The outer lip has a concave rather than straight distal edge.

The sculptural pattern of *A. abrupta's* spire and body whorl is essentially that of the other Coon Creek species, *A. substriata*, as well as that of all three Coffee Sand species. This pattern's distinguishing characters are as follows: The axial ribs of the spire are diminished on the body whorl where they merely cause a noding effect on the spiral lirae. On the lower half of the penultimate whorl are four or five (depending on the position of the suture) closely spaced primary lirae, the upper of which is enlarged on the body whorl where it forms a modest

carina that extends as a ridge up the posterior rostral spine on the outer lip. Above this lira are three broadly spaced primary lirae which occupy the upper half of the penultimate whorl and the region between the carina (or shoulder) and suture of the body whorl. The base below the carina is covered with around ten spiral lirae, the upper five or six of which are the strongest.

Range: Upper Cretaceous (Cenomanian-Maastrichtian).

Anchura coffea n. sp.
Plate 16, figures 2-3

1964b. *Anchura* aff. *A. substriata* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 366-367, pl. 54, fig. 2-3.

Diagnosis: Large sized *Anchura* with a sculpture like that of the type species and an outer lip with a narrow shank bearing a median spine and with a spur-like anterior arm.

Description: The protoconch and juvenile whorls are unknown. The teleoconch of the most complete specimen consists of seven and one half whorls. The spire is sculptured with axial ribs and spiral lirae that become more broadly spaced with growth. Axial ribs are concave toward the aperture on the early whorls, become somewhat sinuous on the latter whorls, and are diminished on the body whorl where they produce nodes on the spiral lirae but are not evident in the interspaces. The penultimate whorl has nineteen axial ribs and five closely spaced lirae on the lower half, the lower one of which is visible just above the suture and the upper of which form a carina on the body whorl. Above these are three broadly spaced lirae which also appear on the body whorl between the carina and suture. The carina of the body whorl extends as a ridge onto the outer lip and up the lip's posterior rostral spine. The outer lip's shank is narrow and has a secondary spine on its upper margin, a long and narrow posterior arm (which is broken on the type), a spur-like anterior arm, and a fairly straight distal margin. The interior of the shank has a narrow central channel that continues up the posterior arm. The inner lip has a very thick callus. The aperture is lenticular. The base is not completely known but is sculptured on the upper part below the carina with five primary spiral lirae. Secondary lirae occur between the upper two and lower two primaries and below the primaries.

Discussion: Sohl (1964b) tentatively placed this species as *Anchura* aff. *A. substriata* based on fragmentary material that showed the outer lip to have a median spine. However, the outer lip's narrow shank, long and narrow posterior arm, and spur-like anterior arm are characters more closely related to *A. abrupta*. Also, one specimen of *A. abrupta* from the Coon Creek Tongue in Union County, Mississippi, has a median spine. Possession of a median spine may be a plesiomorphic character of the *A. abrupta* group, which includes all the Coffee Sand *Anchura* species. If so, then *A. abrupta s.s.* is the most derived member of this group.

Material: A few incomplete specimens.

Measurements: The incomplete holotype measures 58.4 mm in height and 56.0 mm in width.

Types: Holotype 456997 USNM.

Etymology: Named for the type horizon - Coffee Sand.

Occurrence: Coffee Sand, MGS localities 129 (type locality) and 130.

Anchura corniculata n. sp.
Plate 14, figures 2-3

Diagnosis: Large sized *Anchura* with a sculpture like that of the type species and with prominent median and proximal spines on the outer lip's shank.

Description: Only the body whorl and a portion of the previous two whorls are known. The penultimate whorl has opisthocline axial ribs and seven spiral lirae. The lower half of the whorl has four closely spaced lirae, the upper of which forms a modest carina on the second half of the body whorl and extends as a ridge onto the outer lip and up the posterior rostral spine. Above the carina on the body whorl are three broadly spaced lirae, the upper of which forms a subsutural collar, and below the carina are five strong lirae followed by four weaker ones. The axial ribs fade out on the second half of the body whorl where they produce nodes at intersections with spiral lirae. These lirae are covered with fine striations. The outer lip has a broad shank with prominent secondary and proximal spines (which point toward each other like a pair of inturned horns), a lobate anterior arm, and a long and narrow posterior arm. The aperture is lenticular and has a posterior canal extending up the proximal spine of the outer lip, a narrow medial channel extending onto the outer lip's shank and up the posterior arm, and a long anterior rostrum. The inner lip has a thick callus that broadens on the shell's base where it is depressed or concave in its central region.

Discussion: The outer lip of this species has a broad shank and lobate anterior arm, as does *A. substriata*. However, it differs from that species in having a prominent proximal spine extending from the subsutural collar above the aperture's anterior canal. A disconcerting aspect of the holotype is the mended shell break at the inception of the outer lip. The outer lip's shank has a dimple just below its central ridge that is probably the result of injury; however, it is not likely that the well formed opposing medial and proximal spines that characterize this taxa can be attributed to a defective repair of a shell breakage. These spines resemble a pair of horns and outline a prominent sulcus on the shank's posterior margin. Other than the holotype, only one additional fragmentary specimen of this species is known. It also has a proximal spine extending from the subsutural collar of the body whorl above the anterior canal. Both specimens are from the upper clay bed (bed E) of the Chapelville horizon, while *A. coffea* is known only from the lower sand bed (bed B) of that horizon.

Material: Two incomplete specimens.

Measurements: The holotype is missing the spire and

measures 47.5 mm in height and 47 mm in width.

Types: Holotype 456998 USNM.

Etymology: Named for the horn like appearance of the outer lip's proximal and median spines (*corniculata*: Latin for horned, horn shaped).

Occurrence: Coffee Sand, MGS locality 129, bed E.

Anchura chapelvillensis n. sp.
Plate 14, figures 4-7; Plate 15, figures 7-8

Diagnosis: Small sized *Anchura* with a sculpture like that of the type species though finer and with an outer lip having a narrow shank with a long and narrow posterior arm, a spur-like anterior arm, a concave distal margin, a long, recurved, channeled proximal spine above the aperture's anterior canal, and which may or may not have a median spine.

Description: Only the last one and one fourth whorl of the protoconch is known. This whorl is smooth and has a rounded carina or shoulder. The junction of the protoconch and teleoconch is abrupt. The teleoconch consists of ten and one half whorls, the first two of which are carinate and are sculptured with eight spiral lirae, the fourth one below the suture forming the carina, and fine opisthocline ribs which are concave toward the aperture. The next four whorls are evenly convex and are sculptured with eight strong spiral lirae and weaker opisthocline ribs. On the seventh whorl the axial ribs surpass the spiral lirae in strength, the apical angle broadens, and a secondary lira appears between the first and second lirae below the suture. The axial ribs continue to increase in size on the eighth and penultimate whorls and additional secondary lirae appear between the eight primaries. On the penultimate whorl the arrangement of the spiral lirae is like that found in the type species, with five closely spaced lirae on the whorl's lower half and three broadly spaced lirae on the upper half. The fourth lira below the suture (the uppermost of the lower lirae) forms a carina on the body whorl that extends as a ridge onto the outer lip and up the posterior arm. The outer lip has a narrow shank that has a long, narrow, recurved, proximal spine extending from the subsutural collar of the body whorl. It may or may not also have a median spine (about one half of the specimens do). The shank terminates into a long and narrow posterior arm and a spur-like anterior arm and has a concave distal margin. The aperture is lenticular with an anterior canal extending up the proximal spine of the outer lip. It also has a long and narrow channel extending onto the shank of the outer lip and up the posterior arm and has a long, straight anterior rostrum. The inner lip has a strong callus. The shell's base is sculptured below the carina with seven primary spiral lirae and additional secondary ones.

Discussion: The outer lip of this species has a narrow shank, a long and narrow posterior arm, and a spur-like anterior arm, as does the type species *Anchura abrupta*, but is half its size. It also differs from the type species in having a long recurved proximal spine and in the presence of a median spine on the outer lip's shank. The occurrence of a median spine in only half the specimens collected suggests that this feature may be due to sexual dimorphism. *A. chapelvillensis* is rather common in bed B of the Chapelville horizon at MGS locality 129.

Material: Several specimens.

Measurements: The holotype measures 35.0 mm in height and 32.5 mm in width.

Types: Holotype 456999 USNM.

Etymology: Named for the type horizon - the Chapelville horizon of the Coffee Sand.

Occurrence: Coffee Sand, MGS locality 129.

Genus PTEROCERELLA Meek, 1864

Type by original designation, *Harpago tippana* Conrad, 1858.

Diagnosis: Medium sized shell with spire of moderate height and whorls smooth to carinate; aperture lenticular to ovate with the long axis strongly inclined to that of the shell's axis of coiling; outer lip greatly expanded with six flat and thin digitations interconnected with variable amounts of shell webbing; two digits extend from the aperture's posterior margin, one is median, and three extend from the anterior margin (modified from Sohl, 1960, p. 108).

Discussion: *Pterocerella* is restricted to the Upper Cretaceous of the Gulf and Atlantic coastal plains (Sohl, 1960, p. 109) and is represented by a small group of species. Only three Gulf Coastal Plain species are known from well preserved specimens consisting of the original shell material. These are *P. tippana* (Conrad, 1858) from the Owl Creek Formation (Mississippi), *P. poinsettiformis* Stephenson, 1941, from the Ripley Formation (Tennessee and Mississippi) and the Nacotoch Sand (Navarro Group of Texas), and a new species described herein, *P. maryea*, from the Coffee Sand. A fourth species, *P. pontotocensis* Sohl, 1960, is known only from external molds from the Prairie Bluff Chalk. The specimens of *P. maryea* and *P. poinsettiformis* illustrated in Plate 16 are the best preserved specimens figured to date and show important details that characterize the genus.

The most distinguishing characters of *Pterocerella* are the six elongate flat digits and associated thin shell webbing that extend from the aperture. These digits are here numbered one through six beginning with the first anterior digit left of the aperture and counting consecutively to the most posterior digit flanking the left side of the spire. Digits one through three comprise the anterior digits, digit four is the medium digit, and digits five and six are the posterior digits. The aperture is lenticular and has an axis that is inclined at a 40° angle to that of the spire. The anterior extension of the apertural axis is in line with the aperture's anterior canal that extends down the middle of the second digit. A projection of this axis at the posterior end follows the midline between the posterior digits five and six. All digits have leveed channels along the midline

of their interior sides and median ridges on the exterior sides. Varying amounts of thin shell webbing extend from the digital margins. In *P. tippana* and *P. maryea*, shell webbing connects posterior digit six to the spire, while in *P. pontotocensis* the anterior digit one is connected to the spire. The spire of *P. poinsettiformis* is generally free from the digital webbing.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Pterocerella maryea n. sp.
Plate 15, figure 4; Plate 16, figures 4-5, 8-9

1964b. *Pterocerella* sp. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 367-368, pl. 54, fig. 4-5.

Diagnosis: A small sized *Pterocerella* with a narrow carinate spire, a narrow bicarinate body whorl, a smooth base, and with the posterior two digits of the lip strongly interconnected to each other and to the right side of the spire by shell webbing.

Description: The protoconch is dome-shaped, consisting of two and one eighth smooth, convex whorls. The terminus of the protoconch is abrupt and the carinae of the teleoconch begin immediately thereafter (see Plate 16, figures 8-9). The teleoconch consists of four narrow whorls. Whorls of the spire are strongly carinate and angular along their midline and the body whorl is bicarinate with a smooth base. The aperture is lenticular with an axis inclined at a 40° angle to that of the spire. Extending from the aperture are the six long and flat digits that characterize the genus. These digits are bordered by varying degrees with thin shell webbing but only the posterior two digits and the right side of the spire are interconnected with this webbing. Though the digital termini are incomplete on the holotype, a fragment illustrated in Plate 15, figure 4, shows the digits to end in a long, narrow point.

Discussion: This species is probably most closely related to *P. poinsettiformis* (see Plate 16, figures 6-7) as noted by Sohl (1964b, p. 367), but is only half the size of that species. It also differs in its more narrow spire and body whorl, in lacking spiral swelling on the base, and in having the posterior digit interconnected with the spire; this latter character is also present in the type species *P. tippana*. A carinate species of *Pterocerella* intermediate in size between *P. poinsettiformis* and *P. maryea* occurs in the Coon Creek Tongue at its type locality. This taxon may be a variation or unnamed subspecies of *P. maryea*.

Material: One complete specimen and several partial specimens.

Measurements: The holotype including its apertural digits is 25.0 mm in height and 19.8 mm in width.

Types: Holotype 457000 USNM.

Etymology: Named for the writer's wife, Mary E. Y. Dockery.

Occurrence: Coffee Sand, MGS localities 129 (type locality) and 130. A variation of this species may occur in the Coon Creek Tongue at its type locality in McNairy County, Tennessee. Sohl (1964b, p. 368) suggested that *Pterocerella* specimens from the Blufftown Formation in Alabama and Georgia might be the same species as those from the Coffee Sand.

Genus TUNDORA Stephenson, 1941

Type by original designation, *Tundora tuberculata* Stephenson, 1941.

Diagnosis: Small sized, rotund, low spired shell having spiral ornamentation beneath callus coating bearing rows of tubercles; callus coating thickened along left side (in apertural view) of spire to form a *Calyptraphorus*-like callus ridge; posterior canal adnate to right side of spire in part with tip continuing as a curved, grooved, spike; outer lip expanded and digitate with two, grooved, labral spines and a rostral spine; the anterior labral spine bearing a ventrally directed terminal keel.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Tundora tuberculata Stephenson, 1941
Plate 27, figures 1-2; Plate 40, figures 1-2

1941. *Tundora tuberculata* Stephenson, Texas Univ. Bull. 4101, p. 313-314, pl. 59, fig. 1-4.

1964b. *Tundora* cf. *T. tuberculata* Stephenson. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 368, pl. 54, fig. 20-22, 27.

Diagnosis: Medium-sized, rotund shell sculptured with tuberculate spiral lirae and with a grooved apical spike, a rostral spine, and two, grooved, labral spines extending from the outer lip, the anterior one having a keel at its end; parietal lip with a broad callus pad bordered by a callus ridge extending to the apical spike.

Description: The protoconch is unknown. The teleoconch is rotund with a characteristic sculpture of tuberculate spiral lirae. The largest of the lirae extend onto the first and second digits of the outer lip. Above the upper of these on the body whorl are three strong lirae, between them are two lesser lirae, and below them are nine or so weak lirae. The penultimate whorl bears six tuberculate lirae; above this the spire is callus coated and bears large, broadly spaced tubercles. The posterior canal of the outer lip terminates in an apical spike; below this are two, grooved, labral spines and a grooved, rostral spine. The anterior labral spine bears a 4.6 mm thick, anchor-shape, ventrally-directed keel at its terminus (the spine in front of the keel is only 1.4 mm thick). The parietal lip has a prominent callus pad bordered by a thick callus ridge that is excavated behind and extends to the apical spike.

Discussion: Fragments of this species are frequently found in the Chapelville horizon of the Coffee Sand. The only complete specimen known is shown in figures 1-2 of Plate 40 and was collected from the top of bed E at MGS locality 129 by Chris Garvie. This specimen agrees well with the type material figured by Stephenson (1941) from the Navarro

Group of Texas. It also provides additional information on the form of the digitate outer lip, including the presence of a keel on the anterior labral spine. As noted by Garvie (personal communication), *Tundora* resembles *Tessarolax* from the Aptian of the Isle of Wight. It differs in having tubercles, straighter digits (spines), a keel on the anterior labral spine, and a parietal callus pad. The prominent callus ridge bordering the ventral callus pad along the spire's left side has been compared to the callus ridge of *Calyptraphorus* by Sohl (1964b).

Material: A few fragments and one complete specimen.

Types: Holotype 76984 USNM; paratype 76985 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 129 (type locality) and 130. Texas: Neylandville Marl of the Navarro Group, Navarro County, Texas.

The *Pugnellus* Clade

Discussion: Popenoe (1983) placed *Pugnellus* in his Subfamily Arrhoginae based on the straight rostrum and, in part, on the quadrate and thickened outer lip (lip margin entire except for posterolateral process), characters found in the extant genus *Arrhoges*. However, Popenoe placed *Gymnarus* and *Pyktes*, taxa once included within *Pugnellus*, in his subfamily Aporrhainae based on their possession of a ventrally reflected anterior canal/rostrum and of a posteriorly produced outer lip having a prominent posteriorly reflected projection extending from the shoulder of the body whorl, characters found in the extant genus *Aporrhais*. The similar callus-coated, pug-spired, adult form attained by these three taxa was attributed to convergence. Popenoe (1983, p. 746) stated that the net effect of the adult callus coating was to "obscure or hide adolescent features of taxonomic inportance and to reproduce bizarre specimens that are superficially similar." However, he did not characterize the differences between the protoconchs or juvenile sculpture of his *Gymnarus-Pyktes* group and *Pugnellus*. Also, his description (1983, p. 761) of the Subfamily Arrhoginae as being "high-spired" would seem to exclude the short-spired *Pugnellus*.

The juvenile sculpture of a *Pugnellus* is well illustrated by a young adult specimen of *Pugnellus densatus*, the type species for *Pugnellus*, on hand from the Coon Creek type locality. It has a fully formed outer lip, but its spire is not coated with callus. This shell shows the protoconch to be conical and composed of four smooth convex whorls (apical tip missing), and the teleoconch to consist of five whorls. The first two whorls of the teleoconch are sculptured with fine, closely spaced, spiral lirae, which fade away on the third whorl beginning at the lower suture and continuing to the upper one. The penultimate whorl has fine opisthocline growth lines that are concave toward the aperture. These growth lines are sinuous on the body whorl, and sinuous axial ribs appear on the upper half of the latter third of this whorl.

Popenoe (1983) nicely illustrates the juvenile sculpture of the type species for both *Gymnarus*, *G. manubriatus*, and *Pyktes*, *P. aspris*. *Gymnarus manubriatus* has a juvenile sculpture of closely spaced axial ribs of similar shape to the growth lines of *Pugnellus densatus*. These ribs are crossed by even finer spiral lirae. *Pyktes aspris* has a juvenile sculpture of fine spiral lirae and a carina just above or covered by the suture. Both *Gymnarus* and *Pyktes* have sinuous axial ribs similar to those of *Pugnellus* on the upper half of the body whorl; however, these ribs appear earlier in the species' sculptural ontogeny than for *Pugnellus*. All three genera have fine spiral lirae in their juvenile sculpture, and the carinate spire of *Pyktes* is as different from *Gymnarus* as it is from *Pugnellus*. The sculpture of the helicocone does not indicate a grouping of *Gymnarus* and *Pyktes* that would exclude *Pugnellus*.

Another reason Popenoe gave for placing *Gymnarus* and *Pugnellus* in separate subfamilies was that they generally occurred in separate provinces (with some exceptions). *Gymnarus* belonged to a Cretaceous Indo-Pacific faunal province that included a region from California to western South America, while *Pugnellus* belonged to an Atlantic province that included the southeastern United States and Mexico. He did note a dubious exception to these distributions with the possible occurrence of a *Gymnarus* (*Pugnellus calcaris* Stephenson, 1947) from a deep well in the Eutaw Formation in Grenada County, Mississippi. Popenoe did not comment on the large *Gymnarus*, *G. abnormalis*, that occurs along with *Pugnellus* in the Campanian Coffee Sand and the Maastrichtian Coon Creek Tongue of the Ripley Formation. Also present in the Coffee Sand is a new species of *Lispodesthes*, a genus closely related to *Gymnarus* and *Pyktes*.

Pugnellus and *Gymnarus* are placed here within the Family Aporrhaidae as was done by Popenoe. However, Popenoe's subfamily divisions are not recognized, and the taxa *Pugnellus*, *Gymnarus*, and *Pyktes* along with *Lispodesthes* are considered to be closely related. This group possesses a combination of characters including a thickly callus-coated, pug-nosed spire and callus-thickened outer lip margin that distinguish it from other aporrhaids. The orientation and form of digitations on the outer lip and the reflection of the anterior canal/spine are plastic features within the Aporrhaidae that may vary on the generic level (i.e., the anterior spine of *Anchura* is reflected to the left in the type species *A. abrupta* as shown in Plate 15, figures 1-3, but is straight in other species of this genus). These characters are considered here to be of secondary importance.

Genus GYMNARUS Gabb, 1868

Type by monotypy, *Pugnellus manubriatus* Gabb, 1864.

Diagnosis: Small to large sized, low-spired, callus-coated shell with extended outer lip having a thickened margin and a hook-like posterior extention; anterior rostrum ventrally reflected; sculpture of sigmoidal axial ribs on body whorl.

Range: Upper Cretaceous (Cenomanian-Maastrichtian).

Gymnarus abnormalis (Wade, 1926)
Plate 12, figures 5-9

1923. *Pugnellus* sp. Stephenson, North Carolina Geol. Survey, v. 5, p. 374, pl. 93, fig. 12.
1926. *Pugnellus abnormalis* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 149, pl. 52, fig. 6-7.
1927. *Pugnellus levis* Stephenson, U. S. National Museum, Proc., v. 72, art. 10, p. 22, pl. 9, fig. 1-5.
1960. *Pugnellus (Gymnarus) abnormalis* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 115-116, pl. 15, fig. 1, 6, 9, 13.

Diagnosis: Large sized *Gymnarus* with a ventrally keeled, posterior hook on the outer lip and a rounded callus ridge running the length of the left ventral side of the body whorl and spire.

Description: Only the adult form of this species is known and it is completely covered in callus. The body whorl and spire are smooth with a callus ridge on the left ventral side that terminates in a knob or point at the shell's apex. The aperture is elongate with a broad posterior sinus and an anterior canal on the basal spine. This spine curves in a ventral direction near its tip. The outer lip has a massive posterior hook with a channel along its posterior margin that extends from the aperture's posterior sinus to the hook's posterior apex. Adjacent to the aperture and below the channel is a ridge along the hook's proximal margin. A keel is situated along the hook's ventral lateral edge. This keel and the proximal ridge are separated by a central depression as shown in the apical view figured in Plate 12, figure 8. The lower part of the outer lip has a ventrally directed fold at about the mid-region of the posterior canal. Below this fold is a prominent sulcus after which the basal spine is modestly curved in a ventral direction.

Discussion: This bizarre species is the largest known *Gymnarus* and shows little change from the Campanian Coffee Sand to the Maastrichtian Coon Creek Tongue. It lacks the sinuous axial ribs of the type species *G. manubriatus*, but this is possibly a result of the thick callus coating on the shell's dorsal region. The basal spine of *G. abnormalis* and *G. manubriatus* have the same basal sinus and curvature, but these features are more pronounced in the latter (the type) species.

Material: One complete and a few partial specimens.

Measurements: The incomplete holotype measures 84 mm in height and 66 mm in width. The largest specimen (from the Coon Creek Tongue) figured here is 91 mm in height and 66 mm in width.

Types: Holotype 32922 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Union County. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality). North Carolina: Peedee Formation, Rocky Point quarry, Pender County.

Genus LISPODESTHES White, 1876

Type species, *Anchura nuptialis* White.

Diagnosis: Medium to large sized, short spired, callus-coated shell with expanded outer lip having a thickened margin and a median digitation below a hook-like posterior projection; anterior rostrum curved or straight.

Discussion: The new species of *Lispodesthes* described here from the Coffee Sand is the first record of the genus in the southeastern United States. It shares with *L. rotundus* (Waring) from the Jalama Formation (upper Campanian - early Maastrichtian) of California the distinction of being one of the latest occurrences of this genus. Other occurrences include the type species *L. nuptialis* (White) from the Colorado Group (Cenomanian-Turonian) of Arizona and *L. panda* Stephenson and *L. patula* Stephenson from the Woodbine Formation (Cenomanian) of Texas.

Range: Upper Cretaceous (Cenomanian-Maastrichtian).

Lispodesthes amplus n. sp.
Plate 13, figures 1-2, 5-6

Diagnosis: Large sized *Lispodesthes* with two broadly-spaced digits or rays on the outer lip and with a straight and slightly flaring anterior rostrum.

Description: Only the adult shell is known and it is smooth and completely covered with callus. The holotype is light brown with a darker brown color zone on the lower half of the dorsal side that has rays extending toward the apertural digits of the outer lip (see Plate 13, figure 5). The aperture is elongate with a moderately wide anterior canal and a broad posterior sinus. The posterior hook of the outer lip has a broad and shallow channel on the posterior margin and is only gently curved toward the posterior. Midway between this hook and the shell's base is a second digit, which may be solid or bear a shallow channel. The margin of the outer lip is moderately thickened and is swollen at the base of the posterior hook. The anterior rostrum and associated anterior canal are moderately wide and the canal is somewhat flared toward the base. The rostrum is straight rather than curved as in other species of *Lispodesthes*.

Discussion: This species is significantly larger than the other species of this genus and is unique in that the dorsal side is so thickly covered in callus that the underlying sculpture does not show through. It is similar to *Lispodesthes rotundus* (Waring) of the Jalama Formation of California in its large size, the broad spacing betwen the hook and lower digit of the outer lip, and in lacking an extended posterior canal on the spire. It differs from this species in that its posterior hook is located at the top of the aperture and body whorl rather than below the top, its anterior canal is broad and straight, and its dorsal side is completely covered by callus. *Lispodesthes amplus* parallels the adult form of *Gymnarus abnormalis*. Both of these are the largest species in their genera and have the

sculpture of the helicocone concealed beneath a thick coat of callus. LouElla Saul (personal communication) suggested the placement of *L. amplus* in *Lispodesthes* rather than *Gymnarus* as earlier considered.

Material: Two largely complete specimens and a fragment of an outer lip.

Measurements: The holotype measures 63.4 mm in height and 55 mm in width.

Types: Holotype 457001 USNM.

Etymology: Named for its large size as compared with other species of the genus (*amplus*: Latin for large).

Occurrence: Coffee Sand, MGS locality 129.

Genus PUGNELLUS Conrad, 1860

Type by monotypy, *Strombus densatus* Conrad, 1858.

Diagnosis: Medium to large sized, short-spired, callus-coated shell with expanded outer lip having a thickened margin - especially so in the middle region between the knob-like posterior and anterior processes, which flank the lip's posterior and anterior sinuses; anterior rostrum straight; sculpture of sigmoidal axial ribs on body whorl.

Range: Upper Cretaceous (Turonian-Maastrichtian).

Pugnellus densatus (Conrad, 1858)
Plate 12, figures 3-4

1858. *Strombus densatus* Conrad, Philadelphia Acad. Nat. Sci., Jour., 2nd. ser., v. 3, p. 330, pl. 25, fig. 14.
1860. *Pugnellus densatus* Conrad. Conrad, Philadelphia Acad. Nat. Sci., Jour., 2nd ser., v. 4, p. 284, pl. 46, fig. 31.
1877. *Pugnellus typicus* Gabb, Philadelphia Acad. Nat. Sci., Proc., v. 28, p. 298.
1904. *Pugnellus densatus* Conrad. Cossmann, Essais Paleoconchologie Comparee, v. 6, p. 37, pl. 7, fig. 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. Survey, v. 5, p. 373, pl. 92, fig. 11, 12.
1926. *Pugnellus densatus* Conrad. Wade, U. S. Geol. Survey, Prof. Paper 137, p. 148, pl. 52, fig. 4-5.
1940. *Pugnellus densatus* Conrad. Stephenson and Monroe, Mississippi Geol. Survey, Bull. 40, pl. 13, fig. 1-2.
1940. *Pugnellus (Pugnellus) densatus* Conrad. Wenz, Handbuch der Palaozoologie: Gastropoda, v. 4, p. 940, fig. 2747-2748.
1944. *Pugnellus densatus* Conrad. Shimer and Shrock, Index Fossils of North America, p. 497, pl. 203, fig. 27-28.
1960. *Pugnellus densatus* Conrad. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 112-114, pl. 14, fig. 4-5, 9-10, 13-16, 19-20.
1964b. *Pugnellus* aff. *P. densatus* Conrad. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 368.
1983. *Pugnellus densatus* Conrad. Popenoe, Jour. Paleont., v. 57, no. 4, p. 742-743, fig. 6E-H.

Discussion: Only the outer lip and a portion of the dorsal body whorl have been collected for this species from the Coffee Sand. The most complete fragment on hand is a large form of the species but has the same characteristic margin of the outer lip and closely spaced sinuous ribs on the upper dorsal portion of the body whorl. This specimen is not as large as *Pugnellus goldmani* Gardner.

A specimen of *Pugnellus goldmani* from the Coon Creek Tongue of the Ripley Formation in Union County, Mississippi, is figured here for comparison with *Pugnellus densata*. The size of the Coffee Sand *Pugnellus* specimen is intermediate between these two species but has the closely spaced sinuous ribs found on *P. densata*.

Material: A few fragments have been found in the Coffee Sand at MGS locality 129.

Measurements: The figured specimen from the Coon Creek Tongue measures 38.8 mm in height and 25.8 mm in width.

Types: Holotype lost; hypotypes 15016 ANSP, 128535-128540 USNM.

Occurrence: This species has a broad distribution in the Gulf and Atlantic coastal plains, occurring in the Coffee Sand (MGS locality 129), Ripley, and Owl Creek (type horizon) formations in Mississippi and equivalent strata in Texas, Tennessee, Alabama, North Carolina, Maryland, and New Jersey (see Sohl, 1960, p. 114).

Family COLOMBELLINIDAE Fischer, 1884

Genus COLOMBELLINA d'Orbigny, 1842

Type by subsequent designation, *Rostellaria monodactylus* Deshayes, 1842.

Diagnosis: Small sized, thick, medium to low spired, coarsely sculptured shell with thickened, denticulate outer lip, heavily callused and reflected inner lip, short anterior canal, and short to extended posterior canal (after Sohl, 1960, p. 110-111).

Range: Upper Cretaceous (Neocomian-Maastrichtian).

Colombellina cancellata n. sp.
Plate 16, figure 10

Diagnosis: Small sized cancellate *Colombellina* lacking a strongly expanded inner and outer lip.

Description: The protoconch is dome shaped with a flat top and consists of about two convex whorls. The teleoconch is cancellate and consists of two whorls. The first whorl has

three spiral lirae, the upper one forming a subsutural collar and the lower two flanking the whorl's midline, and coarse axial ribs that form nodes where they intersect the lirae. On the body whorl the lirae coarsen to form cords, which include the subsutural collar and after a moderately broad interspace, seven additional cords. These cords are noded where they are crossed by 17 strong axial ribs. Every fourth to fifth rib is enlarged so as to form modest varices. The aperture is lenticular and the outer lip is denticulate but not expanded. The inner lip has a thin callus layer and three parietal plications that correspond to the fifth, sixth, and seventh cords below the subsutural collar. Three stronger columellar plications occur below the parietal ones.

Discussion: This species is monotypic and differs most notably from *Colombellina americana* Wade of the Coon Creek Tongue in lacking a strongly expanded inner and outer lip. As this difference may be a factor of the shell's developmental stage, the shell sculpture is probably a more useful way to distinguish these species. The sculpture of *C. americana* consists of noded spiral cords, while *C. cancellata* is cancellate with both strong spiral cords and axial ribs.

Material: One specimen.

Measurements: The holotype measures 8.0 mm in height and 5.35 mm in width.

Types: Holotype 457002 USNM.

Etymology: Named for its cancellate sculpture.

Occurrence: Coffee Sand, MGS locality 129, bed E.

Superfamily VANIKOROIDEA Gray, 1840
Family HIPPONICIDAE Troschel, 1861

Genus HIPPONIX DeFrance, 1819

The specimen named by Dockery (1991) as *Hipponix coffea* n. sp. is here placed as the adult stage of *Damesia keownvillensis* Sohl, 1960, in the Family Amathinidae.

Superfamily CALYPTRAEOIDEA Lamarck, 1809
Family CALYPTRAEIDAE Lamarck, 1809

Genus THYLACUS Conrad, 1860

Type by monotypy, *Thylacus cretaceus* Conrad, 1860.

Diagnosis: Small sized, elongate, curved, cap-like shell with globular naticoid protoconch, roughened outer surface, and horseshoe-shaped, thin, internal, lamellae-like prongs for muscle support (after Sohl, 1960, p. 94).

Discussion: *Thylacus* is a monotypic genus that is here placed in the Calyptraeidae based on the form of its larval shell as figured in Plate 18. *Thylacus cretaceus* superficially resembles *Capulus*, and was placed as a questionable subgenus of *Capulus* by Wenz (1940, p. 898). Sohl (1960, p. 94) pointed out that the unique horseshoe shaped muscle support of this taxon merited a separation from *Capulus* as a distinct genus. Klaus Bandel (personal communication) suggested that *Thylacus* was more closely related to *Calyptraea* than *Capulus* based on its larval shell. Upon this recommendation, *Thylacus* is here placed in the Family Calyptraeidae rather than the Capulidae. The larval shell has a naticiform appearance from the dorsal view but on the ventral view it has a spiral shelf as in *Calyptraea*. Right and left prongs develop from the edge of this shelf (see Plate 18, figure 4) and later form a thin, horseshoe-shaped platform with free distal ends that supports the muscles (see Plate 18, figure 1).

Range: Upper Cretaceous (Campanian-Maastrichtian).

Thylacus cretaceus Conrad, 1860
Plate 17, figures 3-7; Plate 18, figures 1-4

1860. *Thylacus cretaceus* Conrad, Philadelphia Acad. Nat. Sci., Jour., v. 4, 2nd. ser., p. 290, pl. 46, fig. 22.
1923. *Thylacus cretaceus* Conrad. Stephenson, North Carolina Geol. Survey, v. 5, p. 55, pl. 88, fig. 20-21.
1926. *Thylacus cretaceus* Conrad. Wade, U. S. Geol. Survey, Prof. Paper 137, p. 166, pl. 58, fig. 1, 5, 11.
1940. *Capulus* (?*Thylacus*) *cretaceus* (Conrad). Wenz, Handbuch der Palaozoologie: Gastropoda, pt. 4, p. 898, fig. 2641.
1960. *Thylacus cretaceus* Conrad. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 94-95, pl. 10, fig. 1-4, 7.
1964b. *Thylacus cretaceus* Conrad. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 366, pl. 54, fig. 16-18.

Diagnosis: Small sized, elongate, cap-like shell with a naticiform protoconch and raised blade-like, horseshoe-shaped muscle support with free distal ends.

Description: The naticoid protoconch consists of three whorls after which the shell expands immediately to assume the adult cap-like form (see Plate 18, figures 2 and 3). The pre-expanded juvenile has a concave base with an umbilicate spiral shelf from which protrude the tiny right and left prongs of the incipient muscle support (see Plate 18, figure 4). When fully developed the muscle support is a horseshoe-shaped, blade like process with free distal ends that is located below the overhanging apex of the interior of the posterior end. The shell is longer than wide and has a sinuous lateral margin that conforms to the shape of the gastropod collumella to which it was attached. The exterior is smooth except for growth lines and rugae.

Discussion: *Thylacus cretaceus* is commonly found attached to the collumella of gastropod shells as seen in place on a young *Volutomorpha* figured in Plate 17, figure 3. This is presumed to be the species' preferred if not only habit as judged from the convexity of the shell's lateral margin (see Plate 17, figure 5).

Material: Numerous specimens.

Measurements: The largest specimen figured from the Coffee Sand is 7.0 mm in length and 3.6 mm in width.

Types: The holotype is missing from the ANSP; hypotypes 31958, 73028, 128483-128485 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130; also the Ripley (probable type horizon; present at MGS locality 127) and Owl Creek formations. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County.

Family CAPULIDAE Fleming, 1822

Genus CAPULUS Monfort, 1810

Type by original designation, *Patella hungaricus* Linné, 1758.

Diagnosis: Medium to large sized, conical, cap-shaped shell with apex post-centrally located and more or less spiral; aperture rounded to oval; internal muscle scar horseshoe-shaped; no septum present; surface smooth or sculptured (after Davies, 1971, p. 326).

Range: Jurassic?, Upper Cretaceous - Recent.

Capulus? sp.
Plate 17, figure 2

Discussion: A single incomplete specimen of this species is questionably assigned to *Capulus*. It has a fragile and nearly symmetrical shell with the apex overhanging the posterior margin. The exterior is sculptured with fine radial threads.

Material: One specimen.

Measurements: The figured specimen measures 10.4 mm in length and 9.0 mm in width.

Occurrence: Coffee Sand, MGS locality 129.

Genus TRICHOTROPIS Broderip and Sowerby, 1829

Type by subsequent designation, *Turbo bicarinata* Sowerby, 1825.

Diagnosis: Medium sized, turbinate shell with enlarged body whorl, narrow umbilicus, and pointed, anterior terminus of columella; aperture somewhat anteriorly channeled; labrum strongly prosocline posteriorly; whorls sculptured with two spiral keels having oblique growth line striae in between (after Davies, 1971, p. 328).

Range: Upper Cretaceous (Campanian) - Recent.

Discussion: Ponder and Warén (1988, p. 300) dropped the family Trichotropidae and placed *Trichotropis* in the same family with *Capulus* based on anatomical grounds.

Trichotropis squamosa (Gabb, 1876)
Plate 17, figures 11-12

1877. *Gyrotropis squamosus* Gabb, Acad. Nat. Sci. Philadelphia, Proc., v. 28, p. 300, pl. 17, fig. 5.

1923. *Trichotropis squamosa* (Gabb). Stephenson, North Carolina Geol. Survey, v. 5, p. 369-370, pl. 93, fig. 6-7.

Diagnosis: A medium sized, umbilicate *Trichotropis* with a strongly carinate spire and bicarinate body whorl.

Description: The protoconch consists of two or more whorls (apex not completely known) and is smooth and strongly carinate on the last whorl with an apertural sulcus below the carina at its juncture with the teleoconch. The surface of the teleoconch is rougher than that of the protoconch and has strongly prosocline growth rugae. It has a strongly carinate spire and a bicarinate body whorl. The carinae are spinose where they intersect the growth rugae. Spiral threads are present on the upper peripheral margin of the upper carina. Growth rugae are particularly strong on the margin between carinae and on the base where they give the shell an imbricate appearance. The body whorl and aperture are incompletely known. The suture of the body whorl is below the level of an elevated inner region of the subsutural ramp so as to form a channel. The base has a large umbilicus with a sharply raised margin that is spinose at the intersections with growth rugae.

Discussion: The Coffee Sand specimens of this species are only about one third the size of the holotype (and only previously known specimen) from the Snow Hill Calcareous Member of the Black Creek Formation of North Carolina. As a result, they differ from the type due to their ontogenetic stage. The major difference is in the length of the base. On the Coffee Sand specimens, the distance between the two marginal carinae is about the same as the distance between the lower carina and the umbilical margin, while, on the holotype as figured by Stephenson (1923, pl. 93, fig. 7), the distance between the lower carina and the umbilical margin is twice that between the marginal carinae.

Material: A few specimens.

Measurements: The holotype measures 28 mm in height and 23 mm in width. The largest incomplete specimen from the Coffee Sand measures 9.8 mm in height.

Types: Holotype 2305 ANSP.

Occurrence: Mississippi: Coffee Sand, MGS locality 129. North Carolina: Snow Hill Calcareous Member of the Black Creek Formation (type horizon), Snow Hill.

Genus CERITHIODERMA Conrad, 1860

Type by monotypy, *Cerithioderma prima* Conrad, 1860.

Diagnosis: Small to medium sized, high-spired, turbiform shell with short, pointed anterior canal that is deflected to the left; aperture subcircular to quadrate; outer lip often thickened; columellar callus of inner lip sometimes does not completely cover umbilicus leaving a small opening; sculpture of axial and spiral elements with the axials sometimes becoming obsolete on the body and penultimate whorls (in part after Palmer, 1937, p. 213-214).

Range: Upper Cretaceous (Campanian) - Recent.

Cerithioderma nodosa n. sp.
Plate 17, figures 13-15; Plate 18, figure 5;
Plate 19, figure 4

Diagnosis: Medium sized *Cerithioderma* with a fenestrate juvenile sculpture and an adult sculpture dominated by large axial nodes.

Description: The protoconch is smooth and flat-topped with two and one half convex whorls. The suture of the first two whorls lies in a plane perpendicular to the axis and is depressed below the whorl's convex upper sides. After two whorls, the suture assumes the inclination of that of the early teleoconch. The teleoconch consists of six whorls with the first whorl having a fenestrate sculpture that is distinct from that of the subsequent whorls. This sculpture consists of three spiral threads that are crossed by axial ribs, which are opisthocline below a flexure between the middle and upper threads. The second whorl is more strongly sculptured with seven or more spiral lirae, closely spaced prosocline axial threads, and broadly spaced prosocline axial nodes. On subsequent whorls, the axial nodes increase in prominence as the spiral lirae and axial threads diminish. These nodes have their greatest relief about one third the whorl's height above the lower suture. The aperture is ovate with a short anterior canal. The body whorl has six or seven axial nodes, which do not continue onto the base. Spiral lirae cover the lower region of the nodes and the base.

Discussion: The holotype, which is also the largest specimen, is like the second largest specimen illustrated in Plate 17, figure 14, in the coarseness of its axial nodes and in having spiral lirae on the lower region of the nodes and the base. The protoconch and first whorl of the teleoconch are not preserved in these specimens, both of which are from MGS locality 129. A smaller third specimen from locality 128 has less prominent and more numerous axial nodes (Plate 17, figure 15). This specimen has the first whorl of the teleoconch preserved, the sculpture of which is the same as the juvenile fourth specimen figured in the SEM photograph in Plate 18, figure 5. The teleoconch of the fourth specimen consists of only two whorls, with the last whorl (body whorl) having even weaker axial ribs than the third specimen. The form of the holotype and next largest specimen with their prominent nodes and lirate base is considered to be typical for the species with the smaller two specimens included within the species' variability. *Cerithioderma nodosa* differs from the type species *C. prima* from the middle Eocene Gosport Sand in that its axial nodes strengthen with growth while the axial ribs of *C. prima* become obsolete.

Material: Several specimens.

Measurements: The holotype which is missing the apex is 17.8 mm in height and 11.5 mm in width.

Types: Holotype 457003 USNM.

Etymology: Named for the species' prominent axial nodes.

Occurrence: Coffee Sand, MGS localities 128 and 129 (type locality).

Superfamily XENOPHOROIDEA Troschel, 1852
Family XENOPHORIDAE Troschel, 1852

Genus XENOPHORA Fischer von Waldheim, 1807

Type by subsequent designation (G. F. Harris, 1897), *Xenophora laevigata* Fischer von Waldheim, 1807 (= *Trochus conchyliophorus* Born, 1780).

Diagnosis: Large sized, depressed-conical shell with narrow to wide peripheral flange and flattened to concave base, which is often umbilicate; spire usually with foreign objects attached; protoconch depressed-conical and multispiral; sculpture usually of only growth lines and a single spiral cord (after Ponder, 1983, p. 17).

Range: Upper Cretaceous (Cenomanian) - Recent.

Subgenus XENOPHORA Fischer von Waldheim, 1807

Diagnosis: *Xenophora* with narrow and simple peripheral flange that is non-porcelaneous on ventral side; umbilicus moderate to closed; foreign objects attached to all whorls of teleoconch and usually occupying more than one third of the dorsal surface (after Ponder, 1983, p. 18).

Range: Upper Cretaceous (Cenomanian) - Recent.

Xenophora (Xenophora) leprosa (Morton, 1834)
Plate 20, figures 1-4

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, Smithsonian Misc. Coll., v. 7, no. 177, 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, Monograph 18, p. 135, pl. 17, fig. 16-19.
1907. *Xenophora leprosa* (Morton). Weller, New Jersey Geol. Survey, Paleontology, v. 4, p. 690, pl. 78, fig. 1-3.
1926. *Xenophora leprosa* (Morton). Wade, U. S. Geol. Survey, Prof. Paper 137, p. 162, pl. 56.
1941. *Xenophora leprosa* (Morton). Stephenson, Texas Univ. Bull. 4101, p. 285, pl. 52, fig. 17-19.
1944. *Xenophora leprosa* (Morton). Shimer and Shrock, Index Fossils of North America, p. 485, pl. 199, fig. 10-11.
1960. *Xenophora leprosa* (Morton). Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 96-97, pl. 10, fig. 19,

23-27.

1983. *Xenophora (Xenophora) leprosa* (Morton). Ponder and Cooper, *in* Ponder, The Australian Museum Memoir 17, p. 71.

Diagnosis: A typical trochiform *Xenophora s. s.* with shells agglutinated to the spire and with a non-umbilicate, concave base.

Description: The protoconch is trochiform, consisting of a little more than four smooth convex whorls. A slightly prosocline growth line marks the terminus of the fourth whorl. The next one eighth whorl has fine spiral threads and terminates abruptly into a raised shell surface that forms the base for an attached shell as indicated by the attachment scar on the upper surface (see Plate 20, figure 4). This juncture marks the protoconch-teleoconch boundary and is concave toward the aperture with a sharply rounded sinus one third the whorl's height above the lower suture. The teleoconch of the largest Coffee Sand specimen consists of five and one half whorls and has shells or shell attachment scars covering most of the dorsal surface (see Plate 20, figure 3). Where attachment scars are not present, the sculpture consists of fine spiral threads. The apical angle is 75°. The base is non-umbilicate and concave with an overhanging peripheral flange. It is covered with growth lines that are concave toward the aperture. The aperture is wide and narrow, the roof of which is the broad base of the previous whorl. The aperture's basal margin is slightly concave in lateral view and strongly concave as viewed from the base (see Plate 20, figure 1).

Discussion: The Coffee Sand specimens of *Xenophora (Xenophora) leprosa* are some of the best preserved specimens of this species found to date. Previously, only a few specimens from the Coon Creek Tongue at its type locality in Tennessee, such as those figured by Wade (1926, pl. 56, fig. 7-8) and Sohl (1960, pl. 10 fig. 19), contained the original shell material. This species occurs commonly as molds in the Prairie Bluff Chalk. It has a teleoconch similar to that of the upper Eocene Moodys Branch species *Xenophora (s.s.) reclusa* (Conrad *in* Wailes, 1854), but its protoconch differs in having four conical whorls rather than three flat-topped whorls as does the latter species. The shell fragments agglutinated to the spire of the *X. (X.) leprosa* specimen illustrated in Plate 20, figure 3, double the shell's width from 25 mm to 50 mm. At the shell's apex these fragments include tiny nacreous flakes from the crushed shells of ammonites. Along the shell's periphery, they include large fragments from the gastropods *Longoconcha* and *Morea* and the bivalves *Idonearca* and *Crassatella*.

Material: One adult specimen and several juveniles.

Measurements: The largest Coffee Sand specimen measures 20.0 mm in height and 25.0 mm in width not including the attached shells.

Type: Holotype 15361 ANSP.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; also in the Ripley Formation (juvenile shells present at MGS locality 127) and common in the Prairie Bluff Chalk. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County.

Superfamily CYPRAEOIDEA Rafinesque, 1815

Discussion: According to Groves (1990), only fifteen cypraeacean species of three genera are known from the Cretaceous deposits of North America. Of these, the Family Cypraeidae includes six species in *Palaeocypraea s.s.*, two species in *Bernaya s.s.*, and five species in *Bernaya (Protocypraea)*. The Family Ovulidae contains one genus with two species in *Eocypraea s.s.* Only two cypraeacean specimens are known from the well preserved faunas of the upper Mississippi Embayment region. These specimens are complete and represent some of only a few Cretaceous cypraeids having the original shell preserved. Both were found in bed E of the Chapelville horizon of the Coffee Sand at MGS locality 129. Luc Dolin (personal communication, 1988) initially identified these specimens as belonging to *Bernaya (s.l.)*. Groves (1990) placed them in a new species *Bernaya (Protocypraea) mississippiensis*.

Family CYPRAEIDAE Rafinesque, 1815
Subfamily BERNAYINAE Schilder, 1927

Genus BERNAYA Jousseaume, 1884

Type by original designation, *Cypraea media* Deshayes, 1835.

Diagnosis: Medium to large cypraeid with somewhat carinate anterior end and smooth dorsum; spire of medium height and partially covered with callus; aperture wide with rounded sides and deep anterior and posterior canals; fossula smooth, concave, and wide (after Groves, 1990, p. 277).

