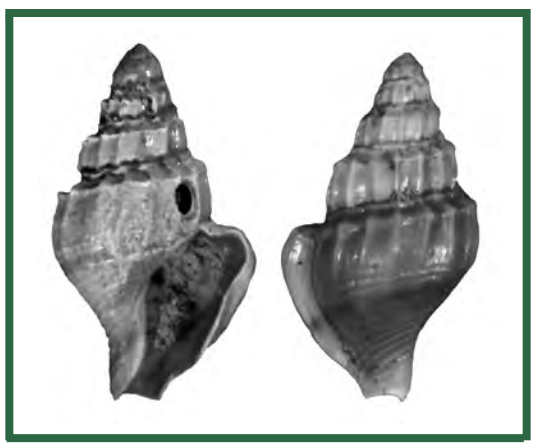

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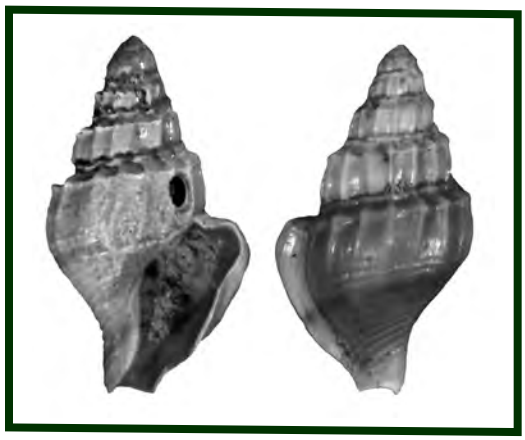

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THE MOLLUSCAN MACROFAUNA OF THE SEGUIN FORMATION (UPPER PALEOCENE) IN CENTRAL TEXAS

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ABSTRACT

Investigation of known Seguin localities led to the discovery of an overlooked diverse and abundant marine fauna in Solomon's Branch, a stream in Bastrop County, Texas. The fauna, a transported assemblage from a marine littoral environment, encompasses a mix of specimen types from large wave-worn individuals to the smallest unworn ornamented species. Following the discovery of this fauna, further field work was undertaken and other Seguin localities with different depositional environments were found and collections made from those sites. Finally, a further suite of specimens was examined within the Texas Natural Science Center, some from localities no longer in existence or now lost. The environment is transitional in character from the deeper water Midway to the nonmarine environment of the chiefly terrestrial Texas Wilcox deposits, and represents the last major marine transgression in this area prior to the Eocene. The fauna is a mix of that derived from early Paleocene and Cretaceous taxa as well as elements that appear to originate from western Africa, the Tethyan region, and the western coast of America. The inferred species' habitat includes a near-shore open marine element, a probable lagoonal component, and brackish water elements. From the 115 molluscan taxa recognized, six have not been recognized to date in sediments later than the Cretaceous, and 30 represent from the Eocene or later records. The following new gastropod genera and subgenera are proposed: *Texaficus*, *Crassauris*, *Latirus* (*Levarlatirus*), *Praesurcula*, and *Apiotoma* (*Lavarotoma*). The following new species and subspecies are described: Bivalvia: *Calorhadia diminutia*, *Adrana seguinensis, Bornia solomonis*, *Mactra* (*Eomactra*) *piscinasina*, *Arcopagia* (*Arcopagia*) *solomonis*, *A.* (*Johnsonella*) *seguinensis*; Gastropoda: *Turritella mortoni crassa*, *Tylotrochus extremus*, *Teinostoma* (*Idioraphie*) *seguinensis, Cochliolepis* (*Tylaxis*) *palaeocenica*, *Solariorbis velarum*, *Natica* (*Carinacca*) *seguinensis, Polinices* (*Euspira*) *perspecta texana*, *Texmelanatria contracta*, *T. brevis*, *Loxotrema texana*, *Pseudoliva globosa*, *Cantharus seguinensis, Colwellia humerosa*, *C. nodulina*, *C. nodulina meta*, *Tritiaria*? *seguinensis, Metula reticulata*, *Latirus* (*Levarlatirus*) *undus*, *L.* (*Levarlatirus*) *textilis*, *Strepsidura cancellata*, *Texaficus obesus*, *Levifusus pagoda seguinensis, L. actuocarinata*, *Fulgurofusus grande*, *Palaeorhaphis palaeocenica*, *Volutocorbis olssoni gracilis*, *Eoancilla hordea*, *Caveola ostium*, *Clinuropsis yanceyi*, *C. tuberculata*, *Praesurcula palaeocenica*, *Coronia vallare*, *Eopleurotoma molineuxae*, *Tropisurcula*? (*Eodrillia*) *cingula*, *Apiotoma* (*Lavarotoma*) *alva*, *Crassauris seguinensis, Pyramidella* (*Syrnola*) *bilineata*, *Turbonilla* (*Chemnitzia*) *obliqueata*, *Odostoma* (*Doliella*) *deprimere*, *Cylichna* (*Cylichnopsis*) *bicarinata*, *Mnestia ovata*, *Retusa* (*Cylichnina*) *bastropensis*; Cephalopoda: *Cimomia contraria*, *Angulithes*? *palaeocenica*. Other changes in taxonomic assignment include: the genus *Lisbonia* is moved from the Nassariidae to the Buccinidae; the genus *Palaeorhaphis* is moved from the Mitridae to the Fasciolariidae; the genus *Fictoacteon* is made a subgenus of *Eoacteon*; *Baluchicardia wilcoxensis* replaces *Venericardia wilcoxensis*; *Cochlodesma howei* replaces *Periploma howei*; *Pachymelania penrosei* replaces *Cerithium penrosei*; *Lisbonia pauper* replaces *Pseudoliva ostrarupis pauper*; *Pleuroploca plummeri* replaces *Fasciolaria? plummeri*; *Fulgurofusus perobliquus* replaces aff. *Falsifusus perobliquus*; *Eoancilla mediavia* replaces *Ancilla mediavia*; *Apiotoma* (*Lavarotoma*) *capex* replaces "*Pleurotoma*" *capex*; *the* genus *Ancillarina* should be used in place of *Ancilla* for several U. S. and European Eocene species; the genus *Coronia* is discussed and several species of that genus in the U. S. Gulf Coast are reassigned to *Gemmula*; the genus *Protosurcula* is moved from the Borsoniinae to the Cochlespirinae. Neotypes are designated for *Turritella polysticha* and *Pseudoliva ostrarupis*.

INTRODUCTION

This monograph is the continuation of a project to investigate the central Texas Tertiary molluscan faunas in finer temporal resolution than is presently known. The Middle Eocene Claibornian Texas faunas are well known from the results of numerous studies, particularly those of Palmer (1937), Harris (1937), Stenzel (1943), Stenzel & Turner (1943), Stenzel *et al.* (1957), and Garvie (1996); for the underlying Midway Group (Paleocene), Harris (1895a, 1896) and Gardner (1935) should be mentioned. During exploratory field work to relocate some localities described by Gardner (1935), the author visited Solomon's Branch in Bastrop County where large concretions, up to 2 m in diameter, were found in the creek bed, and *in situ* embedded in the creek-side walls. Many of these contained a layer of densly concentrated fossil shells, some very large. Even a cursory examination indicated the existence of many new forms. The discovery of a fauna from a nearshore litoral environment is of particular interest, because there appears to be no other known from a similar environment in the Gulf Coast Paleogene.

HISTORY

Harris (1895a, 1897a) originally described fossils coming from Smiley's Bluff, from a well near Elgin, and doubtfully from Rocky Cedar Creek, near Elmo, Kaufman County, which he regarded as being in the Midway Stage. The first evidence of marine deposits of lower Wilcox age west of the Sabine River was reported by Trowbridge (1923) and Gardner (1923), and was expanded on by Gardner (1924). F. B. Plummer in Sellards *et al.* (1933: 574) defined the Seguin Formation to encompass all marine strata between the compact silty clays of the Midway Group and the base of the nonmarine Rockdale (now Wilcox) Formation and further divided it into two members, the lower Solomon Creek clays and sands and the upper Caldwell Knob oyster bed (F. B. Plummer in Sellards *et al.*, 1933: 576–577). The type locality of the Solomon Creek Member is Moss Branch (11-T-102, see Localities), and of the Caldwell Knob Member is Caldwell Knob, both in Bastrop County. Gardner (1935: 54) correlated the Smiley's Bluff outcrop on the Brazos River with the Solomon Creek Member. Beckman (1941) determined the age-boundaries and performed a more detailed description and correlation of major outcrops in the Seguin in Central Texas. Beckman & Turner (1943) reported a disconformity in the Solomon Creek Member and on this basis redefined it as the uppermost member of the Wills Point Formation while the Caldwell Knob Member remained in the Seguin Formation as the lowest member of the Wilcox Group, which placed the formation in the Lower Eocene. I follow F. B. Plummer in Sellards *et al.* (1933), Stenzel & Turner (1951), Rizvi (1958), and Fisher & McGowen (1961) and place the base of the Wilcox at the base of the Seguin Formation, which is at the base of the Solomon Creek Member. H. J. Plummer (1933) and LeBlanc in Barry & LeBlanc (1942) originally placed the Paleocene-Eocene boundary at or near the base of the Wilcox; however, more recent work (Fisher & McGowen, 1967; Yancey *et al.*, 2010) has established that this boundary is well above the Seguin Formation in the lower part of the Calvert Bluff Formation, placing the entire Solomon Creek and Caldwell Knob units in the Middle to Upper Paleocene, lower part of the Wilcox Group.