Range: Upper Jurassic (Tithonian) - Recent.

Subgenus PROTOCYPRAEA Schilder, 1927

Type by original designation, *Eocypraea orbignyana* Vredenburg, 1920.

Diagnosis: Small to medium size cypraeid with a moderately pyriform shape that is somewhat constricted anteriorly; fossula smooth, concave, and wide (after Groves, 1990, p. 278).

Range: Lower Cretaceous (Barremian) - Recent.

Bernaya (Protocypraea) mississippiensis
Groves, 1990
Plate 21, figures 1-3

1988. *Bernaya (s.l.)* n. sp. Dockery, Mississippi Geology, v. 9, no. 2, p. 19, fig. 3.

1990. *Bernaya (Protocypraea) mississippiensis* Groves, Veliger, v. 33, no. 3, p. 279-281, fig. 27-28.

Diagnosis: A small pyriform *Protocypraea* with prominent anterior and posterior basal ridges and a smooth, concave fossula.

Description: The protoconch is covered by the involute body whorl, but in the young specimen figured (see Plate 21, figures 1-3), the spire of the juvenile shell is visible through the callus. This spire has a reticulate sculpture of fine spiral lirae and axial ribs. The holotype, which is not figured here, is larger, and the spire is completely enveloped by the body whorl. The aperture is an elongate slit that runs the length of the shell, is slightly right of the center line, and is reflected to the left at the posterior end. The outer lip is strongly inflated and has 20 teeth along the inner margin; the inner lip has 17 teeth. The fossula is concave and smooth. Both the anterior and posterior ends of the shell have prominent basal terminal ridges. The surface of the shell is smooth and glossy.

Discussion: Groves (1990) stated that this species was different from other Cretaceous cypraeids of the Gulf Coast region and compared it as being most similar to *Bernaya (P.) rineyi* Groves from the Upper Cretaceous (Campanian/ Maastrichtian) Point Loma Formation of San Diego County, California. However, the resemblance is not close as *B. (P.) rineyi* has a more inflated shell, especially toward the anterior and posterior ends. As previously mentioned, *B. (P.) mississippiensis* is the first cypraeid to be reported from the diverse and well preserved Upper Cretaceous gastropod faunas of the upper Mississippi Embayment region.

Material: Two specimens.

Measurements: The holotype measures 21.5 mm in height (length), 13.7 mm in width, and has a dorsal-ventral height of 9.8 mm.

Types: Holotype 446797 USNM; paratype 446798 USNM.

Occurrence: Coffee Sand, MGS locality 129, bed E.

Superfamily NATICOIDEA Forbes, 1838
Family AMPULLINIDAE Cossmann, 1918

Genus AMPULLINA Bowdich, 1882

Type by monotypy, *Ampullaria depressa* Lamarck.

Diagnosis: Large sized, thick, high spired, rather globose, naticoid shell with stepped whorls and spiral rows of fine punctae; umbilicus small and limited by well defined limb; aperture narrowly semilunar; inner lip with thick columellar and parietal callus (after Davies, 1971, p. 343).

Range: Jurassic - Miocene.

"Ampullina" cf. "A." potens Wade, 1926
Plate 20, figure 15

1926. *Ampullina potens* Wade, U. S. Geol. Survey, Prof.Paper 137, p. 165-166, pl. 57, fig. 12-13.
1960. *"Ampullina" potens* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 124, pl. 17, fig. 24-25.

Diagnosis: Large sized, solid naticoid shell with a moderately high spire, modest subsutural ramp, and drop shaped aperture.

Description: The protoconch is unknown. The teleoconch consists of six smooth whorls sculptured only by growth lines. The spire is moderately high with convex whorls and a modest subsutural ramp. On the body whorl, the ramp is diminished toward the aperture. This whorl is sculptured with growth lines that are prosocline on the upper third of the whorl, orthocline on the midregion, and reflected back toward the shell's axis on the base. The aperture is somewhat drop-shaped, and the base is non-umbilicate.

Discussion: Two large specimens of this species from the Coffee Sand at MGS locality 129 are tentatively placed as *"A." potens* Wade. Both are abraded due to transport. They differ from the type specimen from the Coon Creek Tongue of the Ripley Formation (Coon Creek, Tennessee) in having a less stair-stepped spire and a convex rather than flat-sided body whorl. For a discussion of the placement of this species in the genus *"Ampullina"*, see Sohl (1960, p. 124 125). Davies (1971) placed *Ampullina* as a synonym (*nom. nud.*) of *Ampullella* Cox, 1931.

Material: Two specimens.

Measurements: The larger specimen of this species from the Coffee Sand, which is not figured, measures 43.8 mm in height and 32.7 mm in width.

Types: Holotype 73081 USNM.

Occurrence: cf. form - Mississippi: Coffee Sand, MGS locality 129. Typical form - Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality).

Genus AMAURELLINA Fischer, 1885

Type by monotypy, *Natica spirata* Lamarck, 1804.

Diagnosis: Medium sized, naticoid shell with body whorl about two-thirds height; whorls shouldered; aperture subovate with inner lip anteriorly expanded and reflexed; base with umbilical sheath reduced to a rim extending up into the umbilicus (after Sohl, 1960, p. 125).

Range: Upper Cretaceous (Campanian) - Oligocene.

Amaurellina stephensoni (Wade, 1926)
Plate 20, figures 7-8

1926. *Polinices stephensoni* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 163, pl. 56, fig. 13-14.
1941. *Polinices stephensoni* Wade. Stephenson, Texas Univ. Bull. 4101, p. 278, pl. 50, fig. 9-11.
1960. *Amaurellina stephensoni* (Wade). Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 125-126.

Diagnosis: A medium sized naticoid shell with a depressed subsutural ramp and raised shoulder and a narrow

umbilicus with a slender median ridge extending to the outer edge of the aperture's lower inner lip.

Description: The protoconch is unknown. The teleoconch consists of five glossy whorls with a depressed subsutural ramp and raised shoulder. All specimens show a narrow subsutural band on the inner flank of the depressed ramp where the glossy outer layer is absent as if the shell were selectively leached below the suture. The body whorl is globose, and the aperture is large and ovate. The inner lip divides below the umbilicus with the left fork of this split forming a thin median ridge within the narrow umbilicus and the right fork forming the right umbilical margin and the parietal lip.

Discussion: This species is fairly common in the Chapelville horizon of the Coffee Sand. The Coffee Sand specimens agree well with those from the type horizon, the Coon Creek Tongue of the Ripley Formation.

Types: Holotype 73075 USNM; hypotypes 76844 (from Texas), 128565 (from Tennessee), and 128566 (Mississippi) USNM.

Material: Several specimens.

Occurrence: Mississippi: Coffee Sand, MGS localities 128 and 129; Ripley Formation, Union County. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality). Texas: Navarro Group. Georgia: Ripley Formation.

Genus PSEUDAMAURA Fischer, 1885

Type by monotypy, *Natica bulbiformis* Sowerby, 1832.

Diagnosis: Medium to large sized, high spired, naticoid shell with channeled sutures and commonly with spiral sculpture; umbilicus lacking or only a small slit (after Sohl, 1960, p. 126).

Range: Triassic - Miocene.

Pseudamaura lepta Sohl, 1964
Plate 20, figures 5-6

1964b. *Pseudamaura lepta* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 370, pl. 55, fig. 3-5.

Diagnosis: Medium sized, high spired naticoid shell with a narrowly incised suture and fine spiral threads that are strongest just below the sutural channel.

Description: The protoconch is unknown. The teleoconch is high spired and consists of eight glossy whorls, which are sculptured with fine growth lines and microscopically fine spiral threads that are best developed adjacent to the upper suture. The suture is deeply and narrowly incised. Growth lines are most noticeable on the body whorl where they consist of narrow, regularly spaced, light brown, nearly orthocline (prosocline just below suture) bands that stand out from a medium-brown background. The aperture is long and drop-shaped with the left side of the basal lip having a flattened and polished margin. The base is narrowly umbilicate with an umbilical shoulder that extends onto the base as a ridge paralleling the margin of the basal inner lip so as to form a groove between the two.

Discussion: This species is closely related to *Pseudamaura lirata* (Wade, 1926) from the Coon Creek Tongue of the Ripley Formation. Sohl's (1964b, p. 370) comparison of these two species is reversed. Of these species, it is *P. lirata* and not *P. lepta* that "is larger, proportionally stouter, has coarser spiral sculpture, and a stronger sutural channel."

Material: Several specimens.

Measurements: The holotype measures 22 mm in height and 19 mm in width.

Types: Holotype 131633 USNM; paratypes 131634-131635 USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130 (type locality). Alabama and Georgia: Blufftown Formation.

Family NATICIDAE Forbes, 1838
Subfamily GYRODINAE Wenz, 1941

Genus GYRODES Conrad, 1860

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

Diagnosis: Medium to large sized, low spired, naticoid shell having the width greater than the height; umbilicus wide, deep, and free of callus; sculpture restricted to growth lines and commonly nodes or crenulations near suture and umbilical margin; aperture subovate and inclined with a very thin callus on the inner lip (after Sohl, 1960, p. 116).

Range: Lower Cretaceous (Albian) - Paleocene.

Subgenus GYRODES Conrad, 1860

Diagnosis: *Gyrodes* species with a crenulate and sharp umbilical margin, and crenulations near the suture; growth lines near the suture commonly notched (after Popenoe, Saul, and Susuki, 1987).

Range: Upper Cretaceous (Turonian) - Paleocene (Selandian).

Gyrodes (Gyrodes) major Wade, 1926
Plate 20, figures 13-14

1923. *Gyrodes supraplicatus* (Conrad) (in part). Stephenson, North Carolina Geol. Survey, v. 5, p. 358, pl. 89, fig. 1-2 (not fig. 3-5).

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

1926. *Gyrodes crenata* Conrad. Wade, U. S. Geol. Survey, Prof. Paper 137, p. 164, pl. 57, fig. 1-3.

1941. *Gyrodes (Gyrodes) crenata* Conrad. Wenz, Handbuch

der Palaozoologie: Gastropoda, v. 5, p. 1018, fig. 2921.

1944. *Gyrodes supraplicata* (Conrad). Shimer and Shrock, Index fossils of North America, pl. 198, fig. 10-12.

1960. *Gyrodes major* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 118, pl. 16, fig. 6-7, 10-11, 15.

1964b. *Gyrodes major* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 369, pl. 54, fig. 32, 35-37.

Diagnosis: Large sized *Gyrodes* with a slightly concave subsutural ramp and crenulate shoulder and a broad umbilicus with a raised but noncrenulate margin.

Description: The protoconch consists of two and one quarter moderately elevated, smooth, convex whorls with an impressed suture. The protoconch-teleoconch juncture is not distinct. The teleoconch consists of five whorls with a narrowly incised suture, an elevated subsutural rim, a slightly concave subsutural ramp, and a crenulate shoulder. It is glossy and sculptured with closely spaced strongly prosocline growth lines that are reflected at the shoulder so that they are slightly opisthocline between the shoulder and the suture. On large shells, the shoulder and subsutural ramp are diminished on the body whorl near the aperture. The aperture is broadly comma-shaped with a reflected, acute posterior and a basally truncated anterior. The base has an elevated smooth rim along its outer margin and a broad umbilicus. In young specimens, a prominent umbilical shoulder is present, which is excavated from above on the umbilical side. On these shells, the base has a slightly concave spiral ramp between the marginal rim and umbilical shoulder. This ramp becomes less distinct on larger shells as the umbilical shoulder weakens toward the aperture and the entire base slopes into the umbilicus.

Discussion: This species is the largest naticid in the Coffee Sand and is probably responsible for drilling the large beveled holes found in some bivalves, especially in specimens of *Crassatella* and *Cyprimeria*. A drill hole in one large *Cyprimeria* has an outside diameter of 6.5 mm.

Material: Several specimens.

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

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130; Ripley Formation (MGS locality 127), Union County. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality). North Carolina: Snow Hill Marl Member of the Black Creek Formation.

Subgenus SOHLELLA Popenoe, Saul, and Susuki, 1987

Type by original designation, *Gyrodes canadensis* Whiteaves, 1903.

Diagnosis: *Gyrodes* species with asymmetrically inflated, anteriorly rounded whorls having a depressed, concave subsutural ramp and usually tabulate shoulder; umbilical margin biangulate or subrounded (after Popenoe, Saul, and Susuki, 1987, p. 78).

Discussion: Popenoe, Saul, and Susuki (1987, p. 79) stated that: "Most species assigned to *Sohlella* resemble Sohl's group of *G. spillmani* Gabb in their unornamented, slightly concave, tabulate shoulder, but differ from that group in having a more angulate umbilical margin." They do not comment further on the subgeneric position of *Gyrodes spillmani*. This species closely resembles the type species of *Sohlella, Gyrodes (S.) canadensis*, and is here included in that subgenus.

Range: Upper Cretaceous (Cenomanian-Maastrichtian).

Gyrodes (Sohlella) spillmani Gabb, 1861
Plate 20, figures 11-12

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

1861b. *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, Monograph 18, p. 127, pl. 16, fig. 1-4.

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

1941. *Gyrodes subcarinatus* Stephenson, Texas Univ. Pub. 4101, p. 283, pl. 52, fig. 22, 24, 26.

1944. *Gyrodes petrosa* (Morton). Shimer and Shrock, Index fossils of North America, p. 483, pl. 198, fig. 13-15.

1955. *Gyrodes spillmani* Gabb. Stephenson, U. S. Geol. Survey, Prof. Paper 274-E, p. 125, pl. 21, fig. 13-14.

1960. *Gyrodes spillmani* Gabb. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 118-119, pl. 16, fig. 14, 17-18, 20-21, pl. 17, fig. 27.

1964b. *Gyrodes spillmani* Gabb. Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 369, pl. 54, fig. 28-31, 33-34.

1987. *Gyrodes spillmani* Gabb. Popenoe, Saul, and Susuki, Jour. Paleont., v. 61, no. 1, p. 79.

Diagnosis: Small sized, thin-shelled *Gyrodes* having a narrow and depressed subsutural ramp with a raised, smooth, broadly rounded shoulder, and evenly rounded basal and umbilical margins.

Description: The protoconch is moderately elevated and consists of two smooth convex whorls. The protoconch-teleoconch juncture is not distinct. The teleoconch consists of four glossy whorls that are sculptured with strongly prosocline growth lines. These lines are not reflected at the shoulder. Sutures of well preserved specimens are not incised, while other specimens are narrowly incised in part due probably to selective solution below the suture and/or the fact that the shell tends to separate at the suture as a result of wetting and drying. A narrow and depressed subsutural ramp is present that is

bordered by a raised, smooth, broadly rounded shoulder. The aperture is broadly comma-shaped with an angulate posterior, a convex parietal lip, and broadly rounded base. The shell's base has a large umbilicus that lacks or has only a suggestion of an umbilical shoulder, and the basal margin is marked by a broadly rounded indistinct ridge.

Discussion: This species is characterized by its narrow and depressed subsutural ramp and is common in the Coffee Sand.

Material: Several specimens.

Measurements: The largest specimen measured by Sohl (1960, p. 119) from the Coon Creek Tongue of the Ripley Formation has a height of 30.0 mm and a maximum diameter of 33.0 mm. The largest Coffee Sand specimen figure here has a maximum diameter of 28.1 mm.

Types: "Cotypes" 15162 ANSP; hypotypes 131628-131630 (from Mississippi), 128551, 73079, 128549 (all from Tennessee) USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130; also the Ripley, Owl Creek, and Prairie Bluff formations. Alabama: Prairie Bluff Chalk. Tennessee: Ripley Formation. Texas: Nacatoch Sand and Corsicana Marl. New Jersey: Navesink Formation.

Subfamily POLINICINAE Finlay and Marwick, 1937

Genus EUSPIRA Agassiz *in* Sowerby, 1842

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

Diagnosis: Medium to large size, globose, naticoid shell with abutting to impressed sutures; umbilicus of small to medium size and without funicle (after Sohl, 1960, p. 122).

Range: Upper Cretaceous (Cenomanian) - Recent.

Euspira rectilabrum (Conrad, 1858)
Plate 20, figures 9-10

1858. *Natica (Lunatica) rectilabrum* Conrad, Philadelphia Acad. Nat. Sci., Jour., 2nd series, v. 3, p. 334, pl. 35, fig. 28.

1923. *Lunatia carolinensis* Conrad. Stephenson, North Carolina Geol. Survey, v. 5, p. 356, pl. 88, fig. 17-18 (not 19).

?1925. *Lunatia wadei* Cossmann, Essais Paleoconchologie Comparee, v. 13, p. 135.

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

1941. *Polinices rectilabrum* (Conrad). Stephenson, Texas Univ. Pub. 4101, p. 276, pl. 50, fig. 1, 6.

1941. *Polinices rectilabrum texanus* Stephenson, Texas Univ. Pub. 4101, p. 276, pl. 50, fig. 7-8.

1944. *Polinices (Euspira) halli* (Gabb). Shimer and Shrock, Index fossils of North America, p. 483, pl. 198, fig. 23-24.

1955. *Polinices rectilabrum* (Conrad). Stephenson, U. S. Geol. Survey, Prof. Paper 274-E, p. 125, pl. 21, fig. 10-12.

1960. *Euspira rectilabrum* (Conrad). Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 122, pl. 17, fig. 5-7, 12-14.

1964b. *Euspira rectilabrum* (Conrad). Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 370, pl. 55, fig. 1-2, 7-8.

Diagnosis: Small to medium sized, glossy, naticoid shell with incised suture and rounded shoulder or subsutural ramp; umbilicus narrow and without funicle but partially constricted by the thick parietal callus.

Description: The protoconch is flat-topped with an impressed suture and consists of two glossy, convex whorls. There is no demarcation of the protoconch-teleoconch junction and this junction is placed here arbitrarily where the whorls become helically coiled. The teleoconch consists of three to four glossy whorls with strongly prosocline growth lines. The aperture is ovate and the parietal lip has a thick callus that impinges upon the narrow umbilicus. This umbilicus lacks a funicle. Both the umbilical and basal margins are evenly rounded and lack marginal shoulders or angulations. The spire is represented by two forms. Shells of the first form are generally small and have a rounded shoulder. The second form (see Plate 20, figures 9-10) is generally medium-sized with a subsutural ramp that is depressed at the suture and a stair-step spire.

Discussion: This is the most common naticoidean of the Coffee Sand and is also common in both the Ripley and Owl Creek formations. According to Sohl (1964b, p. 370) the variation in the Coffee Sand forms is similar to that found in higher horizons.

Material: Numerous specimens.

Measurements: The largest specimen collected from the Coffee Sand is from MGS locality 129 and measures 21.0 mm in height and 17.0 mm in width.

Types: Holotype lost from the ANSP; hypotypes 73074 (from Tennessee), 131631, 131632 (both from Mississippi), and 3197 (North Carolina) USNM.

Occurrence: Mississippi: Coffee Sand, MGS localities 128, 129, and 130; also from the Ripley and Owl Creek formations. Tennessee: Ripley Formation. Texas: San Miguel Formation, Neylandville Marl, Nacatoch Sand, Corsicana Marl, and Kemp Clay. Alabama and Georgia: Blufftown, Cusseta, Ripley, and Providence formations. North Carolina: Snow Hill Marl Member of the Black Creek Formation.

Superfamily TONNOIDEA Suter, 1913
Family RANELLIDAE Gray, 1854
Subfamily RANELLINAE Gray, 1854

Genus GYRINEUM Link, 1807

Type by original designation, *Gyrineum gyrinum* (Linné, 1758).

Diagnosis: Small to large sized, fusiform to turbinate shell with angular whorls and two opposing rows of channeled varices; labrum varicose and internally denticulate; aperture channeled at both ends with a short, rather straight, columella and anterior canal; sculptured with crenulated spiral threads (after Davies, 1971, p. 348).

Discussion: Alan Beu, New Zealand Geological Survey (personal communication), recommended the placement of the following ranellid species as *Gyrineum (sensu latissimo)* based on the spacing of the varices and on the row of four or five rather prominent nodules on the lower columella. The normal spacing of varices in the Subfamily Ranellinae, which includes *Gyrineum*, is aligned at 180° as compared to a spacing of 240° or two-thirds whorl apart in the Subfamily Cymatiinae. The occurrence of *Gyrineum* in the Coffee Sand cited here significantly extends the first appearance datum published for this genus. According to Beu (1988), the earliest previous record of *Gyrineum* is that of *Gyrineum judithae* Zensmeister, 1983, from the early Paleocene (Danian) of California.

Range: Upper Cretaceous (Campanian) - Recent.

Gyrineum (s.l.) **gwinae** n. sp.
Plate 21, figures 6-7, 9; Plate 22, figures 1-5

Diagnosis: A very small sized *Gyrineum* with a reticulate, bulbous protoconch and a cancellate, varicate teleoconch with evenly rounded whorls, three primary spiral lirae on the spire with intervening secondary lirae, and an elongate aperture with a posterior notch between denticles of the parietal and outer lips.

Description: The protoconch is large in proportion to the teleoconch size and consists of between three and three and one half bulbous whorls with a cancellate sculpture consisting of prosocline threads and eight or nine irregularly spaced spiral threads. The protoconch-teleoconch junction is sharp but not varicate. The teleoconch consists of one and one half whorls on the holotype and largest specimen and is cancellate with collabral ribs and spiral lirae and varices, which are aligned at 180° apart. The whorls are regularly convex and lack a prominent subsutural ramp. The aperture is elongate with an anterior canal and posterior notch. The parietal lip has two teeth and the columellar lip has three teeth (see Plate 22, figure 2). The outer lip is varicate and has six internal teeth.

Discussion: Juveniles of *Gyrineum gwinae* are frequent in the Chapelville horizon of the Coffee Sand at MGS locality 129. The protoconch of this species is large in comparison to the teleoconch, which on the largest specimen consists of only one and one half whorls. Juveniles with a teleoconch of only one half whorl and a varicate apertural lip as shown in Plate 22 are most frequent. In comparison with *Sassia carlea* (described later), this species is much smaller, lacks a prominent subsutural ramp and shoulder angle, and has a posterior apertural notch.

Gyrineum gwinae is closely related to the high-spired and varicate Coon Creek Tongue species *Gyrineum cretaceus* (Sohl, 1960). Sohl placed this species, which was previously known only from the holotype, in the cancellariid genus *Plesiotrition* based in part on the presence of three folds on the inner lip. These folds, however, are not columellar plaits as described by Beu and Maxwell (1987, p. 25). They are formed only on the columellar part of the inner lip in association with the development of the varices of the outer lip as is illustrated for juvenile specimens of *G. gwinae* in Plate 22, figure 2, and do not extend up the columella. As is the case of *G. gwinae* in the Coffee Sand at MGS locality 129, juvenile specimens of *G. cretaceus* are common at the Coon Creek Tongue type locality at Coon Creek. Of the fifty specimens of *G. cretaceus* present in the Mississippi Office of Geology collections, forty-five are juveniles that have developed only up to the first varix, which appears after the first half whorl of the teleoconch. One of the most notable differences between *G. gwinae* and *G. cretaceus* is that the latter species has a smooth and glossy protoconch rather than a reticulate one.

Material: A few adult and several juvenile specimens.

Measurements: The holotype measures 4.1 mm in height and 2.8 mm in width.

Type: Holotype 457004 USNM.

Etymology: Named for the writer's sister, Gwin Wyatt.

Occurrence: Coffee Sand, MGS locality 129.

Gyrineum (s.l.) **gwinae** var.?
Plate 21, figure 8

Diagnosis: A small *Gyrineum* with a cancellate protoconch, thick orthocline collabral ribs, numerous spiral lirae, and an aperture with four parietal teeth, five columellar teeth, six teeth on the outer lip, and a posterior notch.

Description: The protoconch is dome-shaped and consists of three cancellate whorls. The teleoconch consists of two and one half whorls with strong orthocline collabral ribs, numerous spiral lirae, and two varices, which are separated by 180°. The first varix is at the end of the second whorl of the teleoconch and the second is at the end of the next half whorl (at the aperture). Three primary spiral lirae are present on the spire. On the penultimate whorl, the interspaces between these lirae each have three secondary lirae, and six secondary lirae are present between the uppermost primary and the suture. The body whorl has six primary lirae with three secondaries between each, six secondaries above the uppermost primary, and four secondaries below the lowermost primary. The aperture is elongate with an anterior canal that truncates the columella and a prominent posterior notch. The inner lip has four parietal teeth and five columellar teeth. The outer lip has six teeth.

Discussion: This species is very close to *G. gwinae s.s.*

in its general form. The protoconch on the only known specimen is worn but in places shows a cancellate sculpture similar to that of *G. gwinae s.s.* It differs from the typical form in having fewer and stronger axial ribs, a varix after two whorls of the teleoconch rather than after the first half whorl, and in having more numerous teeth on the parietal and columellar lip. The increase in teeth on the inner lip may be a result of the larger shell size.

Material: One specimen.

Measurements: The figured specimen (Plate 21, figure 8) measures 7.1 mm in height and 4.3 mm in width.

Occurrence: Coffee Sand, MGS locality 129, bed E.

Subfamily CYMATIINAE Iredale, 1913

Genus SASSIA Bellardi, 1872

Type by original designation, *Triton appeninicum* Sassi.

Diagnosis: Small to medium size, moderately elongate, fusiform shell with subangular to rounded whorls; sculpture reticulate to decussate, with small tubercles at the intersections; varices irregular (about one per whorl); aperture oval with sharply defined, short, oblique and slightly twisted canal; columella uniformly excavated; parietal fold limiting a well defined posterior gutter; outer lip with wrinkles on parietal callus, better developed posteriorly (after Davies, 1971, p. 347).

Discussion: Alan Beu (personal communication) has placed the following cymatiid species as *Sassia. Sassia* is the most diverse and widespread genus of the Ranellidae and is the only one that unquestionably occurs in Cretaceous rocks (Beu, 1988, p. 85) where it is represented by 8 to 10 species (Beu, personal communication). The earliest undoubted species of *Sassia* is *Tritonium kanabense* Stanton (1893) from the *Inoceramus fragilis* zone of the Colorado Group of Turonian age in Utah (Beu, 1988, p. 87). Five other Cretaceous species of *Sassia* are listed by Beu (1988), four of which occur in the Maastrichtian and one of which ranges from the upper Campanian to the Maastrichtian. The three Campanian species named here add significantly to the number of Cretaceous Ranellidae and represent some of the earliest taxa of this group recorded.

Range: Upper Cretaceous (Turonian) - Recent.

Sassia carlea n. sp.
Plate 21, figures 4-5

Diagnosis: A small sized *Sassia* with collabral ribs and spiral lirae (three primary lirae on the spire and six on the body whorl) overlain by a finer reticulate sculpture of secondary lirae and closely spaced collabral threads, and with six teeth on the outer lip, two lirae on the parietal lip, and three teeth on the columellar lip before the anterior canal.

Description: The protoconch is unknown. The teleoconch consists of four and one half whorls, the first two and one half of which have a broad, downward sloping, subsutural ramp, an angulate shoulder marked by the uppermost of three primary spiral lirae, a flat margin between the uppermost and lowermost lirae, and a sulcus above the suture. The middle lira is weaker than the other two primaries and secondary lirae occur between the primaries and on the ramp. Collabral ribs are prosocline on the ramp, orthocline on the margin where they are noded at intersections with the primary lirae, and disappear in the sulcus. Overlying the coarser elements are fine, closely spaced, collabral threads, which, in conjunction with the secondary lirae, produce a fine reticulate sculpture. The collabral ribs are thickest on the penultimate and body whorls. These whorls together may contain two or three varices including that of the outer lip. Varices are 180° apart on the body whorl, but the spacing between the first varix of the penultimate whorl and the middle varix of the body whorl on the holotype is 270° or three-fourths whorl apart. The last two whorls are more evenly rounded than the earlier ones, but have the same fine reticulate microsculpture. The body whorl has three additional primary lirae below the marginal (or peripheral) three and has secondary and tertiary lirae on the neck. The aperture is somewhat ovate with a flattened posterior margin. The outer lip is varicate and has six teeth on the inner margin opposite the five interspaces between the primary lirae. The basal tooth is below the basal lira. Two spiral lirae are present on the upper parietal lip, the upper one of which is the stronger. Three teeth are present on the columellar lip just above the anterior canal; the lowest of these is smaller than the upper two.

Discussion: Beu (personal communication) identified this species as *Sassia s.s.* It has the strongly cancellate sculpture of *Sassia (s.s.) delafossei* (Rouault, 1850) from the Cuisian (early Eocene) of Gan in southwestern France, but differs from this species in its more prominent subsutural ramp, in having a spire and base of more equal proportions (*S. delafossei* having a high spire and reduced base), and in lacking a constricted posterior apertural notch flanked by enlarged posterior teeth of the parietal and outer lips. The flattened posterior apertural margin of *S. carlea* below the subsutural ramp broadens the distance between the denticulate portion of the outer lip and the denticles of the parietal lip. In this feature, *S. carlea* appears to be unique. Though the varices of the body whorls of the only two complete specimens on hand are 180° apart, this spacing is not considered to be consistent as the holotype has a varix on the penultimate whorl that is 270° apart from the middle varix of the body whorl.

Material: Two specimens.

Measurements: The holotype measures 13.5 mm in height and 8.4 mm in width.

Types: Holotype 457005 USNM.

Etymology: Named for the writer's niece Carlie Brooke Wyatt.

Occurrence: Coffee Sand, MGS locality 129.

Suborder HETEROPODA Lamarck, 1812
Superfamily CARINARIOIDEA Blainville, 1818

Discussion: Kase (1988) reinterpreted *Brunonia annulata* (Yokoyama), a large limpet-shaped fossil from the Lower Cretaceous (Barremian) of Japan, as a member of the carinariid caenogastropods. Carinariids are aberrant pelagic and swimming gastropods that live near the surface of warm seas. They have a vestigial, paper-thin, limpet-like shell that is small in relation to their foot and head mass. A shell similar to that of *Brunonia* occurs in the Chapelville horizon of the Coffee Sand (see Plate 17, figure 8). Though the Coffee Sand taxon has a somewhat thicker shell, it has the low conical form and annular plications exhibited by *Brunonia*. The protoconch of this taxon, however, is hyperstrophic (see Plate 17, figure 9), a characteristic feature of heterostrophid and opisthobranch gastropods. Based on the hyperstrophic protoconch, the Coffee Sand *Brunonia* look-alike is placed as *Anisomyon*, a Cretaceous pulmonate limpet genus related to *Siphonaria*. A description of this taxon follows the Streptoneuran systematic section.

Suborder PTENOGLOSSA Gray, 1853
Superfamily TRIPHOROIDEA Gray, 1847
(=CERITHIOPSOIDEA H. and A. Adams, 1853)
Family TRIFORIDAE Jousseaume, 1884

Genus CERITHIELLA Verrill, 1882

Type by monotypy *Cerithium metula* Loven.

Diagnosis: Protoconch turreted and sculptured with axial ribs and sometimes with one or more spiral carinae; teleoconch turreted and crenulated by axial and spiral sculpture, basal margin bluntly angular, base smooth, columella concave with a strong fold extending to the posterior margin of the anterior canal (modified from Davies, 1971, p. 321).

Range: Cretaceous-Recent.

The *Cerithiella nodoliratum* Group

This group is characterized by a turreted, unicarinate protoconch with collabral ribs restricted to the upper three fourths of the whorl above the carina.

Cerithiella nodoliratum (Wade, 1926)
Plate 23, figures 3-5; Plate 24, figures 3-4; Plate 40, figure 4

1926. *Cerithium nodoliratum* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 155, pl. 54, fig. 4-5.
1960. *Cerithium nodoliratum* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 82-83, pl. 9, fig. 15-16, 24.

Diagnosis: Small turreted shell, last two whorls of protoconch with collabral ribs above a spiral carina, teleoconch cancellate with axial ribs and three spiral ribs that increase in strength toward the bottom of whorl.

Description: The protoconch is turreted and consists of five whorls having curved (concave toward the aperture), opisthocline, collabral ribs; on the last two whorls, collabral ribs are restricted to the upper three fourths of the whorl above a spiral keel. The teleoconch consists of five or more cancellate whorls having axial ribs and three spiral ribs, which increase in strength toward the base of the whorl. The basal margin is bluntly angulate. The columella has a single fold that extends to the posterior margin of the anterior canal. This canal truncates the base of the columella.

Discussion: This species is like *Cerithiella semirugatum* Wade in its unicarinate protoconch with collabral ribs restricted to the area above the carina. It differs from that species in having three rather than four spiral ribs on the teleoconch.

Material: Several specimens.

Types: Holotype 32937 USNM; hypotypes 128459 and 128460 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation in Tippah County. Tennessee: Coon Creek Tongue of the Ripley Formation at Coon Creek in McNairy County.

Cerithiella chapelvillensis n. sp.
Plate 23, figure 8; Plate 24, figure 5

Diagnosis: Small turreted shell, protoconch like that of *C. nodoliratum* but with a narrow channel between the carina and the subsutural collar of the teleoconch's first whorl; teleoconch with convex whorls and secondary spiral ribs appearing between the three primary ribs and becoming equal in strength with the primaries on the body whorl.

Description: The protoconch consists of five whorls having collabral ribs with the last two whorls being unicarinate and having the curved (concave toward the aperture), opisthocline, collabral ribs restricted to the upper three fourths of the whorl between the carina and the upper suture. On the first whorl of the teleoconch, the carina becomes the lowest and strongest of three spiral ribs. The teleoconch consists of six convex whorls with a cancellate sculpture of axial and spiral ribs. The first whorl of the teleoconch has two prominent lower spiral ribs and a faint upper rib that forms a subsutural collar. Between this collar and the carina of the protoconch is a narrow channel. A fourth spiral rib of secondary strength appears on the second whorl between the upper two primary ribs. On the fourth whorl, the axial ribs become broadly rounded and less prominent than the spiral scuplture and a fifth and sixth spiral rib appears respectively above the upper primary rib and between the middle and lower primary ribs. By the sixth whorl, or body whorl, the axial sculpture becomes almost obsolete and a smooth band separates the six spiral ribs from a rib along the basal margin. The first and third spirals above the basal rib are the strongest. The base is sculptured by fine spiral lirae.

The aperture is subcircular with an angulation between the flat columellar wall and the flat base of the penultimate whorl. The anterior canal is twisted and truncates the base of the columella. A columellar fold is present along the canal's posterior margin.

Discussion: This species is like *Cerithiella nodoliratum* in its unicarinate protoconch but differs in developing secondary spiral ribs and in the diminishing of the axial sculpture on the latter whorls. It also has a narrow but prominent gutter between the carina of the protoconch's last whorl and the subsutural collar (the upper spiral rib) of the teleoconch's first whorl.

Material: Two specimens.

Measurements: The holotype measures 5.5 mm in height and 2.0 mm in width.

Types: Holotype 457006 USNM.

Etymology: Named for the community of Chapelville.

Occurrence: Coffee Sand, MGS locality 129.

The *Cerithiella aequalirata* Group

This group is characterized by a high-spired, turreted, bilirate protoconch, which has, in part, a finely reticulate sculpture produced by intersecting opisthocline and prosocline ribs.

Cerithiella aequalirata n. sp.
Plate 23, figures 6-7; Plate 24, figures 6-8;
Plate 40, figures 5-6

Diagnosis: A small turreted shell with high-spired, bilirate protoconch and high-spired, trilirate teleoconch with noded lirae of equal strength.

Description: The protoconch is high-spired and consists of six whorls, the last four of which are bilirate with the upper lira along the whorl's midline. Whorls three through five are reticulate with curved (concave toward the aperture), opisthocline, collabral ribs above the upper lira that intersect finer, curved (concave toward the aperture), prosocline ribs, which continue across the lirae to the lower suture. The prosocline ribs become obsolete on the sixth whorl as the collabral ribs strengthen, cross the spiral lirae, and reach the lower suture. The teleoconch consists of twelve or more whorls (as judged from a composite of specimens), having three strong spiral ribs, which are noded where they cross closely spaced axial ribs, and a weaker upper spiral rib that forms a subsutural collar and is only slightly noded. The spiral lirae of the protoconch form the lower two spiral ribs of the teleoconch with the upper two spiral ribs appearing together at the beginning of the teleoconch's first whorl. The aperture is subcircular with a twisted anterior canal that truncates the base of the columella. A columellar fold is present along the canal's posterior margin. A smooth spiral rib is present along the angular basal margin, and the base is smooth.

Material: Five specimens.

Measurements: The holotype, which includes the last five whorls of the protoconch and eight whorls of the teleoconch, measures 6.5 mm in length and 1.8 mm in width. A larger partial specimen measures 9.3 mm in height and 3.0 mm in width.

Types: Holotype 457007 USNM.

Etymology: Named for the spiral ribs (not counting the subsutural collar), which are of equal strength (*aequalis*: Latin - uniform; *lira*: Latin - ridge).

Occurrence: Coffee Sand, MGS locality 129.

The Noncarinate Group

This group is known from the Coffee Sand only by larval and juvenile shells. The protoconch is high-spired with axial ribs only, which extend from suture to suture. The teleoconch is sculptured with three spiral ribs and axial ribs and has two folds on the columella.

Cerithiella sp.
Plate 23, figures 1-2

Diagnosis: A small turreted shell with a high spired protoconch having axial ribs only and a teleoconch sculptured with three spiral lirae and axial ribs and with two folds on the columella.

Description: The protoconch is turreted and high-spired with regularly convex whorls having numerous, narrow, orthocline to slightly opisthocline, axial ribs. The teleoconch is known from only the first whorl, which is sculptured with three spiral ribs and axial ribs. The aperture is subcircular with a twisted anterior canal that truncates the base of the columella. The columella has a prominent fold along the posterior margin of the anterior canal and a smaller fold above.

Material: Two specimens.

Measurements: The larger specimen measures 1.8 mm in height.

Occurrence: Coffee Sand, MGS locality 129.

Genus MONROEA Stephenson, 1952

Type by monotypy *Monroea castellana* Stephenson.

Diagnosis: Teleoconch turreted and sculptured with spiral ribs of equal strength noded at intersections with axial ribs; whorls compact; aperture with twisted anterior canal that truncates the base of the columella; parietal lip with thin callus; columellar lip with excavated callus fold between parietal lip and anterior canal.

Range: Upper Cretaceous (Cenomanian - Campanian).

Monroea coffea n. sp.
Plate 24, figures 9-10

Diagnosis: Turreted shell with compact whorls having three spiral ribs strongly noded at intersections with axial ribs, columellar lip elevated, basal margin with two smooth lirae, base with fine spiral lirae.

Description: The protoconch is unknown. The teleoconch has ten or more compact whorls that are sculptured with three spiral ribs of equal strength. These ribs are strongly noded at intersections with axial ribs. A weaker unnoded fourth rib is partly visible above the suture on the latter whorls. This rib marks the basal margin on the body whorl. Below it is a weaker spiral rib followed on the base by fine spiral lirations. The aperture is incompletely known but has a thin callus on the parietal wall and an elevated columellar wall between the parietal callus and the anterior canal. The anterior canal is twisted and truncates the base of the columella. A strong columellar fold forms the posterior margin of the anterior canal.

Discussion: This species is like the type species *Monroea castellana* Stephenson, 1952, in its compact whorls with three spiral ribs but differs in having even more compact whorls and thicker spiral ribs with narrow interspaces. *Cerithium simpsonense* Stephenson, 1941, from the Nacatoch Sand in Kaufman County, Texas, also has compact whorls and strongly noded spiral ribs and may belong in *Monroea*, though this possibility was not discussed by Stephenson (1952). *"C." simpsonense* differs from *M. coffea* in having four rather than three noded spiral ribs.

Material: Two specimens.

Measurements: The holotype measures 9.9 mm in height and 3.9 mm in width.

Types: Holotype 457008 USNM.

Etymology: Named for the Coffee Sand.

Occurrence: Coffee Sand, MGS locality 129.

Genus BITTIUM Leach, 1847

Type by subsequent designation (Gray, 1847), *Murex reticulatus* Montagu (=*Strobiformis reticulatus* Da Costa).

Diagnosis: A small turreted-conical shell; protoconch with two spiral lirae; teleoconch sculptured with spiral threads and collabral ribs bearing crenulations at their intersections; last whorl with an antilabial varix, base without collabral ornament; aperture small, oval; outer lip internally laciniate (modified from Davies, 1971).

Bittium? sp.
Plate 24, figures 1-2

Diagnosis: A small high-spired, turreted shell with convex whorls sculptured with axial ribs and fine spiral threads.

Description: The protoconch is unknown. The teleoconch is high-spired and consists of eight whorls sculptured with node-like axial ribs, fine spiral threads, and a subsutural collar. Axial ribs are strongest on the whorl's midsection and diminish toward the sutures. On the penultimate and body whorls, the axials become binodose with a saddle near the whorl's midline and the subsutural collar becomes nodose. The aperture is incompletely known but has a twisted anterior canal. Three large, node-like teeth are recessed about one half whorl behind the outer lip.

Discussion: This small triforid is tentatively placed as *Bittium*.

Material: A few specimens.

Occurrence: Coffee Sand, MGS locality 129.

Genus VARISEILA new genus

Type, *Cerithiopsis meeki* Wade, 1926.

Diagnosis: Small, very slender, flat-sided shell with a high-spired, axially ribbed protoconch and a spirally ribbed teleoconch; aperture with a strongly twisted anterior canal bordered posteriorly by a strong columellar fold.

Description: The high-spired protoconch consists of more than four whorls, which have slightly convex sides and are sculptured with narrow, slightly opisthocyrtic and somewhat opisthocline ribs. The teleoconch consists of ten or more flat-sided whorls sculptured with strong, spiral ribs and fine axial threads. An additional spiral rib is present on the body whorl along the basal margin. The aperture has a short, twisted anterior canal that truncates the base of the columella. This canal is bordered posteriorly by a strong columellar fold. The base is smooth.

Discussion: *Variseila* has a teleoconch like that of the closely related genus *Seila*, but differs in its protoconch. According to Abbott (1974, p. 110), *Seila* has a glassy-smooth protoconch of about three whorls. *Variseila* has a high-spired protoconch of greater than four whorls that is axially ribbed.

Etymology: Named for the variation in sculpture between the axially ribbed protoconch and spirally ribbed teleoconch.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Variseila meeki (Wade, 1926)
Plate 23, figures 9-12; Plate 24, figures 11-12

1926. *Cerithiopsis meeki* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 155, pl. 54, figs. 23-24.
1960. *Seila meeki* (Wade). Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 84, pl. 9, fig. 17-19, 21.

Diagnosis: Like that of genus and with whorls having three spiral ribs; a fourth spiral rib is present on the body whorl along the basal margin.

Description: Like that of genus, again with whorls having three spiral ribs. The upper rib is just below the suture and obscures it so that the teleoconch's sculpture is a continu-

ous sequence of spiral ribs and interspaces with fine axial threads. A space separates the lower rib from the suture below, giving the spiral ribs a fairly regular spacing along the spire and making individual whorls difficult to distinguish.

Discussion: This species is common at MGS locality 127 in the Coon Creek Tongue of the Ripley Formation where it differs from the Coffee Sand form in having a higher apical angle and thus a less narrow spire and in having a stronger lower spiral rib, which is larger than the upper two ribs.

Material: Several specimens.

Measurements: The largest Coffee Sand specimen is incomplete and measures 6 mm in height.

Types: Holotype and paratype 32946 USNM; hypotype 128471 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, MGS locality 127 and other localities in Union County. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County (type locality).

Superfamily JANTHINOIDEA Lamarck, 1810
(=EPITONACEA Berry, 1910)
Family EPITONIIDAE S. S. Berry, 1910

Discussion: The division of the Family Epitoniidae into the subfamilies Nystiellinae and Epitoniinae follows the systematics of Bouchet and Warén (1986). Members of these families have planktotrophic larvae with larval shells, and thus protoconchs, of a characteristic sculpture. The Subfamily Nystiellinae have multiwhorl protoconchs with prominent axial ribs, and the Subfamily Epitoniinae have multiwhorl protoconchs that are smooth with the exception of microscopic sculptural features. A third type of protoconch is present in the Epitoniidae, which has one to one and a half paucispiral smooth whorls. This type has arisen independently in various species of *Epitonium* and *Acirsa* of the Epitoniinae, but is found in all species of *Papuliscala*, a genus placed in the Nystiellinae by Bouchet and Warén (1986).

Subfamily NYSTIELLINAE Clench and Turner, 1952

Genus ECCLISEOGYRA Dall, 1892

Type by original designation, *Delphinula nitida* Verrill and Smith, 1885.

Diagnosis: Small high-spired shells with convex whorls having an axially ribbed protoconch and a teleoconch sculptured with undulating axial lamellae and raised spiral threads; boundary between protoconch and teleoconch sharp with protoconch often terminated by a marked sinusigera dicontinuity (modified from Bouchet and Warén, 1986, p. 481).

Range: Upper Cretaceous (Campanian) - Recent.

Eccliseogyra heliclina n. sp.
Plate 25, figures 1-5; Plate 26, figures 15-16

Diagnosis: Small high-spired shell; protoconch with ophisthocline axial ribs and terminated by a sharp sinusigera discontinuity; teleoconch with strongly convex whorls sculptured with spiral threads and a subsutural ramp bearing only axial lamellae, which continue across the spirals with diminished strength.

Description: The protoconch is conical, consisting of five or more convex whorls sculptured with regularly spaced opisthocline ribs and terminated by a sharp sinusigera discontinuity. The teleoconch consists of three and one half or more convex whorls. These whorls are sculptured with five spiral threads below a subsutural ramp bearing axial lamellae, which continue across the spirals in diminished strength and are visible in the interspaces. The body whorl has a sixth spiral thread along the evenly rounded basal margin and four spiral threads on the base. The aperture is subcircular and the base has a small umbilicus.

Material: Several specimens.

Measurements: The incomplete holotype measures 4.8 mm in height and 1.3 mm in width.

Types: Holotype 457009 USNM.

Etymology: Named for its spiral subsutural ramp (*helix*: Latin, spiral; *clino*: Latin, slope).

Occurrence: Coffee Sand, MGS locality 129.

Eccliseogyra inflata n. sp.
Plate 25, figure 6

Diagnosis: Small shell with axially ribbed conical protoconch terminated by a sinusigera discontinuity and spirally threaded teleoconch with axial lamellae and bulbous first whorl.

Description: The teleoconch is incompletely known but is conical, axially ribbed, and terminated by a sinusigera discontinuity like that of *Eccliseogyra heliclina*. The teleoconch is known from only the first one and a half whorls. These whorls are strongly inflated and sculptured with six spiral threads, the uppermost of which is weaker than the lower five, and axial lamellae. Additional spiral ribs are present on the base.

Discussion: This species differs from *Eccliseogrya heliclina* in the strongly inflated initial whorl of its teleoconch and in lacking a subsutural ramp. It also has six rather than five spiral threads.

Material: Two specimens.

Measurements: The incomplete holotype measures 1.3 mm in height and 0.9 mm in width.

Types: Holotype 457010 USNM.

Etymology: Named for the inflated initial whorl of the teleoconch.

Occurrence: Coffee Sand, MGS locality 129.

Genus OPALIOPSIS Thiele, 1928

Type by original designation, *Scala eleta* Thiele, 1925.

Diagnosis: Small, high-spired shell with a turreted, axially ribbed protoconch and a solid teleoconch sculptured with axial ribs rather than axial lamellae and with or without spiral sculpture (modified from Bouchet and Warén, 1986, p. 489).

Range: Upper Cretaceous (Campanian) - Recent.

Opaliopsis angustocosta n. sp.
Plate 27, figure 9

Diagnosis: Small, high-spired shell; turreted protoconch with broadly spaced opisthocline ribs; teleoconch with convex whorls sculptured with closely spaced, thin, axial ribs and fine spiral threads.

Description: The turreted protoconch consists of four whorls, the last two of which have broadly spaced opisthocline ribs. The teleoconch consists of four convex whorls sculptured with closely spaced, thin, axial ribs and fine spiral threads. The aperture is subcircular, and the base is smooth with a modest marginal cord.

Discussion: This species has convex rather than nearly flat whorls and axial ribs rather than axial lamellae and thus is placed in the genus *Opaliopsis*. It differs from other species of this genus in the narrowness of its axial ribs.

Material: One specimen.

Measurements: The holotype is 3.1 mm in height and 1.2 mm in width.

Types: Holotype 457011 USNM.

Etymology: Named for its narrow ribs (*angusto*: Latin, narrow; *costa*: Latin, rib).

Occurrence: Coffee Sand, MGS locality 129.

Genus PSEUDOCLAVISCALA new genus

Type species, *Pseudoclaviscala laevicosta* n. sp.

Diagnosis: Small, high-spired, solid shell with a multiwhorl, conical, axially ribbed protoconch terminated by a prominent discontinuity, a teleoconch with broad axial ribs and microscopically fine spiral sculpture, and a well defined basal disk.

Discussion: This genus has a teleoconch like that of *Claviscala richardi* (Dautzenberg and De Boury, 1897), the type species of *Claviscala*. It has nearly flat-sided whorls sculptured with broad axial ribs and has a well defined basal disk. *Pseudoclaviscala* differs from *Claviscala* in having an axially ribbed rather than a smooth protoconch, a character that places it in the Subfamily Nystiellinae.

Etymology: Named for the similarity of its teleoconch to *Claviscala* even though its axially ribbed protoconch places it in a different subfamily.

Range: Upper Cretaceous (Campanian).

Pseudoclaviscala laevicosta n. sp.
Plate 26, figure 1; Plate 27, figure 12

Diagnosis: High-spired, solid shell with broad axial ribs and only faint spiral sculpture and a basal disk with faint spiral threads below a modest marginal cord.

Description: The protoconch is unknown. The teleoconch is a solid, high-spired shell consisting of ten or more flat-sided whorls sculptured with broad, orthocline, axial ribs and interspaces of equal dimension. Axial ribs are higher along the whorl's midsection, giving them a convex profile. They are crossed by prosocline growth lines and microscopically fine spiral sculpture. The aperture is subcircular and the base has fine spiral threads and a marginal cord.

Material: Several specimens.

Measurements: The holotype measures 15.0 mm in height and 4.5 mm in width.

Types: Holotype 457012 USNM.

Etymology: Named for its smooth axial ribs (*laevis*: Latin, smooth; *costa*: Latin, rib).

Occurrence: Coffee Sand, MGS locality 129.

Pseudoclaviscala rugacosta n. sp.
Plate 26, figure 2; Plate 41, figure 3

Diagnosis: High-spired, solid shell sculptured with axial ribs bearing a varical crease near the crest and with microscopically fine spiral threads; axial ribs cross marginal cord and fade out on base.

Description: The protoconch is multiwhorled with oblique axial ribs and ends at a strong discontinuity (see figure 3 of Plate 41). The teleoconch consists of seven or more slightly convex whorls with rounded axial ribs and microscopically fine spiral threads. A varical crease is present on the ribs just before the crest. The aperture is subcircular with callus on the parietal and columellar lip. The base has a prominent marginal cord. Axial ribs cross this cord and continue onto the base with diminished strength. Microscopically fine spiral threads cover the base with the same prominence as that of the whorls.

Discussion: This species resembles *Pseudoclaviscala laevicosta* in its high-spired, solid shell with broad axial ribs but differs in its greater apical angle, in having a more prominent spiral microsculpture, in the strong callus of the inner lip, and in its strong basal cord. Also it has fewer axial ribs per whorl.

Material: Two specimens.

Measurements: The holotype measures 20.8 mm in height and 8.0 mm in width.

Types: Holotype 457013 USNM.

Etymology: Named for the varical crease on the axial ribs (*ruga*: Latin, crease; *costa*: Latin, rib).

Occurrence: Coffee Sand, MGS locality 129.

Subfamily EPITONIINAE S. S. Berry, 1910

Genus EPITONIUM Roding, 1798

Type by subsequent designation (Suter, 1913), *Turbo scalaris* Linné.

Diagnosis: High-spired shell with a multispiral and usually smooth protoconch; teleoconch with convex whorl sculptured with axial lamellae and with or without spiral sculpture in interspaces; aperture circular; basal disk usually lacking.

Range: Cretaceous (Campanian) - Recent.

Epitonium faearium n. sp.
Plate 26, figure 13; Plate 27, figures 10-11;
Plate 41, figures 4-5

Diagnosis: High-spired shell with conical, multiwhorl protoconch with closely spaced, strongly oblique axial ribs; teleoconch with convex whorls sculptured with axial lamellae and polished interspaces; apical angle 24°; 14 lamellae on body whorl; basal disk well defined.

Description: The protoconch consists of five or more whorls with convex sides sculptured with closely spaced, strongly opisthocline ribs. It terminates in a prominent sinusigera discontinuity. The teleoconch is high spired with an apical angle of 24°. Its whorls are convex and scuptured with slightly prosocline lamellae; 14 are present on the body whorl. Interspaces between lamellae are polished and smooth except for microscopically fine spiral striations. The aperture is circular with a thin callus on the inner lip. The base has a well defined disk with a marginal cord. Lamellae on the body whorl terminate at the basal cord and continue across the base as prominent growth varices.

Discussion: This species fits well in the genus *Epitonium* except for its well defined basal disk and the planktotrophic form of its protoconch. In these characters it differs from all other species of the genus. It superficially resembles *Punctiscala melaniea* but lacks the punctate spiral microsculpture and rounded ribs. It differs from species of *Striaticostatum* in lacking fluted ribs and spiral sculpture.

Material: Several specimens.

Measurements: The holotype measures 19.0 mm in height and 7.9 mm in width.

Types: Holotype 457014 USNM.

Etymology: Named after Terrell Fae Yonkers, the writer's sister-in-law (*faearium*: Latin, belonging to Fae).

Occurrence: Coffee Sand, MGS locality 129.

Genus ACIRSA Mörch, 1857

Type by subsequent designation (Bouchet and Warén, 1986, p. 526), *Scalaria eschrichti* Holboll *in* Moller, 1842.

Diagnosis: High-spired, solid shell with broad axial ribs and without a basal cord or disc. Spiral sculpture of incised spiral groves is usually present (modified from Bouchet and Warén, 1986, p. 526).

Range: Upper Cretaceous (Campanian) - Recent.

Acirsa gravida Sohl, 1964
Plate 26, figure 3

1964b. *Acirsa (Plesioacirsa?) gravida* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 365, pl. 54, fig. 11-12.

Diagnosis: Slender shell with round-sided whorls sculptured with axial ribs and spiral lirae with secondary spiral threads in the interspaces (modified from Sohl, 1964b, p. 365).

Desciption: The protoconch is unknown. The slender teleoconch consists of eight convex whorls of which the first five have opisthocline transverse ribs, becoming more orthocline with each successive whorl, and the last three have slightly prosocline ribs that diminish with each successive whorl. These whorls have spiral lirae in the interspaces between ribs and on latter whorls have intervening spiral threads. The aperture is ovate and bluntly angular posteriorly. The base is covered with spiral lirae and lacks a marginal cord.

Discussion: Sohl (1964b, p. 365) stated that this species is most closely related to *Acirsa implexa* Sohl from the Ripley Formation of Mississippi.

Material: A few specimens.

Measurements: The incomplete holotype measures 12.3 mm in height and 3.4 mm in diameter.

Type: Holotype 131611 USNM.

Occurrence: Coffee Sand, MGS localities 129 and 130 (type).

Acirsa culmosa Sohl, 1964
Plate 26, figures 4-5

1964b. *Acirsa (Plesioacirsa?) culmosa* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 365-366, pl. 54, fig. 1, 10.

Diagnosis: Slender shell with convex whorls sculptured with spiral lirae that override broad axial ribs (modified from Sohl, 1964b, p. 365).

Description: The protoconch is unknown. The slender teleoconch consists of ten convex whorls, the first five of which have slightly prosocline, sharp-crested ribs with spiral lirae in the interspaces. Axial ribs become more broadly rounded on the latter whorl and are overridden by the spiral lirae. The aperture is ovate and bluntly angular posteriorly. The base is covered with spiral lirae and lacks a marginal cord.

Discussion: This species is distinguished from *Acirsa gravida* with which it occurs in the prosocline, sharp-crested ribs of its early whorls and in the broad ribs of the latter whorl, which are overridden by spiral lirae.

Material: A few specimens.

Measurements: The holotype measures 13 mm in height and 3.8 mm in width.

Type: Holotype 131612 USNM.
Occurrence: Coffee Sand, MGS localities 129 and 130.

Genus PAUCIACIRSA new genus

Type, *Pauciacirsa simplex* n. sp.
Diagnosis: Small, high-spired shell with a smooth paucispiral protoconch; teleoconch with convex whorls sculptured with broad axial ribs and without spiral ornamentation or a basal disc; aperture ovate.
Discussion: The nonplanktotrophic larval shell of this genus resembles that of *Papuliacirsa* in its smooth paucispiral form. However, the teleoconch is like that of *Acirsa* in lacking a basal disk and marginal cord.
Etymology: Named for its paucispiral protoconch.
Range: Upper Cretaceous (Campanian).

Pauciacirsa simplex n. sp.
Plate 27, figures 6-8; Plate 38, figure 4

Diagnosis: Small, high-spired shell with a smooth paucispiral protoconch; teleoconch smooth with the exception of broad axial ribs, which fade out on base.
Description: The protoconch consists of one large, smooth, paucispiral whorl that grades into the teleoconch without a break. The teleoconch has five convex whorls, the first two of which are smooth. The latter three whorls are sculptured with broad axial ribs and lack spiral ornamentation. The aperture is simple and ovate. Axial ribs fade out across the basal margin, which slopes evenly and lacks a marginal cord.
Discussion: This species resembles those of *Acirsa* in its lack of a basal disk or marginal cord but differs in having a paucispiral protoconch.
Material: Several specimens.
Measurements: The holotype measures 3.0 mm in height and 1.0 mm in width.
Type: Holotype 457015 USNM.
Etymology: Named for the simplicity of its shell form and sculpture.
Occurrence: Coffee Sand, MGS locality 129.

Genus PUNCTISCALA de Boury, 1890

Type species by original designation, *Scalaria plicosa* Philippi, 1844.
Diagnosis: High-spired epitoniids with broad rather than lamellar axial ribs, a pitted intritacalx, and a well defined basal disk (modified from Bouchet and Warén, 1986, p. 548).
Range: Upper Cretaceous (Campanian) - Recent.

Punctiscala melaniea n. sp.
Plate 26, figure 14

Diagnosis: High-spired epitoniid with numerous, narrow but nonlamellar, axial ribs; intritacalx with microscopically fine, punctate, spiral grooves; basal disk well defined and with a strong marginal cord.
Description: The protoconch is unknown. The teleoconch consists of eight convex whorls sculptured with numerous, narrow axial ribs and and an intritacalx with microscopically fine, tightly spaced, punctate, spiral grooves, which override the axial ribs. Fourteen axial ribs are present on the body whorl. These ribs terminate at a strong cord along the basal margin. The base is covered with the same spiral microsculpture as is the spire. The aperture is subcircular.
Material: One specimen.
Measurements: The holotype measures 14.0 mm in height and 6.2 mm in width.
Types: Holotype 457016 USNM.
Etymology: Named for the writer's niece, Melanie Ida Marshall.
Occurrence: Coffee Sand, MGS locality 129.

Genus STRIATICOSTATUM Sohl, 1963

Type by original designation, *Striaticostatum harbisoni* Sohl, 1963.
Diagnosis: Medium-sized, high-spired shell with convex whorls sculptured with strong axial ribs composed of fluted lamellae that produce a honeycombed appearance; spiral sculpture present but faint in interspaces; basal disk fairly well defined but axial ribs extend it to the shell's axis (modified from Sohl, 1964a, p. 317).
Range: Upper Cretaceous (Campanian - Maastrichtian).

Striaticostatum griffini n. sp.
Plate 26, figures 10-12

Diagnosis: Medium-sized, high-spired shell with convex whorls and sculptured with strong, fluted, prosocline lamellae and faint spiral sculpture; apical angle 27°-30°; body whorl with eleven to thirteen axial lamellae.
Description: The protoconch is unknown. The teleoconch is high spired and consists of eight convex whorls sculptured with strong, fluted, prosocline lamellae and faint spiral sculpture. Lamellae have a posteriorly directed fold just above the suture and just above the basal disc. The apical angle is 27° to 30°. Eleven lamellae are present on the body whorl. The aperture is circular. The basal disk is a thickened shell platform crossed by axial lamellae and covered with spiral threads.
Discussion: This species is closest to *Striaticostatum sillimani* from the Prairie Bluff Chalk of Mississippi and Alabama and questionably from the Monmouth Group of New Jersey. These species have a similar apical angle, but *S. griffini* has fewer axial lamellae per whorl with 11-13 as compared to 16-18 for *S. sillimani*.
Material: Three specimens.
Measurements: The holotype measures 17.8 mm in

height and 8.1 mm in width.

Types: Holotype 457017 USNM.

Etymology: Named for the property owner of the type locality, Cecil Griffin.

Occurrence: Coffee Sand, MGS locality 129, bed E.

Striaticostatum micropunctatum n. sp.
Plate 26, figure 9

Diagnosis: Medium-sized, high-spired shell with convex whorls sculptured with fluted axial lamellae and finely incised lines bearing microscopically fine punctae in the interspaces; apical angle 30°-35°; 14-17 axial lamellae on body whorl; basal disk prominently thickened.

Description: The protoconch is unknown. The teleoconch consists of six to seven whorls sculptured with fluted axial lamellae. Spiral sculpture between lamellae consists of finely incised lines, often in pairs, bearing microscopically fine punctae. The apical angle is 30°-35°, and the body whorl has 14-17 axial lamellae. The aperture is circular. Axial lamellae cross the basal disk in diminished strength, the interspaces being elevated by thick callus deposits bearing spiral threads.

Discussion: This species differs from *S. griffini* in its more numerous axial lamellae, its higher apical angle, its thicker basal disc, and in having punctate, incised, spiral lines.

Material: Several specimens.

Measurements: The holotype measures 17.4 mm in height and 9.7 mm in width.

Types: Holotype 457018 USNM.

Etymology: Named for the microscopically fine punctae that are present within incised spiral lines.

Occurrence: Coffee Sand, MGS locality 129.

Genus BELLISCALA Stephenson, 1941

Type by original designation, *Belliscala rockensis* Stephenson, 1941, from the Nacatoch Sand, Texas.

Diagnosis: Turreted shell with plumply rounded whorls, deeply impressed sutures, and sculptured with rounded axial ribs and spiral threads; base rounded without a well developed disk.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Belliscala lirata n. sp.
Plate 26, figure 6

Diagnosis: Turreted shell with plump whorls, a deep suture with small subsutural ramp, and sculptured with rounded axial ribs overridden by spiral lirae; base rounded without disk.

Description: The protoconch is unknown. The teleoconch consists of seven plump whorls with impressed sutures and slight subsutural ramp. The apical angle is 41°. Sculptural elements include rounded axial ribs and spiral lirae that override the ribs, forming nodes at the intersections. The upper lira borders a subsutural ramp and forms strong, upturned nobs where it crosses the ribs. The third lira below the suture also forms nobs at intersections with the ribs, but these are not so strong as the upper nobs. Eight spiral lirae are present on the penultimate whorl plus one partially showing above the suture. Fifteen axial ribs are present on the body whorl and fade out on the basal margin. The aperture is ovate and bluntly angular posteriorly and has a thin callus on the inner lip. The basal margin is evenly rounded, and the base in covered with spiral lirae.

Discussion: This species differs from the type species *Belliscala rockensis* Stephenson, 1941, in its coarser spiral sculpture that overrides and forms nodes on the axial ribs and in its greater apical angle.

Material: One specimen.

Measurements: The holotype measures 24.3 mm in height and 13.4 mm in width.

Types: Holotype 457019 USNM.

Etymology: Named for its spiral lirae.

Occurrence: Coffee Sand, MGS locality 129.

Belliscala nodosa n. sp.
Plate 26, figures 7-8

Diagnosis: Turreted shell with convex whorls, subsutural ramp, and nodose sculpture with nodes at intersections of spiral lirae and closely spaced axial elements; base rounded without disk.

Description: The protoconch is unknown. The teleoconch consists of eight convex whorls with a subsutural ramp and sculptured with closely spaced, rounded, axial ribs and spiral lirae, which are noded at their intersections. Four spiral lirae are present on the spire. Twenty-five axial ribs are present on the body whorl. The apical angle is 31° to 34°. The aperture is ovate and has a thin callus on the inner lip. The basal margin is evenly rounded. The base is without disk and is sculptured with spiral lirae.

Discussion: This is the smallest and most nodose of the species described for *Belliscala*. It differs from *B. lirata* in its smaller size, narrower apical angle, and more strongly nodose sculpture.

Material: Two specimens.

Measurements: The holotype measures 11.7 mm in height and 5.5 mm in width.

Types: Holotype 457020 USNM.

Etymology: Named for the shell's nodose sculpture.

Occurrence: Coffee Sand, MGS locality 129.

Genus ACICULISCALA Sohl, 1963

Type by original designation, *Aciculiscala acuta* Sohl, 1963.

Diagnosis: Small, slender shell with smooth multispiral protoconch and axially ribbed teleoconch; basal cord separates

basal disk.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Aciculiscala coffea n. sp.
Plate 27, figures 3-5

Diagnosis: Small, narrow shell with a multispiral smooth protoconch and axially ribbed teleoconch without spiral sculpture; axial ribs truncated at subsutural ramp; cord outlines basal disk.

Description: The protoconch consists of three and a half smooth whorls. The teleoconch consists of seven axially ribbed whorls with a prominent subsutural ramp that truncates the ribs and gives the spire a stair-step appearance. The aperture is ovate with a thin callus on the inner lip. The base has a marginal cord that outlines the basal disk.

Discussion: This species differs from the type species *Aciculiscala acuta* in its thicker and straighter axial ribs and in its more prominent subsutural ramp, which truncates the axial ribs and gives the spire a stair-step appearance.

Material: Several specimens.

Measurements: The holotype measures 1.8 mm in height and 0.6 mm in width.

Types: Holotype 457021 USNM.

Etymology: Named for its stratigraphic horizon, the Coffee Sand.

Occurrence: Coffee Sand, MGS locality 129.

Superfamily EULIMOIDEA H. and A. Adams
Family EULIMIDAE Troschel, 1853

Discussion: The eulimid species listed here from the Coffee Sand represent the earliest record of this family according to Klaus Bandel (personal communication).

Genus EULIMA Risso, 1826

Type by subsequent designation (Bouchet and Warén, 1986), *Eulima glabra* (da Costa, 1778) [=*Eulima subulata* (Donovan, 1803)].

Diagnosis: Small, tall and slender shell with slightly convex or flat glossy whorls; outer lip straight or slightly sinuous (modified after Bouchet and Warén, 1986, p. 318).

Range: Upper Cretaceous (Campanian) - Recent.

Eulima gracilistylis Sohl, 1964
Plate 25, figures 7-9; Plate 26, figure 17; Plate 42, figure 3

1964a. *Eulima gracilistylis* Sohl, U. S. Geol. Survey, Prof. Paper 331-B, p. 309, pl. 50, fig. 31-34.

Diagnosis: Shell moderately large for genus, whorls become broadly rounded in later development stages (Sohl, 1964a, p. 309).

Description: The differentiation between protoconch and teleoconch could not be made. The shell consists of six smooth whorls with slightly impressed sutures. The spire is straight-sided except for the modest convexities of each whorl. The aperture is ovate with a posterior angulation. The basal margin is regularly rounded.

Discussion: This species differs from other eulimids in the Coffee Sand in its impressed suture, gently convex whorls, and subangulate basal margin.

Material: Several specimens.

Measurements: The holotype measures 9.3 mm in height and 3.1 mm in width. The largest Coffee Sand specimen is incomplete and measures 5.5 mm in height.

Types: Holotype 130666 and paratype 130667 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Coon Creek of the Ripley Formation, Tippah and Union counties; Owl Creek Formation, Tippah County. Georgia: Ripley Formation.

Eulima coffea n. sp.
Plate 25, figure 10; Plate 26, figures 18-19; Plate 42, figure 2

Diagnosis: High spired, narrow, glossy, flat-sided shell with indistinct sutures and evenly rounded base; aperture about one half height of body whorl.

Description: The protoconch is unknown. The teleoconch consists of more than five, flat-sided, glossy whorls with indistinct sutures. The aperture is ovate and angulate posteriorly and is about half the height of the body whorl. The basal margin is evenly rounded and the base is short and smooth.

Discussion: This species is distinguished from *Eulima gracilistylis* by its narrower spire, its flat sides and less distinct sutures, and its short aperture and base.

Material: A few specimens.

Measurements: The holotype with apex missing measures 8.4 mm in height.

Types: Holotype 457022 USNM.

Etymology: Named for its stratigraphic horizon, the Coffee Sand.

Occurrence: Coffee Sand, MGS locality 129.

Eulima spirala n. sp.
Plate 9, figure 3; Plate 42, figure 1

Diagnosis: High spired, glossy, flat-sided shell; suture with narrow, translucent band; basal marginal angulate; base convered with closely spaced spiral grooves.

Description: The protoconch is unknown. The teleoconch consists of more than seven, glossy, flat-sided whorls. The latter whorls have a broad and gentle sulcus between the midsection of successive whorls, giving the whorls a slight chevron profile. The aperture is ovate with a posterior angulation. The basal margin is sharply angular. The base is covered with closely spaced spiral grooves.

Discussion: This is the only *Eulima* known to the writer with such an angulate basal margin and with a base sculptured with spiral grooves. The holotype (see figure 1 of Plate 42) has a complete body whorl.

Material: Two specimens.

Measurements: The holotype measures 6.5 mm in height with a broken apex and 2.2 mm in width.

Types: Holotype 457023 USNM.

Etymology: Named for the spiral sculpture of its base.

Occurrence: Coffee Sand, MGS locality 129.

Eulima sp.
Plate 19, figure 3

Discussion: This species has straight sides and a higher apical angle than the other Coffee Sand eulimid taxa. It is known only from the figured specimen.

Occurrence: Coffee Sand, MGS locality 129.

Order HETEROSTROPHA Fischer, 1885
Superfamily ARCHITECTONICOIDEA Gray, 1840
Family MATHILDIDAE Dall, 1889

Genus MATHILDA Semper, 1865

Type by subsequent designation (de Boury, 1883), *Turbo quadricarinatus* Brocchi, 1814.

Diagnosis: Turreted shell with heterostrophic, multiwhorl protoconch inclined between 25° and 90° with teleoconch axis and either exposed at apex or partially enveloped by first whorl of teleoconch; teleoconch of 10 or more whorls with reticulate sculpture of collabral ribs and spiral elements; aperture circular (modified from Bandel, in press).

Range: Triassic-Recent.

Mathilda ripleyana Wade, 1926
Plate 28, figures 4-6

1926. *Mathilda ripleyana* Wade, U. S. Geol. Survey, Prof. Paper 137, p. 171, pl. 53, fig. 11, 16-17.
1960. *Mathilda (Mathilda) ripleyana* Wade. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 130, pl. 18, fig. 13, 18, 20-22.

Diagnosis: Small to medium-sized, turreted, heterostrophic shell with protoconch inclined at 90°; teleoconch carinate with bifid peripheral lira and sculptured with spiral lirae finely noded at intersection with closely spaced growth lines.

Description: The protoconch is elevated at the shell's apex and is at a right angle with the shell's axis. It consists of one and a half smooth whorls. The teleoconch is turreted with eight whorls. It is sculptured with spiral lirae that are finely noded where they intersect closely spaced growth lines. Five spiral lirae are present above the carina on the shoulder of adult whorls with intervening secondary spiral threads appearing on the sixth whorl. Four spiral lirae occur between the bifid peripheral lira of the carina and the lower suture. These are matched in pairs with a large lira below the carina followed by a small one and an even larger lira with a small one just above the suture. Two additional large spiral lirae mark the basal margin of the body whorl. The base is sculptured with closely spaced, finely noded, spiral lirae. The aperture is subcircular.

Discussion: The Coffee Sand forms of this species differ from the Coon Creek topotype material illustrated by Sohl (1960) in having a prominent spiral lira between the carina and lower suture.

Material: Three specimens.

Measurements: Hypotype 128571 USNM with eight+ whorls is 11.3 mm in height and 4.6 mm in width. The largest Coffee Sand specimen with eight whorls has a height of 8.3 mm and a width of 3.8 mm.

Types: Holotype 32931 USNM; hypotype 128571 USNM.

Occurrence: Mississippi: Coffee Sand, locality 129. Tennessee: Coon Creek Tongue of the Ripley Formation, Coon Creek, McNairy County.

Mathilda pentalira n. sp.
Plate 28, figures 7-12

Diagnosis: Small turreted, heterostrophic shell sculptured with five spiral lirae and axial ribs; the fourth lira below suture forms a slight carina.

Description: The protoconch is elevated at the apex and inclined at a 90° angle to the teleoconch axis. It consists of two whorls having opisthocline growth lines as seen from the apical side. The teleoconch consists of four whorls sculptured with spiral lirae and axial ribs. Five spiral lirae are present on the spire with three small ones below the upper suture, a large one forming a carina, and one of intermediate size between the carina and the lower suture. Two additional lirae form the basal margin on the body whorl. The aperture is subcircular. The base is sculptured with weak spiral lirae.

Discussion: This species differs from *Mathilda ripleyana* in its smaller size, in having only five spiral lirae on the spire, and in its weaker carina.

Material: Several specimens.

Measurements: The holotype is 2.7 mm in height and 1.1 mm in width.

Types: Holotype 457024 USNM.

Etymology: Named for the five spiral lirae of the spiral whorls.

Occurrence: Coffee Sand, MGS locality 129.

Mathilda hexalira n. sp.
Plate 28, figures 1-2

Diagnosis: Small turreted, heterostrophic shell sculp-

tured with six spiral lirae, the lower three considerably larger than the upper three, and axial ribs.

Description: The protoconch consists of two whorls with regularly spaced opisthocline growth lines on the apical surface. The teleoconch consists of four whorls sculptured with six spiral lirae and axial ribs. The lower three lirae are much larger than the upper three. A space is present between the lowest lira and the lower suture, and a seventh strong lira is partly emergent above the suture in the type specimen. This seventh lira forms the basal margin on the body whorl. The aperture is subcircular. The base is covered with spiral lirae.

Discussion: This species resembles *Mathilda pentalira* in its protoconch and general sculpture. It differs in having a sixth strong lira above the suture. The three strong lower lirae of this species give it a square-shouldered profile rather than the carinate v-shaped profile of *M. pentalira* and *M. ripleyana*.

Material: Two specimens.

Measurements: The holotype is 3.1 mm in height.

Types: Holotype 457025 USNM.

Etymology: Named for the six spiral lirae of the spiral whorls.

Occurrence: Coffee Sand, MGS locality 129.

Genus ECHINIMATHILDA Sohl, 1964

Type species by original designation, *Mathilda (Echinimathilda) corona* Sohl, 1964a.

Diagnosis: Small- to medium-sized, turreted, anastrophic shell with the protoconch embedded in the apex; teleoconch sculptured with dominant spiral and subordinate axial elements; sides gently rounded, shouldered, or carinate; columellar lip reflected.

Discussion: The genus as here defined is expanded from Sohl's (1960, p. 131) description of "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," to include a small, high-spired, malthildid species with gently rounded sides and anastrophic protoconch previously identified as *Promathilda (Clathrobaculus) parvula* Sohl, 1960. Figures 1-3 of Plate 30 show the protoconch of this species to be embedded like those of *Echinimathilda*. Bandel (in press) states the rotation of the *Promathilda* protoconch to be at 25°. Figure 10 shows the embedded *Echinimathilda* protoconch to be rotated a complete 180° and anastrophic.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Echinimathilda corona Sohl, 1960 var.
Plate 28, figure 3

Diagnosis: Small turreted shell sculptured with six spiral lirae, the fourth from the top being the strongest, and axial ribs; a sulcus occurs between the upper lira and the suture.

Description: The protoconch is unknown. The teleoconch consists of six whorls sculptured with six strong spiral lirae and weak axial ribs that are present only in the interspaces. The fourth lira below the suture is the strongest and forms a carina on the first four whorls. This carina diminishes on later whorls to the point that the body whorl is almost evenly rounded. A sulcus is present on the last four whorls between the suture and first lira below it. The basal margin is marked by a seventh strong spiral lira, which appears on the body whorl. The aperture is subcircular.

Discussion: This species differs from previously described *Echinimathilda* species in having six strong spiral lira, in its subsutural sulcus, in its rounded body whorl, and in its anastrophic protoconch, a characteristic of the genus *Echinimathilda*.

Material: One specimen from the Coffee Sand.

Measurements: The holotype is 10 mm in height and 3.7 mm in width. The Coffee Sand specimen is 3.7 mm in height and 1.8 mm in width.

Types: Holotype 128574 USNM.

Occurrence: Coffee Sand, MGS locality 129; Owl Creek Formation, Owl Creek, Tippah County.

Echinimathilda microstriata n. sp.
Plate 29, figures 1-3

Diagnosis: Small, turreted, anastrophic shell having a subsutural sulcus and sculptured on the spire with five spiral lirations bearing microscopically fine spiral threads that are nodose at intersections with axial ribs.

Description: The protoconch is anastrophic and embedded in the shell's apex. The teleoconch contains six whorls strongly sculptured on the spire with five spiral lirae bearing microscopically fine spiral threads and with axial ribs. Prominent folds or nodes appear where the axial ribs cross the lirae. The first five whorls are carinate about the fourth lirae below the suture. A strong sulcus is present between the suture and first spiral lira below it. The combination of carina and sulcus gives the spire a notched profile at the suture. The aperture is subcircular and reflected at the anterior of the columella. The base is covered with spiral lirae.

Discussion: This species differs from *Echinimathilda corona* in its much smaller size and in the microscopic threads on its spiral lirae.

Material: Two specimens.

Measurements: The holotype is 3.0 mm in height.

Types: Holotype 457026 USNM.

Etymology: Named for the microscopically fine threads on the spiral lirae.

Occurrence: Coffee Sand, MGS locality 129.

Echinimathilda parvula (Sohl, 1960)
Plate 29, figures 4-5; Plate 30, figures 1-3

1960. *Promathilda (Clathrobaculus) parvula* Sohl, U. S.

Geol. Prof. Paper 331-A, p. 133, pl. 18, fig. 17, 29-31.

Diagnosis: A small, high-spired, slender, anastrophic shell sculptured with five spiral lirae on the whorls of the spire and with axial ribs visible only in the interspaces.

Description: The protoconch is anastrophic and embedded in the shell's apex. The teleoconch consists of six or more modestly convex whorls sculptured with five spiral lirae of about equal strength and with thin axial ribs visible only in the interspaces. The aperture is subcircular. The base is evenly rounded and sculptured with spiral lirae.

Discussion: Plate 30, figures 1-3, show the protoconch of this species to be embedded in the shell's apex as it is in other *Echinimathilda* species. Bandel's (in press) diagnosis of *Promathilda*, based on Triassic species, is a shell like that of *Mathilda* but with the protoconch immersed at the apex and with only one dominant spiral keel on the early whorls. The protoconch, according to Bandel's description, is not anastrophic but at a 25°angle to that of the spire. *Echinimathilda parvula* lacks a keel on the early whorls and appears to have an anastrophic protoconch so is not included in *Promathilda*.

Material: A few specimens.

Measurements: The incomplete holotype measures 6.3 mm in height and 2.7 mm in width. A complete specimen from the Coffee Sand with six whorls measures 2.8 mm in height and 1.0 mm in width.

Types: Holotype 128579 USNM; paratypes 128580, 128581 USNM.

Occurrence: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Tippah and Union counties.

Genus ACROCOELUM Cossmann, 1888

Type by original designation, *Mathilda bouryi* Cossmann, 1888.

Diagnosis: Small, thin, turreted shell with the initial whorl of protoconch sunken; teleoconch with rounded whorls sculptured with stronger spiral than axial elements; umbilical fissure commonly present; aperture subcircular (modified from Sohl, 1960, p. 133).

Range: Upper Cretaceous (Campanian) - Eocene.

Acrocoelum? cereum Sohl, 1960
Plate 28, figures 13-15

1960. *Acrocoelum? cereum* Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 133, pl. 18, fig. 23-24.

Diagnosis: Small turreted shell with rounded whorls and sculptured on the spire by five sharp-topped lirae.

Description: Protoconchs are incomplete on Coffee Sand specimens examined. The teleoconch has five rounded whorls sculptured with five, sharp-topped, spiral lirae. Additional lirae cover the rounded base. The aperture is ovate.

Material: A few specimens.

Measurements: The holotype from the Coon Creek Tongue is 1.7 mm in height and 0.85 mm in width. The largest Coffee Sand specimen is 1.4 mm in height.

Types: Holotype 128582 USNM; paratypes 128583 USNM.

Occurrences: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Union County, Mississippi.

Genus GEGANIA Jeffreys, 1884

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

Diagnosis: Medium-sized, turreted, anastrophic shell with the protoconch embedded in the apex; teleoconch with globose rounded whorls sculptured with spiral lirae and weaker axial elements; aperture subovate.

Range: Upper Cretaceous - Recent.

Gegania mississippiensis n. sp.
Plate 31, figures 1-5

Diagnosis: Medium-sized, turreted, anastrophic shell with globose whorls and sculptured on the spire with three large spiral lirae and fine spiral threads, lirae noded at intersections with growth lines.

Description: The protoconch is anastrophic with a little more than one smooth whorl visible at the apex. One specimen (Plate 31, figure 3) shows the protoconch with a terminal lip. The teleoconch consists of eight, rounded, globose whorls. The first whorl has spiral and axial elements of about equal strength with four spiral lirae and intervening threads. In the subsequent whorls, the upper lira and the axial elements are much weaker than the lower three lirae, the upper of which forms the shoulder. The aperture is subcircular. The base is rounded and sculptured with spiral lirae noded at growth lines.

Discussion: The species differs from *Gegania bella* (Conrad, 1860), *G. bella progida* Sohl, 1960, and *G. parabella* (Wade, 1927), all from the Ripley Formation, in having a weaker spiral sculpture and in having only three spiral lirae on the adult whorls.

Material: Several specimens.

Measurements: The holotype measures 14.6 mm in height and 8.0 mm in width.

Types: Holotype 457027 USNM.

Etymology: Named for the State of Mississippi.

Occurrence: Coffee Sand, MGS locality 129.

Genus LEMNISCOLITTORINA Sohl, 1960

Type by monotypy, *Littorina berryi* Wade, 1926.

Diagnosis: Medium-sized, turbinate to spindle-shaped, rather thick, umbilicate, globose, anastrophic shell sculptured

with noded spiral cords.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Lemniscolittorina yonkersi n. sp.
Plate 4, figures 5-6; Plate 5, figures 1-4

Diagnosis: Medium-sized, turbinate, umbilicate, globose shell sculptured with five thick spiral cords on the spire and covered with weaker spirals on the base.

Description: The protoconch is anastrophic with about three smooth whorls, the first being partly obscured by the second and the third becoming orthostrophic. The teleoconch consists of five slightly convex whorls with impressed sutures and sculptured on the spire with five, finely noded, spiral cords and with closely spaced labrial threads in the interspaces. The aperture is ovate and somewhat quadrangular. The basal margin is rounded, and the base is sculptured with nine to ten smooth spiral cords, the inner one of which forms the shoulder of a narrow umbilicus.

Material: Several specimens.

Measurements: The holotype measures 13.0 mm in height and 9.2 mm in width. The larger figured specimen measures 16.2 mm in height and 11.6 mm in width.

Types: Holotype 457028 USNM.

Etymology: Named in memory of Irving M. Yonkers, the writer's father-in-law and a minister in central Mississippi. Brother Yonkers worked to turn young lives around, a character noted in the anastrophic coil of this species, which makes a 180° change in direction.

Occurrence: Coffee Sand, MGS locality 129.

Family ARCHITECTONICIDAE Roding, 1798

Genus HELIACUS d'Orbigny *in* Sagra, 1842

Type by monotypy, *Solarium herberti* Deshayes, 1830 (=*Trochus cylindricus* Gmelin, 1791).

Diagnosis: Relatively high-spired, small architectonicid with spiral sculpture dominant and umbilicate with a field of five spiral lirae on the base.

Range: Upper Cretaceous (Campanian) - Recent.

Heliacus reticulatus n. sp.
Plate 31, figures 6-7; Plate 32, figures 1-4

Diagnosis: A small, anastrophic, globose, discoid shell (about as wide as high) with a fenestrate pattern of crossing spiral and axial elements and with a field of five spiral lirae on the base surrounding the umbilicus.

Description: The protoconch is anastrophic with a little over one smooth whorl exposed at the apex and terminates in a lip. The teleoconch consists of between one and two globose whorls with a fenestrate sculpture of spiral lirae crossed by slightly weaker axial ribs. Five spiral lirae occur above the suture, one at the margin, and five on the base. The aperture is subcircular. The base is umbilicate.

Discussion: This species is similar to *Heliacus cylindricus* (Gmelin, 1791) in its nearly equal height to width ratio, but differs in having a lower spire and more extended base. Also it has weaker spiral lirae and more prominent axial ribs which produce a reticulate sculpture.

Material: A few specimens.

Measurements: The holotype measures 1.5 mm in height and 1.7 mm in width.

Types: Holotype 457029 USNM.

Etymology: Named for its reticulate sculpture.

Occurrence: Coffee Sand, MGS locality 129.

Genus GRANOSOLARIUM Sacco, 1892

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

Diagnosis: Medium-sized, discoid, shell with moderately broad umbilicus and sculptured with noded spiral elements; umbilical margin noded and not separated from remainder of base by groove; umbilical wall with a spiral cord between margin and suture; noded carina present at shell periphery (modified from Sohl, 1964b, p. 360).

Range: Upper Cretaceous (Campanian) - Recent.

Granosolarium coffea Sohl, 1964
Plate 33, figures 1-2, 6; Plate 34, figures 1-5

1964b. *Architectonica (Granosolarium) coffea* Sohl, U. S. Geol. Survey, Prof. Paper 331-C, p. 360, pl. 53, fig. 19-22.

Diagnosis: An architectonicid with peripheral angulation bearing two strong spiral cords (from Sohl, 1964b, p. 360).

Description: The protoconch is anastrophic and consists of one and three fourths smooth whorls. The teleoconch consists of four whorls with incised sutures and is sculptured with noded spiral cords and lirae. Two cords are present above the suture and one below. Between these on the body whorl are four noded lirae. The shell periphery is marked by two noded cords. The base is broadly umbilicate and is noded with spiral lirae and intersecting growth lines. Growth lines or rugae continue into the umbilicus and are noded at the umbilical margin and at an angulation below the suture. The aperture is ovate.

Material: Several specimens.

Measurements: The holotype measures 9 mm in width.

Types: Holotype 131597 USNM; paratype 131598 USNM.

Occurrence: Coffee Sand, MGS localities 129 and 130.

Genus PSEUDOMALAXIS Fischer, 1850

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

Diagnosis: Discoidal shell with very wide umbilicus, flat to low spire, smooth anastrophic protoconch, and whorls angulated at peripheral and umbilical margins so that the whorls have a subrectangular cross section (modified from Sohl, 1960, p. 65).

Range: Upper Cretaceous (Campanian) - Recent.

Pseudomalaxis pateriformis Stephenson, 1955
Plate 33, figures 3-5; Plate 34, figures 6-11

1955. *Pseudomalaxis pateriformis* Stephenson, U. S. Geol. Survey, Prof. Paper 274-E, p. 124, pl. 21, fig. 19-21.
1960. *Pseudomalaxis pateriformis* Stephenson. Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 67, pl. 6, fig. 35, 38.

Diagnosis: Shell large for genus, discoidal, spire concave with down-stepping flat-topped whorls, base concave with sloping whorls, greatest height of shell at flat-sided periphery, noded cords mark the square-shouldered peripheral margins.

Description: The protoconch is anastrophic and consists of one and a half smooth whorls that terminate in a lip. The teleoconch consists of three square-shouldered whorls sculptured with spiral lirae. The umbilicus is so broad that the umbilical margin is directly below the shoulder. Both the top and base of the shell are concave and their margins are marked with a noded spiral cord, giving the shell a planispiral appearance. The top has flat-topped whorls that step down toward the protoconch, which has a partially embedded initial whorl. In contrast, the base has whorls that slope rather evenly toward the protoconch; here all the whorls of the protoconch are visible. The periphery is flat-sided with marginal noded cords standing in relief. The aperture is circular even though the exterior outline of the whorl is subrectangular.

Material: Several specimens.

Measurements: The largest figured specimen has a width of 6.2 mm. The holotype from the Owl Creek Formation measures 13 mm in width and 4 mm in height.

Types: Holotype 20448 USNM; paratype 128173 USNM.

Occurrence: Mississippi: Coffee Sand, MGS locality 129; Owl Creek Formation, MGS locality 126. Missouri: Owl Creek Formation, Crowleys Ridge.

Family OMALOGYRIDAE G. O. Sars, 1878

Genus NEAMPHITOMARIA Bandel, 1988

Type by subsequent designation (Bandel *in* Dockery, this paper), *Pseudomalaxis stantoni* Sohl, 1960.

Diagnosis: Small discoid shell with one or two strong carinae on the base; first whorl planispiral and ornamented with one or two spiral bulges, which in the early whorl wander toward the margin; whorl cross section rounded-quadrate; fine spiral striae present next to carinae (after Bandel, 1988).

Discussion: Bandel (1988) recognized two species within this genus but did not designate either as the type. *Neamphitomaria stantoni* (Sohl, 1960) was referenced first followed by *Neamphitomaria rotella* (I. Lea, 1833) from the Gosport Sand (late middle Eocene) of Alabama. Bandel here designates *N. stantoni* as the type.

Neamphitomaria stantoni has a relatively large and simple protoconch that is almost planispiral and that shows no strong demarcation at the beginning of the teleoconch. This protoconch indicates a lecithotrophic rather than a planktotrophic development and, thus, placement in the Family Omalogyridae. *N. planospira* n. sp. has a protoconch I and II indicative of a planktotrophic larval stage. It is placed in *Neamphitomaria* based on its adult morphology. Many taxa possess both lecithotrophic and planktotrophic larval stages.

Range: Upper Cretaceous (Campanian) - Eocene.

Neamphitomaria stantoni (Sohl, 1960)
Plate 35, figures 1-3

1960. *Pseudomalaxis? stantoni* Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 67, pl. 6, fig. 29, 39, 43, 44.
1988. *Neamphitomaria stantoni* Sohl. Bandel, Mitt. Geol.-Palaont. Inst. Univ. Hamburg, v. 67, p. 7-8.

Diagnosis: Small subdiscoidal shell with convex apical surface and concave basal surface and sculptured with one or two strong peripheral cords and a strong basal carina (after Sohl, 1960).

Description: The protoconch consists of one planispiral whorl that is smooth with the exception of a carina visible on the apical side. The teleoconch continues smoothly from the protoconch and consists of between one and two whorls sculptured with collabral ribs. A strong carina marks the shoulder of the apical surface and another marks the basal margin. The periphery between these carinae is convex and may bear a medial carina. The base is concave and evolute with all whorls readily visible and is sculptured with axial ribs. The aperture is subcircular.

Discussion: Coffee Sand forms of this species differ from those in the Coon Creek Tongue (the type horizon) in having an axial sculpture.

Material: A few specimens.

Measurements: The largest figured specimen is 1.6 mm in width. The paratype from the Coon Creek Tongue measures 2.3 mm in width.

Type: Holotype 128414 USNM; paratype 128415 USNM.

Occurrence: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Tippah County, Mississippi.

Neamphitomaria reticulata n. sp.
Plate 11, figure 1; Plate 32, figure 5; Plate 37, figures 1-2

Diagnosis: Minute sized, circular shell with flattened spire, squared shoulders, reticulate sculpture, and large umbilicus.

Description: The shell's initial whorl is continuous in form with that of the adult whorls. These whorls are moderately convex and form an otherwise flattened spire with a trough along the suture. The sculpture is reticulate with closely spaced longitudinal ribs dominating over spiral lirae. A zone free of spiral lirae occurs below the suture in the subsutural trough. The first subsutural lira is the largest, and the subsequent lirae become finer toward the margin. Longitudinal ribs cover the whorls and continue onto the upper peripheral cord at the shell margin. The shell margin is flat and bounded by an upper and lower peripheral cord and is covered with longitudinal ribs. The base of the shell has a large umbilicus and a reticulate sculpture with spiral lirae and longitudinal ribs covering the entire surface.

Discussion: This species is characterized by the flatness of the shell and its subrectangular profile. The reticulate microsculpture and general form superficially resemble that of *Cyclostremiscus ottonius* (Palmer, 1947) from the Moodys Branch Formation (upper Eocene). *C. ottonius* also has an upper and lower peripheral cord bordering the shell margin. However, the Coffee Sand species lacks the planktotrophic larval shell of *Cyclostremiscus*; its initial whorl is continuous in form with the adult shell as in *Neamphitomaria*. It differs from other *Neamphitomaria* species in its reticulate microsculpture.

Material: Two specimens.

Measurements: The holotype measures 1.4 mm in diameter with half the body whorl missing.

Types: Holotype 457030 USNM.

Etymology: The species is named for its reticulate sculpture.

Occurrence: Coffee Sand, MGS locality 129.

Neamphitomaria planospira n. sp.
Plate 35, figures 4-8; Plate 36, figures 1-4

Diagnosis: Small subdiscoidal shell with a flat apical surface, squared shoulder, nearly flat periphery, strongly angulate basal margin, and concave base; protoconchs I and II well defined.

Description: The protoconch consists of a polygonally pitted protoconch I of one half whorl, and a smooth protoconch II of one and a half whorls that are slightly convex on the apical side. The teleoconch consists of one to two whorls with the apical side flattened and sculptured with collabral ribs or growth lines. The flattened spiral surface extends to a square-shouldered peripheral angulation. Below this angulation, the periphery is flat, extending to the sharp angulation of the basal margin. The base is concave and evolute with all the whorls visible. It is sculptured with collabral ribs, which are stronger near the whorl's outer margin. The aperture is subcircular.

Discussion: This species differs from *Neamphitomaria stantoni* in its flatter spiral surface, in having the first carina or shoulder angulation at the periphery, in having a flat periphery between the shoulder and basal margin, in having the angulation of the basal margin at the periphery, and, most notably, in having a planktotrophic protoconch II.

Material: Several specimens.

Measurements: The holotype measures 1.3 mm in width.

Types: Holotype 457031 USNM.

Etymology: Named for its flat spiral surface.

Occurrence: Coffee Sand, MGS locality 129.

Superfamily PYRAMIDELLOIDEA Gray, 1840
Family STREPTACIDIDAE Knight, 1931

Genus STREPTACIS Meek, 1872

Type by original designation, *Streptacis whitfieldi* Meek.

Diagnosis: Small, elongate-turreted, heterostrophic shell with protoconchs at 90° to the spire; whorls gently convex; sculpture smooth with sinuous collabral growth lines having a subsutural sulcus; sutures incised; aperture ovate; columella without folds; labrum internally smooth.

Range: Upper Carboniferous - Late Cretaceous (Campanian).

Streptacis? bogradi n. sp.
Plate 19, figure 5; Plate 37, figures 3-5

Diagnosis: Small, elongate-turreted, smooth shell with sinuous growth lines and heterostrophic protoconch and without columellar folds.

Description: The heterostrophic protoconch is one third submerged and consists of one and a half smooth whorls with axial folds just below the suture. The teleoconch consists of four and a half or more smooth, modestly convex whorls with impressed sutures and sinuous growth lines. The aperture is ovate with the labrum internally smooth.