GEOLOGICAL SETTING

The term Seguin is used here as a rock unit encompassing the first occurrence of the clays or silts, commonly lignitic or carbonaceous, from above the shales or glauconitic strata of the Midway shales to the final fossiliferous oyster lentil of the Caldwell Knob Member. The Midway Stage is used in the sense of Murray (1955) as a time-rock unit in the Tertiary prior to the deposition of the *Odontogryphaea thirsae* (Gabb, 1862) (= *Ostrea thirsae*) and *Ostrea multilirata* Conrad in Emory, 1857, beds. Rizvi (1958) stated that the Seguin is the topmost fossiliferous marine unit of the Paleocene in Texas, however, Beckman & Turner (1943) noted a marine lentil 61 m above the top of the Caldwell Knob Member in Milam County, and recent work by Yancey (pers. comm., 2011) has established that marine mollusks and shark teeth occur in the upper part of the Calvert Bluff Formation indicating that marine strata do occur well up into the Wilcox Group. The Seguin Formation is recognized as a surface outcrop up to 1.5 km wide, extending from the Trinity River to the Rio Grande (F. B. Plummer in Sellards *et al.*, 1933), and on into Mexico (Perrilliat & Vega, 2003). In the subsurface, the thickness has been measured as between 15 m and 579 m with a median of *ca.* 29 m (Sellards *et al.*, 1933), whereas in central Texas, it has a median of approximately 28 m (Stenzel & Turner, 1951). It occurs at the end of a shallowing-up trend from the probable deep-shelf environments of the Kincaid Formation to the middle neritic environments of the Wills Point Formation (Agostino & Yancey, 1996; Kellough, 1965), and consists of a transgressive shallow-marine sequence of glauconitic sands and silts topped by an oyster-reef biostrome. The lower Solomon Creek Member rests conformably on the Kerens Member of the Wills Point Formation, which is composed of dark clays containing typical Wills Point foraminiferans; in southwestern Texas, the member rests disconformably on the Kincaid Formation. The Solomon Creek Member can be recognized by the evenly laminated clays and silts with occasional concretions and small pyrite/marcasite nodules, and by the massive concretionary sandstone boulder beds near the base and top of the unit. In the field, the presence of disk-shaped, reddish-brown calcareous concretions, often carbonaceous and lignitic, varying from 30 cm to 3 m long and 15 cm to 2 m thick, are often diagnostic of the unit.

The fossil bed in which the majority of the species and specimens were found occurs near the top of the Solomon Creek Member at Solomon's Branch and appears to be a storm-transported fauna that was deposited in local depressions and hollows, some of which might have been tidal channels. The base of the fossil bed rests on sandy silts; within this layer (which has an average thickness of approximately 7.5 cm) the specimens decrease in size upward and the layer is capped by massive, cross-bedded sands. At the Solomon's Branch (locality 11-T-13), Beckman (1941: 10) placed the disconformity at the base of the Caldwell Knob Member in the upper 3.2 m of the creekside section; examination by the author has found no obvious lithological break, and the transition appears to be conformable, although the lithology does change gradually from laminated clays and silts to a massive gray sand. Oldani (1988) pointed out that, although generally the change of sedimentation from the Midway into the Wilcox is continuous and transitional from marine to fluviodeltaic, a disconformity such as Beckman & Turner (1943)

reported could represent a local feature, one that is quite likely to occur within a deltaic depositional regime. The Caldwell Knob Member is a gray, massive, commonly cross-bedded, slightly glauconitic calcareous sand, which can be topped by an oyster bed of up to 7 m thick. At the Seguin type locality of Moss Branch (11-T-103), the upper part of the Caldwell Knob Member is well exposed and the characteristic oyster bed rests on approximately 5.6 m of gray shales and yellow/whitish sands. The sands are strongly cross-bedded, and Rizvi (1958) noted that this cross-bedding varies in magnitude and direction from place to place, indicating rapidly varying sea conditions. This oyster bed has been traced (Gardner, 1924: 143) from the Brazos River to the Rio Grande.

Two locations known to the author that show the entire section of the Solomon Creek Member are localities 11-T-13 (Solomon's Branch) and 165-T-200 (Pond Creek), where both the upper and lower concretionary layers are well exposed, bracketing the section. These concretionary layers appear to have been formed *in situ* and are post-depositional, as indicated by the presence of animal borings, slump structures, and undistorted, unexpanded cross-bedding running through the concretions (Rizvi, 1958: 24). Rizvi (1958) also carried out the most detailed analysis of the Seguin paleoenvironment and concluded that the deposition occurred in rapidly fluctuating nearshore environments most probably consisting of shallow-marine, deltaic, and lagoonal phases. Fisher & McGowan (1967: 113–114) published maps that show the Elgin-Colorado river locations laying within one principal delta of the ancient Rockdale lobate Delta system, situated approximately along the drainage of the modern Colorado River, while the Pond Creek and Smiley's Bluff locations are within another delta system close to the modern Brazos River drainage system. Both sets of localities are close to areas of maximum fluvial sand deposition in the ancient deltas, analogous to the sand-rich, lobate, shoal-water deltas of the modern Rhone. The presence of clay beds containing leaf fragments and lignite suggest lagoonal deposits, although even within those beds occasional small concentrations of mollusks, "*Ophiomorpha*" sp., and animal burrows occur, indicating a marine environment. The overlying Hooper Formation could be partially marine because it is composed of glauconitic sands and shales although no marine fossils have been yet been found; the Simsboro Formation, which grades into the lower Calvert Bluff Formation, is totally nonmarine in nature with siltstones, clays, and lignite beds (Fisher & McGowan, 1961), containing a flora of plant fossils, and a fauna of freshwater bivalves and "*Viviparus*"-like gastropods as is indicated by the collections deposited in the Texas Natural Science Center (TNSC).