Discussion: The general form of this species fits Davies' (1971, p. 398) description of *Eulimella*, which has smooth sides and no columellar folds. However, John Wise (personal communication) has studied Recent species of *Eulimella* and believes them to be different from the Coffee Sand taxon described here in that the Recent ones are thin-shelled, fragile, and transparent. *Turbonilla*, a large and diverse group having moderately thick shells, is another possibility, but generally has straight collabral ribs. James Corgan (personal communication) believes this taxon to be a new pyramidellid genus related to *Syrnola*.

The sinuous growth line of this Coffee Sand taxon is a

primitive character that distinguishes it from most other extant pyramidellid genera. Similar growth lines are present in the Carboniferous to Permian Family Streptacididae. The writer, following the suggestion of Steve Tracey (personal communication), questionably places this species in *Streptacis?*, a heterostrophic pyramidellid with smooth sides, sinuous growth lines, and lacking columellar folds. This placement extends the range of this late Paleozoic genus into the Late Cretaceous.

Material: Several specimens.

Measurements: The holotype measures 1.5 mm in height and 0.5 mm in width.

Types: Holotype 457032 USNM.

Etymology: This species is named in honor of our Assistant Director, Michael B. E. Bograd, editor of this and many other Mississippi Office of Geology publications.

Occurrence: Coffee Sand, MGS locality 129.

Family AMATHINIDAE Ponder, 1987
Genus DAMESIA Holzapfel, 1888

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

Diagnosis: Medium-sized, radially sculptured, limpet-like shell, with a neritiform protoconch marked by coarse spiral ornament; interior of teleoconch characterized by prominent horseshoe-shaped muscle scar at pallial margin.

Discussion: *Damesia* Holzapfel, 1888, is placed here with *Amathina* in the Superfamily Pyramidelloidea, Family Amathinidae Ponder, 1987. Sohl (1960, p. 63) followed Holzapfel (1888, p. 168) in placing this genus in the family Neritidae, though he stated that this placement was in doubt. *Damesia* is represented in Campanian-Maastrichtian sediments of the Gulf Coastal Plain by the species *D. keownvillensis* Sohl, 1960. Specimens of this species illustrated in figures 8 and 9 of Plate 2 clearly show the protoconch not to be involutely coiled as in the Neritidae, but to be heterostrophic and like that described by Ponder (1987, p. 19) for the pyramidelloidean limpet *Amathina*.

Range: Upper Cretaceous (Campanian-Maastrichtian).

Damesia keownvillensis Sohl, 1960
Plate 2, figures 5-9; Plate 17, figure 1; Plate 38, figures 1-3

1960. *Damesia keownvillensis* Sohl, U. S. Geol. Survey, Prof. Paper 331-A, p. 63-64, pl. 5, fig. 37-38, pl. 6, fig. 40-42.

Diagnosis: *Damesia* with tilted protoconch, thin inner lip, and five to six strong flat-topped spirals (modified from Sohl, 1960, p. 63).

Description: The initial half whorl of the protoconch is tilted and elevated. This is followed by two neritiform whorls sculptured with five to six spiral cords and terminating in an abrupt varix. The last three-quarters of these whorls are rapidly expanding, becoming more limpet-like in shape. The broad flat aperture and arched dorsum give the protoconch a D-shaped profile in the apical view. The base of the protoconch is umbilicate with the umbilicus being constricted by the broad platform of the inner lip. The flattened inner lip and rounded outer lip produce a D-shaped outline (see figure 2 of Plate 38) that can be recognized in the apical scar of the adult limpet-form shell where the protoconch is missing (see figure 3 of Plate 38). The protoconch's outer lip is slightly digitate at intersections with spiral cords. The teleoconch is a *Capulus*-shaped, limpet-like shell with a posteriorly directed apex and is sculptured with radial lirae. It is marked internally by a prominent horseshoe-shaped muscle scar along the pallial margin that is a continuous narrow band below the apex (posterior margin) and that is expanded anteriorly with a short gap at the anterior margin. The shape of the teleoconch margin is variable, depending on the shape of its host bivalve.

Discussion: The adult shell of this species illustrated in figure 1 of Plate 17 was named *Hipponix coffea* n. sp. in the unpublished dissertation of Dockery (1991). This specimen is missing the apical region and was attributed to *Hipponix* based on the form of its horseshoe-shaped muscle scar. A second adult specimen (figure 3 of Plate 38) recently collected by Earl Manning (December 22, 1992) from bed E at MGS locality 129 is complete and bridges the gap between *Hipponix coffea* and *Damesia keownvillensis*. The apex of this specimen terminates in a 0.5 x 1.0 mm scar with a 0.3 mm wide beveled periphery where the protoconch was attached. This scar and beveled peripheral zone are the same size and shape (1.1 x 1.6 mm) as the aperture of the larval shell described as *Damesia* (figure 2 of Plate 38). The terminal varix of the protoconch can be seen near the lip of the juvenile shell illustrated in figures 8 and 9 of Plate 2. A larger juvenile specimen in figure 1 of Plate 38 shows the protoconch attached to the early limpet-like shell. Figure 6 of Plate 2 shows a detached protoconch with an aperture that has been plugged with callus. Plugging of the protoconch probably occurred shortly after the shell assumed its adult limpet form. The D-shaped apical scar of the adult shell represents the fracture of the protoconch's callus plug, and the beveled periphery is the separation surface below the outer lip's terminal varix. It is possible that the *Capulus*-attributed taxa *C. monroei* Sohl, 1960, *C. corrugatus* Wade, 1926, and *C. cuthandensis* Stephenson, 1941, also belong to *Damesia*. The horseshoe-shaped muscle scar that is characteristic of adult Coffee Sand specimens of *Damesia* fits the "conspicuous horse-shoe shaped" muscle of *Amathina tricarinata* (Linné) as described by Ponder (1987, p. 6).

Material: Several specimens from the Coffee Sand.

Measurements: The holotype measures 2.9 mm in height and 3.9 mm in width. The largest Coffee Sand adult specimen measures 12.2 mm in height and 19.5 mm in width.

Type: Holotype 128403 USNM; paratype 128404 USNM.

Occurrence: Coffee Sand, MGS locality 129; Coon Creek Tongue of the Ripley Formation, Tippah and Union

counties.

Subclass EUTHYNEURA Spengel, 1881
Order BASOMMATOPHORA A. Schmidt, 1855
Superfamily SIPHONARIOIDEA Gray, 1840
Family SIPHONARIIDAE Gray, 1840

Genus ANISOMYON Meek and Hayden, 1860

Type by subsequent designation, *Helcion patelliformis* Meek and Hayden, 1860.

Diagnosis: Medium-sized, patelliform, thin shell with posteriorly-directed apex and bulbous, sinistrally coiled protoconch.

Discussion: This genus was originally described from the Cretaceous of Nebraska (Meek and Hayden, 1860). According to Stephenson (1941) it is represented by undescribed species in the Black Creek Formation of North Carolina and Owl Creek Formation of Mississippi, one species from the Cretaceous of California, and six species from the Upper Cretaceous (Montana Group) of the Western Interior. Richards and Shapiro (1963) described a species from the Upper Cretaceous *Exogyra cancellata* Zone of Delaware.

Range : Cretaceous

Anisomyon sp.
Plate 17, figures 8-10; Plate 39, figures 1-4

Description: The protoconch consists of one and a half smooth bulbous whorls. The teleoconch is a patelliform shell that is strongly elevated near the apex. It is sculptured with annular undulations and a posterior ridge.

Discussion: Based on its characteristic annular undulations, this species may be the same as the undescribed species figured by Stephenson (1923, pl. 96, fig. 1-2) from the Snow Hill Member of the Black Creek Formation at Blue Banks Landing on the Tar River in North Carolina.

Measurements: The largest specimen measures 34.4 mm in length.

Occurrence: Coffee Sand, MGS locality 129.

PLATES

Figured Specimens. This bulletin is an expansion of a dissertation on the Coffee Sand gastropods (Dockery, 1991) that included the streptoneuran gastropods exclusive of the Stenoglossa, Ptenglossa, and Heterostropha. Plates 1-22 are from that dissertation, and plates 22-35 are added to include the Ptenglossa and Heterostropha. All type specimens are deposited at the U. S. National Museum Natural History Building as designated by the abbreviation USNM. Figured specimens housed at the Mississippi Office of Geology are designated by the abbreviation MGS, an abbreviation of the agency's old name - Mississippi Geological Survey. These are numbered successively as they appear on the plates beginning with 1494 on Plate 1 and ending with 1754 on Plate 42 with the exception of a gap at 1720-1736 on Plate 35. MGS figured specimen numbers 1720-1736 (Case, 1991) and 1803-1904 (Manning and Dockery, 1992) are used in recent reports on Cretaceous fossils. Gaps between these series are the result of allotting blocks of numbers to ongoing works with sufficient cushion to assure that the series would not overlap. MGS figured specimens to date include:

1-634 in Mississippi Bureau of Geology Bulletin 122 (1980)
635-638 in Mississippi Geology, v. 1, no. 3, p. 13-15 (1981)
639-1099 in Mississippi Bureau of Geology Bulletin 123 (1982)
1100-1102 in Mississippi Geology, v. 3, no. 3, p. 9-12 (1983)
1103-1475 in Mississippi Bureau of Geology Bulletin 124 (1984)
1476-1479 in Mississippi Geology, v. 5, no. 2, p. 11-15 (1984)
1480-1492 in Mississippi Geology, v. 5, no. 3, p. 1-8 (1985)
1493 in Mississippi Geology, v. 6, no. 2, p. 1-16 (1985)
1494-1719 this bulletin
1720-1736 in Mississippi Geology, v. 11, no. 3, p. 1-8 (1991)
1737-1754 this bulletin
1803-1904 in Mississippi Office of Geology Circular 4 (1992)

Photography. The larger specimens figured here were generally coated with magnesium oxide before being photographed. This process involves mounting the specimen on a block with modeling clay and holding it over the smoke of a burning ribbon of metallic magnesium. The resulting thin coat of white oxide brings out the fine details of the shell's sculpture.

Small specimens were photographed at three locations with scanning electron microscopes. Ernest E. Russell photographed specimens on the scanning electron microscope at Mississippi State University; Marcos Montes photographed others on the Mississippi Institute for Technology Development scanning electron microscope, which resides at (and now belongs to) the University of Mississippi Dental School at Jackson; and Vicky D. Andrews photographed those in plates 36-42 on the scanning electron microscope at Millsaps College.

Specimens prepared from SEM photography were mounted on stubs and gold-coated. Numerous specimens were placed on most stubs to maximize the use of SEM time. This procedure proved unfortunate as some specimens near the edge were crushed, as noted in the plate explanations, during subsequent handling after being photographed. Stubs containing specimens figured in this bulletin are numbered 10-31 and are housed in the figured specimen collection at the Mississippi Office of Geology. Specimens on stubs 12 and 16 were removed by Klaus Bandel for further SEM work. These specimens are now housed individually. SEM 4x5 inch negatives and prints are on file at the Office of Geology and are arranged chronologically by the date taken and numerically by the number of the photograph. This information is given in the plate explanations for SEM illustrations.

EXPLANATION PLATE 1

Figure — Page

1-4 **Calliomphalus (Calliomphalus) paucispirilus** Sohl, 1964 44-45

1. Figured specimen 1494 MGS (x8.3), diameter 3.85 mm. Coffee Sand, MGS locality 129.
2. Same specimen as figure 1. Umbilical view (x9).
3. Figured specimen 1495 MGS (x5), height 6.7 mm, width 7mm. Coffee Sand, MGS locality 129.
4. Figured specimen 1496 MGS (x5), height 7.6 mm, width 7.7 mm. Coffee Sand, MGS locality 129.

5 **Calliomphalus (Planolateralus) tuberculosus** Sohl, 1964 45

Figured specimen 1497 MGS (x5), height 6.6 mm, width 6.4 mm. Coffee Sand, MGS locality 129.

6-12 **Ataphrus griffini** n. sp. 45-46

6. Figured specimen 1498 MGS (x8), width 3.4 mm. Coffee Sand, MGS locality 129.
7. Same specimen as figure 6. Apical view showing color pattern (x8).
8. Same specimen as above (x8). Basal view showing umbilicus.
9. Figured specimen 1499 MGS (x8), width 3.4 mm. Coffee Sand, MGS locality 129. pical view showing color pattern.
10. Same specimen as figure 9. Apertural view (x8) showing color pattern.
11. Holotype 456983 USNM (x7), width 4.0 mm. Coffee Sand, MGS locality 129.
12. Same specimen as figure 11 (x9). Basal view with umbilicus closed.

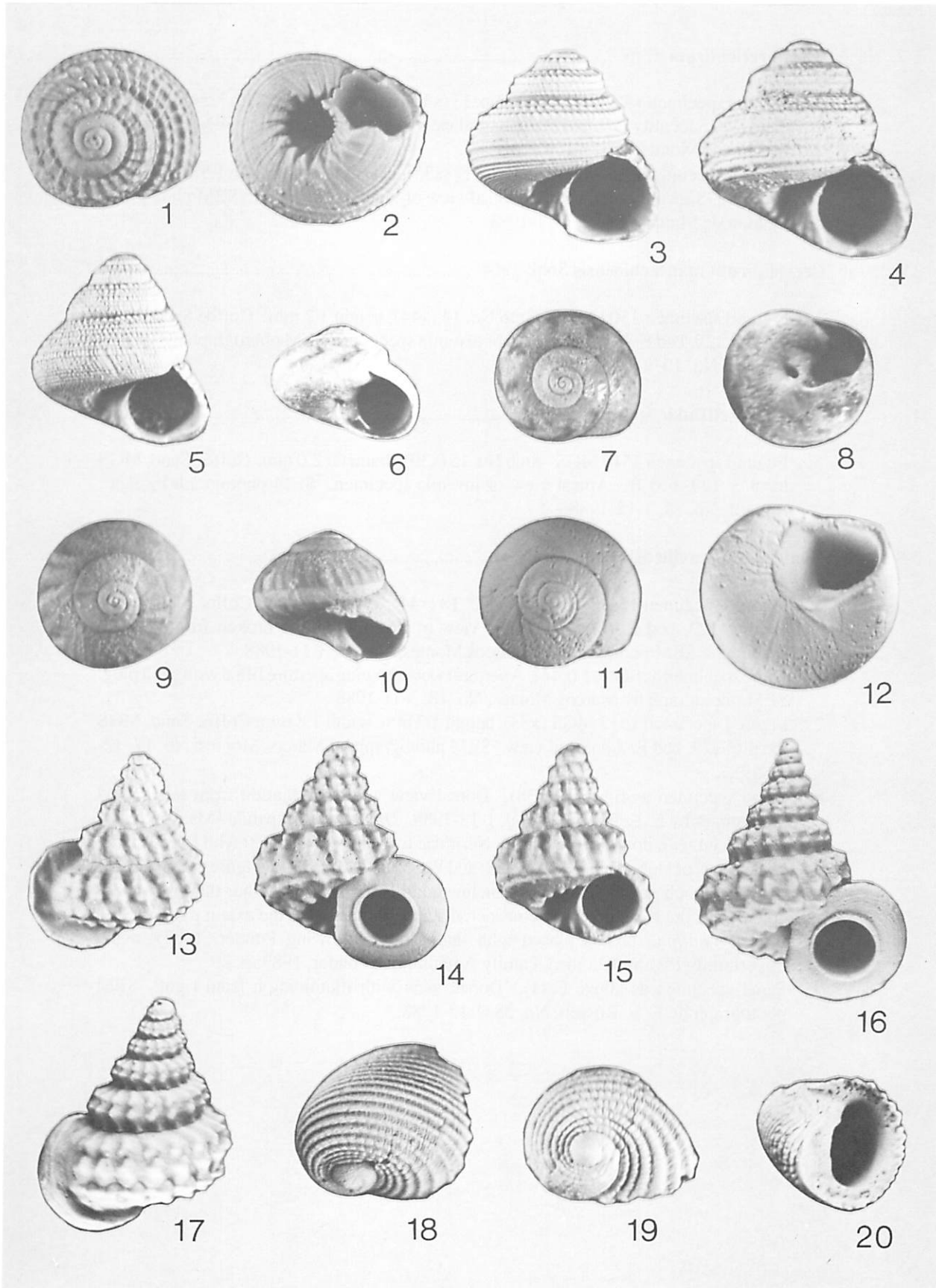
13-17 **Urceolabrum mantachieensis** Sohl, 1964 59-60

13. Figured specimen 1500 MGS (x6.5), height 5.3 mm, width 4.7 mm. Coffee Sand, MGS locality 129.
14. Figured specimen 1501 MGS (x6.5), height 6.0 mm, width 5.2 mm. Coffee Sand, MGS locality 129.
15. Figured specimen 1502 MGS (x8), height 4.2 mm, width 3.4 mm. Coffee Sand, MGS locality 129. Apertural view of young individual without thickened outer lip.
16. Figured specimen 1503 MGS (x7.5), height 6.0 mm, width 4.7 mm. Coffee Sand, MGS locality 129.
17. Figured specimen 1504 MGS (x8), height 5.0 mm, width 4.1 mm. Coffee Sand, MGS locality 129.

18-20 **Nerita reticulirata** n. sp. 43-44

18. Figured specimen 1505 MGS (x8), width 4.0 mm. Coffee Sand, MGS locality 129. Specimen damaged and repaired after photograph.
19. Figured specimen 1506 MGS (x8), width of broken shell 3.7 mm. Coffee Sand, MGS locality 129.
20. Specimen missing. Apertural view (x8).

PLATE 1



EXPLANATION PLATE 2

Figure — Page

1-2 **Nerita reticulirata** n. sp. 43-44

1. Figured specimen 1507 MGS - Stub No. 13 (x33), height 1.6 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed E. Apertural view of juvenile specimen. SEM photograph by Marcos Montes, No. 16, 12-14-1987.
2. Figured specimen 1508 MGS - Stub No. 17 (x35), height 1.6 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed E. Dorsal view of juvenile specimen. SEM photograph by Marcos Montes, No. 2, 3-11-1988.

3 **Urceolabrum mantachieensis** Sohl, 1964 59-60

Figured specimen 1509 MGS - Stub No. 14 (x44), height 1.2 mm. Coffee Sand, MGS locality 129, bed E. Apertural view of juvenile specimen. SEM photograph by Marcos Montes, No. 10, 3-10-1988.

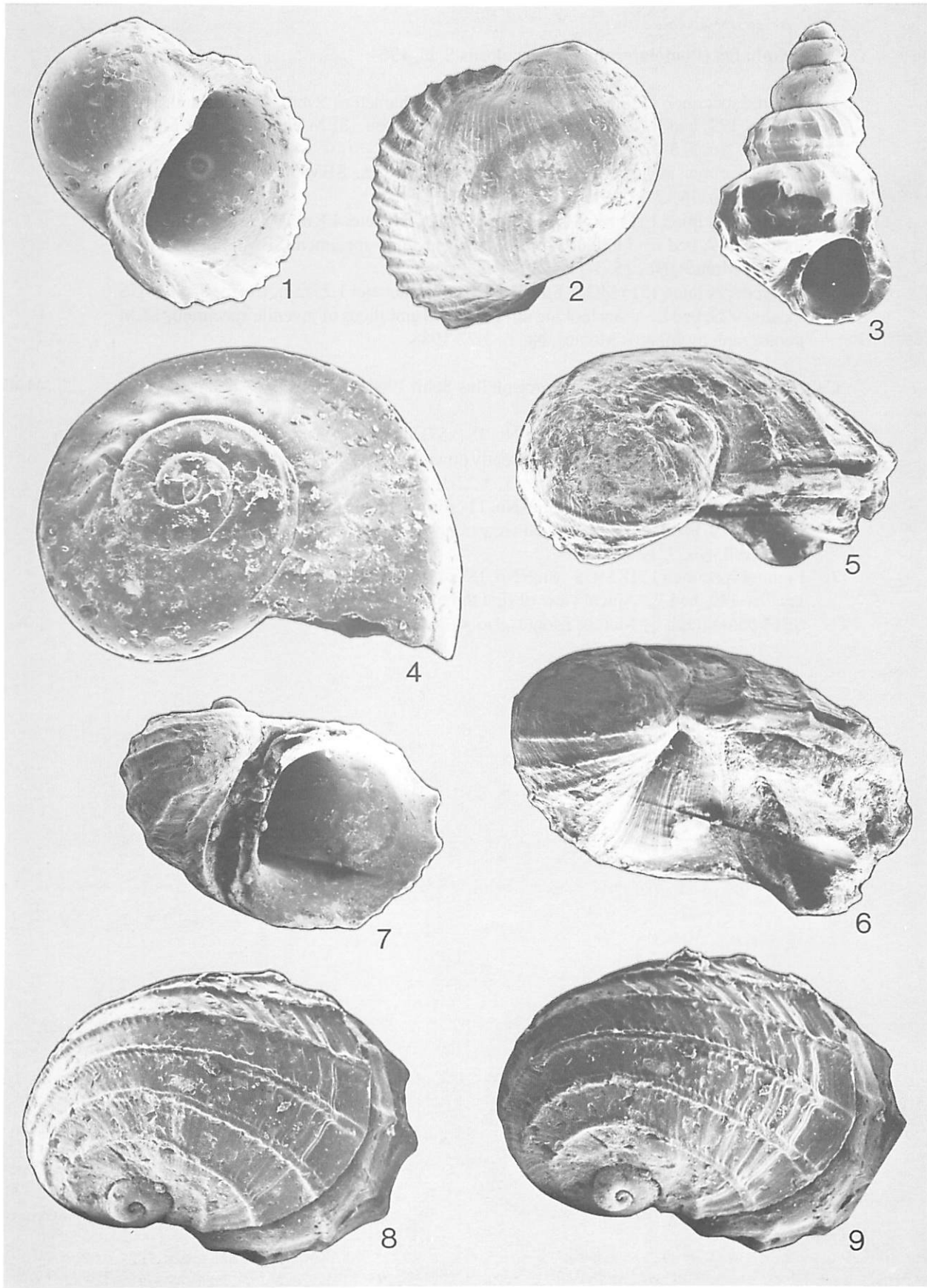
4 **Ataphrus griffini** n. sp. 45-46

Figured specimen 1510 MGS - Stub No. 15 (x39), diameter 2.0 mm. Coffee Sand, MGS locality 129, bed B. Apical view of juvenile specimen. SEM photograph by E. E. Russell, No. 24, 1-12-1988.

5-9 **Damesia keownvillensis** Sohl, 1960 94

5. Figured specimen 1511 MGS - Stub No. 18 (x44), width 1.6 mm. Coffee Sand, MGS locality 129, bed E. Oblique apical view of juvenile whorls broken from a larger specimen. SEM photograph by Marcos Montes, No. 21, 3-11-1988.
6. Same specimen as figure 5 (x44). Apertural view showing aperture filled with shell plug. SEM photograph by Marcos Montes, No. 18, 3-11-1988.
7. Figured specimen 1512 MGS (x33), height 1.2 mm, width 1.8 mm. Coffee Sand, MGS locality 129, bed E. Apertural view. SEM photograph by Marcos Montes, No. 17, 12-14-1987.
8. Same specimen as figure 7 (x38). Dorsal view with illumination from left. SEM photograph by E. E. Russell, No. 9, 1-12-1988. *Damesia* (Campanian-Maastrichtian) was placed with doubt in the Family Neritidae by Sohl (1960, p. 63) who followed the placements of Holzapfel (1888, p. 168) and Wenz (1938b, p. 419). Figures 8 and 9 show the protoconch of this taxon to be inclined and heterostrophic rather than involutely coiled as in the Neritidae. It is considered here to be related to the extant pyramidellid limpet *Amathina* and is placed with that genus (following Ponder, 1987) in the Superfamily Pyramidelloidea, Family Amathinidae Ponder, 1987, p. 29.
9. Same specimen as above (x41). Dorsal view with illumination from right. SEM photograph by E. E. Russell, No. 28, 1-12-1988.

PLATE 2



EXPLANATION PLATE 3

Figure | Page

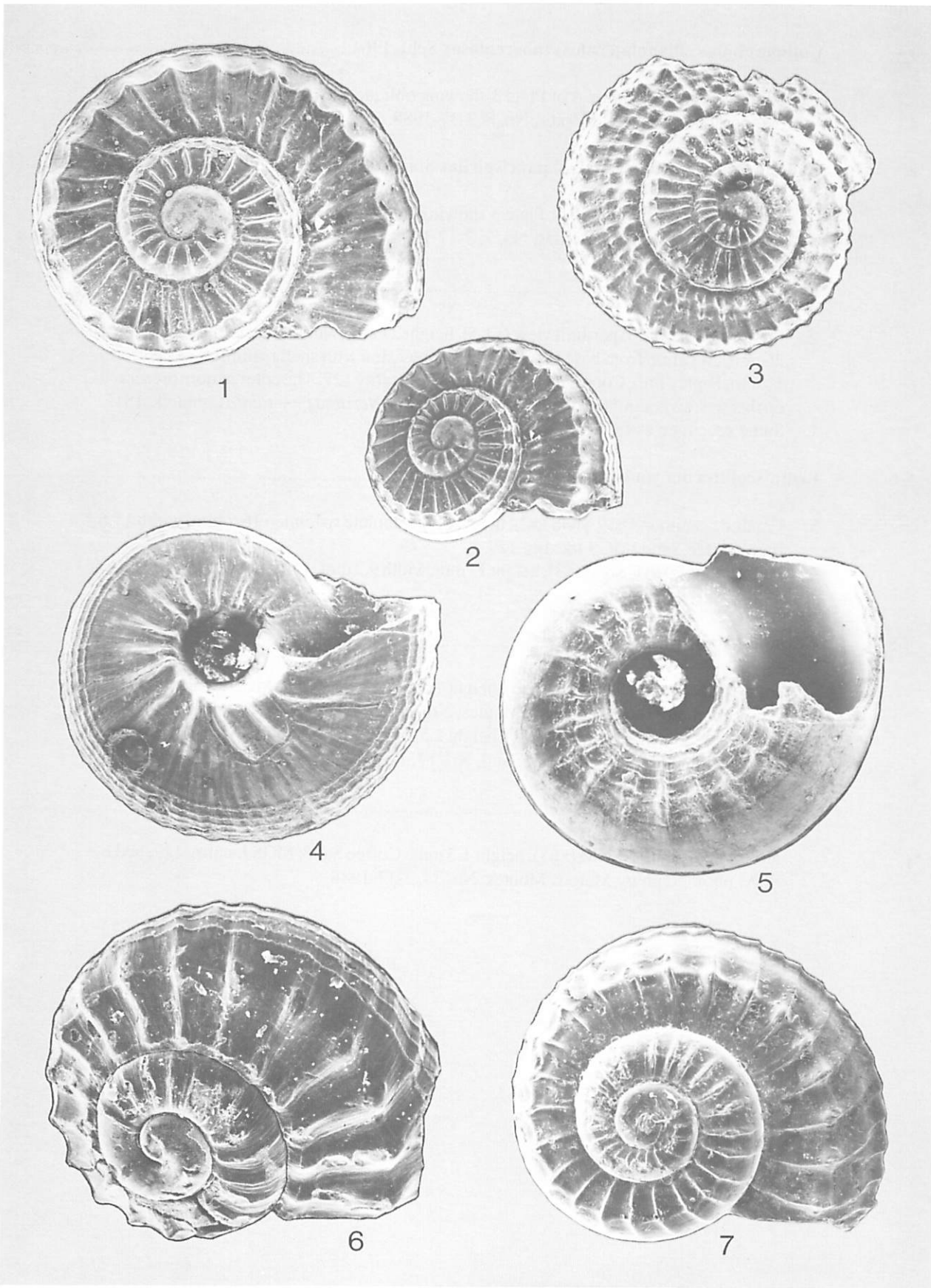
1-4 **Calliomphalus (Planolateralus) tuberculosus** Sohl, 1964 45

1. Figured specimen 1513 MGS - Stub No. 18 (x61), diameter 1.2 mm. Coffee Sand, MGS locality 129, bed E. Apical view of juvenile specimen. SEM photograph by Marcos Montes, No. 5, 3-22-1988.
2. Same specimen as figure 1 (x40). Oblique view of apex. SEM photograph by Marcos Montes, No. 16, 3-11-1988.
3. Figured specimen 1514 MGS - Stub No. 18 (x32), diameter 1.8 mm. Coffee Sand, MGS locality 129, bed E. Oblique apical view of juvenile specimen. SEM photograph by Marcos Montes, No. 15, 3-11-1988.
4. Figured specimen 1515 MGS - Stub No. 18 (x57), diameter 1.25 mm. Coffee Sand, MGS locality 129, bed E. View looking directly down umbilicus of juvenile specimen. SEM photograph by Marcos Montes, No. 6, 3-22-1988.

5-7 **Calliomphalus (Calliomphalus) paucispirilus** Sohl, 1964 44-45

5. Figured specimen 1516 MGS - Stub No. 18 (x57), diameter 1.3 mm. Coffee Sand, MGS locality 129, bed E. View looking directly down umbilicus of juvenile specimen. SEM photograph by Marcos Montes, No. 7, 3-22-1988.
6. Figured specimen 1517 MGS - Stub No. 11 (x66), diameter 1.0 mm. Coffee Sand, MGS locality 129, bed B. Oblique apical view of juvenile specimen. SEM photograph by E. E. Russell, No. 7, 12-2-1987.
7. Figured specimen 1518 MGS - Stub No. 18 (x41), diameter 1.8 mm. Coffee Sand, MGS locality 129, bed E. Apical view of first three whorls broken from an adult specimen. SEM photograph by Marcos Montes, No. 4, 3-22-1988.

PLATE 3



EXPLANATION PLATE 4

Figure — Page

1 **Calliomphalus (Planolateralus) tuberculosus** Sohl, 1964 45

Same specimen as figure 4 of Plate 3 showing oblique view of umbilicus (x60). SEM photograph by Marcos Montes, No. 8, 3-17-1988.

2 **Calliomphalus (Calliomphalus) paucispirilus** Sohl, 1964 44-45

Same specimen as figure 5 of Plate 3 showing oblique view of umbilicus (x60). SEM photograph by Marcus Montes, No. 7, 3-17-1988.

3-4 **Neritina** sp. 44

3. Private collection. Apertural view (x1.5), height 27 mm, width of incomplete specimen 26 mm, elevation from base to top (vertical dimension with shell resting on its aperture) 17 mm. Ripley Fm., Coon Creek Tongue, MGS locality 127. The color pattern preserved on this species is similar to that of the Recent species *Neritina punctulata* Lamarck, 1815.
4. Same specimen as figure 3 (x1.5).

5-6 **Lemniscolittorina yonkersi** n. sp. 91

5. Figured specimen 1519 MGS (x2), height of incomplete specimen 16.2 mm, width 11.6 mm. Coffee Sand, MGS locality 129.
6. Holotype 457028 USNM (x3), height 13 mm, width 9.2 mm. Coffee Sand, MGS locality 129.

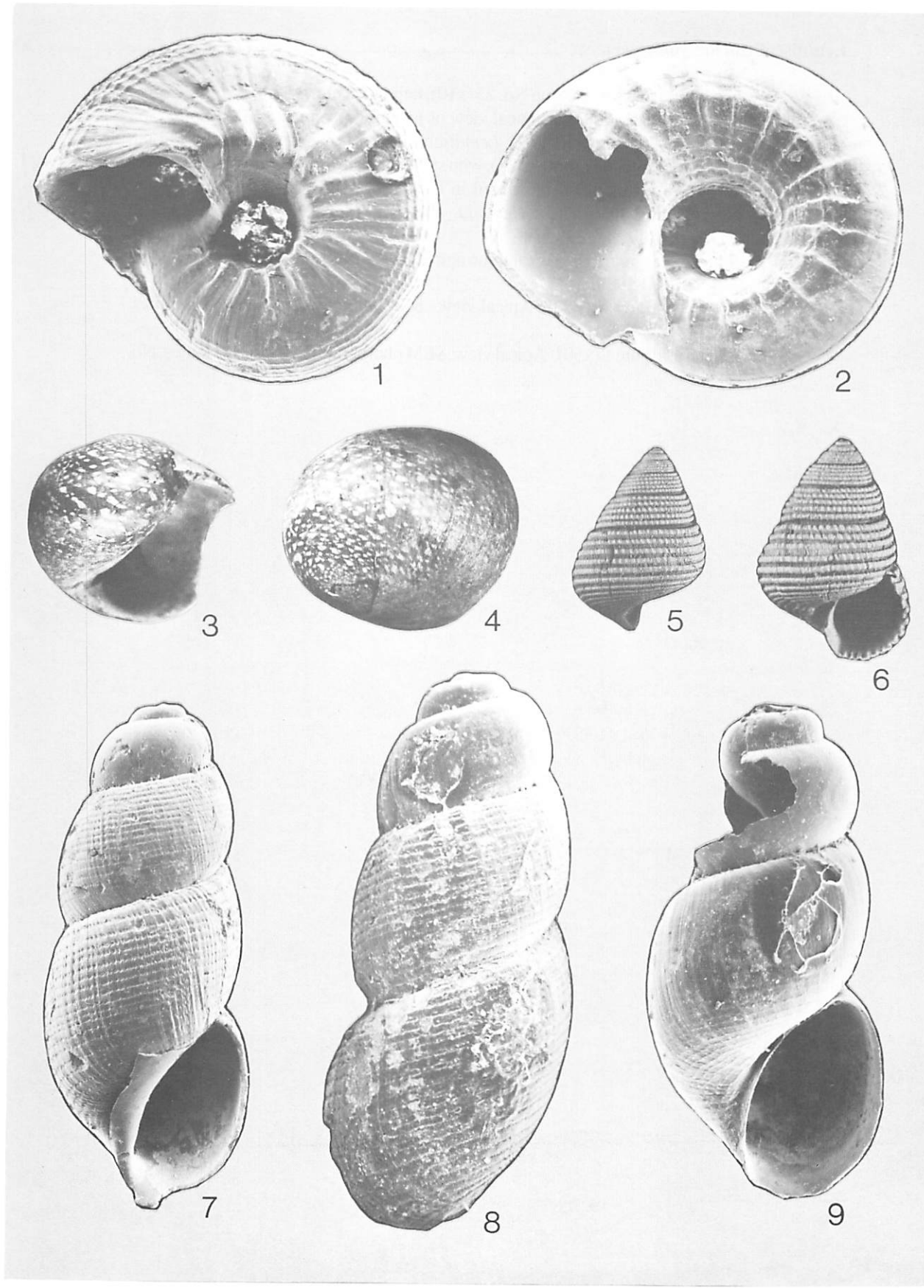
7-8 **Ceratia cylindrata** n. sp. 55-56

7. Figured specimen 1520 MGS (x55), height 1.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 2, 12-14-1987.
8. Figured specimen 1521 MGS (x61), height 1.5 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 17, 1-12-1988.

9 **Hyala fragila** n. sp. 55

Holotype 456991 USNM (x65), height 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 33, 3-17-1988.

PLATE 4

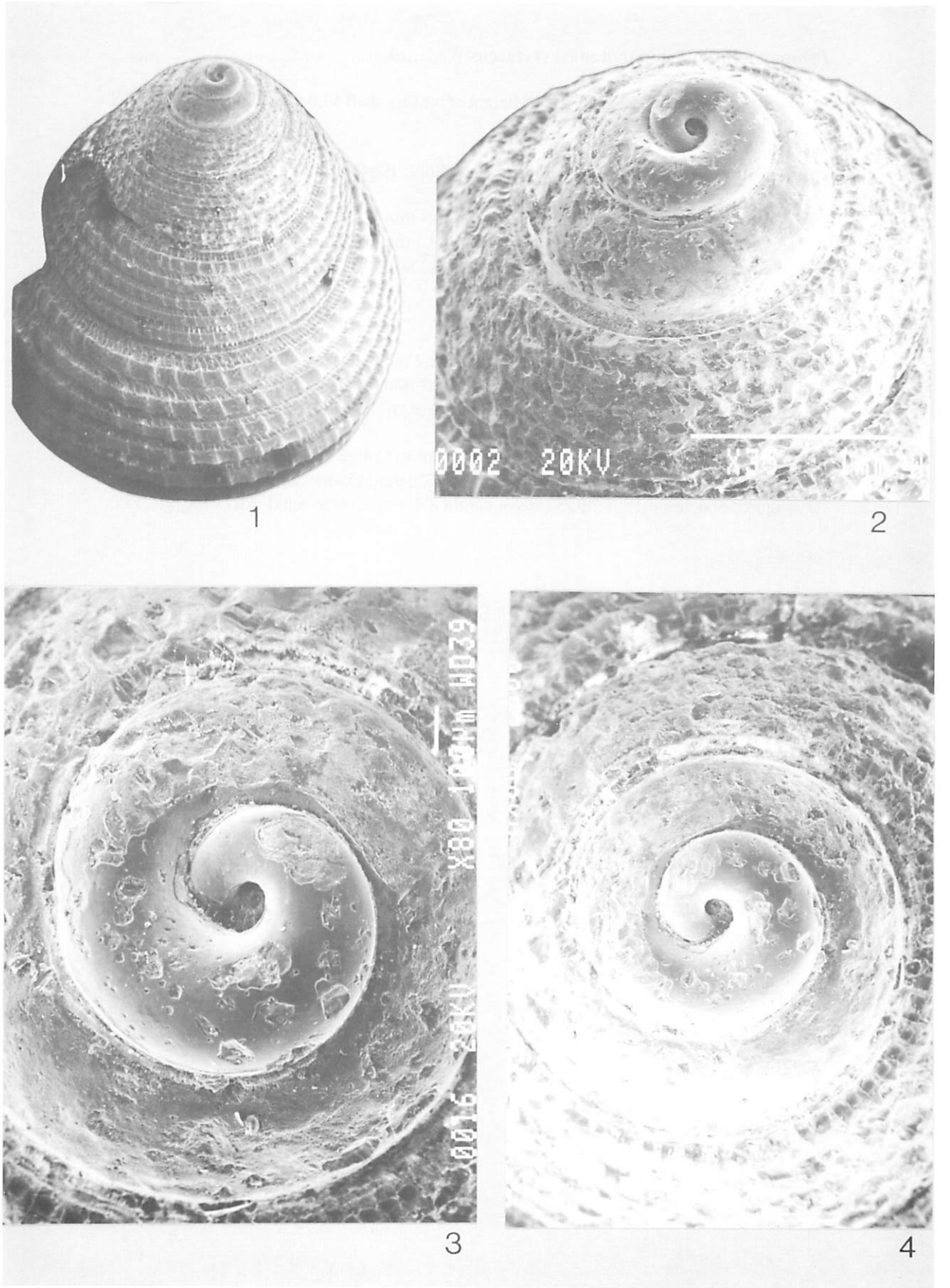


EXPLANATION PLATE 5

Figure		Page
1-4	**Lemniscolittorina yonkersi** n. sp.	91

1. Figured specimen 1522 MGS - Stub No. 22 (x10), height 7.5 mm, width 7.5 mm. Coffee Sand, MGS locality 129. Oblique apical view of juvenile specimen. SEM photograph by Marcos Montes, No. 1, 2-10-1989. *Lemniscolittorina* was originally placed in the Family Littorinidae by Sohl (1960, p. 85), who stated that the protoconch was unknown. The apical views of this taxon illustrated in figures 1-4 show the protoconch to be anastrophic and most like that of *Gegania*. *Lemniscolittorina* is here placed with *Gegania* in the Family Mathildidae.
2. Same specimen as figure 1 (x35). Oblique apical view. SEM photograph by Marcos Montes, No. 2, 2- 10-1989.
3. Same specimen as figure 1 (x80). Apical view. SEM photograph by Marcos Montes, No. 16, 2-10-1989.
4. Same specimen as figure 1 (x50). Apical view. SEM photograph by Marcos Montes, No. 3, 2-10-1989.

PLATE 5



EXPLANATION PLATE 6

Figure — Page

1 **Tympanotonus (Tympanotonus) cretaceus** Wade, 1926 46-47

Figured specimen 1523 MGS (x1), height of broken shell 47.0 mm. Coffee Sand, MGS locality 129, bed E.

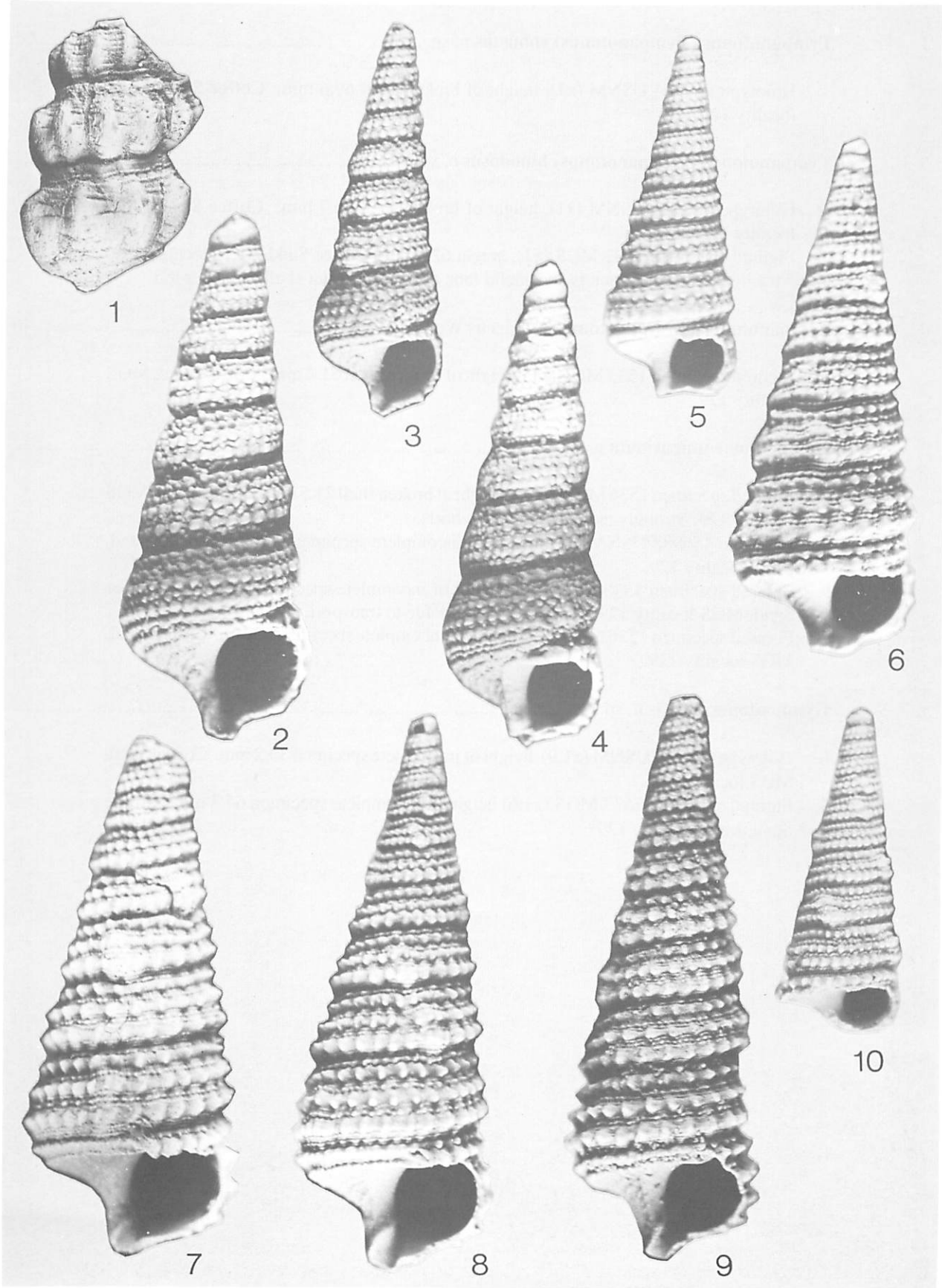
2-4 **Tympanotonus (Exechocirsus) cowickeensis** (Sohl, 1964) 48

2. Figured specimen 1524 MGS (x7), height 13.4 mm. Coffee Sand, MGS locality 129.
3. Figured specimen 1525 MGS (x8.6), height 9.3 mm. Coffee Sand, MGS locality 129.
4. Figured specimen 1526 MGS (x7), height 12.2 mm. Coffee Sand, MGS locality 129.

5-10 **Tympanotonus (Exechocirsus) trilirus** n. sp. 48

5. Figured specimen 1527 MGS (x7.7), height 8.2 mm. Coffee Sand, MGS locality 129.
6. Figured specimen 1528 MGS (x7), height 13.2 mm. Coffee Sand, MGS locality 129.
7. Figured specimen 1529 MGS (x7), height of broken shell 13.0 mm. Coffee Sand, MGS locality 129.
8. Holotype 456986 USNM (x5.8), height 17.0 mm. Coffee Sand, MGS locality 129.
9. Figured specimen 1530 MGS (x5.8), height 17.0 mm. Coffee Sand, MGS locality 129.
10. Figured specimen 1531 MGS (x6.8), height 8.4 mm. Coffee Sand, MGS locality 129.

PLATE 6



EXPLANATION PLATE 7

Figure — Page

1 **Tympanotonus (Tympanotonus) robustus** n. sp. 47

Holotype 456984 USNM (x1), height of broken shell 69.6 mm. Coffee Sand, MGS locality 129.

2-3 **Tympanotonus (Tympanotonus) binodosus** n. sp. 47

2. Holotype 456985 USNM (x1), height of broken shell 66.7 mm. Coffee Sand, MGS locality 129.
3. Figured specimen 1532 MGS (x1), height 62.5 mm. Coffee Sand, MGS locality 129. Attached to the specimen is an annelid tube at top and oyster shells at lower left.

4 **Tympanotonus (Tympanotonus) cretaceus** Wade, 1926 46-47

Figured specimen 1533 MGS (x1), height of broken shell 51.4 mm. Coffee Sand, MGS locality 129.

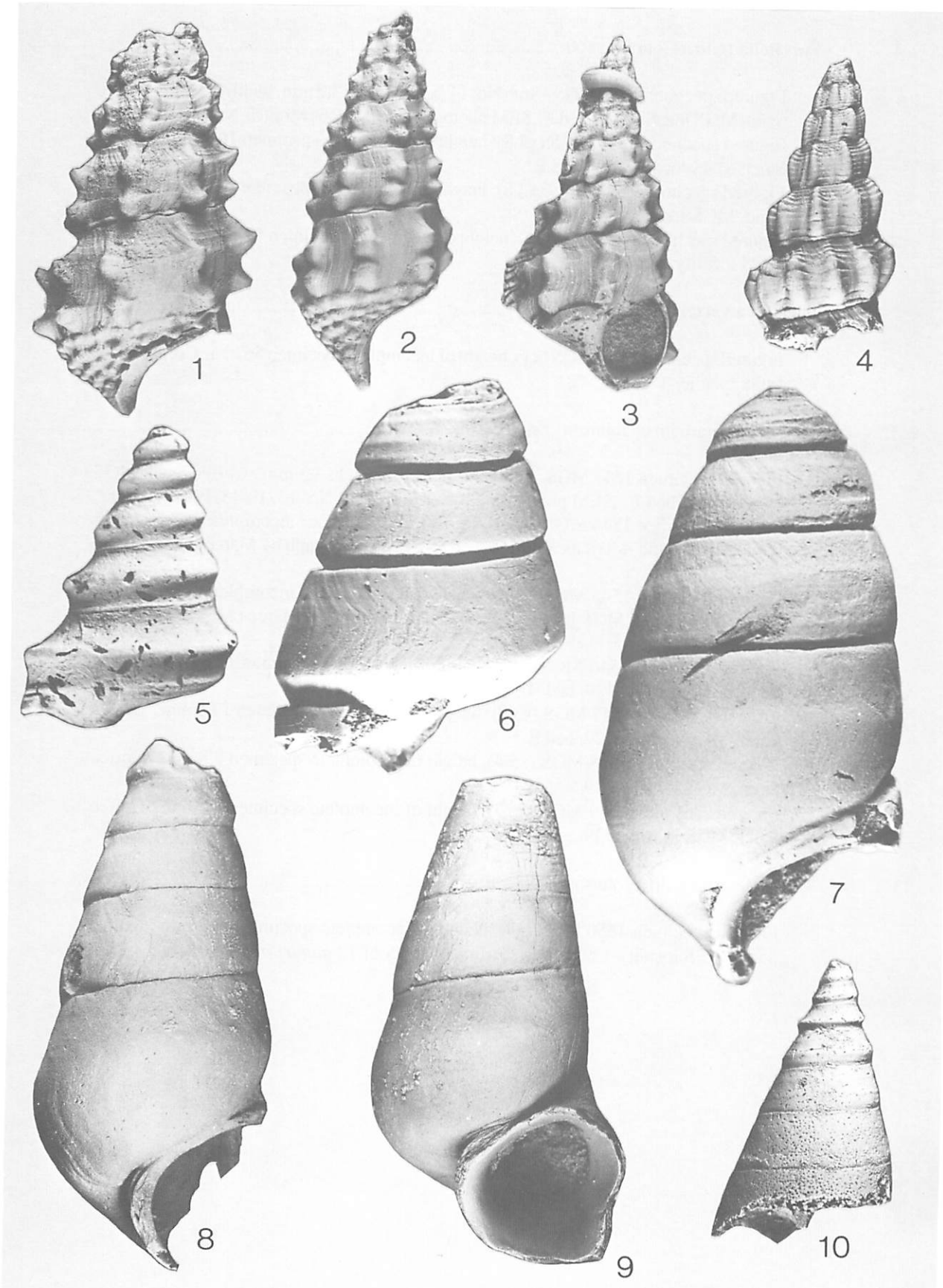
5, 8-10 **Gymnentome unicarinata** n. sp. 52-53

5. Figured specimen 1534 MGS (x2.5), height of broken shell 21.5 mm. Coffee Sand, MGS locality 129. Strongly carinate juvenile whorls.
8. Holotype 456988 USNM (x1), height of incomplete specimen 92 mm. Coffee Sand, MGS locality 129.
9. Figured specimen 1535 MGS (x1), height of incomplete specimen 87.5 mm. Coffee Sand, MGS locality 129. Specimen is worn due to transport.
10. Figured specimen 1536 MGS (x1), height of incomplete specimen 52 mm. Coffee Sand, MGS locality 129.