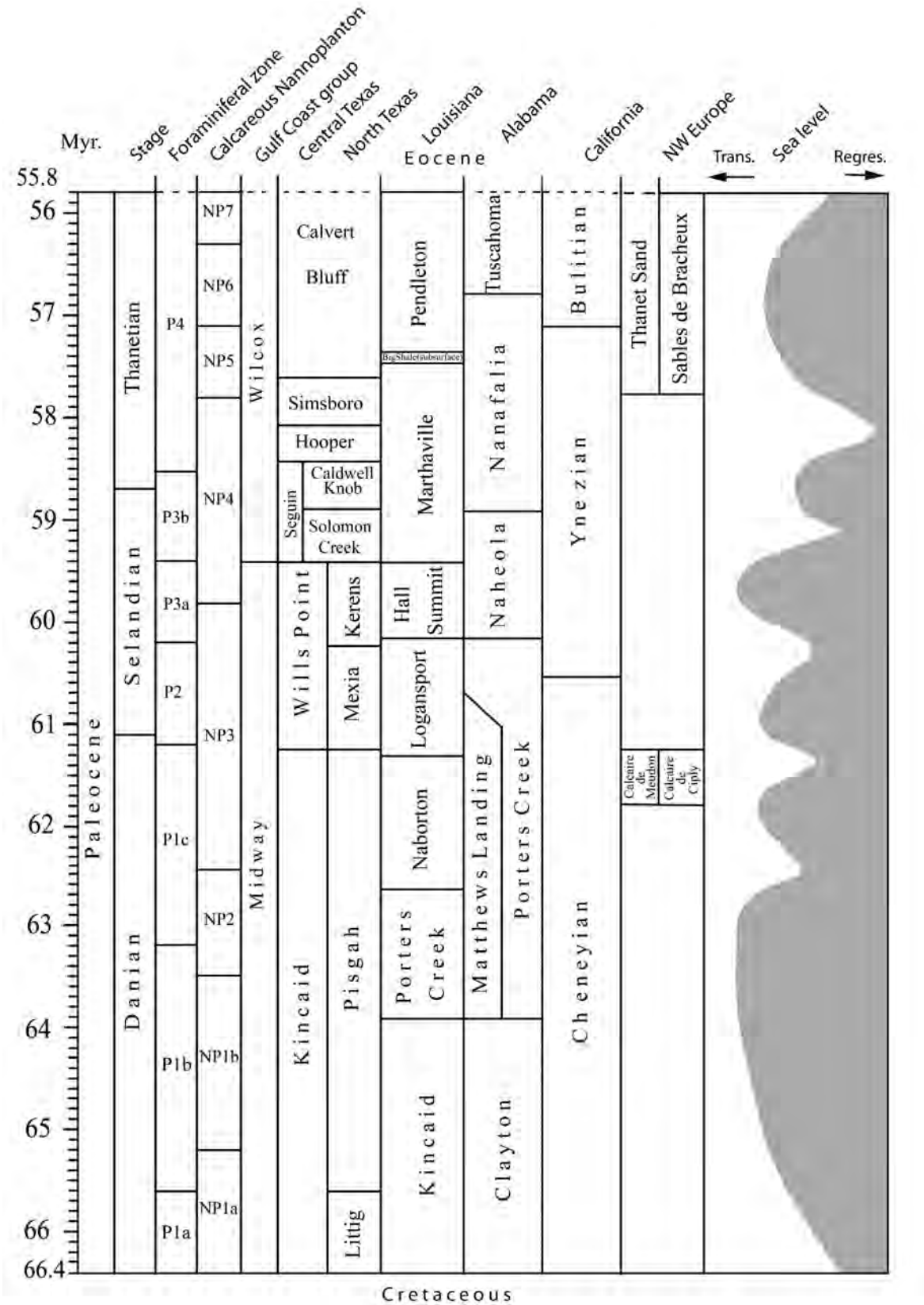
CORRELATION WITH OTHER FAUNAS

Text-fig. 1 was compiled from several sources; the dates from the Paleocene stages follow the International Commission of Stratigraphy[1]; Rosen (2007) and the work of Crabaugh & Elsik (2000) were used for planktonic and nannoplanktonic chronostratigraphy; data from Mancini & Tew (1990), Yancey *et al.* (2010), and Dockery in Aubry *et al.* (1998) were used for placing the formational boundaries in the Gulf Coastal Plain. The work of McDougall in Scheirer (2007) was used for correlation with the Californian section, whereas for northwestern Europe, Aubry *et al.* (2000) and Neal (1996) were consulted. The sea-level chart by Mancini & Tew (1990) was used, with the sea-level maxima and minima adjusted to reflect the new relative positions of the planktonic micropaleontological zones within the Paleocene age scale; the similarity of this chart with that by Neal (1996: text-fig. 3) in the Danien could indicate a coincident region-wide transgression of the early Atlantic and Gulf Coast areas.

Crabaugh & Elsik (2000) inferred a gap between the Solomon Creek and Caldwell Knob members, but field evidence presented by Beckman (1941), Giannone (1951), and the author shows no major unconformities and thus no missing section.

The section at the type locality on Moss Branch (locality 11-T-102 and nearby) contains the entire Caldwell Knob Member and most of the Solomon Creek Member; at Solomon's Branch, the sections from low in the Caldwell Knob Member down to the underlying Wills Point can be recognized. A tentative correlation can be made with the eastern Gulf Coast section utilizing the oyster *Odontogryphaea thirsae*, because at several localities, both *O. thirsae* and *Ostrea multilirata* co-occur (LeBlanc in Barry & LeBlanc, 1942). The Caldwell Knob Member is capped by a bed of *T. duvali* (Gardner, 1927), a species coeval with and originally described as a subspecies of *O. multilirata*, but now given full specific rank; one specimen of *O. multilirata* from the underlying Solomon Creek Member was found in the TNSC collections, thus extending the range of that species downward. Glawe (1989) found *O. thirsae* from both the subsurface Big Shale Member in Louisiana and the surface exposures to be within the planktonic foraminiferal P4 zone, and thus stratigraphically equivalent to both the lower Nanafalia Formation of Alabama and the upper Caldwell Knob Member. The Big Shale, dated at 57.4 Ma (Crabaugh & Elsik, 2000), has been traced from Louisiana into southern Texas where there is overlap with the Tilden Shale, both units being placed at the transition between the subsurface lower and upper Wilcox subgroups (Hargis, 1996).

[1]https://engineering.purdue.edu/Stratigraphy/gssp/index.php?__parentid=2, accessed 2011.



Text-fig. 1—Paleocene lithostratigraphy, biostratigraphy, and sea-level changes of the Gulf Coast correlated with sections in California and northwestern Europe.

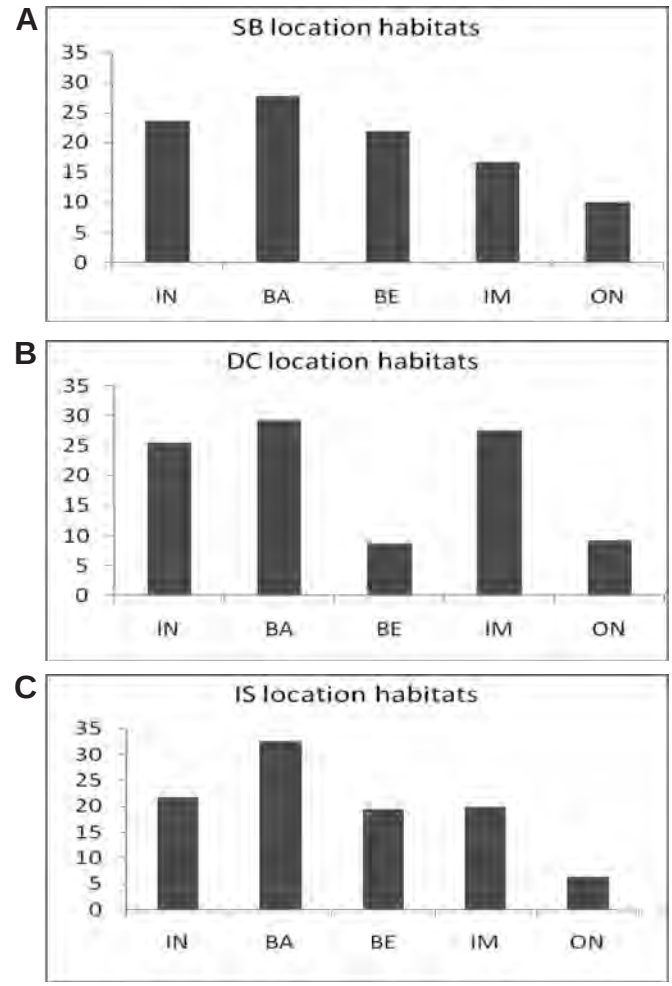
MATERIALS AND METHODS

Material Examined

This study is based on more than 2,400 specimens collected from outcrops in the field and augmented by examination of more than 200 specimens from the TNSC collections where all of the material collected by the geologists of the Texas Surveys now resides. The majority of the specimens came from the base of the concretionary boulder bed (*cf.* bed EE, Text-fig. 2); another smaller set of specimens with many juveniles came from the "*Turritella*" layer in bed DD, at the mouth of Dry Creek (locality 11-T-101); a much smaller number of specimens came from the laminated silty layers in bed DD. The specimens from bed EE were found in very hard calcitic-cemented sandstone boulders and it required a 30-lb hammer with chisels to break fossiliferous pieces off of the boulders; extracting specimens from those pieces was very difficult. Trying to remove more matrix most often resulted in considerable damage to the specimens; in the case of gastropods, the rock usually split along a cleavage plane on the side opposite the aperture, leaving exterior shell material on one piece of rock and the remainder of the specimen on the other; similarly extracting bivalves usually left part of the exterior shell on one piece and the remainder on the other, rarely leaving the important hinge features exposed. Probably at least two or three times the 2,400 useable specimens that were recovered, were broken during the process of trying to obtain useable material. The very few specimens that fortuitously split to show part of the apertural side visible in gastropods, or split near the hinge in bivalves, were prepared further with a miniature air hammer, electric vibroengraver, and Dremel grinder, an extremely laborious process that was often unsuccessful. The "*Turritella*" layer fauna was most commonly found in the neighborhood of indurated clay concretions, and was generally well-preserved; most specimens were juveniles. The third set of specimens from the clays and silt exposures, were usually small and delicate and eroded due to weathering and leaching. The TNSC furnished specimens from locations that were no longer accessible or lost.

Photography and Image Processing

Medium to small specimens were photographed with a 5 Mb pixel digital camera, macrolens, and bellows. Specimens less than 5 mm were photographed with the digital camera attached to a microscope eyepiece, while using 10 or 20x magnification. Multiple images were taken of all specimens at different focal lengths and CombineZM stacking software was utilized to produce a final image. Image quality was then improved by using Adobe Photoshop CS3 to manipulate levels, brightness and contrast of the image. Photoshop was also used to decrease the contrast and visual impact of the matrix for those specimens partially embedded in it and often of a similar color.



Text-fig. 2—Faunal diversity for the three major habitats as a percentage of total fauna for each habitat. (A) Solomon's Branch location habitats. (B) Dry Creek location habitats. (C) *In situ* silt/shale location habitats.

Terminology and Classification

Gastropods are described in the traditional North American orientation with the apex above and the aperture below. Morphological terms used are those defined by R. C. Moore (1960). For bivalves, the orientation follows Stenzel *et al.* (1957) and the morphological terms used are those from R. C. Moore (1969). Scaphopods are described following Hodgekinson (1974), and nautiloids following Miller (1947). Higher taxa classifications and treatment order follow Bouchet & Rocroi (2005) for the gastropods, and Bieler *et al.* in Bouchet & Rocroi (2010) for bivalves, except where noted in the text. New taxa are defined for reasonably complete adult individuals that cannot be assigned to types in museum

collections or from the published literature; I follow the philosophy of Garvie (1996: 20–21) in assigning new taxa, and in the taxonomic level proposed (species, subspecies, etc.). If only juveniles were found, or all specimens from that species are badly damaged, then no specific name is given. I follow Bengtson (1988: 226) in the use of open nomenclature, but with the addition that *Agenus* cf. *Agenus aspecies* is used in the sense of a confident assignment to genus *Agenus* but also that the species attribution is closer to *aspecies* than any other species in that genus. This is a stronger attribution than *Agenus* cf. *aspecies*, which in Bengston's view indicates just a provisional identification to the species. The basis for species synonymies in the southern and eastern United States is that of Palmer & Brann (1965–1966); when used, their open nomenclature designations are replicated unchanged because their use of open nomenclature differs from Bengston's, and a proper conversion would require study of and access to all relevant species. Any updating and additions to their synonymy follow Bengston (1988) in open nomenclature use.

Repositories and Abbreviations

CLG: The author's collection. The Non-vertebrate Paleontology department, Texas Natural Science Center, The University of Texas at Austin, should be contacted for access.

CNHM: Chicago Natural History Museum (now Field Museum of Natural History), Chicago, Illinois.

GSATC: Geological Survey of Alabama, Type Collection, University of Alabama (formerly Alabama Museum of Natural History).

LV: left valve.

PRI: Paleontological Research Institution, Ithaca, New York.

RV: right valve.

TMM: Non-vertebrate Paleontology, Texas Natural Science Center, The University of Texas at Austin. Repository of several collections, including the old Texas Geological Survey collections, the Bureau of Economic Geology collections, and University of Texas collections; each had their own catalog numbering system, often consisting of BEG, NPL, or P, followed by a number. All are now prefixed by TMM.

TNSC: Texas Natural Science Center, Austin.

USNM: United States National Museum (now National Museum of Natural History), Smithsonian Institution, Washington, DC.

COMPOSITION OF THE FAUNA AND ENVIRONMENTAL SETTING

Apart from the mollusks, the following fauna has also been found:

Shark and ray teeth

Eotorpedo hilgendorfi Jaekel, 1904. Known from the Paleocene and Eocene of Morocco and the eastern United States. A selachian ray.

Striatolamia cf. *macrota* (Agassiz, 1843). Known from the Eocene of North and South America, the United Kingdom, Morocco and New Zealand. A sand tiger shark.

Geleprhinus sp. Paleocene and Eocene, worldwide distribution. A tope shark.

Ginglymostoma sp. Known from the Cretaceous and Tertiary of Europe and the U. S. A nurse shark.

Triakis? sp. Known from the Eocene to Recent. A leopard shark.

Coupatezia sp. or *Plesiobatis* sp. Known from Upper Cretaceous to Lower Eocene. A ray.

Palaeohypotodus sp. Known from the Cretaceous to Oligocene of Europe and the U. S. A shark.

Myliobatidae sp. Cretaceous to Recent. An open-ocean eagle ray.

Otoliths

Trachichthyidarum stringeri Nolf & Dockery, 1993. Eocene of Alabama.

Acropomatidarum sp. Known from the Cretaceous to the Eocene.

Harpadontidarum sp. Known from the Eocene of Europe.

Congridae spp.

Ariidae spp.

Merlucciidae spp.

Bryozoan

Callopora spp. One encrusting bryozoan found on the surface of a species of *Clinuropsis* Vincent, 1913, and one other bryozoan branch fragment.

Crab claws

Callianassa? spp. One complete claw in a silt block and several other fragmentary specimens from the indurated fossil layer.

Ostracod

One specimen.

Foraminifera

Cristellaria sp. One specimen.

Plantae

Entada? sp. Tropical distribution. Uncommon.

Macuna? sp. Tropical vine. Common.

Fossil log with tubes and shells (cf. *Bankia* sp.) and oyster spat.

Henri Cappetta (pers. comm., 2011), examined the shark fauna and determined the taxa, and Dirk Nolf (pers. comm., 2011), determined the otolith fauna, and stated the otoliths are all from juvenile fishes, from a near-shore environment.

A few mollusks reported by previous workers have not been found in this study. F. B. Plummer in Sellards *et al.* (1933: 581) listed several species from Solomon's Branch in the Bureau of Economic Geology (now the TNSC collections) that have not been found. None of the named taxa in F. B. Plummer's lists can be confidently assigned to specimens in the TNSC collections and because much of the taxonomy of the species referred to has also changed in the intervening years, the lists (with the exception of the comments made below) has little value for this study. Beckman (1941: 37–38, pl. 4) and (Giannone, 1951: 15–19, pl. 4) listed and figured several species, none of which have been available for examination. The following comments are made on species reported:

Levifusus supraplanus Harris, 1899a, mentioned by F. B. Plummer (1933). If this identification is correct, this would be an addition to the Seguin fauna. There is one specimen in the Museum collections of *Fulgurofusus grandis* n. sp., a species with some superficial resemblance to *L. supraplanus*, and it is believed that F. B. Plummer (1933) misidentified this taxon.

Priscoficus juvenis (Whitfield, 1865) (= *Fuscoficula* cf. *F. juvenis*), by F. B. Plummer in Sellards *et al.* (1933). No species of Ficidae have been found by the author and because any identification of this species outside of the Ficidae is unlikely, it is taken as a valid occurrence.

Protocardia sp. *cf.* F. B. Plummer in Sellards *et al.* (1933). This could be a mistaken identification of a worn *Acanthocardium* (*Schedocardia*) *hatchetigbeense* Aldrich in Smith, 1886, but specimens of *Protocardia* (usually assigned to genus *Nemocardium* in the Tertiary) are easily recognizable, and because *Nemocardium* is found in the underlying Midway and above in the Lower Eocene, it is taken as valid.

Cylene sp. Beckman (1941: 37–38, fig. 15). Error for *Cyllene* sp., a nassariid. From the figure it appears to be *Colwellia humerosa* n. sp.

Brachidontes (?) *stubbsi* Harris in Harris & Veach, 1899b. Giannone (1951: 17–19, pl. 4, figs 1, 2, 6) reported casts of this species from the Caldwell Knob Member. The species is known from the equivalent Marthaville Formation of Louisiana and is taken as valid.

Adding the three likely valid species above results in a fauna comprised of 91 different taxa to genera/subgenera, and 115 recognized to species/subspecies levels.

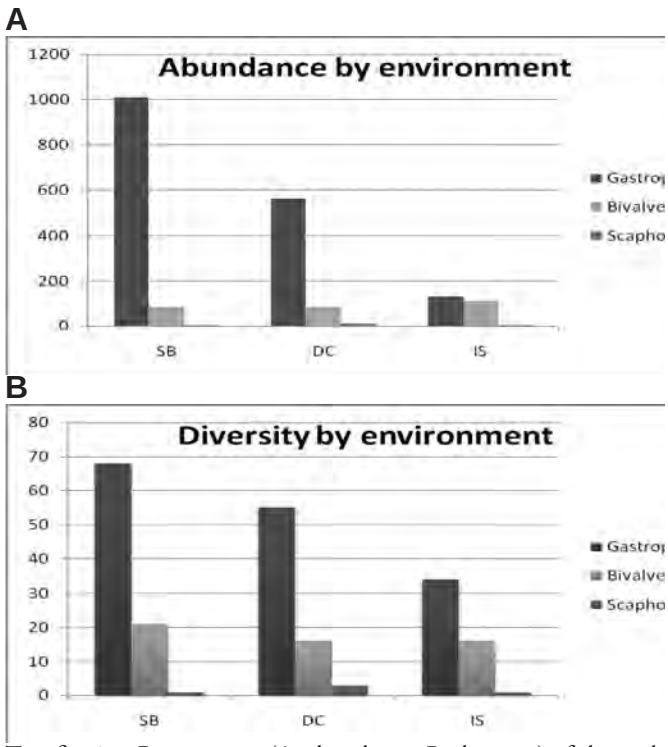
The field-collected specimens were found in four depositional settings:

1. a thick, cemented fossil layer with abundant large gastropods, mostly heavily abraded and worn; the deposit contains rounded quartz pebbles up to 40 mm in size, indicative of a high-energy transported assemblage. The depositional environment is most likely a channel deposit. It was only found at one site, that of Solomon's Branch, locality number 11-T-13;
2. a layer with a discontinuous set of concretions enclosing an abundant, well-preserved fauna of small gastropods, bivalves, and scaphopods. In this layer, which is correlated with the "*Turritella polysticha*" bed ("*Turritella* layer" of Beckman, 1941: 14, 16, fig. 2), but away from the vicinity of the concretions, a sparse fauna of primarily larger gastropods was found. The faunal concentrations are size limited to approximately 20 mm and are probably the result of low-energy current action near the sea floor;
3. the occasional fossils found in the clayey silts and sands between beds AA and EE (Text-fig. 2), excluding the "*Turritella polysticha*" bed. Specimens are sparse in the exposures, almost always thin shelled, and give all indications that they have not been transported far from the site where they were last living;
4. the Caldwell Knob oyster bed, from locality 11-T-103, is almost exclusively oysters, but includes rare steinkerns of tellinids and possibly venerids. This bed will not be discussed further in the following analysis.

Because nautiloids are pelagic animals, they are also not discussed in the faunal and environmental analyses. I shall refer to (1) with code SB (Solomon's Branch), (2) with code DC (Dry Creek), and (3) with code IS for the *in situ* silt/shale environments.

The fauna in each depositional setting is dominated, both in abundance and diversity (number of taxa), by gastropods; bivalves are uncommon and only in the case of three individuals were both valves found together (Text-fig. 3).