6-7 **Gymnentome canalis** n. sp. 53

6. Holotype 456989 USNM (x1.9), height of incomplete specimen 36.2 mm. Coffee Sand, MGS locality 129.
7. Figured specimen 1537 MGS (x1.6) height of incomplete specimen 64.3 mm. Coffee Sand, MGS locality 129.

PLATE 7



EXPLANATION PLATE 8

Figure — Page

1-4 **Turritella trilira** Conrad, 1860 49-50

1. Figured specimen 1538 MGS - Stub No. 14 (x30), height 3.2 mm, width 0.9 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 6, 3-10-1988.
2. Figured specimen 1539 MGS (x3.8), height of incomplete specimen 16.7 mm. Coffee Sand, MGS locality 129, bed E.
3. Figured specimen 1540 MGS (x3.8), height of incomplete specimen 18.4 mm. Coffee Sand, MGS locality 129, bed E.
4. Figured specimen 1541 MGS (x1), height of incomplete specimen 57 mm. Coffee Sand, MGS locality 129, bed E.

5 **Turritella vertebroides** Morton, 1834 50-51

Figured specimen 1542 MGS (x1), height of incomplete specimen 56 mm. Coffee Sand, MGS locality 129.

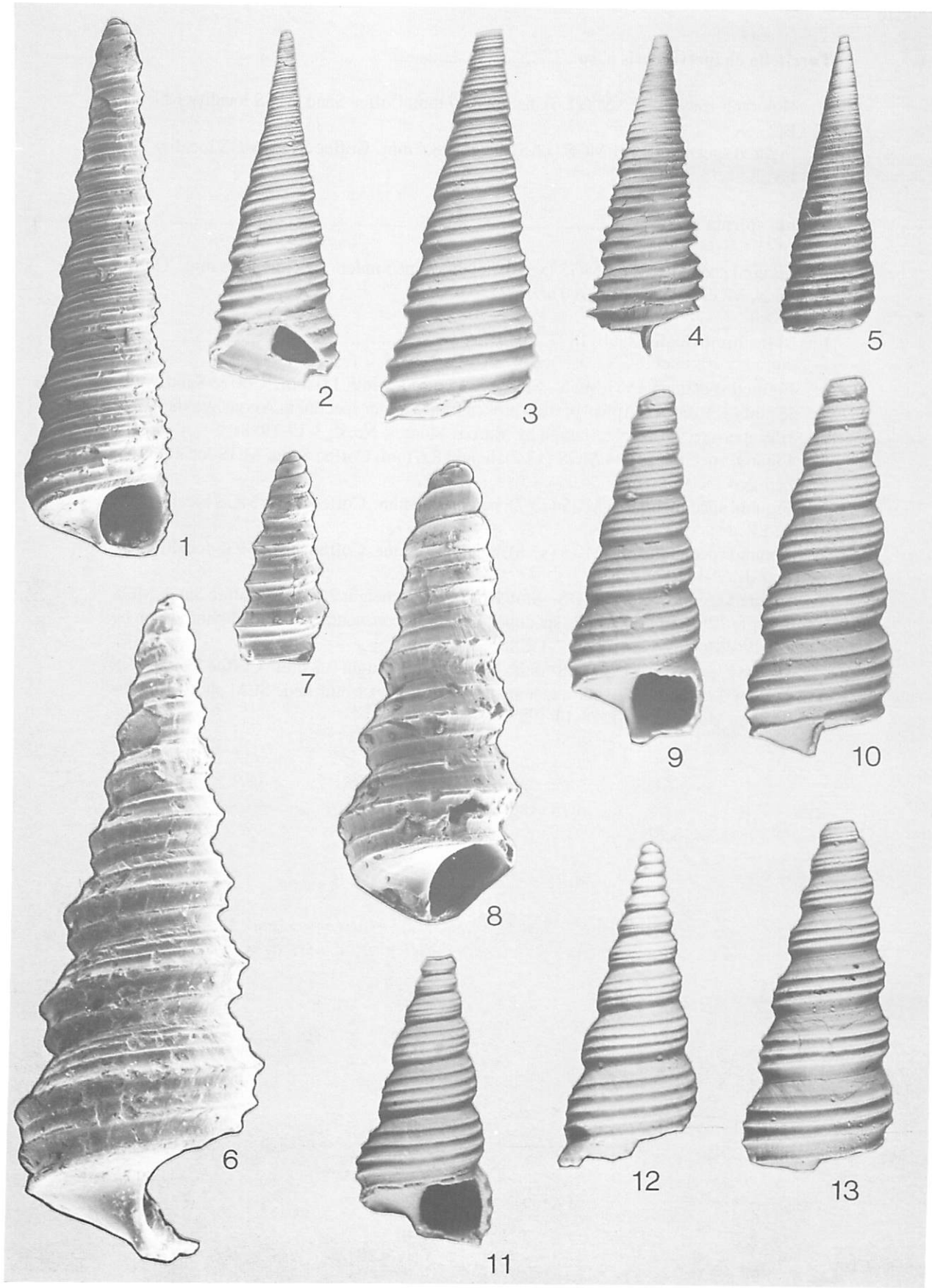
6-12 **Turritella quadrilira** (Johnson, 1898) 50

6. Figured specimen 1543 MGS - Stub No. 10 (x36), height 3.3 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 13, 10-13-1987.
7. Figured specimen 1544 MGS - Stub No. 14 (x30), height of incomplete specimen 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 6, 3-10-1988.
8. Figured specimen 1545 MGS - Stub No. 14 (x55), height of incomplete specimen 1.5 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 7, 3-10-1988.
9. Figured specimen 1546 MGS (x5), height of incomplete specimen 12.6 mm. Coffee Sand, MGS locality 129, bed B.
10. Figured specimen 1547 MGS (x3.9), height of incomplete specimen 17.6 mm. Coffee Sand, MGS locality 129, bed E.
11. Figured specimen 1548 MGS (x5.4), height of incomplete specimen 9.8 mm. Coffee Sand, MGS locality 129.
12. Figured specimen 1549 MGS (x6.7), height of incomplete specimen 8.8 mm. Coffee Sand, MGS locality 129.

13 **Turritella quadrilira** Johnson, 1898 var. 50

Figured specimen 1550 MGS (x4), height of incomplete specimen 16.2 mm. Coffee Sand, MGS locality 129, bed B. Trilirate variety of *T. quadrilira*.

PLATE 8



EXPLANATION PLATE 9

Figure — Page

1-2 **Turritella chapelvillensis** n. sp. 51

1. Holotype 456987 USNM (x1.5), height 31.7 mm. Coffee Sand, MGS locality 129, bed B.
2. Figured specimen 1551 MGS (x1.5), height 28.4 mm. Coffee Sand, MGS locality 129, bed B.

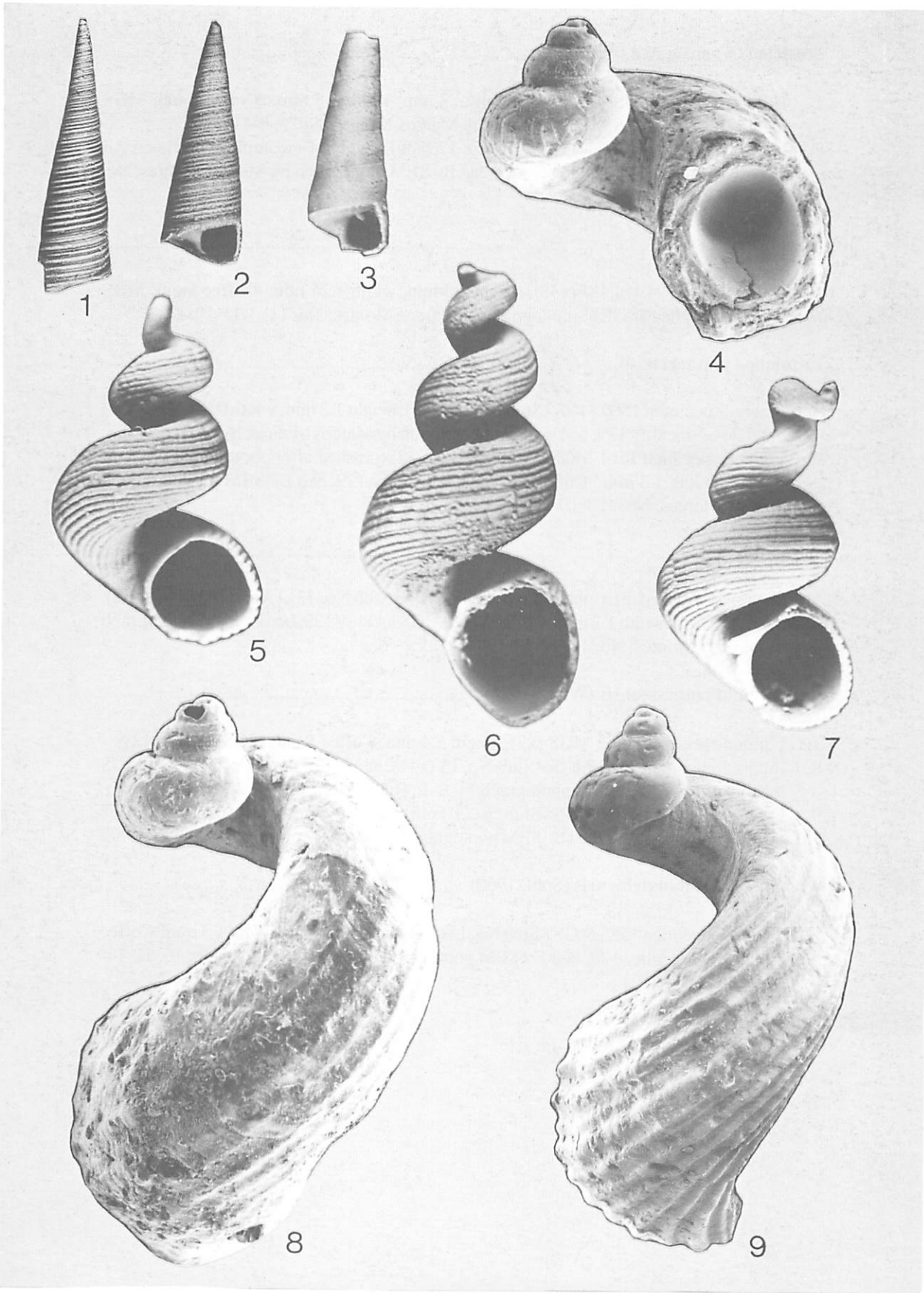
3 **Eulima spirala** n. sp. 87-88

Figured specimen 1552 MGS (x6.9), height of incomplete specimen 5.8 mm. Coffee Sand, MGS locality 129. A *Turritella* look-alike.

4-9 **Laxispira lumbricalis** Gabb, 1877 52

4. Figured specimen 1553 MGS - Stub No. 16 (x55), width 1.0 mm. Coffee Sand, MGS locality 129, bed E. Apical portion broken from a larger specimen. A concave shell plug fills aperture. SEM photograph by Marcos Montes, No. 4, 3-17-1988.
5. Figured specimen 1554 MGS (x7.2), height 8.6 mm. Coffee Sand, MGS locality 129, bed B.
6. Figured specimen 1555 MGS (x5.7), height 14.5 mm. Coffee Sand, MGS locality 129, bed B.
7. Figured specimen 1556 MGS (x5.8), height 10.8 mm. Coffee Sand, MGS locality 129, bed B.
8. Figured specimen 1557 MGS - Stub No. 19 (x50), height 2.0 mm. Coffee Sand, MGS locality 129, bed E. Juvenile specimen with protoconch attached. SEM photograph by Marcos Montes, No. 16, 3-17-1988.
9. Figured specimen 1558 MGS - Stub No. 12 (x40), height 2.2 mm. Coffee Sand, MGS locality 129, bed E. Juvenile specimen with protoconch attached. SEM photograph by Marcos Montes, No. 5, 12-14-1987.

PLATE 9



EXPLANATION PLATE 10

Figure — Page

1-2 **Stosicia** (s.l.) **antiqua** n. sp. 54

1. Holotype 456990 USNM (x24), height 3.3 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Marcos Montes, No. 3, 3-11-1988.
2. Figured specimen 1559 MGS - Stub No. 17 (x36), height of incomplete specimen 2.3 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Marcos Montes, No. 4, 3-11-1988.

3 **Nozeba crassa** n. sp. 57

Holotype 456994 USNM (x32), height 2.3 mm, width 1.24 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Marcos Montes, No. 11, 3-11-1988.

4-5 **Entomope ponderi** n. sp. 56

4. Figured specimen 1560 MGS - Stub No. 13 (x44), height 1.2 mm, width 0.9 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 3, 3-10-1988.
5. Figured specimen 1561 MGS - Stub No. 13 (x32) (crushed after photography), height 1.9 mm, width 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 1, 3-10-1988.

6 **Entomope** sp. 56-57

Specimen crushed after photography (remains on Stub No. 13). Apertural view (x32), height 2.1 mm, width 1.2 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 14, 12-14-1987.

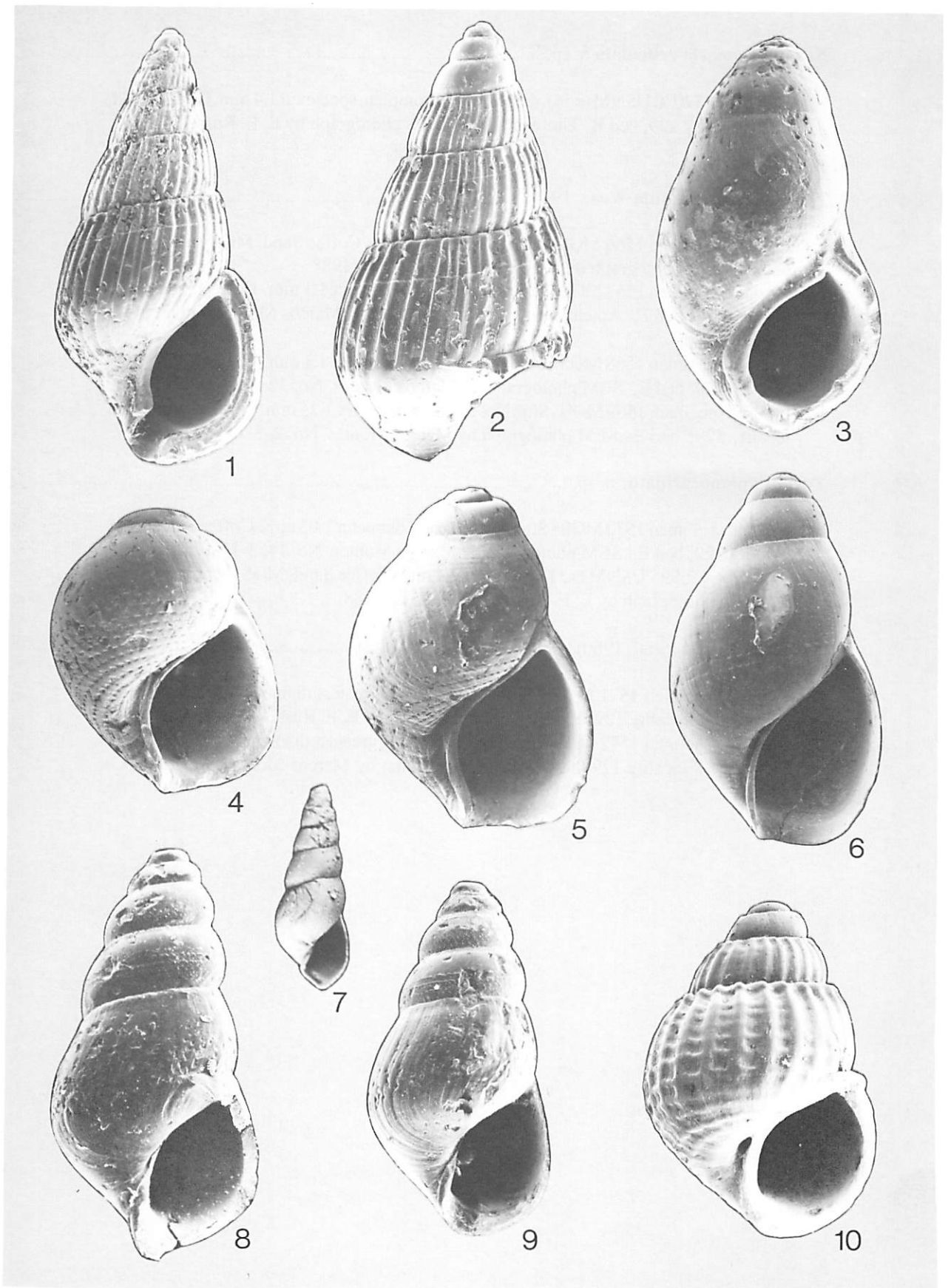
7-9 **Cossmannia tennesseensis** (Wade, 1926) 55

7. Figured specimen 1562 MGS (x7), height 5.4 mm. Coffee Sand, MGS locality 129.
8. Figured specimen 1563 MGS - Stub No. 15 (x44), height 1.7 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 18, 1-12-1988.
9. Figured specimen 1564 MGS - Stub No. 20 (x48), height 1.3 mm, width 0.7 mm. Coffee Sand, MGS locality 29, bed E. SEM photograph by Marcos Montes, No. 37, 3-17-1988.

10 **Alvania** (s.l.) **tallahatchiensis** (Sohl, 1960) 53-54

Figured specimen 1565 MGS - Stub No. 13 (x32), height 1.9 mm, width 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 19, 12-14-1987.

PLATE 10



EXPLANATION PLATE 11

Figure — Page

1 **Neamphitomaria reticulata** n. sp. 93

Holotype 457030 USNM (x56), diameter of incomplete specimen 1.4 mm. Coffee Sand, MGS locality 129, bed B. Umbical view. SEM photograph by E. E. Russell, No. 15, 12-2-1987.

2-5 **Teinostoma prenanum** Wade, 1926 59

2. Figured specimen 1566 MGS (x37), diameter 2.0 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 5, 1-12-1988.
3. Figured specimen 1567 MGS - Stub No. 16 (x44), diameter 1.1 mm. Coffee Sand, MGS locality 129, bed E. Apical view. SEM photograph by Marcos Montes, No. 3, 3-17-1988.
4. Figured specimen 1568 MGS Stub No. 20 (x53), diameter 1.1 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 32, 3-17-1988.
5. Figured specimen 1569 MGS - Stub No. 16 (x46), diameter 1.25 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 2, 3-17-1988.

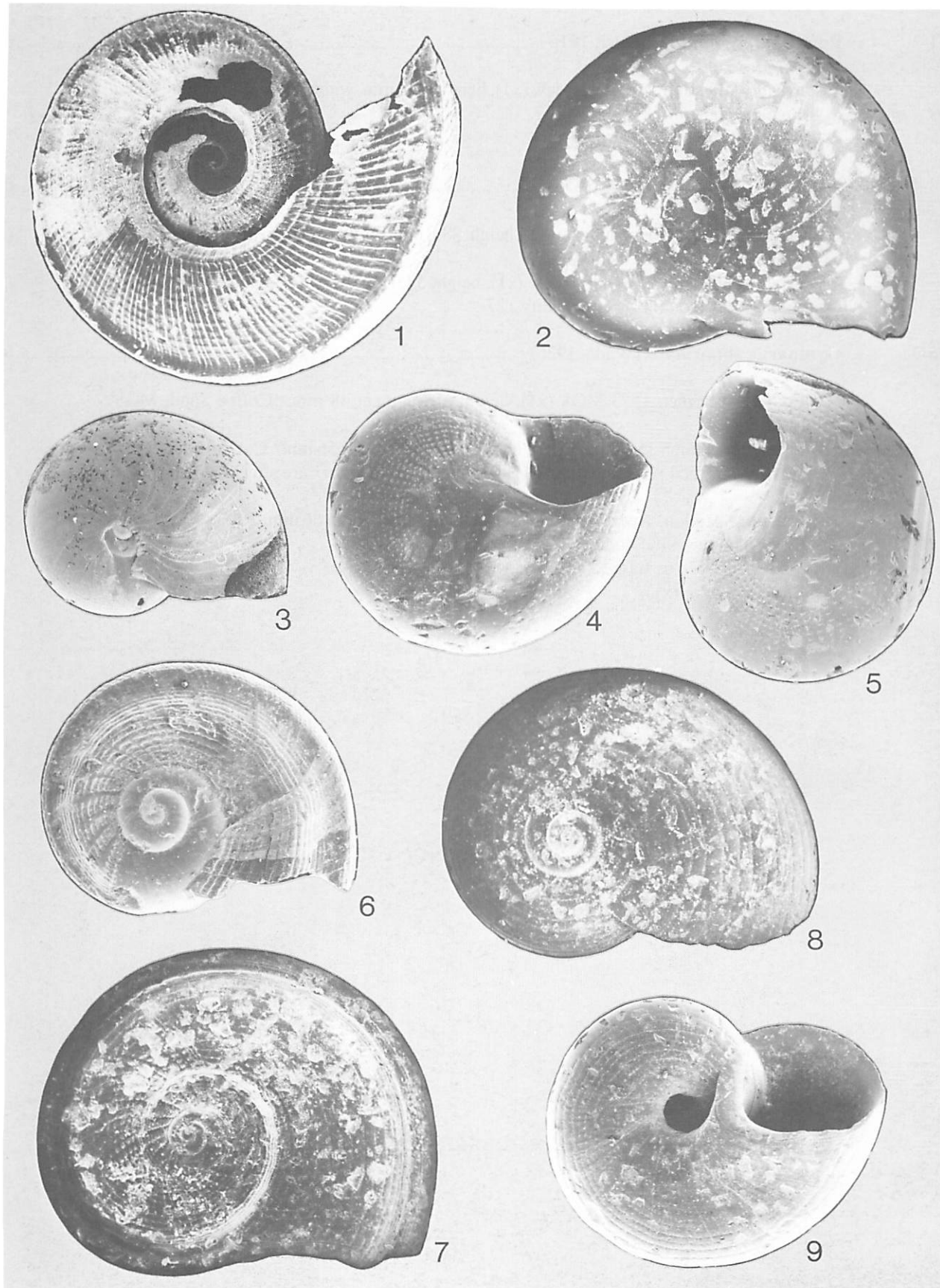
6-7 **Tornus? planocarinatus** n. sp. 58

6. Figured specimen 1570 MGS - Stub No. 19 (x56), diameter 1.05 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 14, 3-17-1988.
7. Holotype 456995 USNM (x31), diameter 2.4 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 3, 1-12-1988.

8-9 **Solariorbis clara** (Sohl, 1960) 58-59

8. Figured specimen 1571 MGS - Stub No. 15 (x31), greatest diameter 1.9 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 8, 1-12-1988.
9. Figured specimen 1572 MGS - Stub No. 20 (x41), greatest diameter 1.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 28, 3-17-1988.

PLATE 11



EXPLANATION PLATE 12

Figure — Page

1-2 **Pugnellus goldmani** Gardner, 1916 68

1. Private collection. Apertural view (x1), height 66.8 mm, width 43.0. Ripley Fm., Coon Creek Tongue, MGS locality 127.
2. Same specimen as figure 1 (x1).

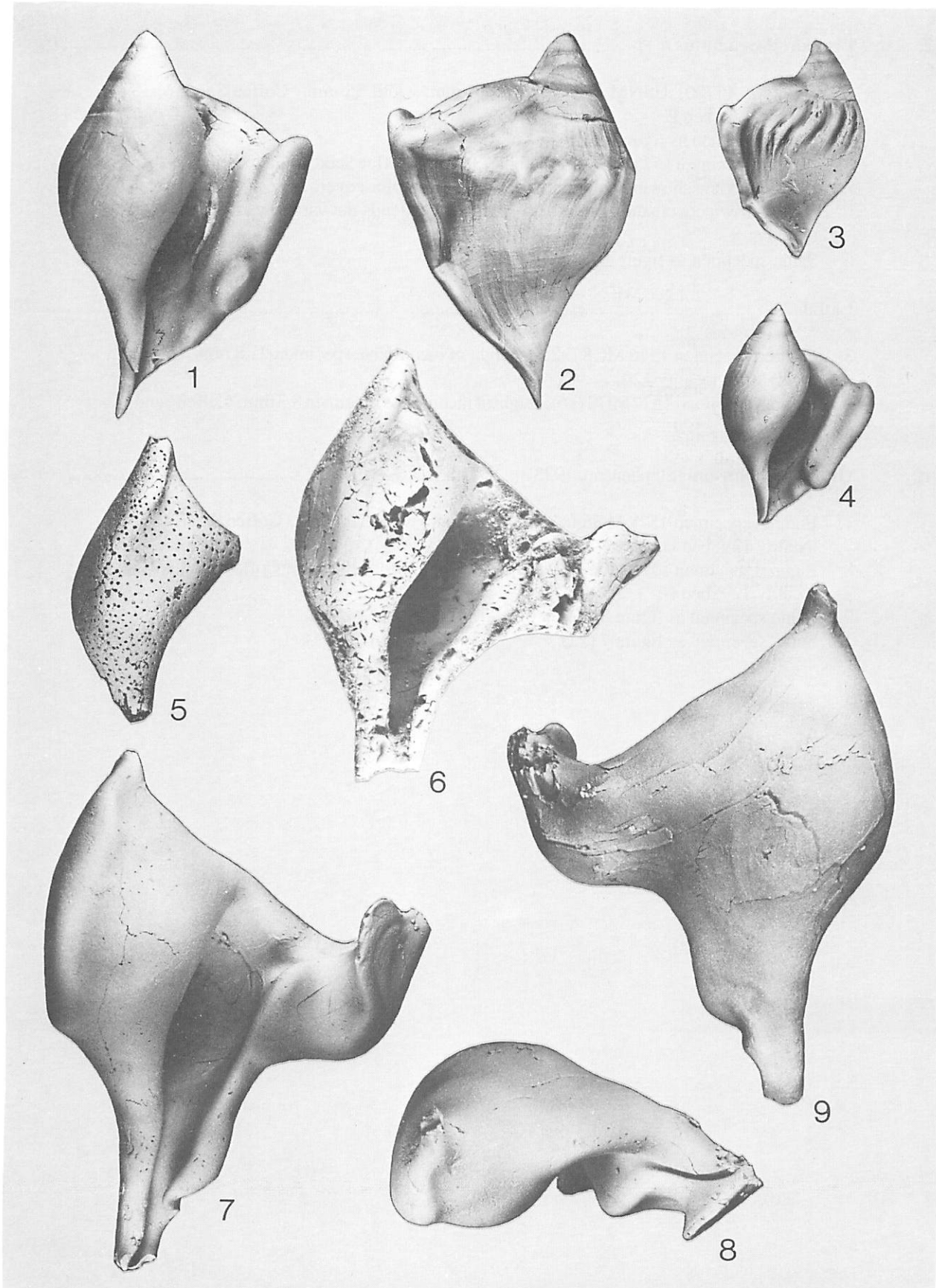
3-4 **Pugnellus densatus** (Conrad, 1858) 68

3. Private collection. Dorsal view (x1), height 38.8 mm, width 25.8 mm. Ripley Fm., Coon Creek Tongue, MGS locality 127.
4. Private collection. Apertural view (x1), height 37.6 mm, width 26.4 mm. Ripley Fm., Coon Creek Tongue, MGS locality 127.

5-9 **Gymnarus abnormalis** (Wade, 1926) 67

5. Figured specimen 1573 MGS (x1), height of fragment 48 mm. Coffee Sand, MGS locality 129.
6. Figured specimen 1574 MGS (x1), height 64.6 mm, width 56 mm. Coffee Sand, MGS locality 129, bed A. Annelid tubes and indurated sand matrix are attached to the outer lip.
7. Private collection. Apertural view (x1), height 91 mm, width 66 mm. Ripley Fm., Coon Creek Tongue, MGS locality 127.
8. Same specimen as figure 7 (x1).
9. Same as above (x1).

PLATE 12



EXPLANATION PLATE 13

Figure — Page

1-2, 5-6 **Lispodesthes amplus** n. sp. 67-68

1. Holotype 457001 USNM (x1), height 63.4 mm, width 55 mm. Coffee Sand, MGS locality 129, bed E.
2. Same specimen as figure 1.
5. Figured specimen 1575 MGS (x1), height 73.6 mm. Coffee Sand, MGS locality 129, bed B. Dorsal view showing color pattern. A light tan color covers spire and outer lip. A darker brown covers the lower dorsal region and extends outward toward the digits in two rays.
6. Same specimen as figure 5 (x1).

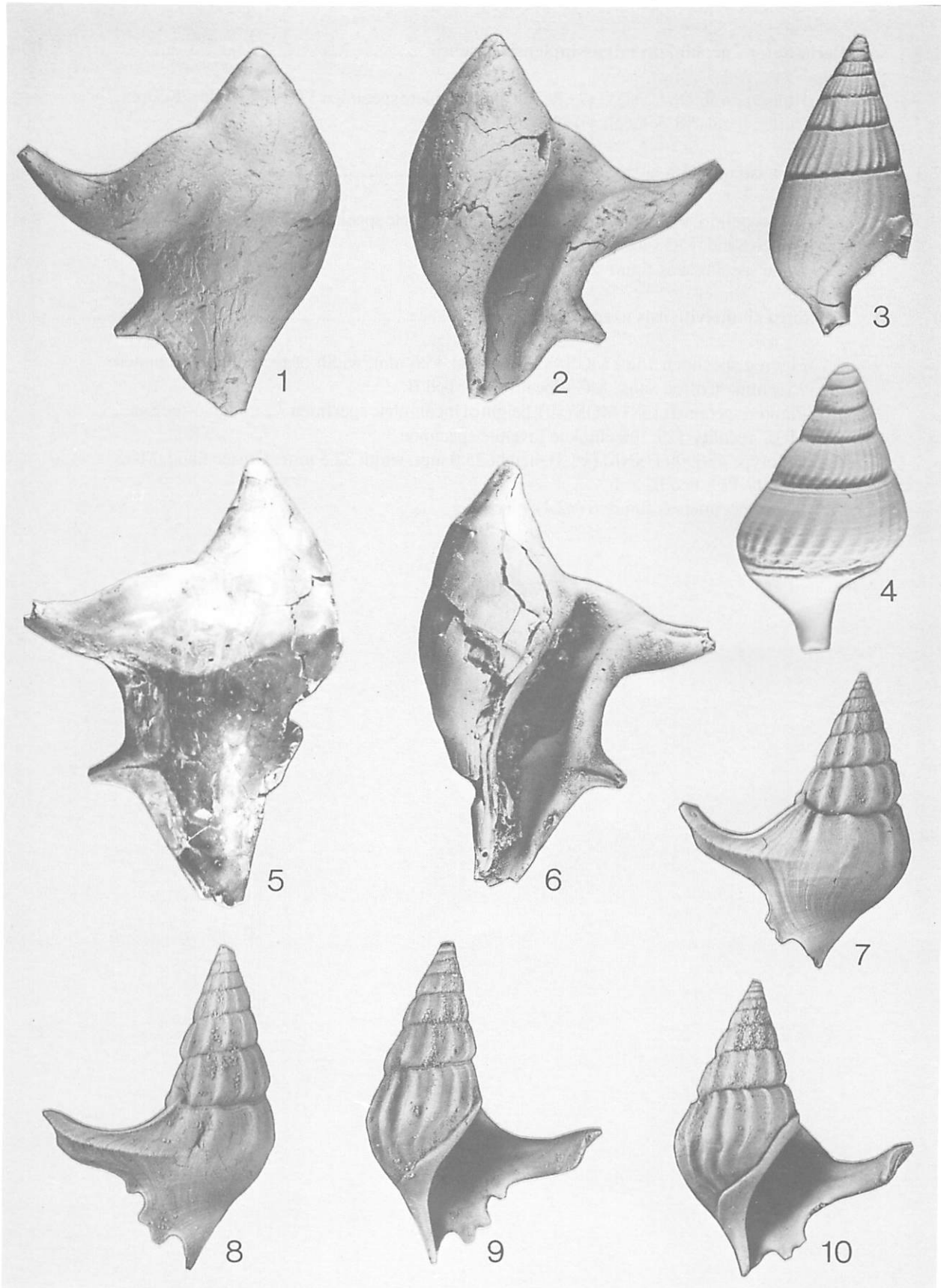
3-4 **Latiala?** sp. 61

3. Figured specimen 1576 MGS (x2.4), height of incomplete specimen 21.8 mm. Coffee Sand, MGS locality 129.
4. Figured specimen 1577 MGS (x6), height of incomplete specimen 8.3 mm. Coffee Sand, MGS locality 129.

7-10 **Graciliala johnsoni** (Stephenson, 1923) 61-62

7. Figured specimen 1578 MGS (x2), height 26 mm, width 20.5 mm. Coffee Sand, MGS locality 129, bed B.
8. Figured specimen 1579 MGS (x2), height 28.2 mm, width 20.2 mm. Coffee Sand, MGS locality 129, bed B.
9. Same specimen as figure 8 (x2).
10. Same specimen as figure 7 (x2).

PLATE 13



EXPLANATION PLATE 14

Figure — Page

1 **Perissoptera prolabiata mississippiensis** n. subsp. 60-61

Holotype 456996 USNM (x2), height of incomplete specimen 37.5 mm, width 28.5 mm. Coffee Sand, MGS locality 129, bed B.

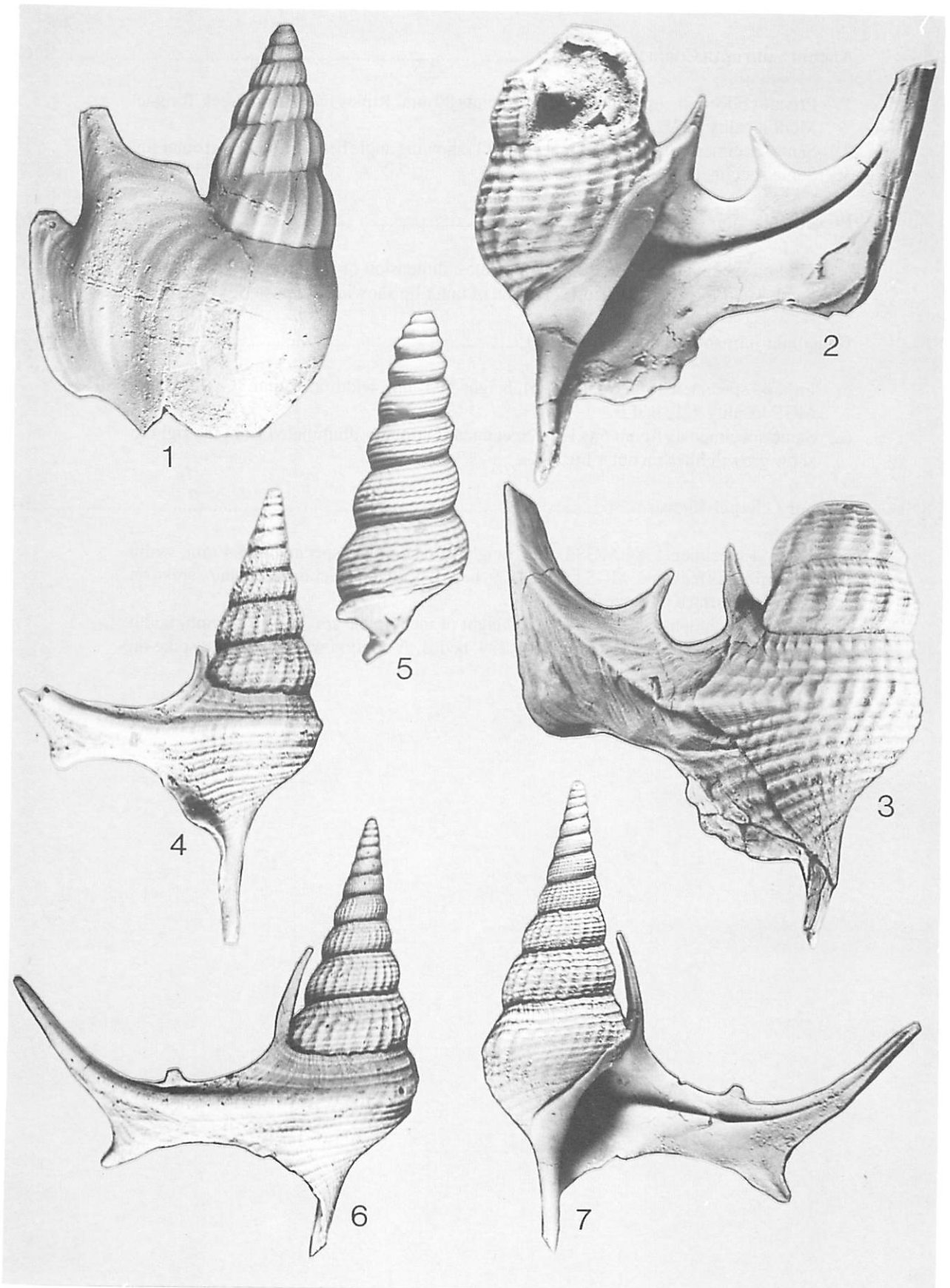
2-3 **Anchura corniculata** n. sp. 63-64

2. Holotype 456998 USNM (x1.7), height of incomplete specimen 47.5 mm, width 47 mm. Coffee Sand, MGS locality 129, bed E.
3. Same specimen as figure 2 (x1.7).

4-7 **Anchura chapelvillensis** n. sp. 64

4. Figured specimen 1580 MGS (x2.2), height 35.6 mm, width of incomplete specimen 25.5 mm. Coffee Sand, MGS locality 129, bed B.
5. Figured specimen 1581 MGS (x9), height of incomplete specimen 7.2 mm. Coffee Sand, MGS locality 129. Incomplete juvenile specimen.
6. Holotype 456999 USNM (x2.3), height 35.0 mm, width 32.5 mm. Coffee Sand, MGS locality 129, bed B.
7. Same specimen as figure 6 (x2.4).

PLATE 14



EXPLANATION PLATE 15

Figure — Page

1-3 **Anchura abrupta** Conrad, 1860 62

1. Private collection. Apertural view (x1), height 80 mm. Ripley Fm., Coon Creek Tongue, MGS locality 127.
2. Same specimen as figure 1. Labral view (x1) showing angle between spire and outer lip.
3. Same specimen as above (x1).

4 **Pterocerella maryea** n. sp. 65

Figured specimen 1582 MGS (x2.4), greatest dimension of fragment 23 mm. Coffee Sand, MGS locality 129, bed B. Portion of outer lip showing the posterior two digits.

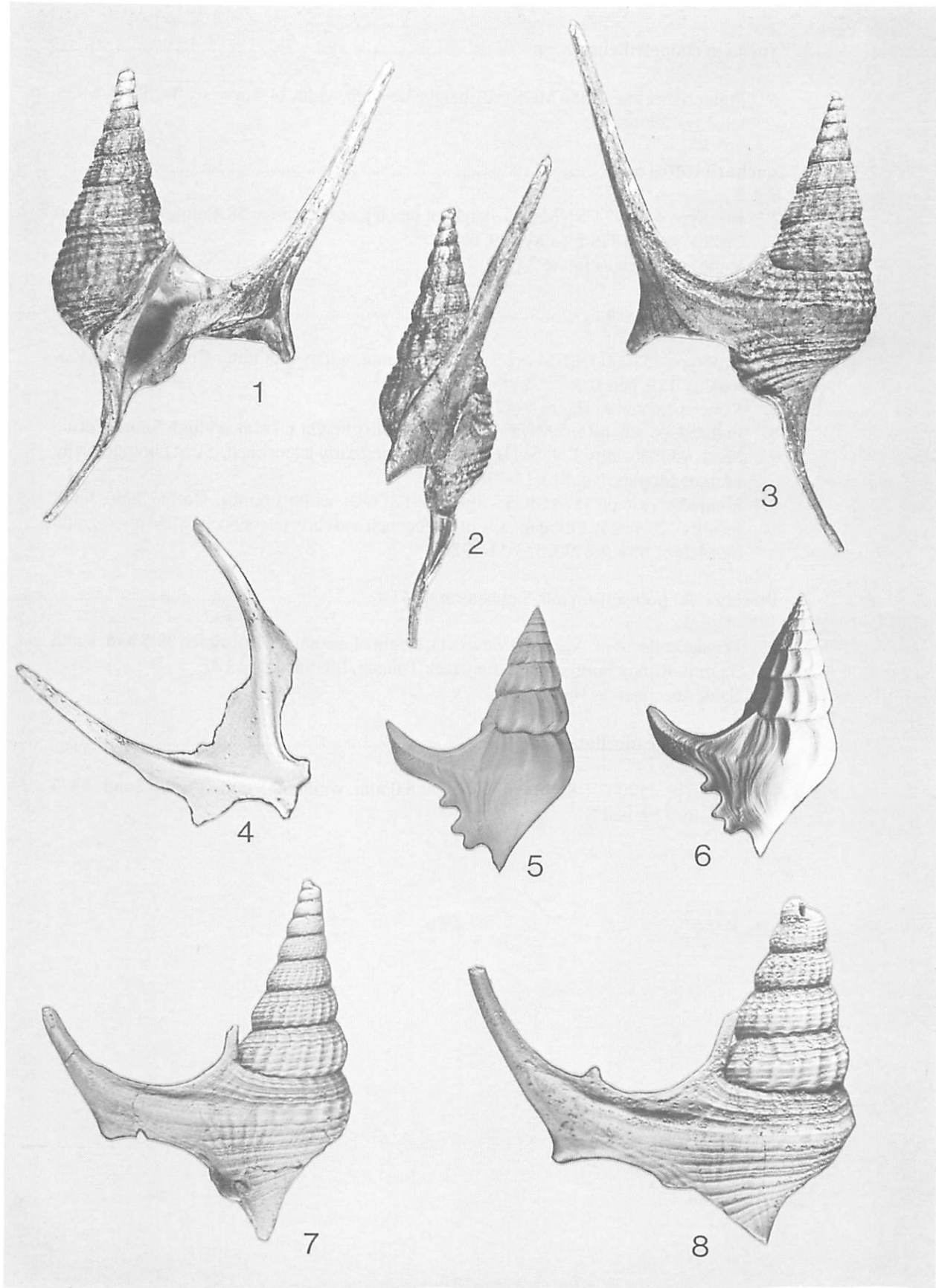
5-6 **Graciliala johnsoni** (Stephenson, 1923) 61-62

5. Figured specimen 1583 MGS (x1.5), height 31.1 mm, width 22.7 mm. Coffee Sand, MGS locality 129, bed B.
6. Same specimen as figure 5 (x1.5). Specimen is strongly illuminated from the right to show growth lines on outer lip.

7-8 **Anchura chapelvillensis** n. sp. 64

7. Figured specimen 1584 MGS (x2.5), height of incomplete specimen 25.4 mm, width 22.3 mm. Coffee Sand, MGS locality 129, bed B. Variation lacking secondary spike on the upper surface of outer lip.
8. Figured specimen 1585 MGS (x2.5), height of incomplete specimen 24.7 mm, width 28.6 mm. Coffee Sand, MGS locality 129, bed B. Variation with secondary spike on outer lip.

PLATE 15



EXPLANATION PLATE 16

Figure — Page

1 **Anchura chapelvillensis** n. sp. 64

Figured specimen 1586 MGS (x2), height 32.4 mm, width 24.5 mm. Coffee Sand, MGS locality 129, bed B.

2-3 **Anchura coffea** n. sp. 63

2. Holotype 456997 USNM (x1), height of incomplete specimen 58.4 mm, width 56 mm. Coffee Sand, MGS locality 129, bed B.
3. Same specimen as figure 2 (x1).

4-5, 8-9 **Pterocerella maryea** n. sp. 65

4. Holotype 457000 USNM (x2.2), height 25 mm, width 19.8 mm. Coffee Sand, MGS locality 129, bed B.
5. Same specimen as figure 4 (x2).
8. Figured specimen 1587 MGS - Stub No. 17 (x40), height 1.7 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed B. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 8, 3-11-1988.
9. Figured specimen 1588 MGS - Stub No. 17 (x40), width 1.6 mm. Coffee Sand, MGS locality 129, bed B. Oblique view of protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 9, 3-11-1988.