The faunal content of the three depositional settings is quite distinct. Only 39 taxa, or 32.5% of the total, have been found in more than one location. The fauna of SB is primarily dominated by large robust gastropods, naticids, and nassariid mudsnails; only 12 species, or 4.5% of the total, constitute 80% of the total faunal abundance. For DC, *Turritella* spp. dominate, comprising over 24% of the total fauna; secondarily dominant taxa are the opisthobranchs, the volute *Volutocorbis*, and nassariids. The depositional setting of IS, which is probably representative of a muddy lagoonal and near-shore environment, is dominated by the nassariid *Colwellia*, followed



Text-fig. 2—Composition (A, abundance; B, diversity) of the mollusk fauna by depositional setting.

by *Turritella*, *Natica, Latirus*, and *Pseudoliva*; these last four genera constitute more than 80% of the fauna of IS.

Following Garvie (1996: 18), the marine environmental continuum is now subdivided into six habitats, so as to ascertain in which habitats each of the three depositional environments, *viz.* SB, DC, IS, would correspond to. The six habitats are:

- Inside intertidal (IT): river channel near mouth; inside beach and marsh, shallow depth; brackish.
- Bay and pass (BA): occasional salinity reduction, combined brackish and marine or transitional faunas.
- Beach (BE): essentially zero depth to approximately 3 m; normal marine.
- Inner to middle neritic (IM): approximately 3 m to approximately 90 m; normal marine.
- Outer neritic (ON): approximately 90 m to approximately 180 m; normal marine.
- Slope (SL): shelf edge to continental rise; open sea.

In this study, no taxa have been assigned to slope habitat so that habitat is here ignored. To ascertain the paleoenvironmental setting, each taxon within SB, DC, and IS is assigned to the most probable habitat (Garvie, 1996) and the faunal diversity is plotted as a percentage of total fauna for each habitat (Text-fig. 2).

For each of the three locations, the maximum number of species fall within BA (the bay and pass habitat). The double peak seen in the DC location environment is likely the result of specimens derived from those presumedly transported species found in the indurated concretions, and those species that lived locally.

Examination of the molluscan fauna from the perspective of feeding type shows the overwhelming dominance of the carnivorous species; feeding type is taken from Todd (2007). Carnivores comprise from between 56% and 90% of the total fauna, dependant on the environment. Only at locality DC is there a significant number of gastropod suspension feeders comprising just above 20% of the fauna. Bivalves are a minor component of the fauna except at locality IS where deposit feeders comprise almost 27% of the fauna. With regard to microgastropods, defined as those gastropods with an adult size less than 5 mm, the numerical distribution within superfamilies agrees more closely with the Lower Paleocene distribution given by Garvie in Geiger & Ruthensteiner (2007: 299, text-fig. 3) than with the equivalent for the Eocene.

Sellards *et al.* (1933: 579) stated that the Seguin Formation consists of shallow-water marine sediments, deposited in the littoral zone and along a beach on a flat marshy coast. Rizvi (1958: 108–110) docmented Seguin sediments composed of fine glauconitic sands, highly fossiliferous concretionary sands and silts, nonglauconitic unfossiliferous sands, and silts and clays with lignite and leaf fragments, indicating deposition in a shallow-water neritic zone, offshore of a marshy coast, sluggish rivers, lagoons, and some deltaic areas; the extremely fine sediments indicate a large flat coastal plain. Rizvi (1958: 111) determined kaolinate in the clays, indicating a warm and humid climate, a fact also noted by Sloan & Thomas (in Aubry *et al.*, 1998), who also found high latitude temperature values for the Upper Paleocene to be much warmer than current values. The maps published by Fisher & McGowen (1969) place the collection areas to be within two ancient deltaic systems. The composition of the molluscan fauna that correlates most closely with a modern bay-pass habitat, the presence of seeds of tropical vines and trees found in the fossil concretionary layer, and the occurrence of wind or current transported pelagic species such as nautiloids and speciec of Myliobatidae suggest an environment near the distal edge of the delta, perhaps on the back side of a barrier island, for the Solomon Creek Member. The Caldwell Knob Member with the in-place oyster reef and highly crossbedded sands suggests a brackish bay environment nearer or within the estuary.

ORIGINS OF THE FAUNA

In just over 35% of the taxa treated, the range extends downward from that previously known, to the Upper Paleocene. Six of these (*Cochlodesma* Couthouy, 1839, *Eomactra* Cossmann

in Cossmann & Peyrot, 1909b, *Metula* H. & A. Adams, 1853, *Palaeorhaphis* Stewart 1927, *Surculoma* Casey, 1904, and *Terebrifusus* Conrad, 1865a) are known from the Gulf Coast Lower Eocene. A further 21 taxa are known from the Middle Eocene, whereas three (*Johnsonella* Afshar, 1969, *Cochliolepis* Stimpson, 1858, and *Spirolaxis* Monterosato, 1913) are only known from the Miocene or above. Some reasons for these numerous range extensions can be given, *viz*.: (1) many small species such as *Cochliolepis*, *Spirolaxis*, pyramidellids, and the Philinoidea are delicate, rare, often overlooked, and demand special collecting techniques for their recovery; (2) some taxa with slowly evolving lineages over long time periods, such as the Corbulidae and some Turridae, need extensive reference collections for recognition of new taxa; (3) the Seguin inferred environment of a nearshore, bay and pass habitat, is considerably different from the deeper water Kincaid, Wills Point, and Matthews Landing beds where most Paleocene Gulf Coast collecting has been done; (4) the fact that most of the fauna at locality 11-T-13 (SB) is within an indurated matrix increases the survival of thin-shelled taxa such as *Tylotrochus extremus* n. sp.; had it been found in the glauconitic sands, shales, and silts where most Gulf Coast collecting takes place, this taxon would most likely have been crushed and probably never recognized. Noteworthy is the presence of six taxa that are known from the Upper Cretaceous and one (*Tylotrochus* Koken, 1896) from the Triassic; two of these, the astartid taxon *Vertericardiella* Chavan in Moore, 1969, and the cancellariid *Caveola* Stephenson, 1941, are very common in the Upper Cretaceous Kemp Clay at Webberville, Texas, and their survival is probably due to the increased resilience of epifaunal shallow-water species to environmental stress over that of a deepwater fauna, a condition also reported in the Cenomanian/Turonian extinctions (Abdelhady in Elewa, 2008: 115–120). None of these six taxa survives past the Seguin, with likely the marine regression exposing shelf habitats being the extinction cause (Dockery in Aubry *et al.*, 1998: 310–311).

Several taxa appear suddenly in the Gulf Coast record with no apparent local precursors and so are probably immigrants from outside the area. The Seguin species of *Terebrifusus* for instance, although smaller than the later Eocene representatives, is evolutionarily conservative, being closely similar to the later Middle Eocene species, *T. amoenus* (Conrad, 1833b) and *T. multiplicatus* (H. C. Lea, 1841); it has no obvious ancestors either within or outside the Gulf Coast area. Two taxa from which precursors can be inferred are: *Clinuropsis* and *Strepsidura* Swainson, 1840. Both occur in the Lower Paleocene of Nigeria (Adegoke, 1977), whereas *Clinuropsis* also occurs in the Paleocene of Belgium and the Belgium Congo (Powell, 1966). A probable descendant of *Clinuropsis* is *Andicula* Olsson, 1929, a similar speightiid from the Lower Eocene of Peru (Olsson, 1929) and the Lower Eocene of Trinidad (Rutsch, 1943). Adegoke (1977) noted the similarity of the Ewekoro Paleocene fauna to the Midway Stage of the Gulf Coastal Plain, as well as the Soldado fauna of Trinidad (Maury, 1912; Rutsch, 1943) and the Brazilian Pernambuco fauna (Maury, 1912; Penna, 1965). The genotype of *Clinuropsis*, *C. diderrichi* Vincent, 1913, occurs both in the Ewokoro fauna and Soldado faunas, whereas the closely similar *C. nodulina* n. sp. differs but little from *C. togoensis* (Oppenheim, 1915) and appears to be the ancestor of *Andicula occidentalis* (Woods in Bosworth, 1922) of the Lower Eocene of Peru. Changes in ocean circulation in the southern Atlantic in Upper Paleocene times (Cornfield & Norris in Aubry *et al.*, 1998), probably allowed molluscan larvae to be swept in on ocean currents from the West African fauna, populating the Texas coast in the Seguin, and Trinidad and Peru in the Lower Eocene. The connection must have been already in place in Lower Paleocene times judging by the occurrence of genus *Wendella* Adegoke, 1977, in both the Ewokora fauna and the Midway fauna of Alabama. *Wendella*, with the type species *Cerithium globoleve* Harris, 1896, a synonym of *Gymnentome* Cossmann in Cossmann & Peyrot, 1909b, a member of Glauconiidae Pchelintsev, 1953, a family abundant in marginal marine environments of the Cretaceous Tethys (Sohl, 1987: 1094). The molluscan migration continued on in the Eocene with several Tethyan taxa being found in California (Palmer in C. G. Adams & Ager, 1967; Squires, 1987; Dockery in Aubry *et al.*, 1998), but this faunal migration path appears already to have been in place in Upper Paleocene times because the taxa *Carinacca* Marwick, 1924, and *Loxotrema* Gabb, 1868, now known from the Seguin Paleocene, are both found in the Eocene of California, and *Loxotrema* also found in Kamchatka. Adegoke (1977: 46–47) pointed out that many elements of the Ewokoro fauna are indicative of extremely shallow-water depositional depth, so molluscan larvae originating there could find the shallow-water Seguin environment a suitable place to grow; the preponderance of large robust members of Speightiidae and Cerithiidae, and other thick-shelled species in both locations is remarkable. At the other end of the scale is the first appearance of large numbers of small mudsnails, the nassariids, here assigned to *Colwellia* Nuttall & Cooper, 1973, and *Tritiaria* Conrad, 1865a, in the Gulf Coast Paleocene. The later Eocene nassariids, *Colwellia* and *Tritiaria* from the Reklaw Formation, and *Dorsanum* Gray, 1847, and *Buccitriton* Conrad, 1865a, from the middle Claibornian of the Gulf Coast region, are often found in abundance in sediments regarded as marginally marine, sometimes making up more than 50% of the total fauna. In the Seguin, they appear to be numerically the most common species when fossiliferous rock surfaces are examined; only extraction difficulties prevented their collection in greater numbers. Cernohorsky (1984: 19)