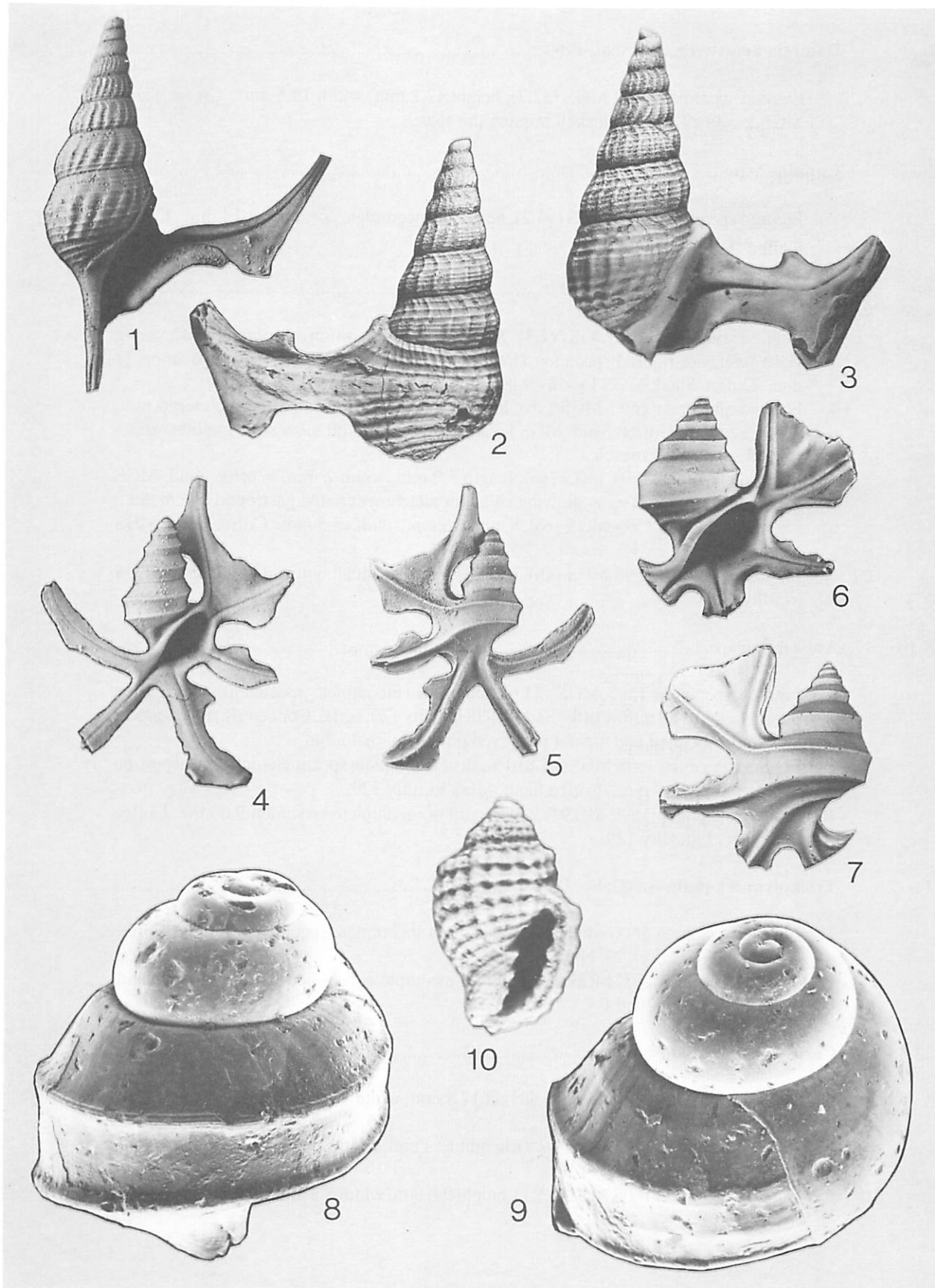
6-7 **Pterocerella poinsettiformis** Stephenson, 1941 64

6. Private collection. Apertural view (x1), height of incomplete specimen 38.5 mm, width 38 mm. Ripley Formation, Coon Creek Tongue, MGS locality 127.
7. Same specimen as figure 6 (x1).

10 **Colombellina cancellata** n. sp. 68-69

Holotype 457002 USNM (x5.3), height 8.0 mm, width 5.35 mm. Coffee Sand, MGS locality 129, bed E.

PLATE 16



EXPLANATION PLATE 17

Figure — Page

1 **Damesia keownvillensis** Sohl, 1960 94

Figured specimen 1589 MGS (x2.7), height 12.2 mm, width 19.5 mm. Coffee Sand, MGS locality 129. Adult shell missing the apex.

2 **Capulus?** sp. 70

Figured specimen 1590 MGS (x4.2), height of incomplete specimen 10.4 mm. Coffee Sand, MGS locality 129.

3-7 **Thylacus cretaceus** Conrad, 1860 69-70

3. Figured specimen 1591 MGS (x2.3). Specimen in life position on columella of a young *Volutomorpha*, figured specimen 1592 MGS. Height of *Volutomorpha* specimen 27 mm. Coffee Sand, MGS locality 128.
4. Figured specimen 1593 MGS (x6), length (=height) of incomplete specimen 6 mm, width 3.5 mm. Coffee Sand, MGS locality 129. Apertural view showing horseshoe-shaped support for muscle.
5. Figured specimen 1594 MGS (x6), length 3.9 mm, width 2 mm. Coffee Sand, MGS locality 129. Lateral view showing sinus for attachment to the gastropod columella.
6. Figured specimen 1595 MGS (x6), length 6.5 mm, width 3.5 mm. Coffee Sand, MGS locality 129.
7. Figured specimen 1596 MGS (x6), length 7.0 mm, width 3.6 mm. Coffee Sand, MGS locality 129.

8-10 **Anisomyon** sp. 95

8. Figured specimen 1597 MGS (x1.6), length of incomplete specimen including the internal mold 34.4 mm. Coffee Sand, MGS locality 129, bed E. Concentric ridges appear on exterior of shell and are not preserved on the internal mold.
9. Figured specimen 1598 MGS (x5.8), length of incomplete specimen (only apical portion is illustrated) 10.9 mm. Coffee Sand, MGS locality 129.
10. Figured specimen 1599 MGS (x2.6), length of incomplete specimen 9.6 mm. Coffee Sand, MGS locality 129.

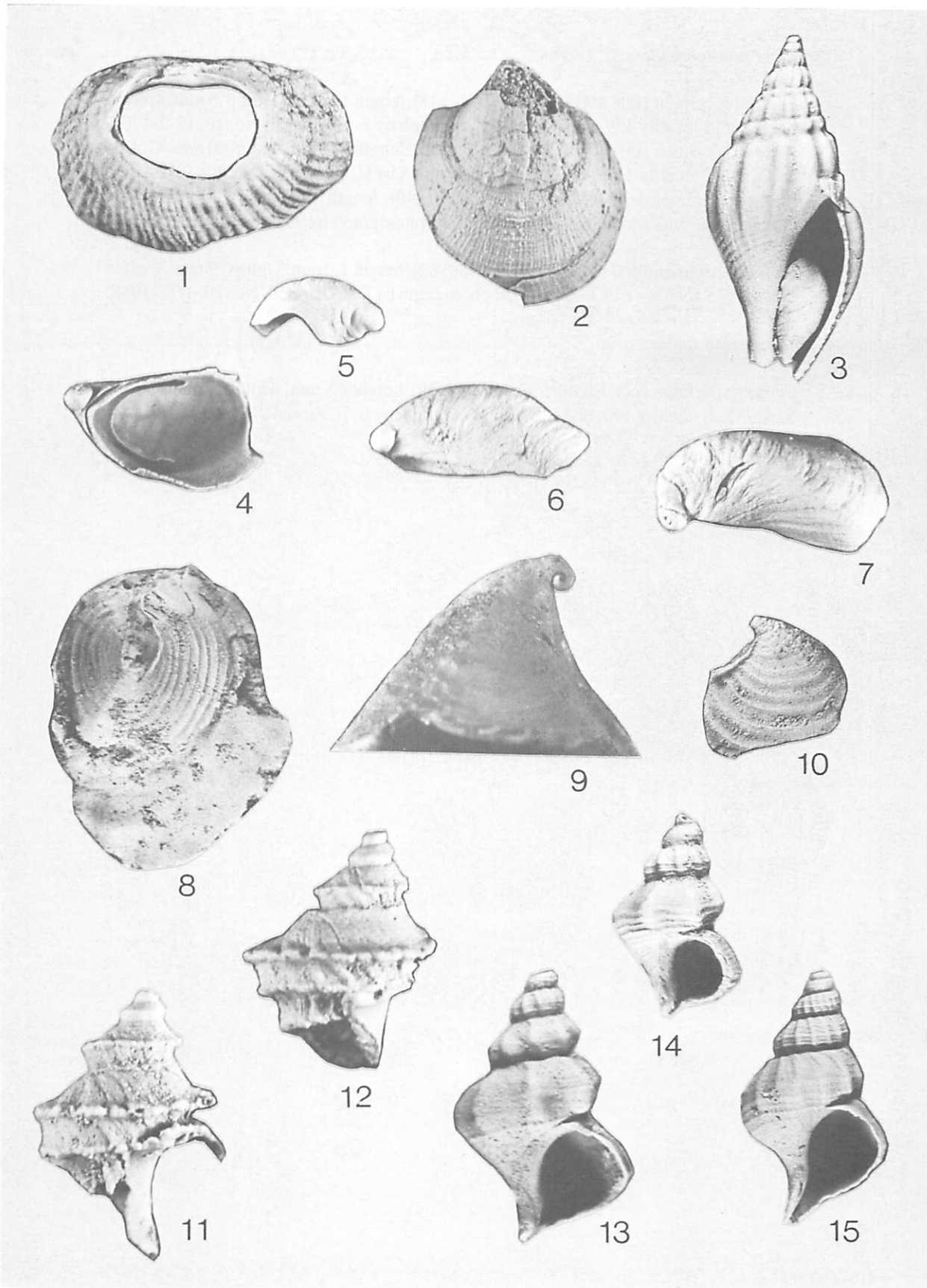
11-12 **Trichotropis squamosa** (Gabb, 1876) 70

11. Figured specimen 1600 MGS (x4.9), height of incomplete specimen 9.8 mm. Coffee Sand, MGS locality 129, bed E.
12. Figured specimen 1601 MGS (x5), height of incomplete specimen 8.3 mm. Coffee Sand, MGS locality 129, bed E.

13-15 **Cerithioderma nodosa** n. sp. 71

13. Holotype 457003 USNM (x2.8), height 17.8 mm, width 11.5 mm. Coffee Sand, MGS locality 129.
14. Figured specimen 1602 MGS (x2.7), height 13.1 mm, width 8.3 mm. Coffee Sand, MGS locality 129.
15. Figured specimen 1603 MGS (x5.1), height 9.0 mm, width 5.3 mm. Coffee Sand, MGS locality 128.

PLATE 17



EXPLANATION PLATE 18

Figure — Page

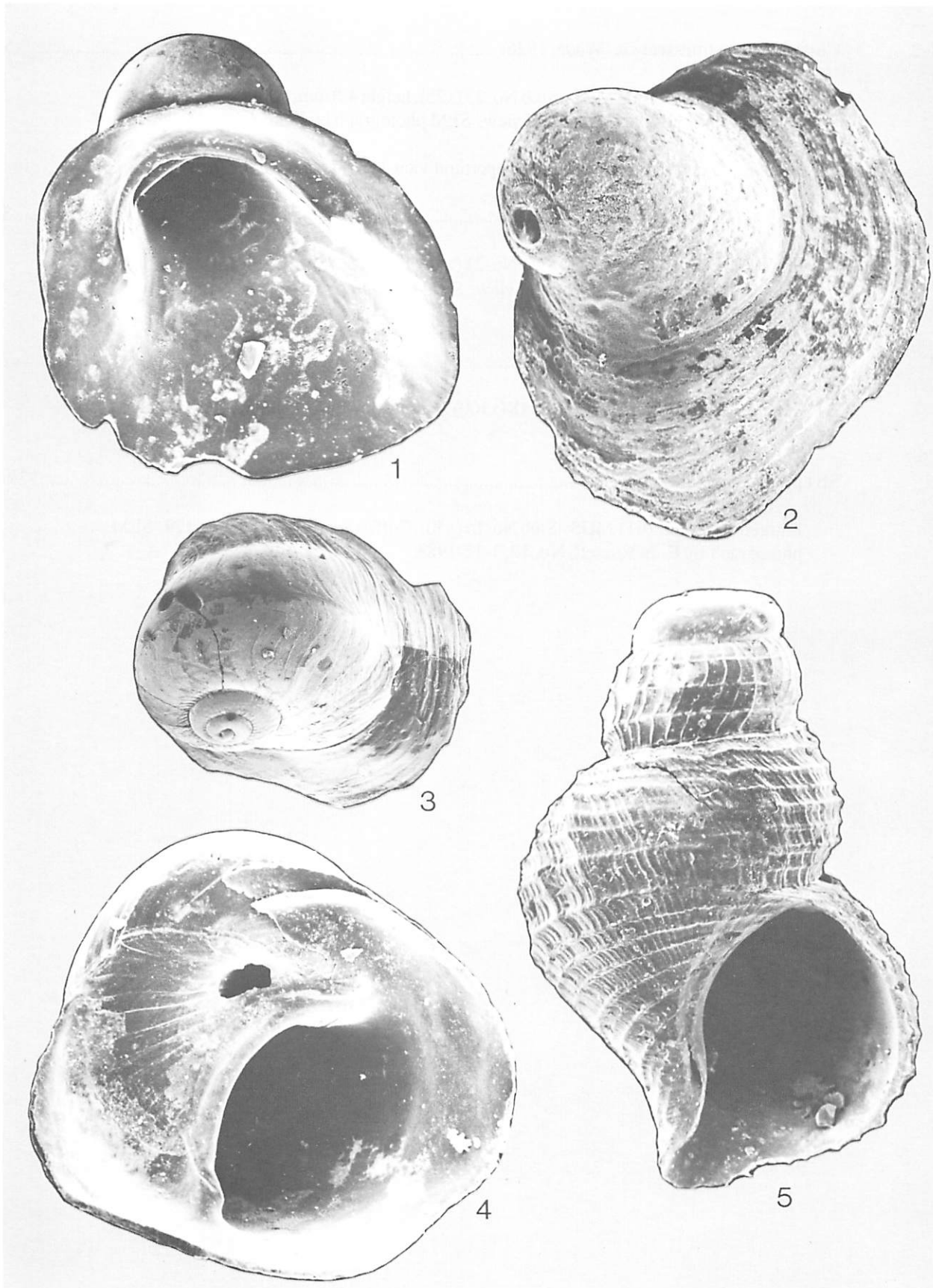
1-4 **Thylacus cretaceus** Conrad, 1860 69-70

1. Figured specimen 1604 MGS - Stub No. 11 (x43), length 1.8 mm, width 1.6 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 16, 12-2-1987.
2. Figured specimen 1605 MGS - Stub No. 11 (x43), length 1.8 mm, width 2.0 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 17, 12-2-1987.
3. Figured specimen 1606 MGS - Stub No. 14 (x40), length 1.45 mm, width 1.25 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 26, 12-14-1987.
4. Figured specimen 1607 MGS - Stub No. 15 (x80), length 1.0 mm, width 0.9 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 20, 1-12-1988.

5 **Cerithioderma nodosa** n. sp. 71

Figured specimen 1608 MGS - Stub No. 23 (x39), height 2.8 mm, width 1.8 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 10, 12-2-1987.

PLATE 18



EXPLANATION PLATE 19

Figure — Page

1-2 **Cossmannia tennesseensis** (Wade, 1926) 55

1. Figured specimen 1609 MGS - Stub No. 23 (x25), height 4.8 mm, width 2.0 mm. Coffee Sand, MGS locality 129. Apertural view. SEM photograph by Marcos Montes, No. 12, 2-10-1989.
2. Same specimen as figure 1. Oblique apertural view (x25) to show thickened outer lip.

3 **Eulima** sp. 88

Figured specimen 1610 MGS - Stub No. 21 (x45), height 2.2 mm, width 1.0 mm. Coffee Sand, MGS locality 129. Apertural view. SEM photograph by Marcos Montes, No. 6, 2-10-1989.

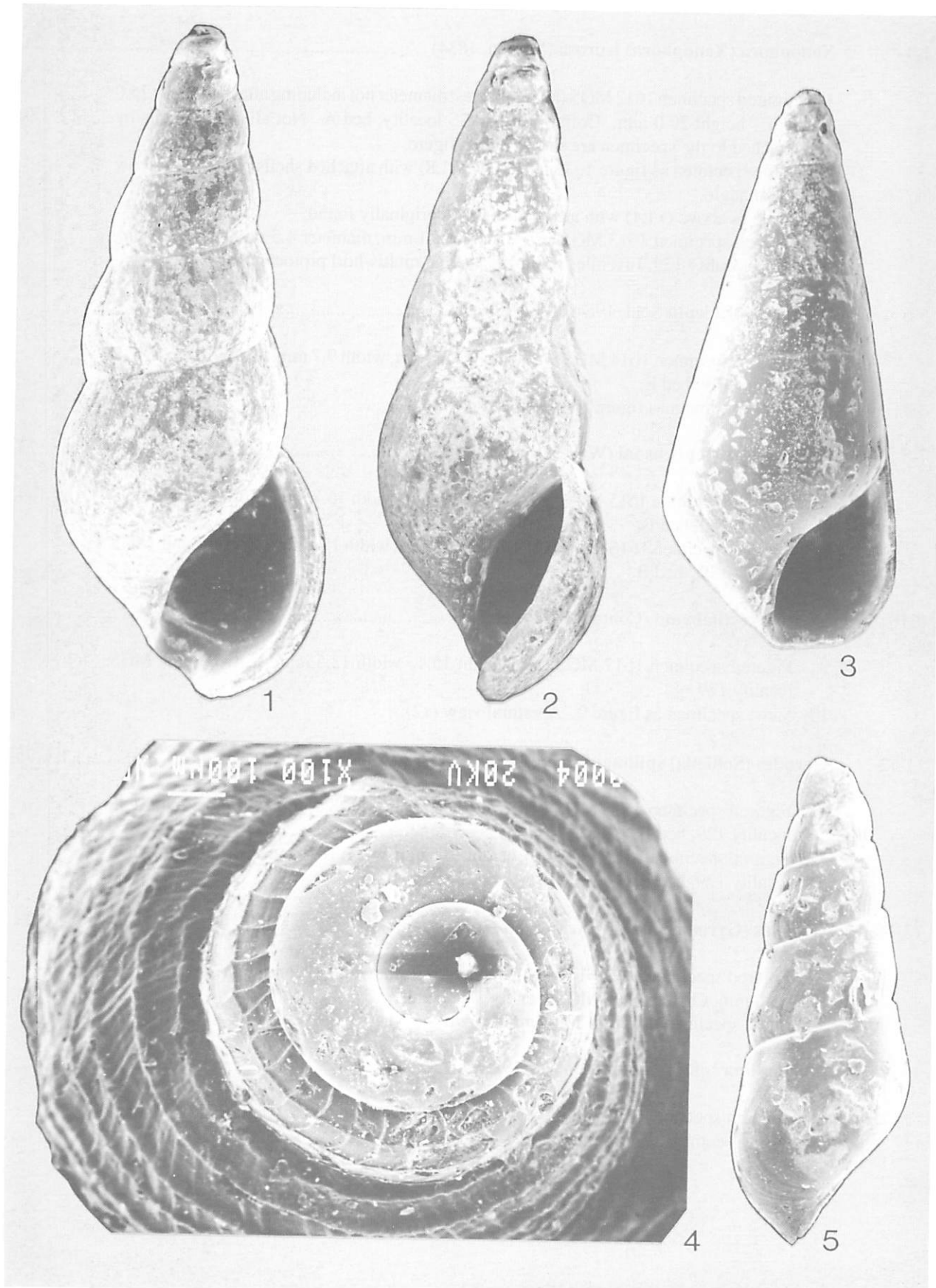
4 **Cerithioderma nodosa** n. sp. 71

Same specimen as figure 5 of Plate 18 (x100). Apical view. SEM photograph by Marcos Montes, No. 4, 5-30-1989.

5 **Streptacis? bogradi** n. sp. 93-94

Figured specimen 1611 MGS - Stub No. 15 (x50). Coffee Sand, MGS locality 129. SEM photograph by E. E. Russell, No. 12, 1-12-1988.

PLATE 19



EXPLANATION PLATE 20

Figure — Page

1-4 **Xenophora (Xenophora) leprosa** (Morton, 1834) 71-72

1. Figured specimen 1612 MGS (x2.5), greatest diameter not including attached shells 25.0 mm, height 20.0 mm. Coffee Sand, MGS locality, bed A. Not all shells originally attached to the specimen are shown in this figure.
2. Same specimen as figure 1. Lateral view (x1.8) with attached shells removed to show spiral angle.
3. Same as above (x1.4) with attached shells as originally found.
4. Figured specimen 1613 MGS (x7.3), height 3.1 mm, diameter 4.5 mm. Coffee Sand, MGS locality 129. Juvenile specimen showing multiwhorl protoconch.

5-6 **Pseudamaura lepta** Sohl, 1964 74

5. Figured specimen 1614 MGS (x3), height 15.7 mm, width 9.7 mm. Coffee Sand, MGS locality 129, bed E.
6. Same specimen as figure 5. Apertual view (x3).

7-8 **Amaurellina stephensoni** (Wade, 1926) 73-74

7. Figured specimen 1615 MGS (x2), height 19 mm, width 16.7 mm. Coffee Sand, MGS locality 129, bed B.
8. Figured specimen 1616 MGS (x2), height 22.5 mm, width 17.8 mm. Coffee Sand, MGS locality 129, bed B.

9-10 **Euspira rectilabrum** (Conrad, 1858) 76

9. Figured specimen 1617 MGS (x2), height 15.4, width 12.5 mm. Coffee Sand, MGS locality 129.
10. Same specimen as figure 9. Apertural view (x2).

11-12 **Gyrodes (Sohlella) spillmani** Gabb, 1861 75-76

11. Figured specimen 1618 MGS (x1.8), greatest diameter 28.1 mm. Coffee Sand, MGS locality 129, bed B.
12. Figured specimen 1619 MGS (x2), height 15.5 mm, width 18.8 mm. Coffee Sand, MGS locality 129, bed B.

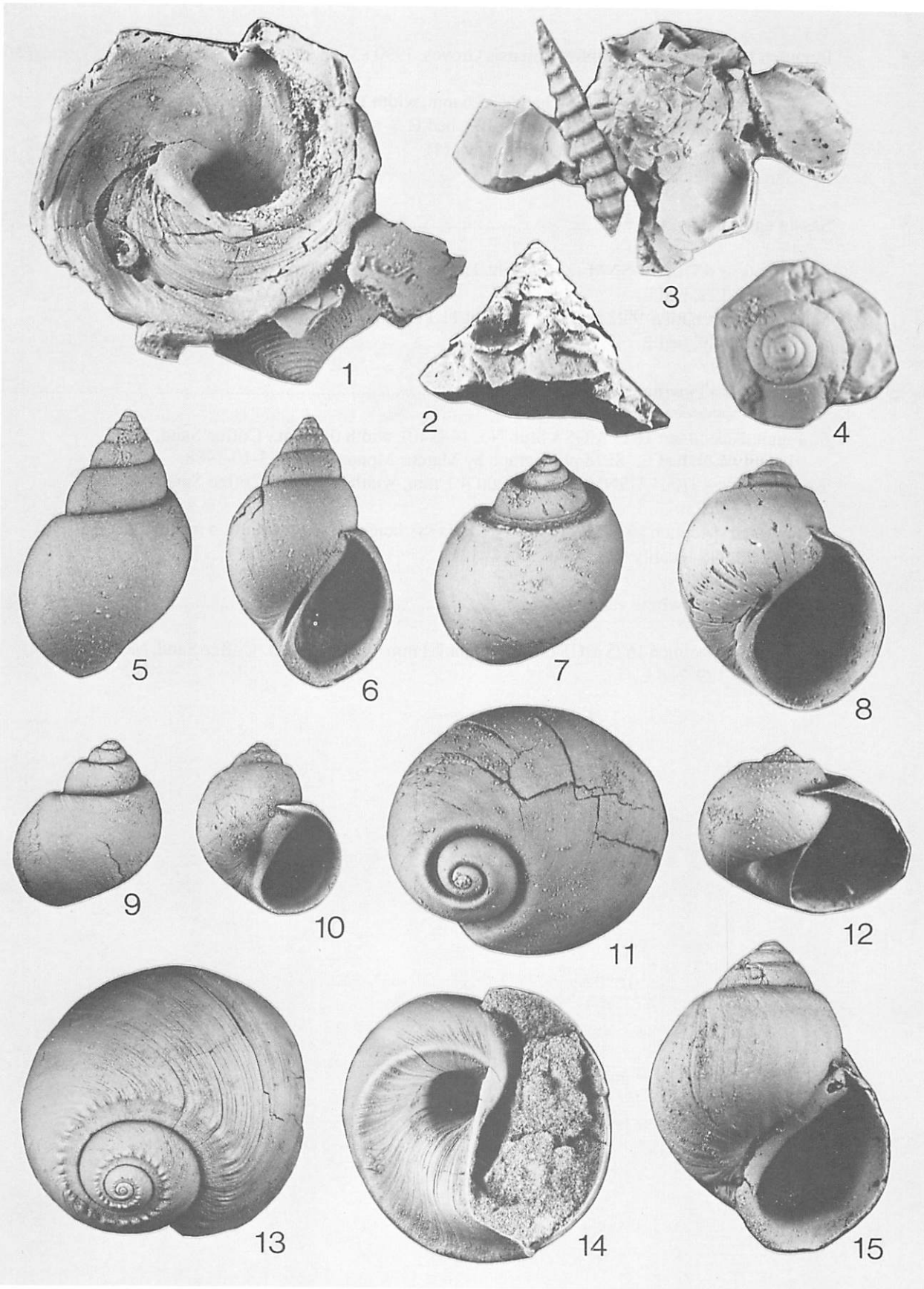
13-14 **Gyrodes (Gyrodes) major** Wade, 1926 74-75

13. Figured specimen 1620 MGS (x1), height 45.0 mm, width 49.7 mm, greatest diameter 53.0 mm. Coffee Sand, MGS locality 129, bed B.
14. Same specimen as figure 13. Umbilical view (x1).

15 **"Ampullina" cf. "A." potens** Wade, 1926 73

Figured specimen 1621 MGS (x1.5), height 37.0 mm, width 29.0 mm. Coffee Sand, MGS locality 129, bed B.

PLATE 20



EXPLANATION PLATE 21

Figure — Page

1-3 **Bernaya (Protocypraea) mississippiensis** Groves, 1990 72-73

1. Paratype 446798 USNM (x4), height 15.6 mm, width 10.5 mm, depth from base to top 8.2 mm. Coffee Sand, MGS locality 129, bed E.
2. Same specimen as figure 1. Lateral view (x4).
3. Same specimen as above (x4).

4-5 **Sassia carlea** n. sp. 78

4. Holotype 457005 USNM (x5), height 13.5 mm, width 8.4 mm. Coffee Sand, MGS locality 129, bed E.
5. Figured specimen 1622 MGS (x5), height 11.1 mm, width 7.3 mm. Coffee Sand, MGS locality 129, bed E.

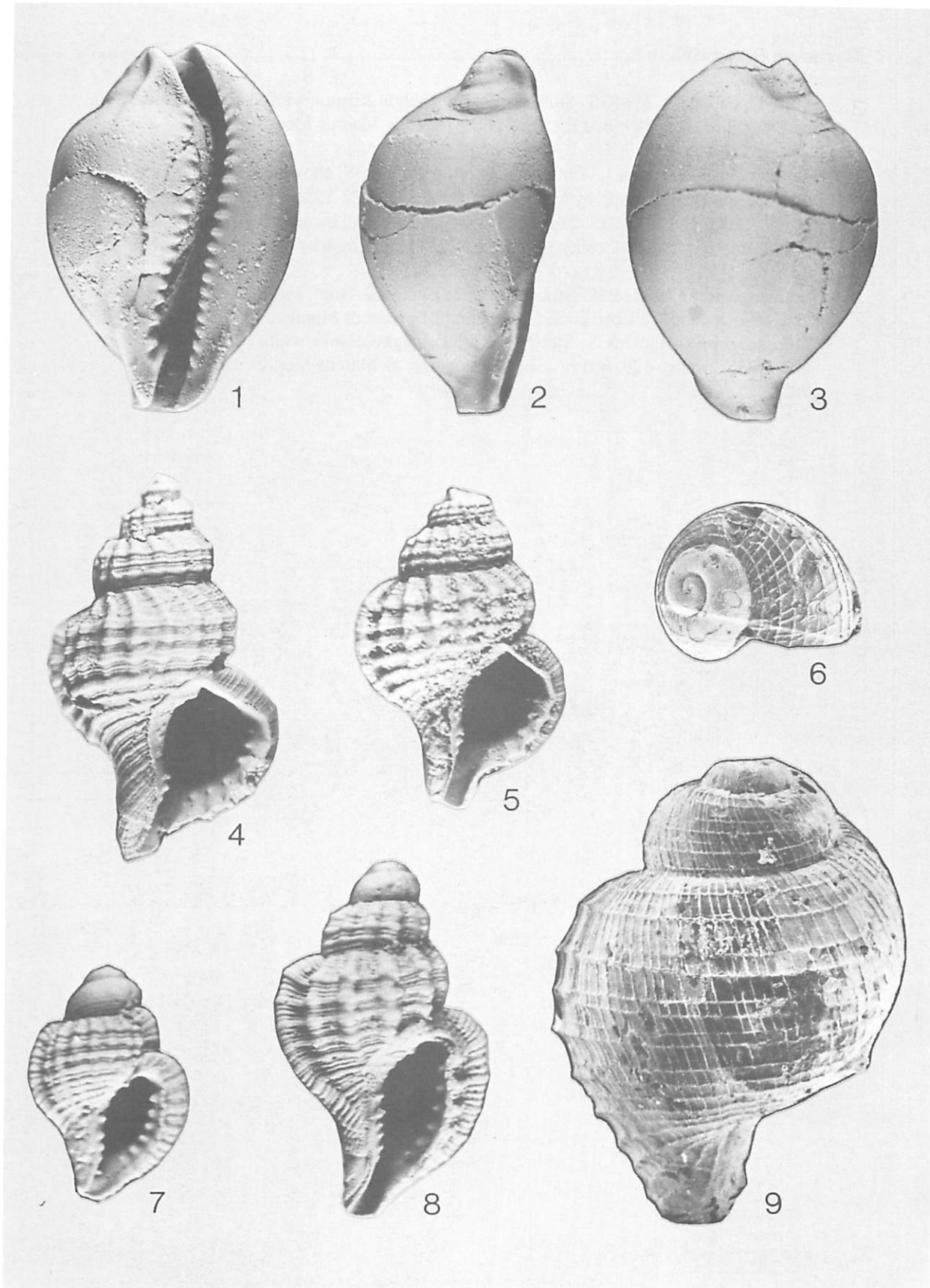
6-7,9 **Gyrineum (s.l.) gwinae** n. sp. 77

6. Figured specimen 1623 MGS - Stub No. 14 (x40), width 0.8 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 9, 3-10-1988.
7. Holotype 457004 USNM (x10), height 4.1 mm, width 2.8 mm. Coffee Sand, MGS locality 129.
9. Figured specimen 1624 MGS Stub No. 11 (x38), height 2.0 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed E.

8 **Gyrineum (s.l.) gwinae** var.? 77-78

Figured specimen 1625 MGS (x8.7), height 7.1 mm, width 4.3 mm. Coffee Sand, MGS locality 129, bed E.

PLATE 21

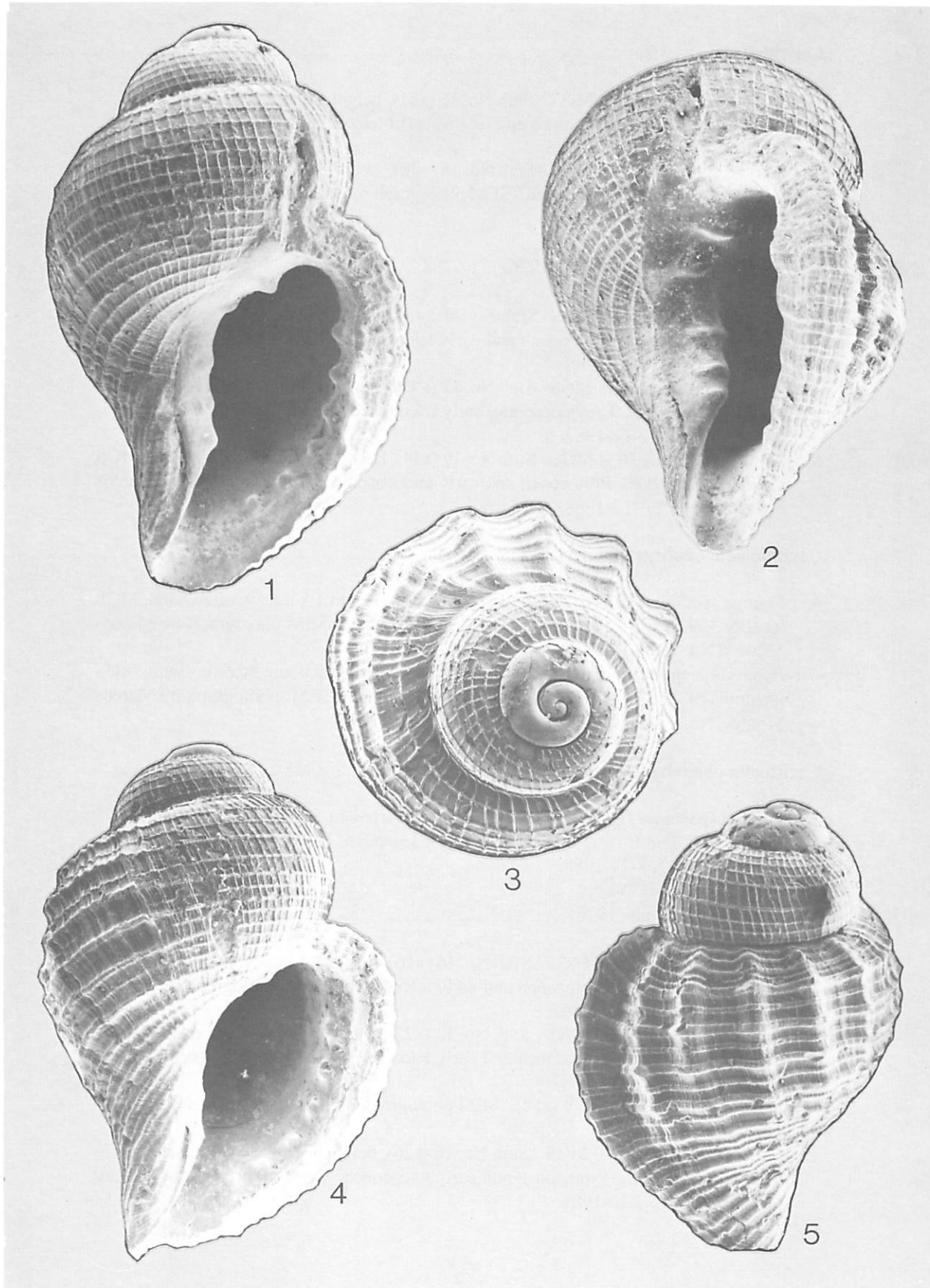


EXPLANATION PLATE 22

Figure		Page
1-5	**Gyrineum (s.l.) gwinae** n. sp.	77

1. Figured specimen 1626 MGS - Stub No. 19 (x38), height 2.6 mm, width 1.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 12, 3-17-1988.
2. Same specimen as figure 1. Oblique view of aperture (x38) showing denticulation of inner lip. SEM photograph by Marcos Montes, No. 2, 3-22-1988.
3. Figured specimen 1627 MGS - Stub No. 14 (x45), diameter of incomplete specimen 1.45 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 25, 12-14-1987.
4. Figured specimen 1628 MGS - Stub No. 19 (x38), height 2.4 mm, width 1.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 1, 3-22-1988.
5. Figured specimen 1629 MGS - Stub No. 16 (x38), height 2.2 mm, width 1.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 13, 3-10-1988.

PLATE 22



EXPLANATION PLATE 23

Figure — Page

1-2 **Cerithiella** sp. 80

1. Figured specimen 1630 MGS - Stub No. 15 (x51), height 1.8 mm. Coffee Sand, MGS locality 129, bed B. Protoconch and first whorl of teleoconch. SEM photograph by E. E. Russell, No. 26, 1-12-1988.
2. Figured specimen 1631 MGS - Stub No. 18 (x48), height 1.5 mm. Coffee Sand, MGS locality 129, bed E. Protoconch. SEM photograph by Marcos Montes, No. 12, 3-11-1988.

3-5 **Cerithiella nodoliratum** (Wade, 1926) 79

3. Figured specimen 1632 MGS - Stub No. 20 (x48), height 1.75 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 26, 3-17-1988.
4. Figured specimen 1633 MGS Stub No. 12 (x41), height 1.4 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 8, 12-14-1987.
5. Figured specimen 1634 MGS - Stub No. 19 (x44), height 1.95 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 15, 3-17-1988.

6-7 **Cerithiella aequalirata** n. sp. 80

6. Figured specimen 1635 MGS - Stub No. 16 (x28), height 1.8 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 17, 3-10-1988.
7. Figured specimen 1636 MGS - Stub No. 12 (x39), height 2.0 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 7, 12-14-1987.

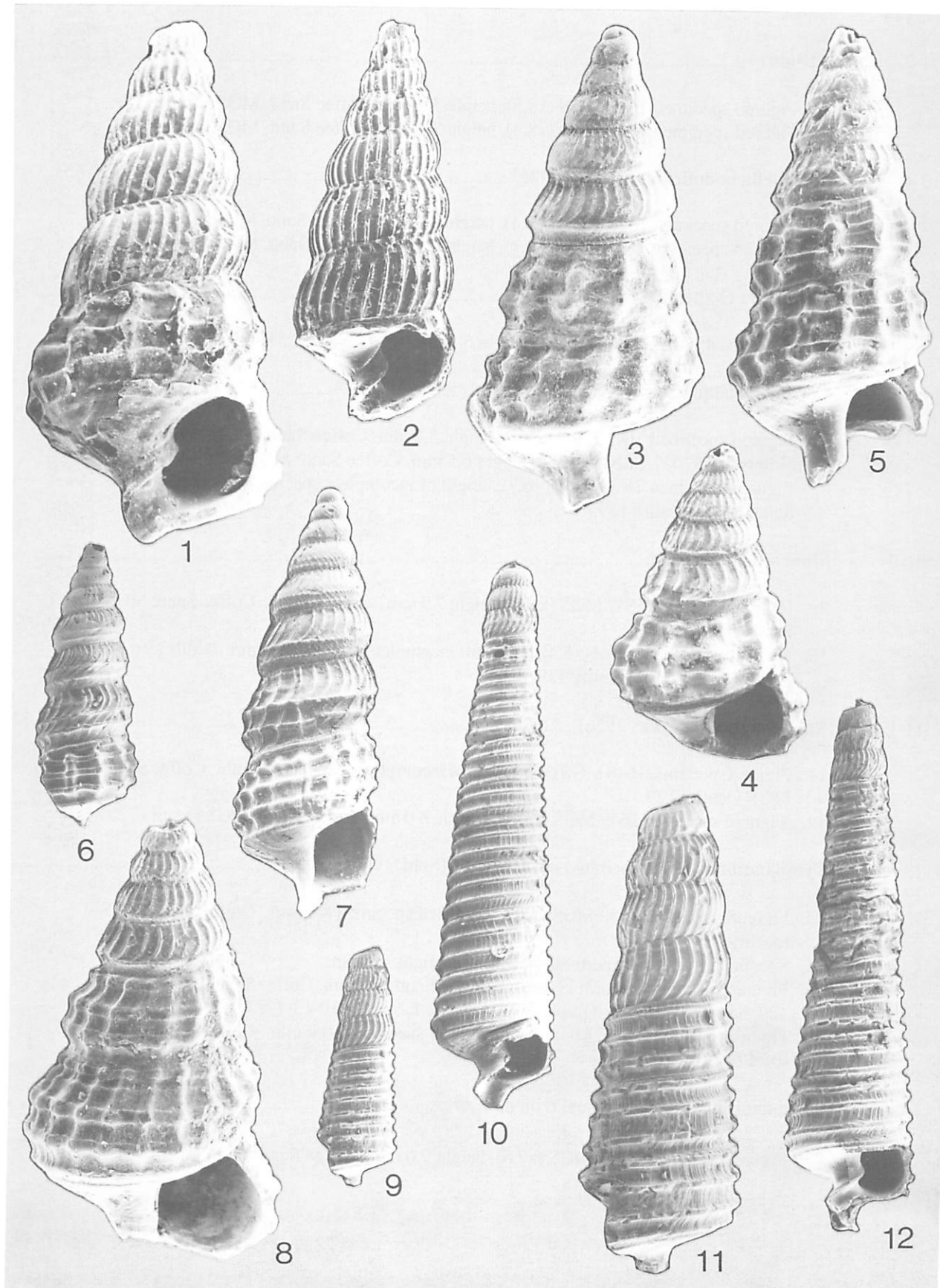
8 **Cerithiella chapelvillensis** n. sp. 79-80

Figured specimen 1637 MGS - Stub No. 20 (x54), height 1.5 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 29, 3-17-1988.

9-12 **Variseila meeki** (Wade, 1926) 81-82

9. Figured specimen 1638 MGS Stub No. 16 (x26), height 1.5 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 16, 3-10-1988.
10. Figured specimen 1639 MGS - Stub No. 13 (x22), height 4.3 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 21, 12-14-1987.
11. Same specimen as figure 9 (x53). SEM photograph by Marcos Montes, No. 6, 3-17-1988.
12. Figured specimen 1640 MGS - Stub No. 16 (x26), height 3.7 mm. Coffee Sand, MGS locality 129, bed E. Protoconch and early teleoconch. SEM photograph by Marcos Montes, No. 16, 3-10-1988.

PLATE 23



EXPLANATION PLATE 24

Figure — Page

1-2 **Bittium?** sp. 81

1. Figured specimen 1641 MGS (x8.5), height 3.9 mm. Coffee Sand, MGS locality 129.
2. Figured specimen 1642 MGS (x8.3), height 3.6 mm. Coffee Sand, MGS locality 129.

3-4 **Cerithiella nodoliratum** (Wade, 1926) 79

3. Figured specimen 1643 MGS (x 9.1), height 3.4 mm. Coffee Sand, MGS locality 129.
4. Figured specimen 1644 MGS (x9.1), height 4.5 mm. Coffee Sand, MGS locality 129.

5 **Cerithiella chapelvillensis** n. sp. 79-80

Holotype 457006 USNM (x9.3), height 5.5 mm. Coffee Sand, MGS locality 129.

6-8 **Cerithiella aequalirata** n. sp. 80

6. Figured specimen 1645 MGS (x8.1), height 5.0 mm. Coffee Sand, MGS locality 129.
7. Holotype 457007 USNM (x7.9), height 6.5 mm. Coffee Sand, MGS locality 129.
8. Figured specimen 1646 MGS (x6.7), height of incomplete specimen 9.3 mm. Coffee Sand, MGS locality 129.

9-10 **Monroea coffea** n. sp. 81

9. Figured specimen 1647 MGS (x6.6), height 7.9 mm, width 3.3 mm. Coffee Sand, MGS locality 129.
10. Holotype 457008 USNM (x5.4), height off incomplete specimen 9.9 mm, width 3.9 mm. Coffee Sand, MGS locality 129.

11-12 **Variseila meeki** (Wade, 1926) 81-82

11. Figured specimen 1648 MGS (x8), height of incomplete specimen 4.2 mm. Coffee Sand, MGS locality 129.
12. Figured specimen 1649 MGS (x10.3), height 6.0 mm. Coffee Sand, MGS locality 129.

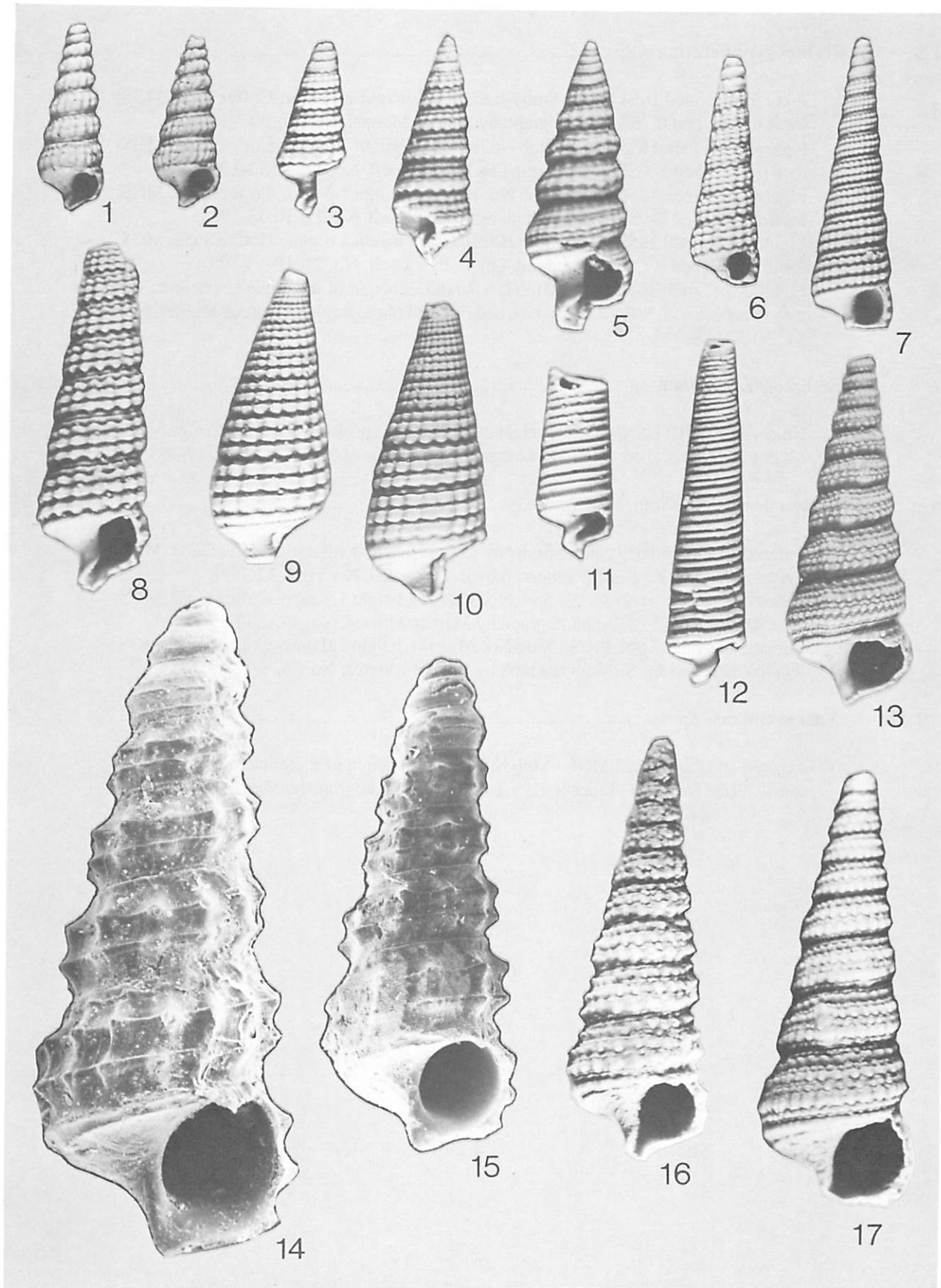
13-15, 17 **Tympanotonus (Exechocirsus) cowickeensis** (Sohl, 1964) 48

13. Figured specimen 1650 MGS (x7.7), height of specimen 8.1 mm. Coffee Sand, MGS locality 129.
14. Specimen missing. Apertural view (x60), height 1.9 mm.
15. Figured specimen 1651 MGS - Stub 10 (x46), height 1.9 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 11, 10-13-1987.
17. Figured specimen 1652 MGS (x7), height of specimen 10.9 mm. Coffee Sand, MGS locality 129.

16 **Tympanotonus (Exechocirsus) trilirus** n. sp. 48

Figured specimen 1653 MGS (x7.8), height 9.6 mm. Coffee Sand, MGS locality 129.

PLATE 24



EXPLANATION PLATE 25

Figure — Page

1-5 **Eccliseogyra heliclina** n. sp. 82

1. Figured specimen 1654 MGS - Stub No. 20 (x57), height 1.15 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 30, 3-17-1988.
2. Figured specimen 1655 MGS - Stub No. 10 (x36), height 2.0 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 14, 10-13-1987.
3. Figured specimen 1656 MGS - Stub No. 10 (x36), height 1.3 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 12, 10-13-1987.
4. Figured specimen 1657 MGS - Stub No. 10 (x56), height 1.8 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 21, 10-13-1987.
5. Figured specimen 1658 MGS - Stub No. 20 (x33), height of incomplete specimen 1.9 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 34, 3-17-1988.

6 **Eccliseogyra inflata** n. sp. 82

Holotype 457010 USNM (x49), height of incomplete specimen 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 31, 3-17-1988.