regarded *Desorinassa* Nuttal & Cooper, 1973, a taxon with a smooth sculpture, as the earliest known Paleocene representative and believed that the species evolved from a buccinid ancestor. Nuttal & Cooper (1973) erected *Thanetinassa*, another Paleocene taxon, with both spiral and collabral ribbing that is morphologically closer to the Seguin species. There is nothing in the published Midway or Upper Cretaceous Gulf coast fauna, or the African Ewokora fauna, or indeed in the extensive collection of small species from the Cretaceous Kemp Clay, which might suggest an immediate ancestor; it therefore appears that the Seguin nassariids could well be Tethyan immigrants during the Lower Paleocene with one similar Cretaceous species known from the Indian Tethys (Stoliczka, 1867 in 1867–1871: 144).

MEASURED SECTIONS AND LOCALITIES

Measured sections for four localities were given by Beckman (1941); they include two localities: Solomon's Branch (11-T-13) and Moss Branch (11-T-102), from which the author has collected fossils. Beckman separated the Solomon's Branch section into 20 named levels (A to T). Many of those levels could not be recognized today and it is believed they are features of purely local areal extent and have little or no value beyond the confines of this locality. Over the ten years that the author has been visiting this locality, the original sandstone concretions no longer outcrop on the creek walls, and all are now at the floor of the creek; none were ever seen on the other side of the creek. A simpler section is given below in which the main features can be traced over an area from the Smiley's Bluff locality (165-T-2) on the Brazos River and nearby creeks, to the Moss Branch area near the Colorado River, a distance of *ca.* 85 km. The two more easily traceable beds are the upper and lower sandstone concretionary beds EE and AA (beds R and F of Beckman, 1941: 10–14), separated by generally poorly laminated sands and silts, with occasional local lenticular concretionary layers. At Solomon's Branch, the main fossiliferous section is on an unnamed side creek of which only layers BB to GG are visible; downstream on the main creek, a distance of *ca.* 300 m, a large bluff on the main creek exposes the lower AA bed, but the top EE concretionary layer is poorly exposed there. The best overall section is the locality 165-T-200 where both the basement and concretionary upper beds are exposed in one overall section separated by *ca.* 4.5 m of clays, sands, and silts. At Solomon's Branch, where overburden and slumping have obscured the section, Beckman (1941) gave the distance between the two concretionary beds as 14.6 m. At the classic Smiley's Bluff locality where Harris (1895a) collected many fossils, the beds were still well exposed in 1941, as shown by Beckman's published photograph and measured section, but they are now covered by alluvium and vegetation. Just downstream of that is a river bend with a vertical scoured section of *ca.* 6 m in height, ranging from the upper concretionary bed to a thin sandy/pebble conglomerate that defines the boundary between the Solomon Creek Member and the overlying Caldwell Knob Member.

At locality 11-T-13, most of the larger fossils were obtained from a layer occurring at the base of the indurated sandstone boulders, some of which exceeded 3 m in diameter. A much smaller number of fossils were obtained from the sandy/silt layers at the various locations. The *Turritella polysticha* Stenzel & Turner, 1940, layer at the base of bed DD noted by Beckman (1941) is no longer prominent, but a few fossils, primarily *T. polysticha*, were obtained from this level. At the mouth of Dry Creek (11-T-101), there is a thin layer with abundant *T. polysticha* and many other species, the fossils occurring primarily in and in the immediate neighborhood of brown lenticular concretions; the author believes that this correlates stratigraphically with Beckmans *Turritella* bed. This layer is the source of many species that do not occur in Solomon's Branch (Text-fig. 4; Table 1).

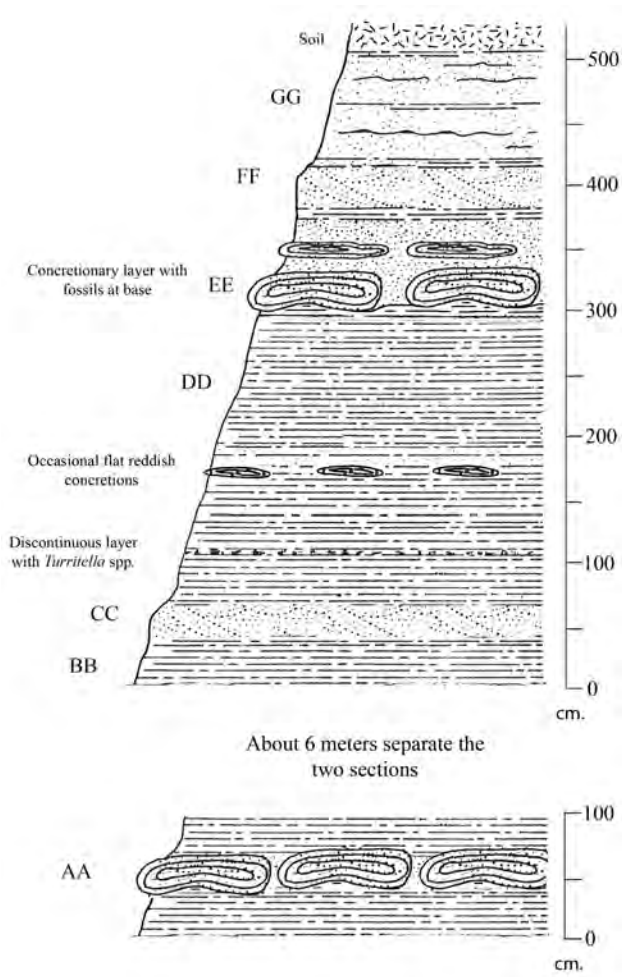
Locality Descriptions

The locality descriptions (see also Text-fig. 5) are given verbatim from the original text as written by the survey parties and contained in the field books at the TNSC, some dating to prior to 1900. In some cases these descriptions are the only available information on the localities.

11-T-3: "Bastrop County. Solomon's Farm. Downstream along the creek back of Solomon's house and about 0.25 mi. east of its junction with Wilbarger Creek, or about 800' downstream from the remains of an abandoned wagon bridge." This appears to be the same location as Plummer Sta. 1269 (F. B. Plummer in Sellards *et al.*, 1933: 61–60). The abandoned wagon bridge, now a concrete bridge, is over the dead-end road to Speir Cemetery; 800 m downstream from the bridge is a cattle pond, formed by damming the creek, and 100 m down from that is a small side creek, the source of most of the fossils of this study. The specimens under this locality number came from the sand and silt layers (cf. Text-fig. 4: units BB–DD) in a small side branch *ca.* 152 m from the cattle pond. 30°15'51.23"N, 97°25'02.03"W.

11-T-13: This locality has the same map location as 11-T-3, but specimens under this locality number came from the upper concretionary layer (cf. Text-fig. 4: unit EE) in a small side branch *ca.* 152 m from the cattle pond. 30°15'51.23"N, 97°25'02.03"W.

11-T-19. Trigg ranch near headquarters of creek. This locality is lost, but from ancillary information might have been some miles south of the town of Bastrop. The specimens in the TNSC Museum reliably indicate the Seguin Formation.



Text-fig. 4.—Profile of locality 11-T-13, Solomon's Branch section.

11-T-74: "Bastrop County. Caldwell Knob oyster bed on Moss Branch, west Bastrop County. To reach the locality turn left (North) on county lane off Austin-Bastrop Highway, 14.9 miles east of Montopolis Bridge. This lane is 0.55 mi. west of the old Mason Store. 200' off highway make sharp right turn through gate. Follow road past Negro house to oyster shell pits .5 mi. from hwy. This loc. is approximately 0.2 mi. east and across small branch of Moss Branch from type locality of Caldwell Knob." Private land, not accessible now, and the source of many specimens in the TNSC. 30°09'42.35"N, 87°28'06.74"W.