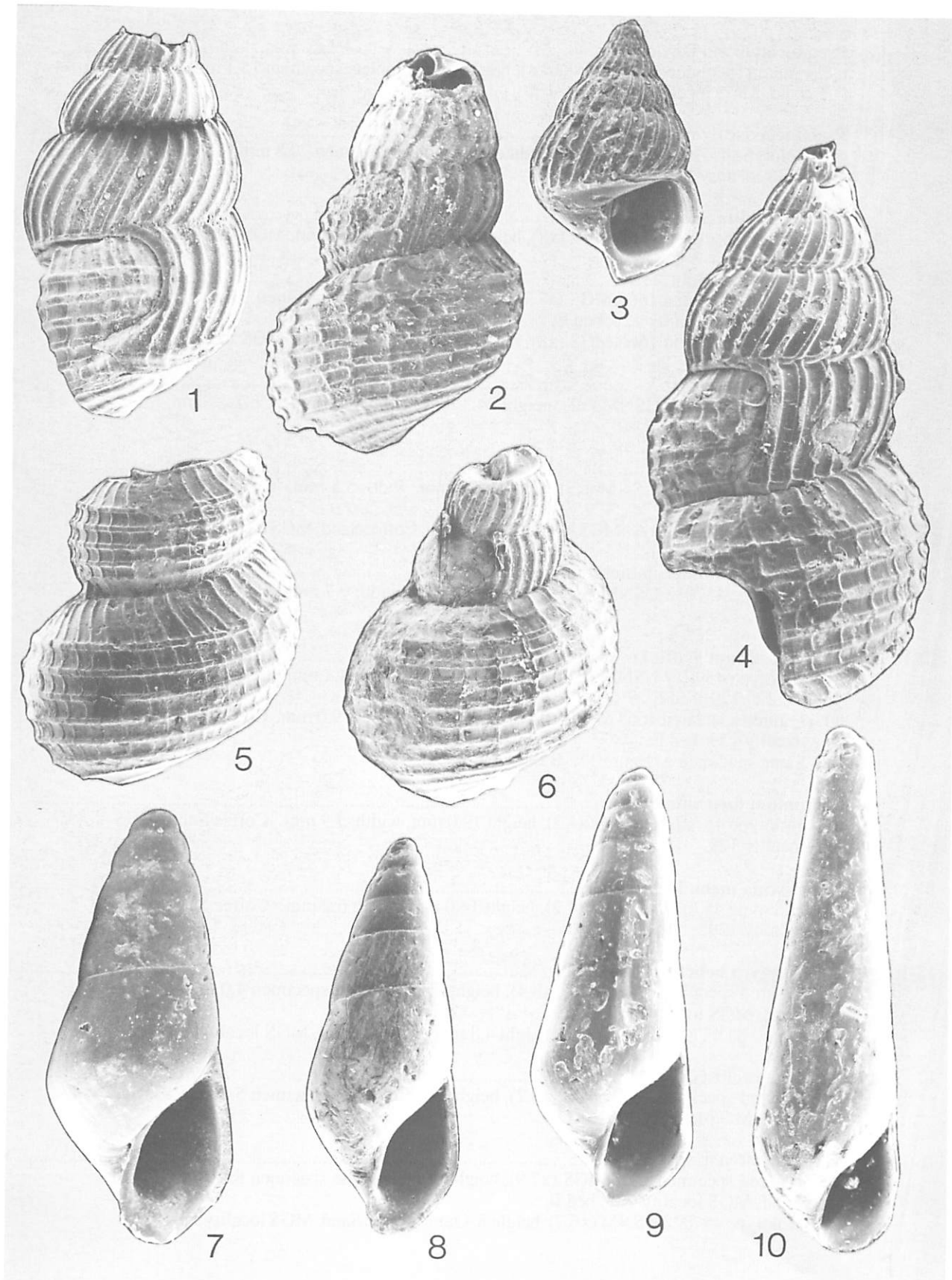
7-9 **Eulima gracilistylis** Sohl, 1964 87

7. Figured specimen 1659 MGS - Stub No. 15 (x49), height 1.6 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by E. E. Russell, No. 10, 1-12-1988.
8. Figured specimen 1660 MGS - Stub No. 20 (x41), height 1.8 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 36, 3-17-1988.
9. Figured specimen 1661 MGS - Stub No. 20 (x41), height 2.0 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 35, 3-17-1988.

10 **Eulima coffea** n. sp. 87

Figured specimen 1662 MGS - Stub No. 18 (x37), height of incomplete specimen 2.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 11, 3-17-1988.

PLATE 25



EXPLANATION PLATE 26

Figure — Page

1 **Pseudoclaviscala laevicosta** n. sp. 83
Figured specimen 1663 MGS (x5.4), height of incomplete specimen 15.1 mm. Coffee Sand, MGS locality 129.

2 **Pseudoclaviscala rugacosta** n. sp. 83
Holotype 457013 USNM (x2), height of incomplete specimen 20.8 mm. Coffee Sand, MGS locality 129.

3 **Acirsa gravida** Sohl, 1964 84
Figured specimen 1664 MGS (x8), height 9.3 mm. Coffee Sand, MGS locality 129.

4-5 **Acirsa culmosa** Sohl, 1964 84-85
4. Figured specimen 1665 MGS (x7.7), height of incomplete specimen 7.0 mm. Coffee Sand, MGS locality 129, bed E.
5. Figured specimen 1666 MGS (x8), height 6.7 mm. Coffee Sand, MGS locality 129.

6 **Belliscala lirata** n. sp. 86
Holotype 457019 USNM (x2), height 24.3 mm, width 13.4 mm. Coffee Sand, MGS locality 129.

7-8 **Belliscala nodosa** n. sp. 86
7. Holotype 457020 USNM (x5), height 11.7 mm, width 5.5 mm. Coffee Sand, MGS locality 129.
8. Figured specimen 1667 MGS (x7), height 5.9 mm. Coffee Sand, MGS locality 129, bed B.

9 **Striaticostatum micropunctatum** n. sp. 86
Holotype 457018 USNM (x2.5), height 17.4 mm, width 9.7 mm. Coffee Sand, MGS locality 129.

10-12 **Striaticostatum griffini** n. sp. 85-86
10. Holotype 457017 USNM (x2.5), height 17.8 mm, width 8.1 mm. Coffee Sand, MGS locality 129, bed E.
11. Figured specimen 1668 MGS (x2), height 18.8 mm, width 9.0 mm. Coffee Sand, MGS locality 129, bed E.
12. Same specimen as figure 11. Basal view (x2.5).

13 **Epitonium faearium** n. sp. 84
Holotype 457014 USNM (x4.2), height 19.0 mm, width 7.9 mm. Coffee Sand, MGS locality 129.

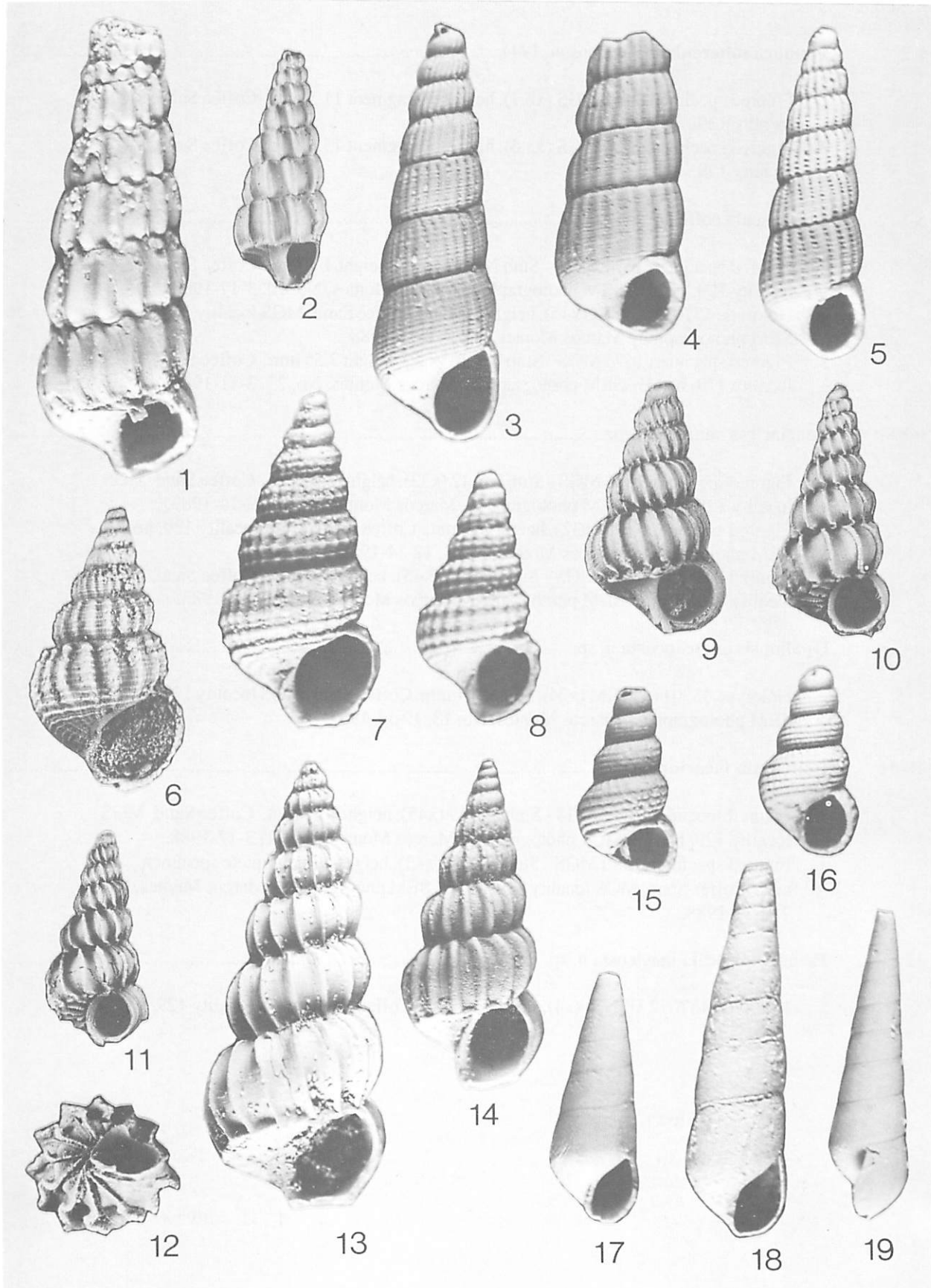
14 **Punctiscala melaniea** n. sp. 85
Holotype 457016 USNM (x4.2), height 14.0 mm, width 6.2 mm. Coffee Sand, MGS locality 129.

15-16 **Eccliseogyra heliclina** n. sp. 82
15. Figured specimen 1669 MGS (x8.4), height of incomplete specimen 4.0 mm. Coffee Sand, MGS locality 129.
16. Holotype 457009 USNM (x7), height 4.8 mm. Coffee Sand, MGS locality 129.

17 **Eulima gracilistylis** Sohl, 1964 87
Figured specimen 1670 MGS (x8.2), height of incomplete specimen 5.5 mm. Coffee Sand, MGS locality 129, bed B.

18-19 **Eulima coffea** n. sp. 87
18. Figured specimen 1671 MGS (x7.9), height of incomplete specimen 8.5 mm. Coffee Sand, MGS locality 129, bed B.
19. Holotype 457022 USNM (x6.7), height 8.4 mm. Coffee Sand, MGS locality 129, bed B.

PLATE 26



EXPLANATION PLATE 27

Figure — Page

1-2 **Tundora tuberculata** Stephenson, 1941 65-66

1. Figured specimen 1672 MGS (x3.7), height of fragment 11.5 mm. Coffee Sand, MGS locality 129.
2. Figured specimen 1673 MGS (x3.6), height of fragment 13.5 mm. Coffee Sand, MGS locality 129.

3-5 **Aciculiscala coffea** n. sp. 87

3. Figured specimen 1674 MGS - Stub No. 18 (x45), height 1.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 10, 3-17-1988.
4. Holotype 457021 USNM (x45), height 1.8 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 9, 3-17-1988.
5. Figured specimen 1675 MGS - Stub No. 18 (x32), height 2.55 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 23, 3-11-1988.

6-8 **Pauciacirsa simplex** n. sp. 85

6. Figured specimen 1676 MGS - Stub No. 12 (x32), height 2.45 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 4, 12-14-1987.
7. Figured specimen 1677 (x32), height 2.2 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 3, 12-14-1987.
8. Figured specimen 1678 MGS - Stub No. 16 (x45), height 1.4 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 5, 3-17-1988.

9 **Opaliopsis angustocosta** n. sp. 83

Holotype 457011 USNM (x24), height 3.1 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 13, 12-14-1987.

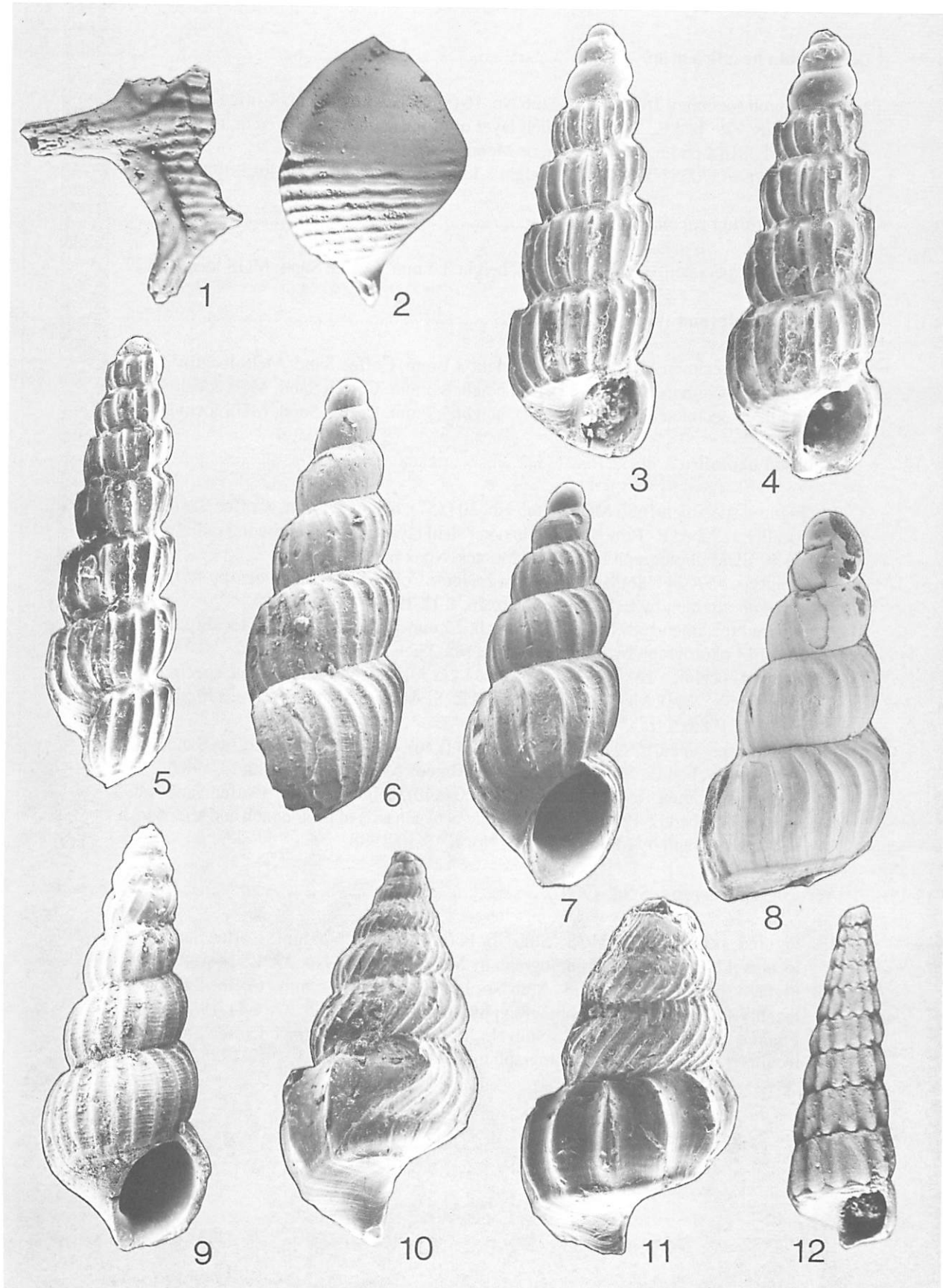
10-11 **Epitonium faearium** n. sp. 84

10. Figured specimen 1679 MGS - Stub No. 19 (x45), height 1.55 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 21, 3-17-1988.
11. Figured specimen 1680 MGS Stub No. 17 (x43), height of incomplete specimen 1.45 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 7, 3-11-1988.

12 **Pseudoclaviscala laevicosta** n. sp. 83

Holotype 457012 USNM (x4), height 15 mm. Coffee Sand, MGS locality 129.

PLATE 27



EXPLANATION PLATE 28

Figure — Page

1-2 **Mathilda hexalira** n. sp. 88-89

1. Figured specimen 1681 MGS - Stub No. 16 (x32), height 2.5 mm. Coffee Sand, MGS locality 129, bed E. The outer shell layer of protoconch is preserved on only the first whorl. SEM photograph by Marcos Montes, No. 15, 3-10-1988.
2. Holotype 457025 USNM (x8.2), height 3.1 mm. Coffee Sand, MGS locality 129, bed B.

3 **Echinimathilda corona** Sohl, 1960 var. 89

Figured specimen 1682 MGS (x7.3), height 3.7 mm. Coffee Sand, MGS locality 129.

4-6 **Mathilda ripleyana** Wade, 1926 88

4. Figured specimen 1683 MGS (x7), height 3.1 mm. Coffee Sand, MGS locality 129.
5. Figured specimen 1684 MGS (x4.2), height 8.3 mm. Coffee Sand, MGS locality 129.
6. Figured specimen 1685 MGS (x6.4), height 5.7 mm. Coffee Sand, MGS locality 129.

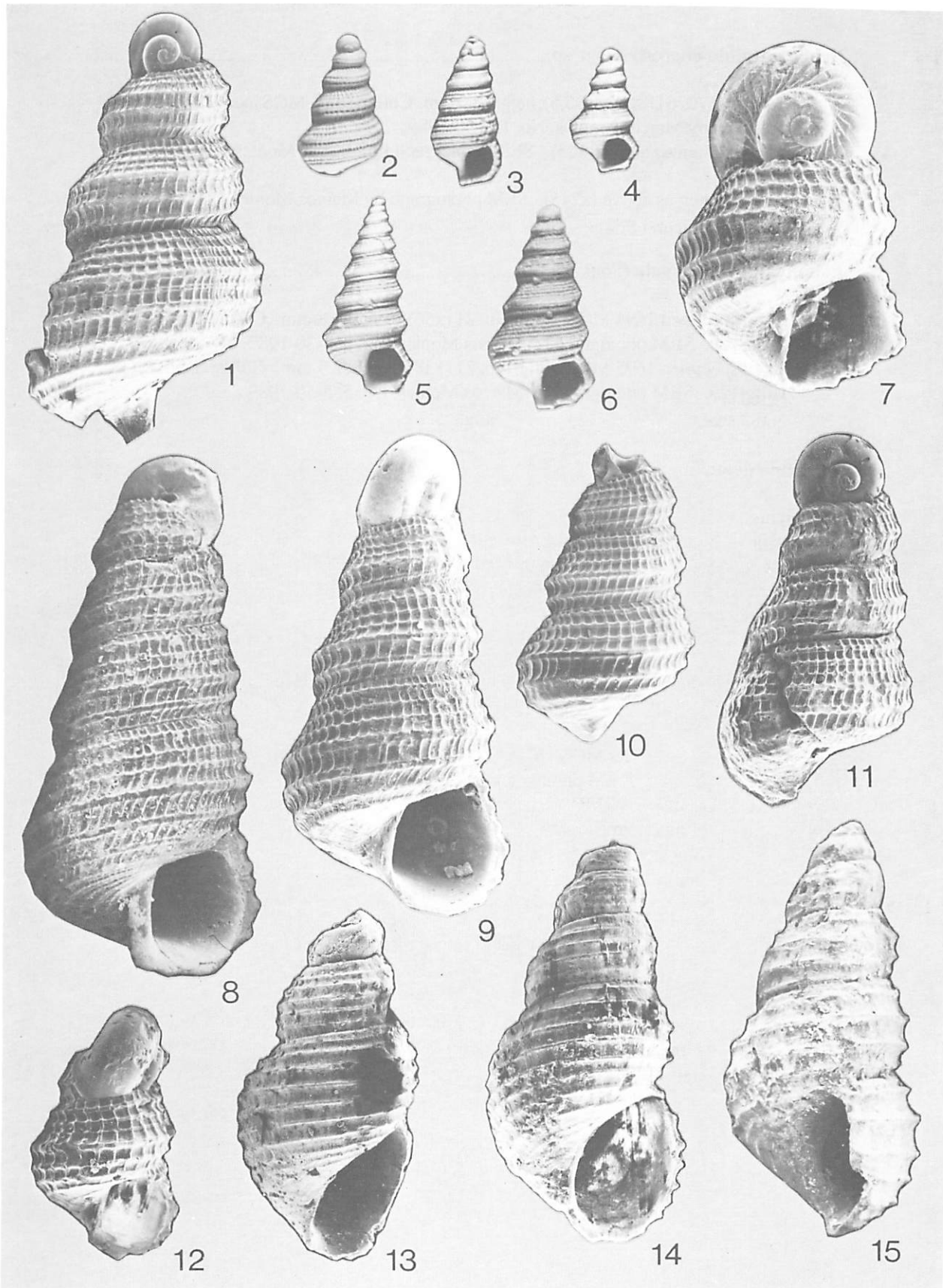
7-12 **Mathilda pentalira** n. sp. 88

7. Figured specimen 1686 MGS - Stub No. 20 (x57), height 1.1 mm. Coffee Sand, MGS locality 129, bed E. Protoconch with outer shell layer preserved showing radial growth lines. SEM photograph by Marcos Montes, No. 24, 3-17-1988.
8. Holotype 457024 USNM (x34), height 2.7 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 16, 1-12-1988.
9. Figured specimen 1687 MGS (x40), height 2.2 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 22, 3-17-1988.
10. Figured specimen 1688 MGS - Stub No. 14 (x30), height of incomplete specimen 1.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 11, 3-10-1988.
11. Figured specimen 1689 MGS - Stub No. 14 (x36), height 1.8 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 28, 12-14-1987.
12. Figured specimen 1690 MGS - Stub No. 20 (x40), height 1.2 mm. Coffee Sand, MGS locality 129, bed E. Profile showing angle between axis of protoconch and teleoconch. SEM photograph by Marcos Montes, No. 20, 3-10-1988.

13-15 **Acrocoelum? cereum** Sohl, 1960 90

13. Figured specimen 1691 MGS - Stub No. 14 (x50), height 1.25 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 27, 12-14-1987.
14. Figured specimen 1692 MGS - Stub No. 18 (x48), height 1.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Marcos Montes, No. 22, 3-11-1988.
15. Figured specimen 1693 MGS - Stub No. 15 (x54), height 1.4 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by E. E. Russell, No. 11, 1-12-1988.

PLATE 28



EXPLANATION PLATE 29

Figure — Page

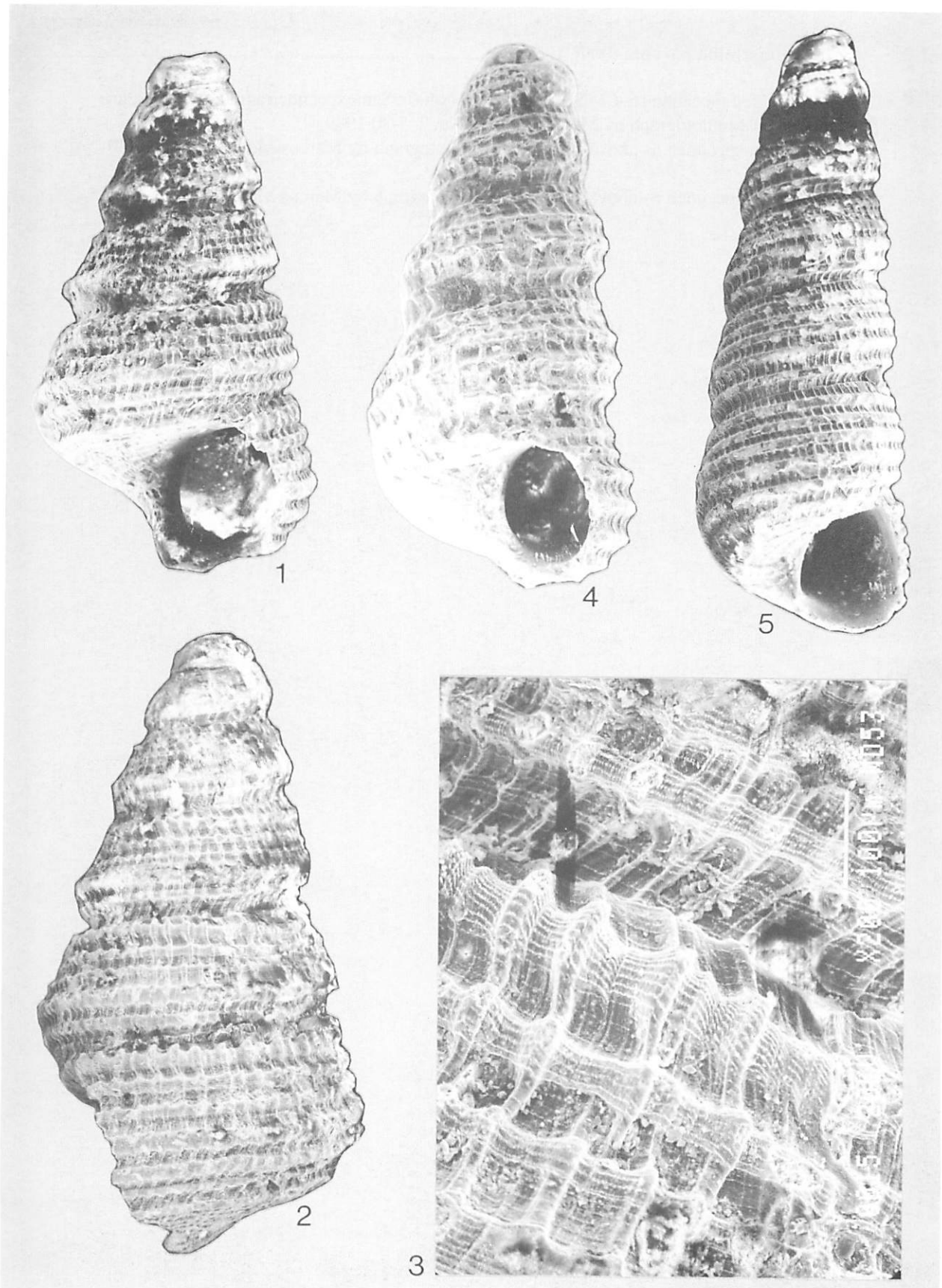
1-3 **Echinimathilda microstriata** n. sp. 89

1. Holotype 457026 USNM (x35.5), height 3.0 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 1, 5-30-1989.
2. Same specimen as above (x43). SEM photograph by Marcos Montes, No. 14, 2-10-1989.
3. Same specimen as above (x215). SEM photograph by Marcos Montes, No. 15, 2-10-1989.

4-5 **Echinimathilda parvula** (Sohl, 1960) 89-90

4. Figured specimen 1694 MGS - Stub No. 21 (x56), height 1.8 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 8, 5-30-1989.
5. Figured specimen 1695 MGS - Stub No. 21 (x38), height 2.9 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 5, 5-30-1989.

PLATE 29

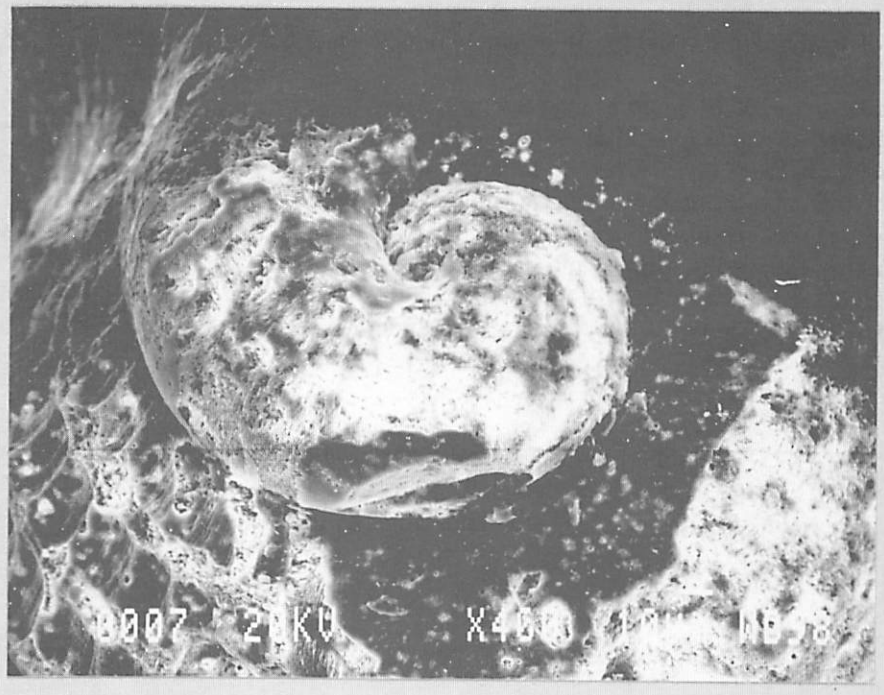


EXPLANATION PLATE 30

Figure		Page
1-3	**Echinimathilda parvula** (Sohl, 1960)	89-90

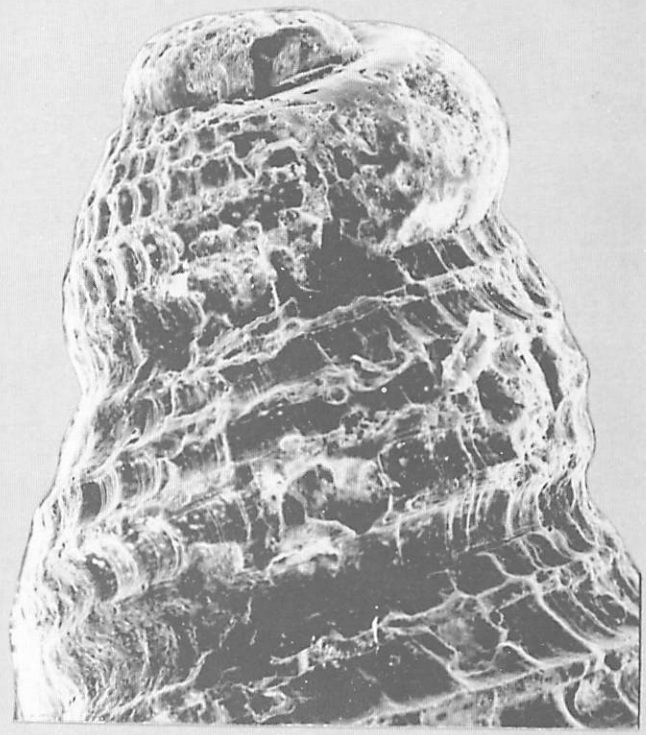
1. Figured specimen 1696 MGS - Stub No. 21 (x400). Same specimen as on Plate 29, figure 4. SEM photograph by Marcos Montes, No. 7, 5-30-1989.
2. Same specimen as above (x200). SEM photograph by Marcos Montes, No. 6, 5-30-1989.
3. Same specimen as above (x150). SEM photograph by Marcos Montes, No. 9, 5-30-1989.

PLATE 30



1

2



3

EXPLANATION PLATE 31

Figure — Page

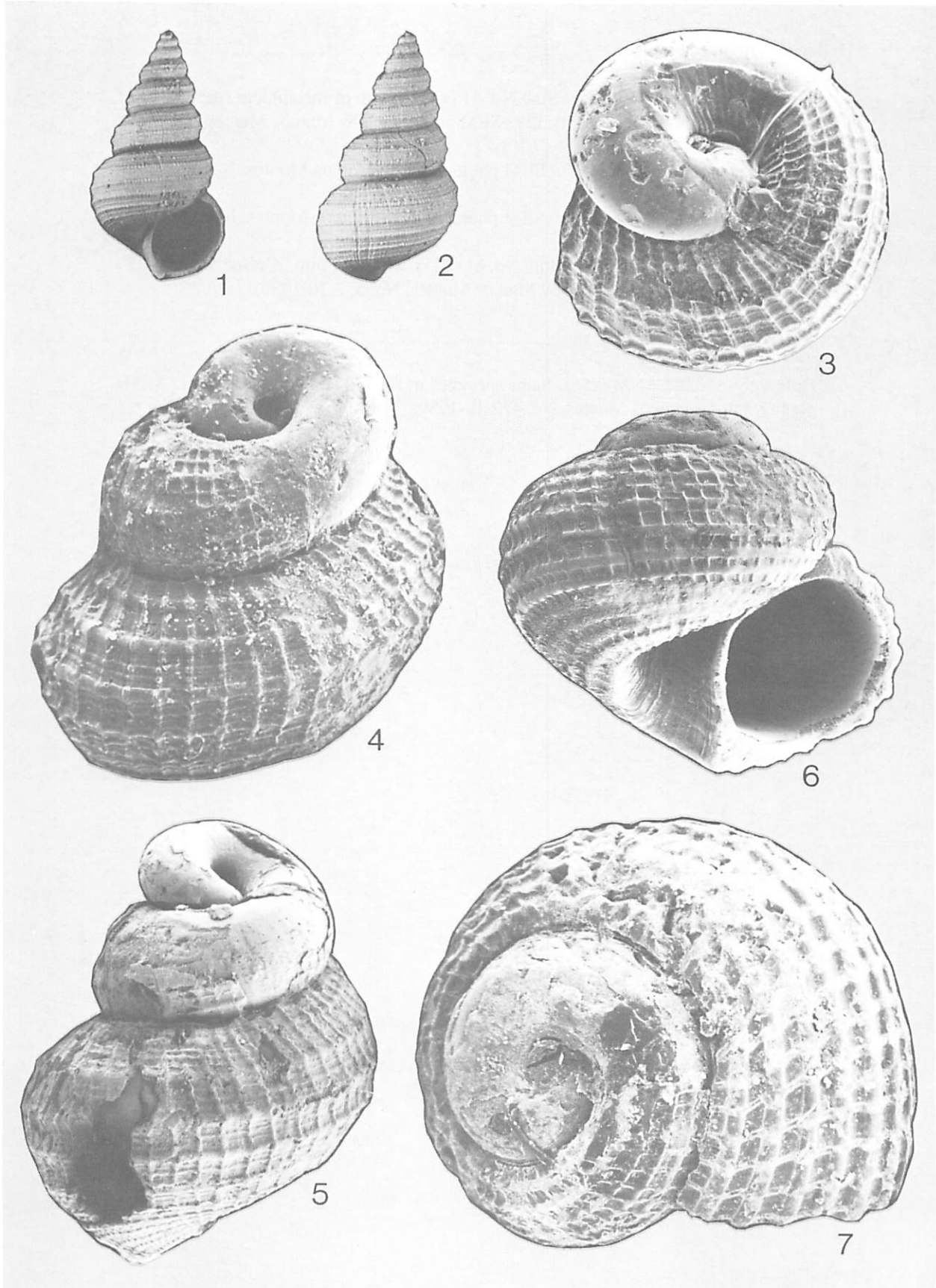
1-5 **Gegania mississippiensis** n. sp. 90

1. Holotype 457027 USNM (x3), height 14.6 mm, width 8.0 mm. Coffee Sand, MGS locality 129.
2. Same specimen as figure 1. Dorsal view (x3).
3. Figured specimen 1697 MGS - Stub No. 20 (x65), width of fragment 1.0 mm. Coffee Sand, MGS locality 129, bed B. Protoconch and first half whorl of teleoconch. SEM photograph by Marcos Montes, No. 38, 3-17-1988.
4. Figured specimen 1698 MGS - Stub No. 15 (x55), height 1.4 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by E. E. Russell, No. 23, 1-12-1988.
5. Figured specimen 1699 MGS - Stub No. 14 (x48), height 1.75 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Marcos Montes, No. 12, 3-10-1988.

6-7 **Heliacus reticulatus** n. sp. 91

6. Holotype 457029 USNM (x43), height 1.5 mm, width 1.7 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Marcos Montes, No. 18, 12-14-1987.
7. Same specimen as above (x56). SEM photograph by E. E. Russell, No. 15, 1-12-1988.

PLATE 31



EXPLANATION PLATE 32

Figure — Page

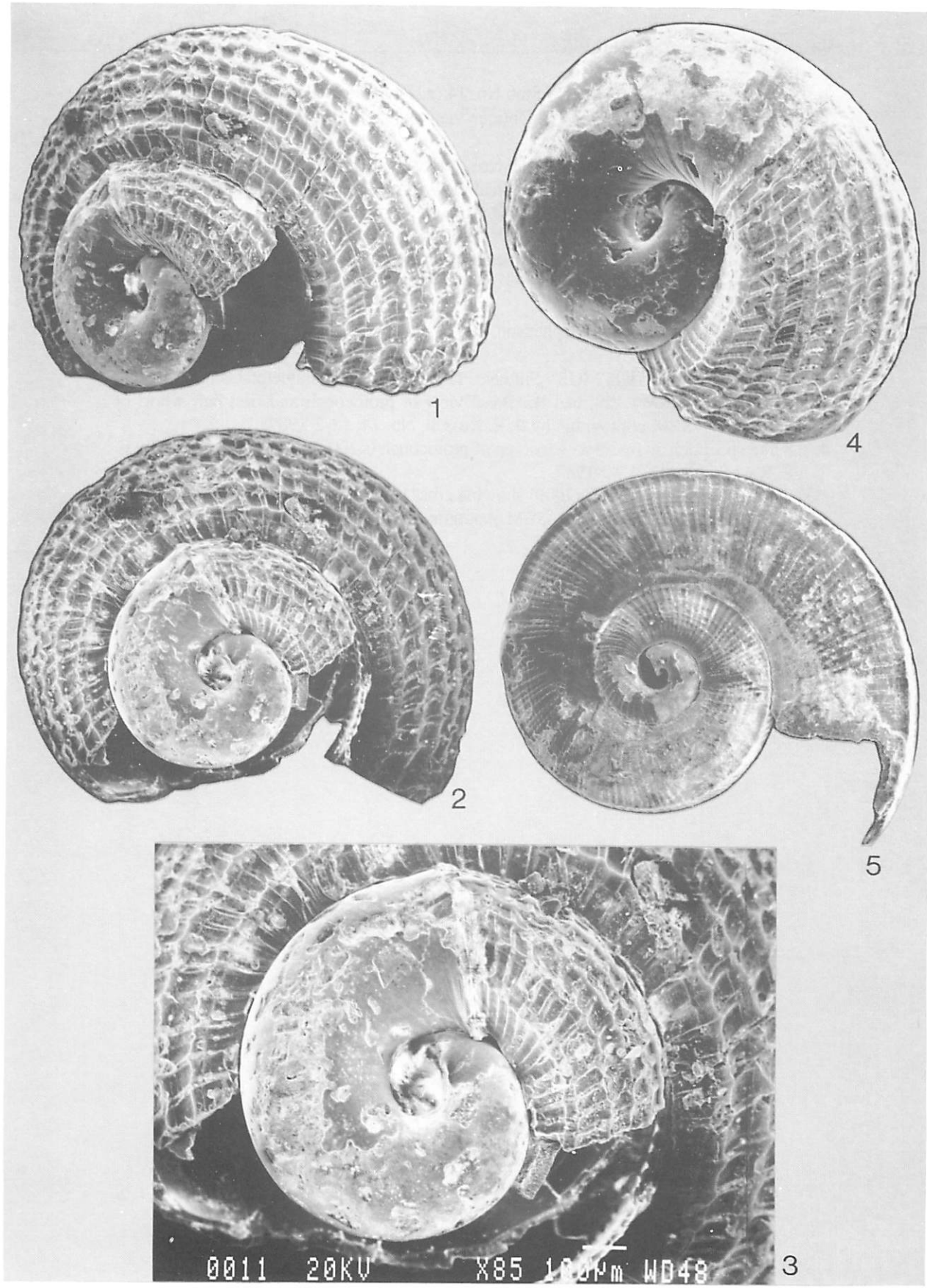
1-4 **Heliacus reticulatus** n. sp. 91

1. Figured specimen 1700 MGS - Stub No. 21 (x47), width of incomplete specimen 1.7 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 9, 2-10-1989.
2. Same specimen as above (x47). SEM photograph by Marcos Montes, No. 10, 2-10-1989.
3. Same specimen as above (x79). SEM photograph by Marcos Montes, No. 11, 2-10-1989.
4. Figured specimen 1701 MGS - Stub No. 21 (x75), width 1.1 mm. Coffee Sand, MGS locality 129. SEM photograph by Marcos Montes, No. 5, 2-10-1989.

5 **Neamphitomaria reticulata** n. sp. 93

Holotype 457030 USNM (x56). Same specimen as figured on Plate 11, figure 1. SEM photograph by Marcos Montes, No. 4, 2-10-1989.

PLATE 32



EXPLANATION PLATE 33

Figure — Page

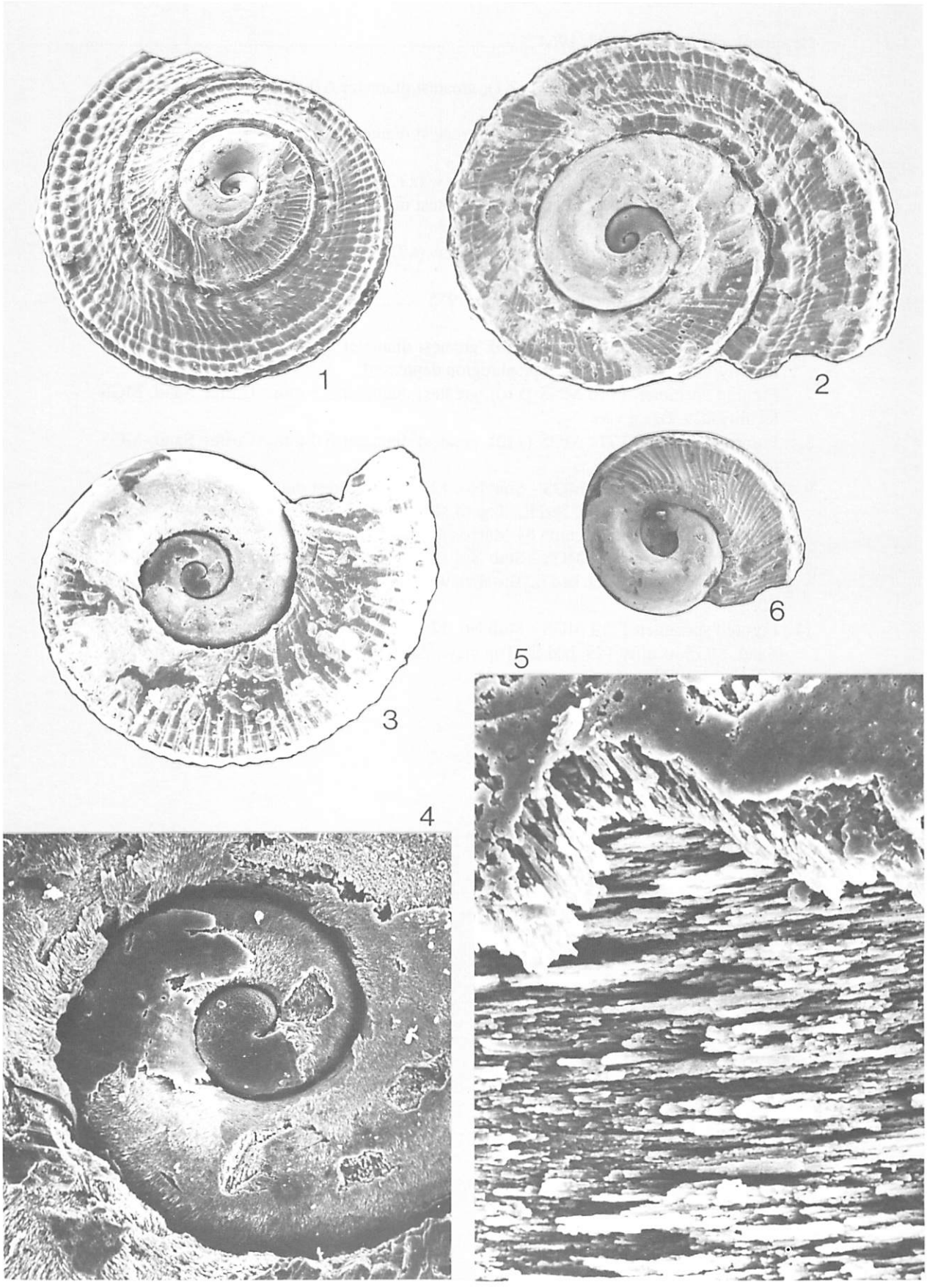
1-2, 6 **Granosolarium coffea** Sohl, 1964 91

1. Figured specimen 1702 MGS - Stub No. 14 (x35), greatest diameter 2.3 mm. Coffee Sand, MGS locality 129, bed E. Oblique view of apex. SEM photograph by Marcos Montes, No. 15, 12-14-1987.
2. Figured specimen 1703 MGS - Stub No. 11 (x59), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. Apical view showing protoconch and first whorl of teleoconch. SEM photograph by E. E. Russell, No. 2, 12-2-1987.
6. Figured specimen 1704 MGS - Stub No. 16 (x45), greatest diameter 0.95 mm. Coffee Sand, MGS locality 129, bed E. Apical view showing protoconch and first half whorl of teloeconch.

3-5 **Pseudomalaxis pateriformis** Stephenson, 1955 92

3. Figured specimen 1705 MGS - Stub No. 11 (x58), greatest diameter 1.3 mm. Coffee Sand, MGS locality 129, bed B. Basal view of protoconch and first half whorl of teleoconch. SEM photograph by E. E. Russell, No. 14, 12-2-1987.
4. Same specimen as figure 3. Close-up of protoconch (x2000). SEM photograph by E. E. Russell, No. 13, 12-2-1987.
5. Same specimen as above (x2000) showing cross lamellar shell structure beneath outer smooth layer (at top of figure). SEM photograph by E. E. Russell, No. 13A, 12-2-1987.