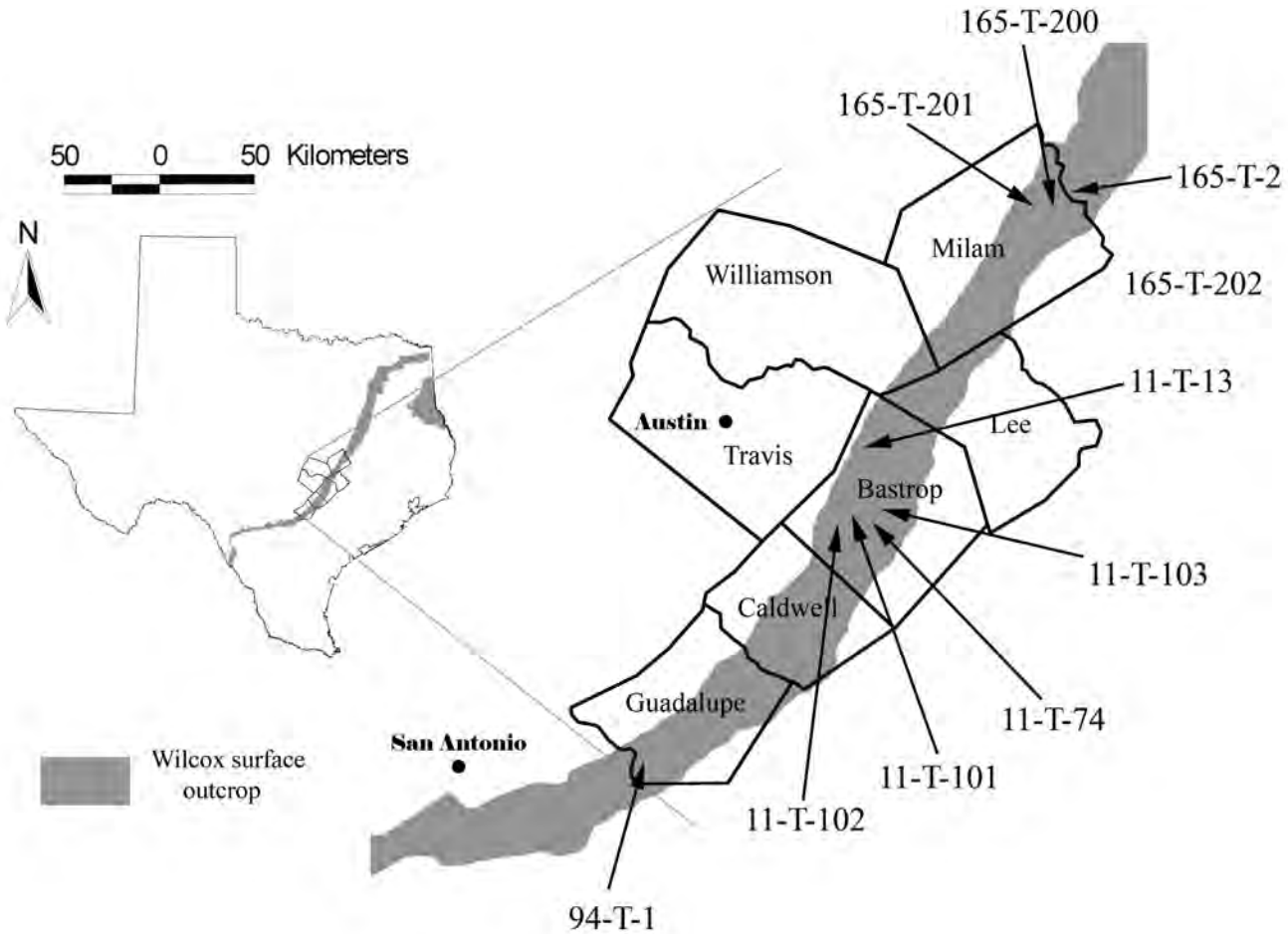
11-T-85: "Bastrop County. Solomon's Creek, 6 mi. South-Southwest. of Elgin (Deussen, 1924: 43; Plummer, 1932: 61–60). F. B. Plummer Sta. 412." Probably the same location as 11-T-13. The "Plumber, 1932" reference is F. B. Plummer in Sellards *et al.*, actually published in 1933 according to University of Texas records. Well-preserved fossils similar to those found at 11-T-13, in the collections of the TNSC.

11-T-100: "Bastrop County. In creek about 0.75 miles west of Big Ben Synd. Solomon #1. Four or 5 miles south of Elgin. On west side of Elgin Bastrop road." This location has not yet been verified; the specimens in the collections have the same matrix as those from 11-T-13.

11-T-101: "Bastrop County. Dry creek, at mouth with Colorado River." Typical sands and silts of the Solomon Creek Member are visible at low-water levels of the Colorado River. A discontinuous layer of brown lenticular concretions outcrop near low water levels with a substantial fauna of mainly juvenile Mollusca. 30°10'58.53"N, 97°28'22.62"W.

Table 1.—Explanation of profile of composite section in Text-fig. 4.

Unit	Thickness (cm)	Descrption
GG	71	Coarsely bedded reddish-brown sand with clay stringers and layers.
FF	84	Finely bedded yellowish-tan sand.
EE	to 84	Discontinuous sandstone boulder layer, sometimes multiple. Base with indurated fossil layer, grading into very coarsely laminated sand and silts.
DD	196	Generally poorly laminated, interbedded, and bioturbidated clays and silts, some finer laminated layers near the base. Occasional small partings with delicate fossils, mainly mollusks.
CC	30	Gray, micaceous, poorly laminated very sandy silt, forming a resistant ledge. Not fossiliferous.
BB	25	Darker clay, sandier and lighter above.
AA	to 50	Indurated sandstone concretionary basal bed.



Text-fig. 5—Map of principal localities mentioned in the text.

11-T-102: "Bastrop County. Moss Branch." Just upstream from the track over the creek leading to Ranch House; Seguin type locality. Beds from the upper concretionary boulder layer to the Caldwell Knob oyster bed outcrop on the creek. 30°10'36.81"N, 97°28'45.04"W.

11-T-103: "Bastrop County. West side of Pavilion Drive, Lost Pines, Bastrop, Texas, 600 meters south of intersection with Estate Row." Caldwell Knob oyster bed. 30°09'23.02"N, 97°28'38.27"W.

21-T-6: Bluff on left side of Brazos River, 460 m (500 yd) below mouth of Little Brazos River, Brazos County, Texas. Eocene, Cook Mountain Formation. 30°37'37.67"N, 96°30'32.10"W.

165-T-2: "Milam County. Smiley Ranch." Probably Smiley's Bluff on the Brazos River, the locality from which Harris (1895a) obtained many fossils. Now covered by alluvium and vegetation. 31°02'13.27"N, 96°46'36.44"W.

165-T-200: Milam County. "Pond Creek, approximately 200 meters upstream from highway FM 2027." A locality showing the complete section of the Seguin between and including the upper and lower concretionary beds; the source of a few mollusks. 31°01'19.84"N, 96°48'31.60"W.

165-T-201: "Milam County. Pond Creek, 1 mile upstream from highway FM 2027." An exposure of the uppermost part of the section with the upper concretionary bed outcropping at creek level; the source of several nautiloids. 31°01'19.55"N, 96°49'18.90"W.

165-T-202: "Milam County. Unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community on FM 2027; banks of creek downstream from intersection with dirt road." Source of many mollusks; the upper sandy bed with numerous *Acanthocardium* sp. 31°02'07.55"N, 96°48'12.08"W.

94-T-1: "Guadeloupe County. New Berlin." Exact locality lost but could be one mile NE of the town. Source of many fossils in the TNSC collection.

SYSTEMATIC PALEONTOLOGY

Phylum **MOLLUSCA** Linnaeus, 1758
Class **BIVALVIA** Linnaeus, 1758
Subclass **PROTOBRANCHIA** Pelseneer, 1889
Order **NUCULIDA** Dall, 1889a
Superfamily **NUCULOIDEA** Dall in Eastman, 1896
Family **NUCULIDAE** Gray in Sabine *et al.*, 1824

Genus ***NUCULA*** Lamarck, 1799

Type Species.—*Arca nucleus* Linnaeus, 1758, by monotypy. Recent, European seas.

Description.—Shell small, nacreous, trigonal to subcircular, inequilateral; anterior end longer than posterior; area behind umbo slightly to strongly depressed. Two sets of chevron-shaped, close-set hinge teeth, with anterior set larger. External surface generally smooth or concentrically striated; valve margins usually finely crenulate.

Remarks.—The genus is recorded from the Cretaceous onward. Recent representatives are deposit feeders and are found in both shallow and deep waters, both in sandy and mud substrata. The genus is more characteristic of boreal and temperate waters. At least 21 species are recorded from the Paleocene and Eocene of the Gulf Coast.

Subgenus ***GIBBONUCULA*** Eames, 1951

Type Species.—*Nucula* (*Gibbonucula*) *corbuliformis* Eames, 1951, by monotopy. Eocene, Pakistan.

Description.—Small, corbuliform, strongly inflated. Lunule and escutcheon poorly defined. Thick-shelled, both coarsely concentric and with fine radial sculpture; inner ventral margin crenate.

Remarks.—Both *Gibbonucula* and *Lamellinucula* Schenck, 1944, show strong concentric sculpture, fine radial sculpture, and a crenate ventral margin. *Gibbonucula* is thicker-shelled and corbuliform in shape, and has very fine radial sculpture.

Nucula* (*Gibbonucula*?) *seguinensis n. sp.
Pl. 1, Figs 2–3

Description.—Shell small, thick-shelled, oblique corbuloid in outline particularly in larger specimens in which anterior and posterior dorsal margins are weakly concave. Hinge teeth meeting at angle of 115–118°. Outer surface with low concentric undulations and fine radial striae. Lunule poorly defined; escutecheon defined by rounded change in shell profile and poorly defined groove. Ventral margin with fine crenulations.