PLATE 33



EXPLANATION PLATE 34

Figure — Page

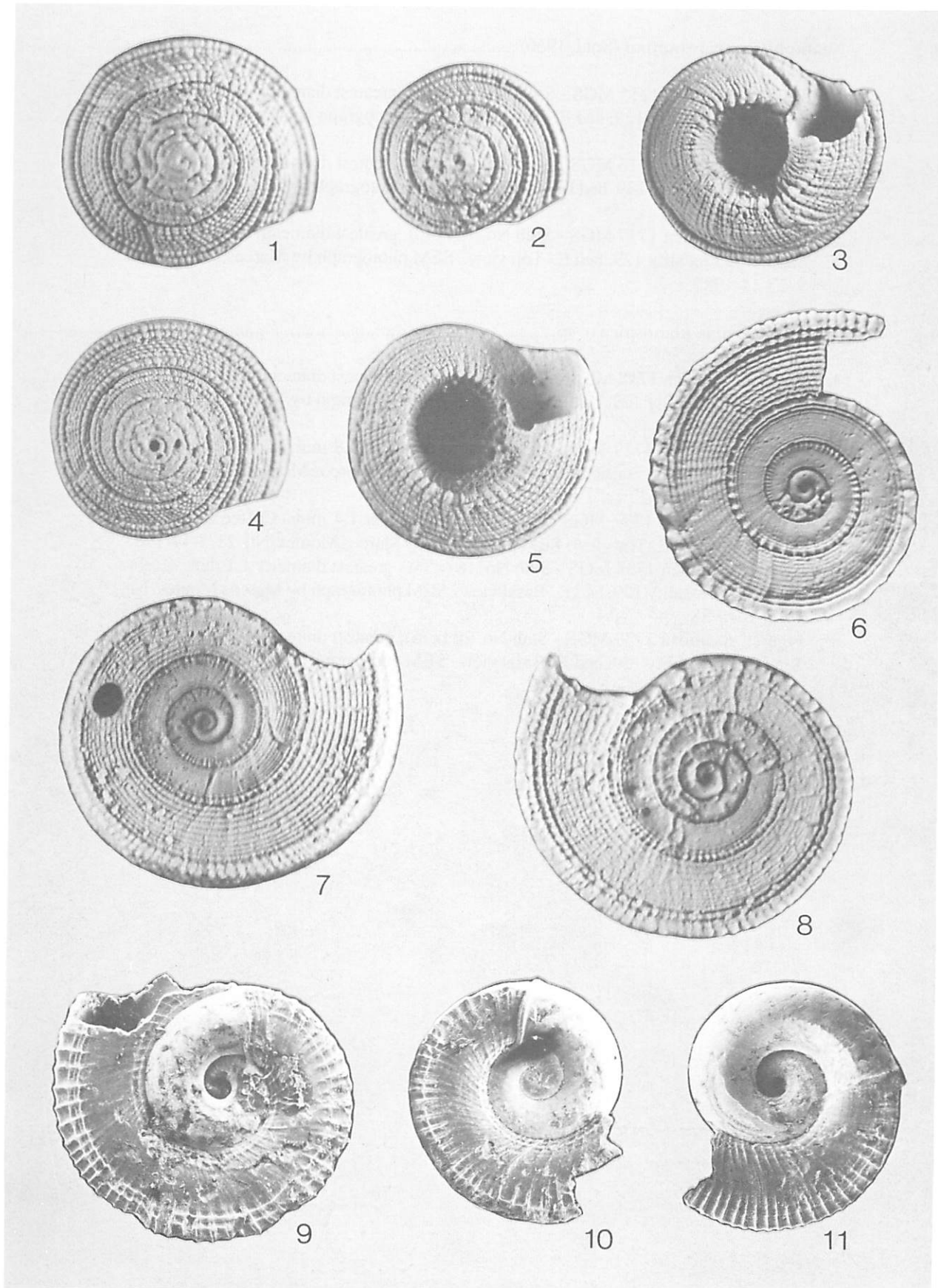
1-5 **Granosolarium coffea** Sohl, 1964 91

1. Figured specimen 1706 MGS (x7.7), greatest diameter 6.0 mm. Coffee Sand, MGS locality 129.
2. Figured specimen 1707 MGS (x8.8), greatest diameter 4.1 mm. Coffee Sand, MGS locality 129.
3. Same specimen as figure 1. Umbilical view (x7.3).
4. Figured specimen 1708 MGS (x6.6), greatest diameter 6.5 mm. Coffee Sand, MGS locality 129.
5. Same specimen as figure 4. Umbilical view (x7).

6-11 **Pseudomalaxis pateriformis** Stephenson, 1955 92

6. Figured specimen 1709 MGS (x10), greatest diameter 5.5 mm. Coffee Sand, MGS locality 129. Top view with apical region depressed.
7. Figured specimen 1710 MGS (x10), greatest diameter 6.2 mm. Coffee Sand, MGS locality 129. Basal view.
8. Figured specimen 1711 MGS (x10), greatest diameter 6.0 mm. Coffee Sand, MGS locality 129. Top view.
9. Figured specimen 1712 MGS - Stub No. 12 (x40), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. Top of shell showing protoconch and first whorl of teleoconch. SEM photograph by Marcos Montes, No. 11, 12-14-1987.
10. Figured specimen 1713 MGS - Stub No. 12 (x40), greatest diameter 1.1 mm. Coffee Sand, MGS locality 129, bed E. Basal view. SEM photograph by Marcos Montes, No. 10, 12-14-1987.
11. Figured specimen 1714 MGS - Stub No. 12 (x40), greatest diameter 1.2 mm. Coffee Sand, MGS locality 129, bed E. Top view. SEM photograph by Marcos Montes, No. 10, 12-14-1987.

PLATE 34



EXPLANATION PLATE 35

Figure — Page

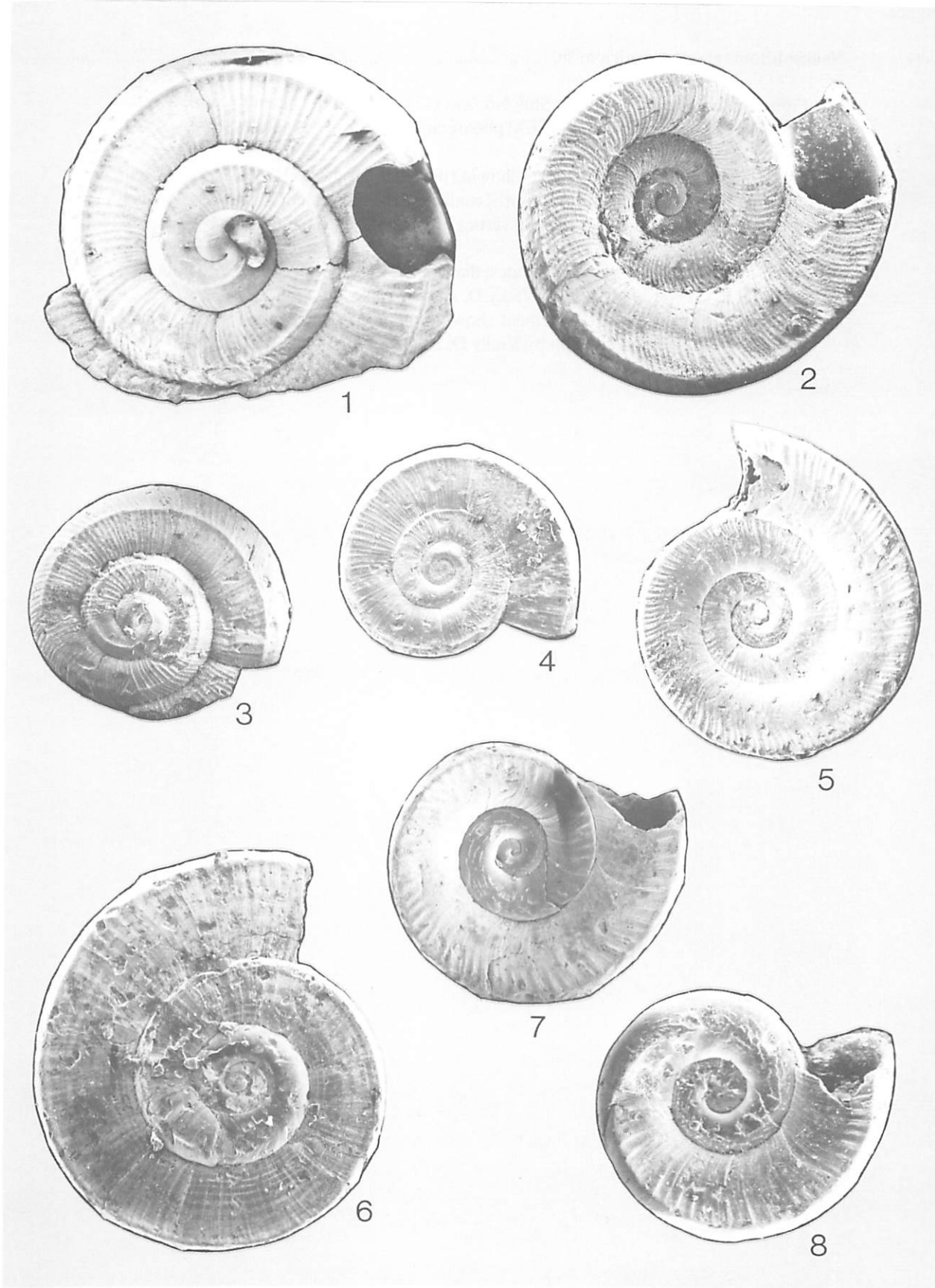
1-3 **Neamphitomaria stantoni** (Sohl, 1960) 92

1. Figured specimen 1715 MGS - Stub No. 16 (x65), greatest diameter 1.1 mm. Coffee Sand, MGS locality 129, bed E. Top view. SEM photograph by Marcos Montes, No. 3, 3-22-1988.
2. Figured specimen 1716 MGS - Stub No. 12 (x40), greatest diameter 1.6 mm. Coffee Sand, MGS locality 129, bed E. Basal view. SEM photograph by Marcos Montes, No. 9, 12-14-1987.
3. Figured specimen 1717 MGS - Stub No. 12 (x40), greatest diameter 1.2 mm. Coffee Sand, MGS locality 129, bed E. Top view. SEM photograph by Marcos Montes, No. 9, 12-14-1987.

4-8 **Neamphitomaria planospira** n. sp. 93

4. Figured specimen 1718 MGS - Stub No. 12 (x33), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. Top view. SEM photograph by Marcos Montes, No. 12, 12-14-1987.
5. Figured specimen 1719 MGS (x33), greatest diameter 1.8 mm. Coffee Sand, MGS locality 129, bed E. Basal view. SEM photograph by Marcos Montes, No. 12, 12-14-1987.
6. Figured specimen 1737 MGS (x54), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. Top view. SEM photograph by Marcos Montes, No. 27, 3-17-1988.
7. Figured specimen 1738 MGS - Stub No. 16 (x54), greatest diameter 1.1 mm. Coffee Sand, MGS locality 129, bed E. Basal view. SEM photograph by Marcos Montes, No. 19, 3-10-1938.
8. Figured specimen 1739 MGS - Stub No. 20 (x75), greatest diameter 0.7 mm. Coffee Sand, MGS locality 129, bed E. Basal view. SEM photograph by Marcos Montes, No. 25, 3-17-1988.

PLATE 35

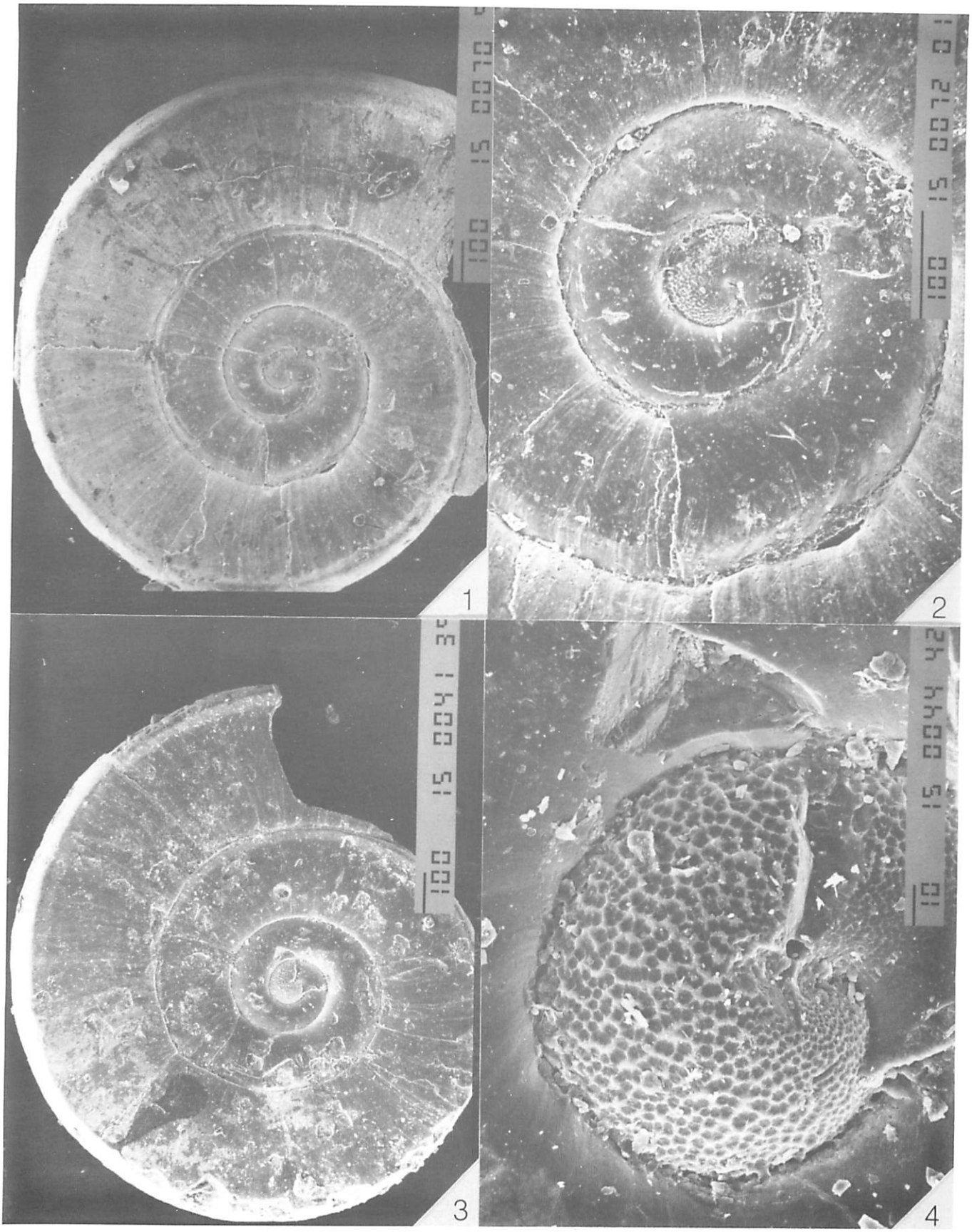


EXPLANATION PLATE 36

Figure		Page
1-4	**Neamphitomaria planospira** n. sp.	93

1. Figured specimen 1740 MGS - Stub No. 25 (x75), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 70, 2-10-1993.
2. Same as above (x200). Enlargement showing the pitted protoconch I consisting of a half whorl with lip horizontal and just right of center and the subsequent, smooth protoconch II of one and a fourth whorls with lip vertical at bottom. SEM photograph by Vicky D. Andrews, No. 72, 2-10-1993.
3. Holotype 457031 USNM (x75), greatest diameter 1.4 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 41, 1-21-1993.
4. Same as above (x750). Enlargement showing the polygonally pitted surface of the protoconch I. SEM photograph by Vicky D. Andrews, No. 44, 1-21-1993.

PLATE 36



EXPLANATION PLATE 37

Figure — Page

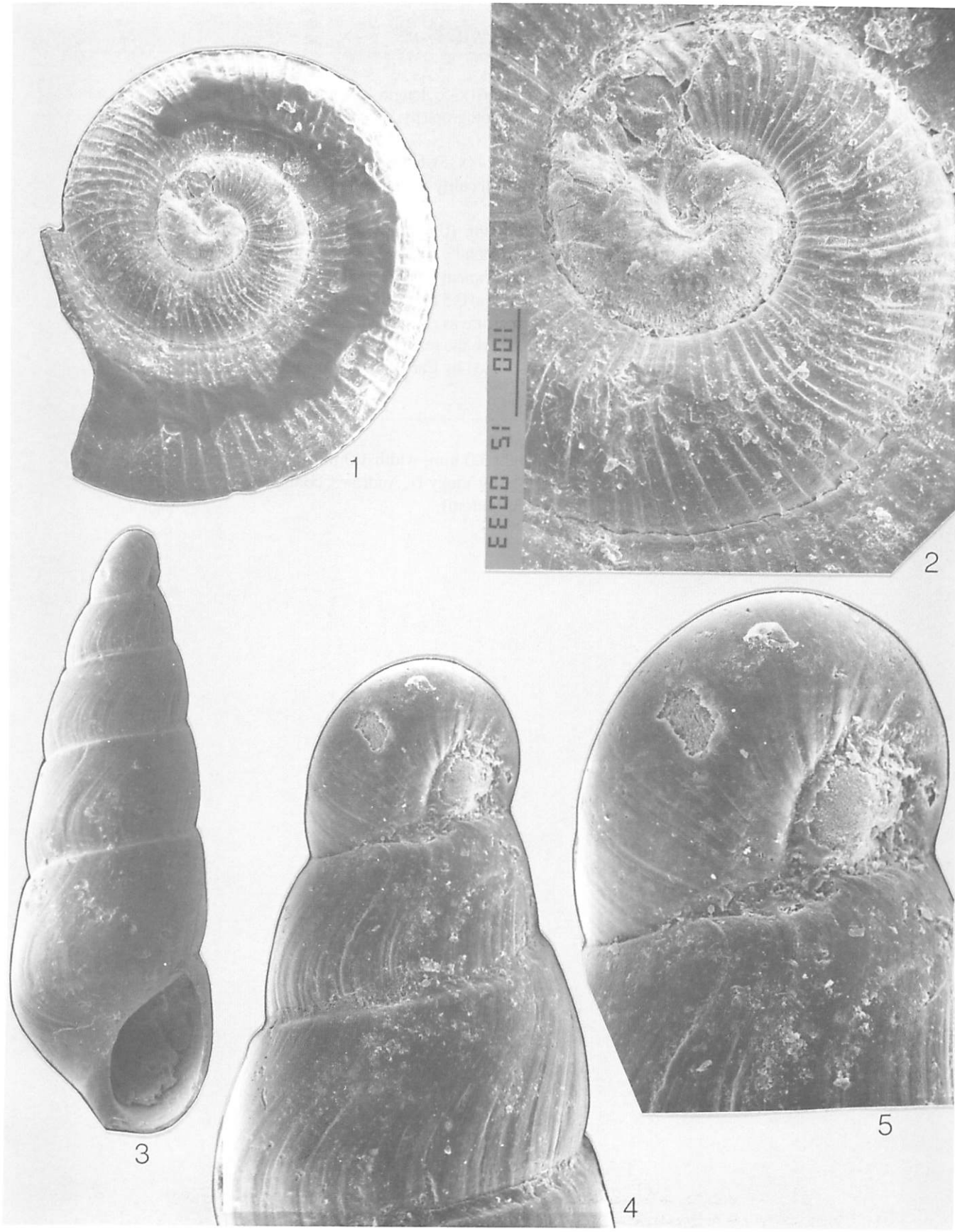
1-2 **Neamphitomaria reticulata** n. sp. 93

1. Figured specimen 1741 MGS - Stub No. 29 (x75), greatest diameter 1.2 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 32, 1-19-1993.
2. Same as above (x200). SEM photograph by Vicky D. Andrews, No. 33, 1-19-1993. The initial whorl is partially crushed in its second half giving the superficial appearance of a varix.

3-5 **Streptacis? bogradi n.** sp. 93-94

3. Holotype 457032 USNM (x75), height 1.5 mm, width 0.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 13, 1-19-1993.
4. Same as above (x200). SEM photograph by Vicky D. Andrews, No. 16, 1-19-1993.
5. Same as above (x350). SEM photograph by Vicky D. Andrews, No. 14, 1-19-1993.

PLATE 37



EXPLANATION PLATE 38

Figure — Page

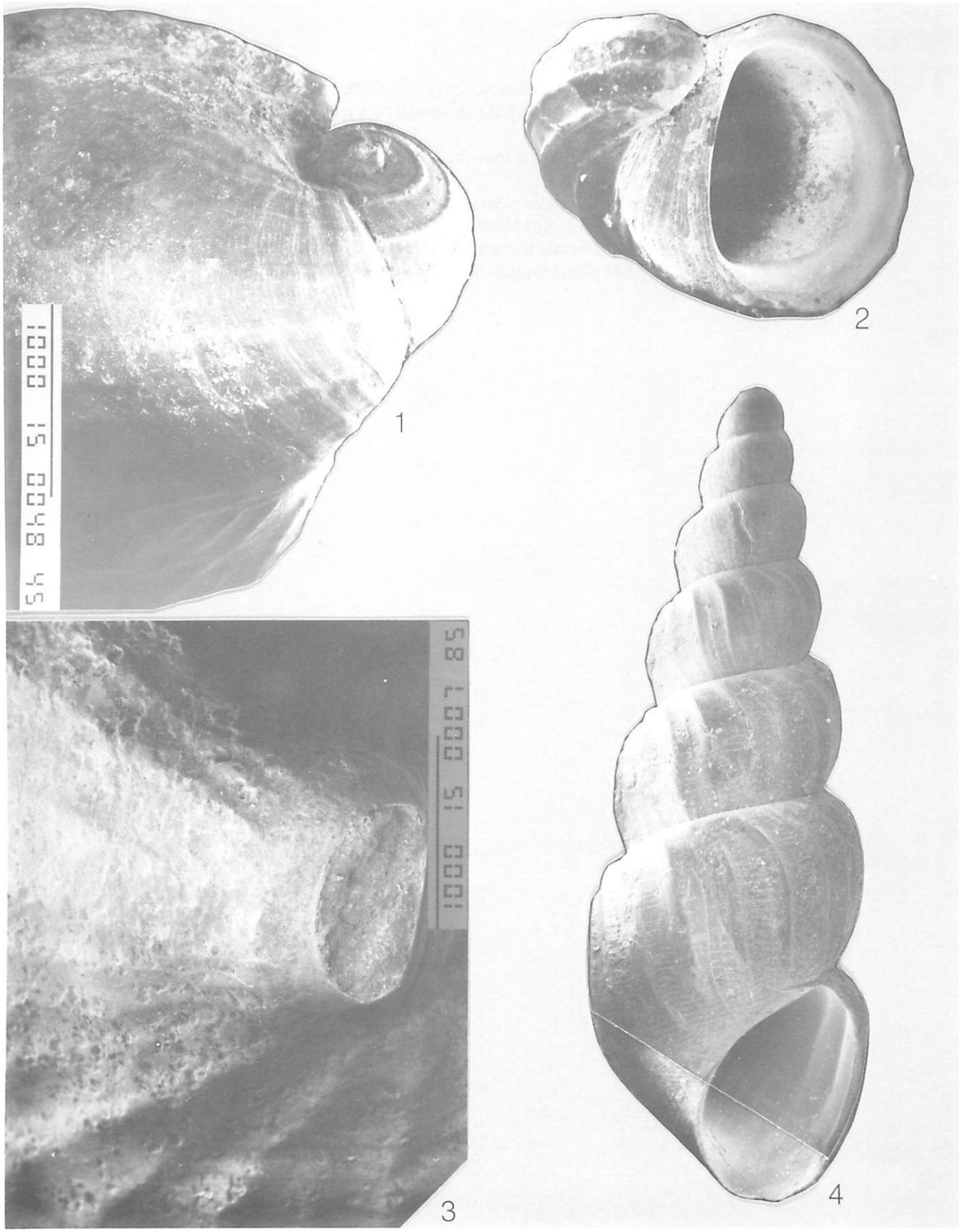
1-3 **Damesia keownvillensis** Sohl, 1960 94

1. Figured specimen 1742 MGS - Stub No. 26 (x35), length 4.0 mm, width 3.5 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 48, 1-21-1993.
2. Figured specimen 1743 MGS - Stub No. 24 (x35), height 1.6 mm, width 2.1 mm. Ripley Formation, Coon Creek Tongue, MGS locality 127. SEM photograph by Vicky D. Andrews, No. 52, 2-10-1993.
3. Figured specimen 1744 MGS (x35), length 10.0 mm, width 11.0 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 7, 1-19-1993. Illustration of apical region showing attachment scar of larval shell beside bar scale. The rounded D- shaped scar is 1.0 mm long and 0.5 mm wide and conforms to the recessed portion of the larval shell's interior aperture as illustrated in figure 2. Surrounding the scar is a 0.3 mm wide beveled zone where the teleoconch was loosely attached to the larval shell's outer lip. Specimen collected by Earl Manning on 12-22-1992.

4 **Pauciacirsa simplex** n. sp. 85

Holotype 457015 USNM (x50), height 3.0 mm, width 1.0 mm. Coffee Sand, MGS locality 129, bed E. SEM photographs by Vicky D. Andrews, composite of No. 30, 1-19-1993 (top) and No. 59, 2-10-1993 (bottom).

PLATE 38

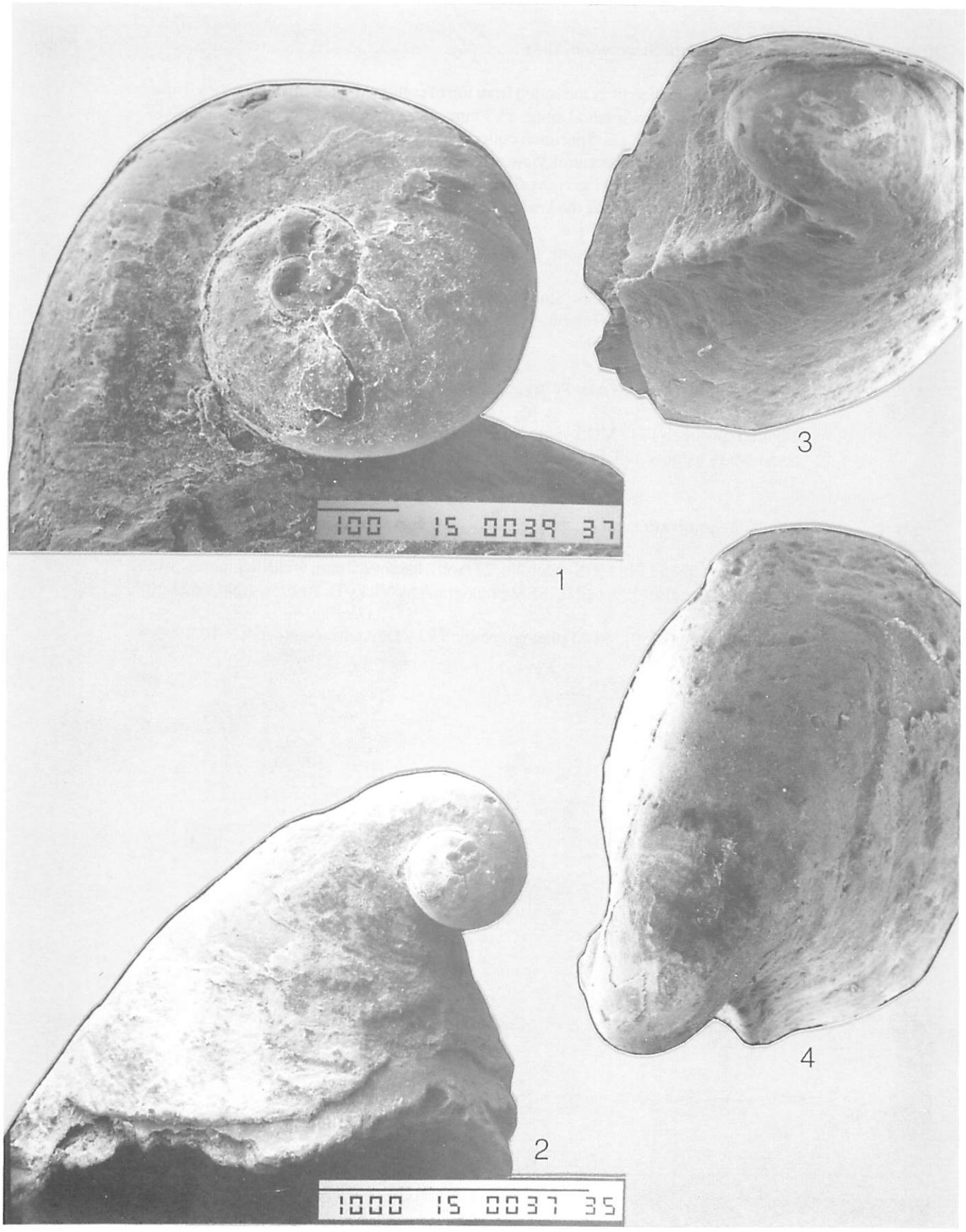


EXPLANATION PLATE 39

Figure		Page
1-4	**Anisomyon** sp.	95

1. Figured specimen 1745 MGS - Stub No. 25 (x150). Coffee Sand, MGS locality 129, bed E. Apical view of larval shell. SEM photograph by Vicky D. Andrews, No. 39, 1-21-1993.
2. Same as above (x50). Left view showing protoconch. SEM photograph by Vicky D. Andrews, No. 37, 1-21-1993.
3. Same as above (x50). Posterior view with apex of larval shell at top showing sinistral coil and the posterior ridge. SEM photograph by Vicky D. Andrews, No. 5, 1-14-1993.
4. Same as above (x50). Dorsal view with anterior at top and showing apex of protoconch facing left side. SEM photograph by Vicky D. Andrews, No. 2, 1-14-1993.

PLATE 39



EXPLANATION PLATE 40

Figure — Page

1-2 **Tundora tuberculata** Stephenson, 1941 65-66

1. Private collection, height as measured from top of callus shield to tip of rostra 23.0 mm, width to tip of posterior labral spine 23.3 mm. Dorsal view (x2). Coffee Sand, MGS locality 129, top of bed E. Specimen collected and prepared by Chris Garvie.
2. Same as above (x2). Apertural view. The anterior labral spine (lower right) has a ventrally directed (toward the viewer) terminal keel. The thickness of the spine in front of the keel is 1.4 mm and at the keel is 4.6 mm.

3 **Alvania (s.l.) tallahatchiensis** (Sohl, 1960) 53-54

Figured specimen 1746 MGS - Stub No. 24 (x35), height 1.9 mm, width 1.1 mm. Ripley Formation, Coon Creek Tongue, MGS locality 127. SEM photograph by Vicky D. Andrews, No. 57, 2-10-1993.

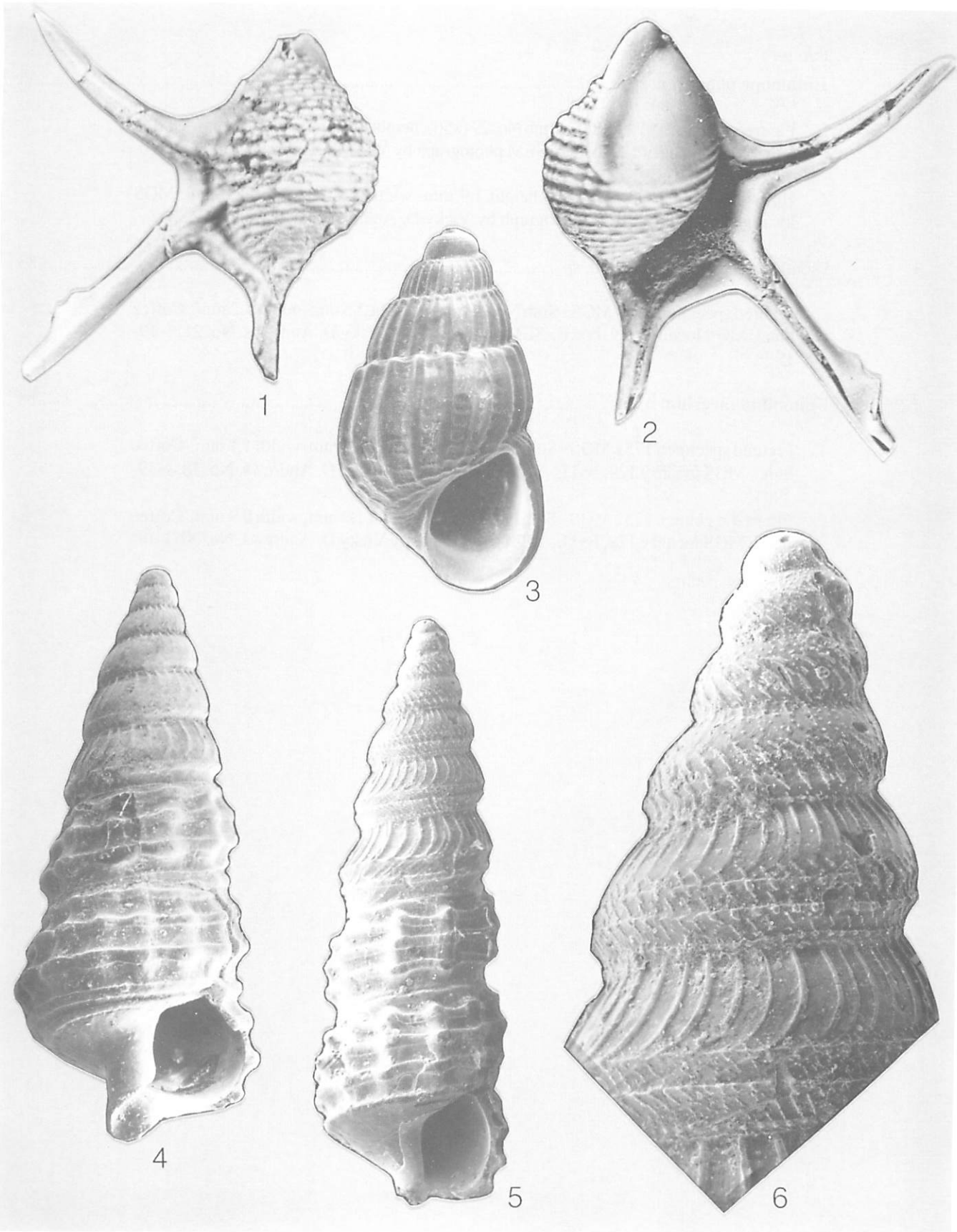
4 **Cerithiella nodoliratum** (Wade, 1926) 79

Figured specimen 1747 MGS - Stub No. 27 (x50), height 2.1 mm, width 0.9 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 67, 2-10-1993.

5-6 **Cerithiella aequalirata** n. sp. 80

5. Figured specimen 1748 MGS - Stub No. 27 (x50), height 2.2 mm, width 0.7 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 65, 2-10-1993.
6. Same as above (x150). SEM photograph by Vicky D. Andrews, No. 64, 2-10-1993.

PLATE 40



EXPLANATION PLATE 41

Figure — Page

1-2 **Entomope ponderi** n. sp. 56

1. Figured specimen 1749 MGS - Stub No. 29 (x50), height 1.6 mm, width 1.3 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 60, 2-10-1993.
2. Holotype 456993 USNM (x50), height 1.9 mm, width 1.3 mm. Coffee Sand, MGS locality 129, bed B. SEM photograph by Vicky D. Andrews, No. 62, 2-10-1993.

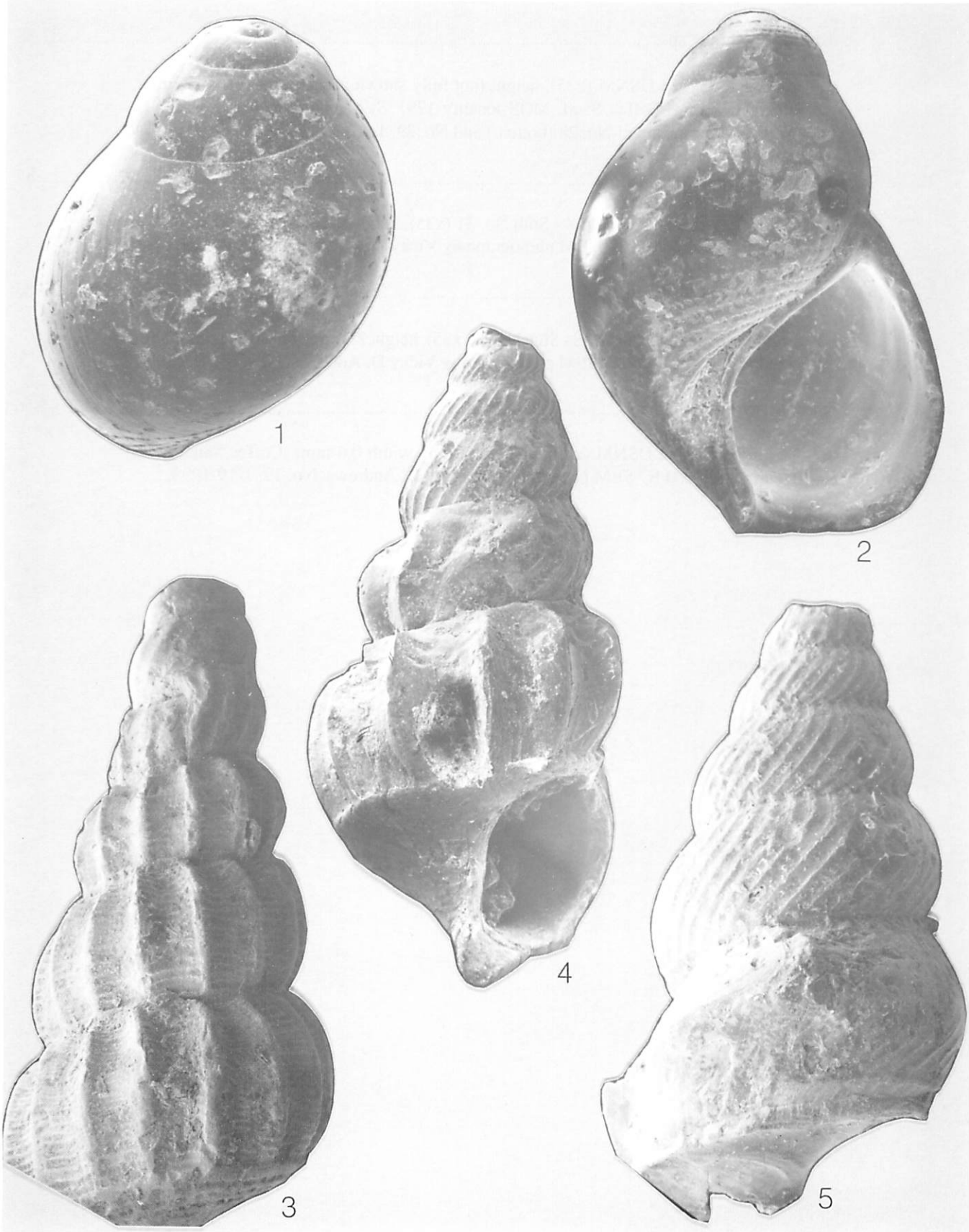
3 **Pseudoclaviscala rugacosta** n. sp. 83

Figured specimen 1750 MGS - Stub No. 31 (x50), height 2.5 mm, width 1.2 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 21, 1-19-1993.

4-5 **Epitonium faearium** n. sp. 84

4. Figured specimen 1751 MGS - Stub No. 30 (x50), height 2.4 mm, width 1.1 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 18, 1-19-1993.
5. Figured specimen 1752 MGS - Stub No. 31 (x75), height 1.2 mm, width 0.9 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 20, 1-19-1993.

PLATE 41



EXPLANATION PLATE 42

Figure — Page

1 **Eulima spirala** n. sp. 87-88

Holotype 457023 USNM (x35), height (not fully shown and missing apex) 6.5 mm, width 2.3 mm. Coffee Sand, MGS locality 129. SEM photographs by Vicky D. Andrews, composite of No. 28 (bottom) and No. 29, 1- 19-1993.

2 **Eulima coffea** n. sp. 87

Figured specimen 1753 MGS - Stub No. 31 (x35), height 3.1 mm, width 0.9. Coffee Sand, MGS locality 129. SEM photograph by Vicky D. Andrews, No. 25, 1-19-1993.

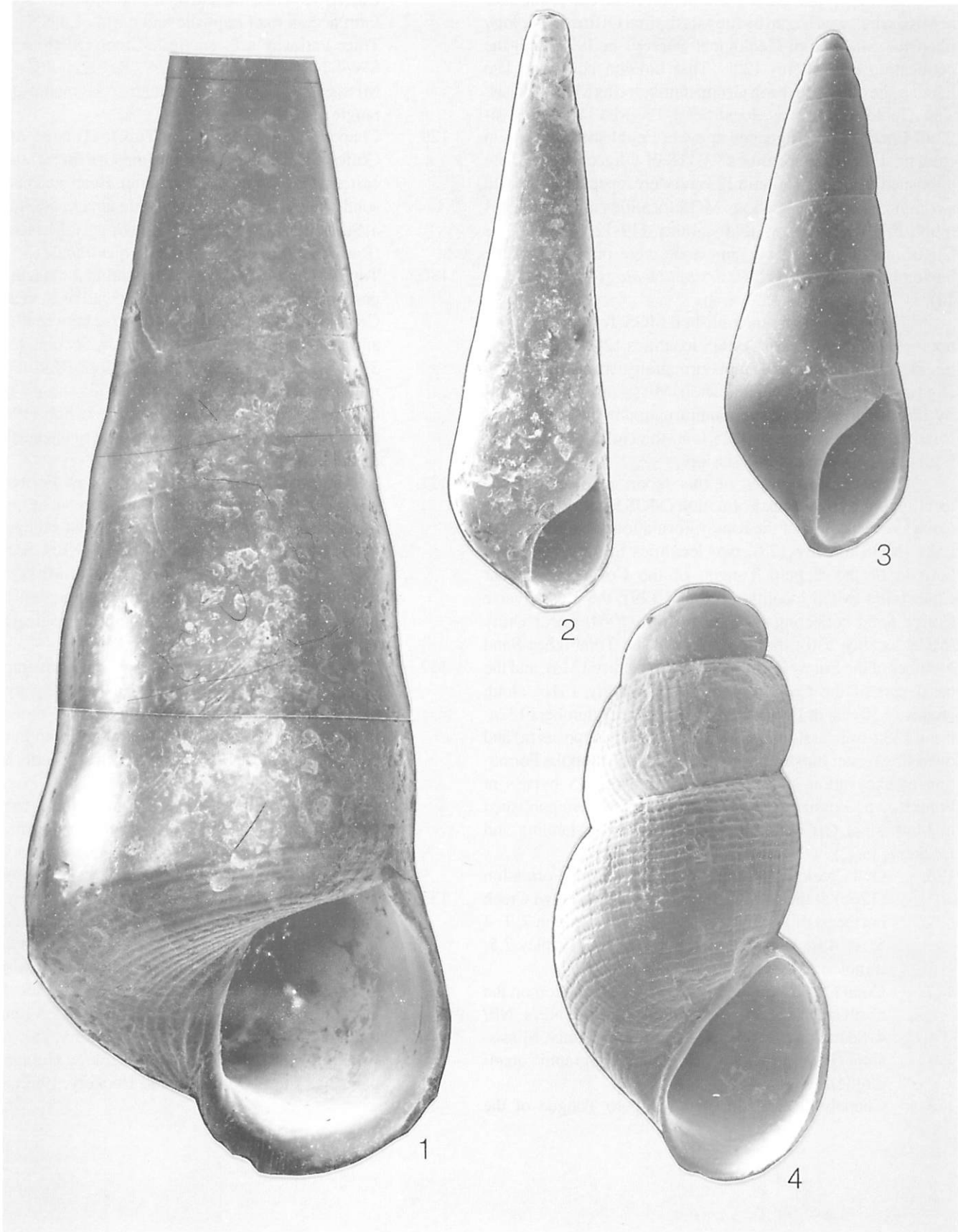
3 **Eulima gracilistylis** Sohl, 1964 87

Figured specimen 1754 MGS - Stub No. 31 (x35), height 2.7 mm, width 0.9 mm. Coffee Sand, MGS locality 129. SEM photograph by Vicky D. Andrews, No. 26, 1-19-1993.

4 **Ceratia cylindrata** n. sp. 55-56

Holotype 456992 USNM (x75), height 1.5 mm, width 0.6 mm. Coffee Sand, MGS locality 129, bed E. SEM photograph by Vicky D. Andrews, No. 19, 1-19-1993.

PLATE 42



LOCALITIES

A listing of numbered localities for fossil collecting sites in Mississippi was begun by the Mississippi Office of Geology (then the Mississippi Geological Survey) in 1977 with the publication of Bulletin 120. That bulletin contained late Eocene sites in the Jackson Group numbered as MGS (Mississippi Geological Survey) localities 1-15. MGS localities 16-72 of Eocene and Oligocene age were published in 1980 in Bulletin 122; MGS localities 73-118 of Oligocene age were published in 1982 in Bulletin 123 and were repeated along with a complete listing of previous MGS localities in Bulletin 124 (published in 1984); MGS localities 119-120 for the late Oligocene Chickasawhay Limestone were published in the September 1982 issue of *Mississippi Geology* (v. 3, no. 1, p. 14).

The following are unpublished MGS Tertiary localities not included in this report. MGS localities 121-123 are in the middle Eocene Cook Mountain Formation just north of the I20/ Highway 15 interchange in Newton, Mississippi; MGS locality 124 is in the Cook Mountain Formation in Clarke County, Mississippi; MGS locality 125 is in the early Eocene Bashi Formation at Meridian, Mississippi.

Cretaceous localities of this report include the type locality of the Owl Creek Formation (MGS locality 126a); the Coon Creek Tongue of the Ripley Formation at Union County Lake (MGS locality 127); two localities in the Chapelville horizon of the Tupelo Tongue of the Coffee Sand near Chapelville (MGS localities 128 and 129); the most diverse Coffee Sand collecting locality of Sohl (1964b) near Unity (MGS locality 130); the upper part of the Tombigbee Sand Member of the Eutaw Formation (MGS locality 131a); and the basal part of the Coffee Sand (MGS locality 131b) along Highway 30 east of Booneville. MGS locality numbers 132a-b and 133a-b are assigned to the vertebrate lag deposits (a) and overlying oyster biostrome (b) in the basal Demopolis Formation at excavation sites along the Highway 45 bypass at Frankstown. Fossils from the latter two sites were published in Mississippi Office of Geology Circular 4 (Manning and Dockery, 1992).

126. Owl Creek Formation (126a) and Clayton Formation (126b) at the Owl Creek type locality on Owl Creek northeast of Ripley; N/2, NE/4, SE/4, Section 7, T. 4 S., R. 4 E., Tippah County, Mississippi (Ripley 7.5-minute topographic quadrangle).

127. Coon Creek Tongue of the Ripley Formation on the north side of Union County Lake; NW/4, NE/4, NE/4, Section 11, T. 6 S., R. 4 E., Union County, Mississippi (Pleasant Ridge 7.5-minute topographic quadrangle).

128. Chapelville horizon of the Tupelo Tongue of the Coffee Sand in a roadcut on the north side of a gravel farm access road opposite and north of the Natchez Trace Parkway's Twentymile Creek Overlook; S/2, SW/4, NE/4, Section 34, T. 7 S., R. 7 E., Lee County, Mississippi (Ratliff 7.5-minute topographic quadrangle).

129. Chapelville horizon of the Tupelo Tongue of the Coffee Sand in a borrow pit (the Griffin pit) on the east side of the Friendship-Pratt Road and on the south valley wall of Twenty Mile Creek; NE/4, NE/4, Section 29, T. 7 S., R. 7 E., Lee County, Mississippi (Ratliff 7.5-minute topographic quadrangle).

130. Tupelo Tongue of the Coffee Sand in a roadcut just north of Unity on the south valley wall of Mantachie Creek and on the west side of a road between Unity and Friendship; NW/4, SW/4, SE/4, Section 9, T. 8 S., R. 7 E., Lee County, Mississippi (Ratliff 7.5-minute topographic quadrangle). This was the most diverse Coffee Sand collecting locality of Sohl (1964b) but is nonfossiliferous at present due to the leaching of shell material in the acid soil.

131. Tombigbee Sand Member of the Eutaw Formation (131a) and Coffee Sand (131b) in a roadcut on the north side of Highway 30 and on the east valley wall of Big Brown Creek; S/2, NE/4, NW/4, NE/4, Section 27, T. 5 S., R. 8 E., Prentiss County, Mississippi (Marietta 7.5-minute topographic quadrangle). This locality was published in Mississippi Geological Survey Bulletin 87 (Parks, 1960, p. 42).

132. "Frankstown Sand," an informal unit containing a vertebrate lag deposit (132a) and overlying oyster biostrome (132b) in the basal Demopolis Formation in roadcuts and road bed of the Highway 45 bypass construction site at Frankstown south of Twenty Mile Creek; S/2, SE/4, Section 2, T. 6 S., R. 6 E., Prentiss County, Mississippi (Baldwyn 7.5-minute topographic quadrangle). This locality was published in Mississippi Office of Geology Circular 4, page 3 as the Frankstown site (Manning and Dockery, 1992).

133. "Frankstown Sand" (133a) and overlying oyster biostrome (133b) in the basal Demopolis Formation in roadcuts and road bed of the Highway 45 bypass construction site north of Frankstown and west of Osborne Creek; NE/4, SE/4, Section 25, T. 5 S., R. 6 E., Prentiss County, Mississippi (Wheeler 7.5-minute topographic quadrangle). This locality was published in Mississippi Office of Geology Circular 4, page 3 as site A (Manning and Dockery, 1992).

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