Remarks.—The Seguin species often shows large concentric rounded undulations, a feature also exhibited by *Nucula* (*Lamellinucula*) *austinclarki* MacNeil, 1951, from the Lisbon Formation in Alabama, which has prominent undulations with a sharp edge on the dorsal side and a hinge teeth angle of *ca.* 130°. *Nucula* (*Nucula*) *mediavia* Harris, 1896, also has a somewhat concave posterior-dorsal margin but shows a strongly angular posterior margin and is more strongly oblique in shape. In outline, the closest *Nucula* from the Gulf Coast Paleogene is *N.* (*N.*) *smithvillensis* Stenzel & Twining, in Stenzel *et al.,* 1957; that species, however, has more angular posterior and ventral margins, is much wider in outline, and has the hinge teeth meeting at an angle of *ca.* 140°.

Etymology.—The specific name *seguinensis* refers to the formation where the species is found.

Type Material.—Holotype: TMM NPL37725. Paratypes: TMM NPL37726–NPL37727, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—28 specimens.

Nucula (?) sp.

Description.—Shell small. Umbonal angle *ca.* 90°. Sculpture of concentrically rounded ribs slightly wider than interspaces; rib cross section more erect on dorsal side. Ventral edge showing marginal denticulations.

Remarks.—Several specimens were found of a concentrically sculptured *Nucula*, probably all juveniles, all partially decorticated and embedded in hard matrix. All specimens are small, to *ca.* 3.3 mm in size. The interior is not visible. Only one concentrically sculptured *Nucula* is known from the Paleogene of the Gulf Coast, *N.* (*Lamellinucula*) *austinclarki*, from the Lisbon Formation of Alabama; that species, the probable ancestor of this taxon, has an umbonal angle of *ca.* 105°, the ribs much more inclined on the dorsal than ventral side, and a more strongly curved ventral margin. Three concentrically sculptured Eocene *Nucula* spp. are also known from France and England; all have much smaller umbonal angles, less pronounced ribs, and have much less similarity than *N. austin-*

clarki. Without better material and a view of the interior it will not be specifically named here.

Material Examined.—6 specimens in CLG, all from locality 11-T-101, the largest (CLG 16639) 3.3 mm in length.

Order **NUCULANIDA** Carter *et al.* in Harper *et al.*, 2000
Superfamily **NUCULANOIDEA** H. & A. Adams, 1858
Family **NUCULANIDAE** H. & A. Adams, 1858

Genus ***NUCULANA*** Link, 1807 in 1806-1808

Type Species.—*Arca pernula* Müller, 1774, by monotypy. Recent, North Polar Seas and North Atlantic.

Description.—Shell moderately high, rostrate, with slightly anterior umbones and obtuse posterior keel. Surface with concentric ornament. Lunule long, thin, sharp-ridged; escutcheon obscure; ligamental pit small, produced posteriorly. Pallial sinus usually present.

Remarks.—Stewart (1930: 52) stressed the importance of the small asymmetric chondophore inclined posteriorly along the compressed series of taxodont teeth in the recognition of this genus. All members of Nuculanidae are deposit feeders.

Nuculana corpulentoides (Aldrich, 1895)
Pl. 1, Figs 6–7

Yoldia corpulentoides Aldrich, 1895b: 18, pl. 5, figs 9, 9a.
Leda corpulentoides (Aldrich). Dall, 1898a in 1890–1903: 578, 594.
cf. *Nuculana corpulentoidea* [*sic*] (Aldrich). Barry in Barry & LeBlanc, 1942: 46, pl. 2, figs 8–9.
Nuculana corpulentoidea [*sic*] (Aldrich). Wasem & Wilbert, 1943: 188, 192, pl. 31, fig. 6.

Description.—Shell tumid, oblong, nearly equilateral, anteriorly rounded, posteriorly produced, with oral opening at extremity. Teeth numerous, equal or nearly so on each side; fosset deep. Weak umbonal ridge running toward posterior end. Surface smooth to finely concentrically striated [after Aldrich, 1895b: 70].

Remarks.—The Sabine Stage specimens are close to those from the Pendleton Formation from the Louisiana-Texas border region. The Pendleton specimens often show stronger medial concentric sculpture than those from the Tuscahoma and Nanafalia formations of Alabama. This species is similar to *Nuculana cliftonensis* (Clark & Martin, 1901), which is distinguished by its more rostrate form and regular concentric folds. *Nuculana coelatella* (Van Winkle, 1919) is distinguished by its much rougher sculpture and larger size.

Type Information.—Lectotype: USNM 638966, from Tuscahoma Landing, Tombigbee River, Choctaw County, Alabama. Figured Seguin specimens: TMM NPL37728 and NPL37729, from locality 11-T-3. Remaining hypotypes in CLG.

Material Examined.—18 specimens, the largest (CLG 7815) 14.4 mm in length, 7.8 mm in width.

Nuculana milamensis (Harris, 1895)
Pl. 1, Figs 4–5

Leda milamensis Harris, 1895a: 47, pl. 1, fig. 4; Dall, 1898a in 1890–1903: 578. Not *Leda milamensis* Harris, Harris 1896: 54 (in part), pl. 4, fig. 8; not Brann & Kent, 1960: 447 (= *Nuculana hannahae* Palmer & Brann, new name, 1965 in 1965–1966).
Leda (Sacella) milamensis Harris. Gardner, 1935: 121 (in part).
Nuculana milamensis (Harris). Palmer & Brann, 1965 in 1965–1966: 220.

Revised Description.—General form as figured. Surface covered with fine concentric lines except near anterior margin and posterodorsal edge where surface is smooth and polished; concentric lines replaced behind rostral ridge by irregular, widely spaced, low folds. Height *ca.* 40% of length, medially much inflated. Posterior remarkably narrow, flattened.

Remarks.—This species is rare in collections. Only four specimens were found, two from the Texas Museum collections, both broken, and two, both somewhat damaged from locality 11-T-101. A juvenile has the concentric striae ending at a line *ca.* 10° from the anterior margin and also becoming evanescent before the rostral ridge.

Type Information.—Holotype: TMM BEG35671, from locality 165-T-2. Figured Seguin specimen: TMM NPL37661, from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—4 specimens, the largest (figured specimen, TMM NPL37661) 15.7 mm in length.

Genus ***CALORHADIA*** Stewart, 1930

Type Species.—*Leda pharcida* Dall, 1898a in 1890–1903, by original designation. Bashi Member of the Hatchetigbee Formation, Lower Eocene, Alabama.

Description.—Shell elongate; umbones slightly anterior; anterior end rounded, slightly produced; posterior end produced, bicarinate. Lunule sharply defined by raised edge; escutcheon lanceolate, bisected by line; resilifer deep, wide. Sculpture of raised concentric threads separated by wider interspaces, often forming row of raised nodes on rostrum.

Calorhadia diminutia n. sp.
Pl. 1, Fig. 12

Description.—Shell very small, moderately inflated, wide, with height *ca.* 50% length. Umbones anterior at *ca.* 0.59 of length; anterior end rounded; posterior end weakly rostrate, bicarinate, with anterior side defined by shallow depressed ray running from umbo to ventral edge, there forming shallow sinus; another weaker ray running from umbo to anteroventral margin. Lunule and escutcheon narrow, delimited by raised line. Surface sculpture of raised lines and slightly wider interspaces, becoming closer together as they approach ventral margin. Ligamental pit deep, extended posteriorly. Pallial sinus deep, U-shaped.

Remarks.—This species has characters intermediate between *Nuculana* and *Calorhadia*. The ligamental pit is elongated (oblique in *Nuculana*), the posterior end is weakly bicarinate, and both genera have concentric sculpture.

The strong concentric raised lines of this species, the weakly bicarinate rostrum, and the posterior ray of more prominent lines at the posterior dorsal margin places it closer to *Calorhadia*. *Nuculana eoa* (Gardner, 1935) (= *Leda eoa* Gardner, 1935) from the Littig (lowest member) of the Midway Group in Texas is close in size and in its sculpture of concentric lines, but it lacks the bicarinate rostrum. Another similar species is the middle Claibornian *Calorhadia compsa* (Gabb, 1860), a typical *Calorhadia*, much more elongate, with much stronger and more widely spaced concentric lines, and two prominent rays defined by the nodular development of the concentric lines that define the margins of the bicarinate rostrum. *Calorhadia diminutia* n. sp. is likely the intermediate stage in the development of this line. From illustrations, another similar species is *Nuculana parilis* (Conrad, 1848); this is approximately the same size, typically *ca.* 8 mm in length, but is a broader species, with almost medial umbones and finer sculpture.

Etymology.—The specific name *diminutia* (Latin, diminutive) refers to the small size of this species.

Type Material.—Holotype: TMM NPL37894. Paratype: TMM NPL37895, both from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—9 specimens, the largest (CLG 16614) 9.6 mm in length.

***Calorhadia*?** sp.
Pl. 1, Fig. 13

Description.—Shell short; umbones almost central; ventral margin nearly straight, rostrum feebly bicarinate. Sculpture of fine concentric lines that become obsolete on rostrum.

Remarks.—One juvenile specimen was obtained embedded in matrix and in which the interior cannot be observed; it cannot be assigned to any known species. The outline is between that of *Calorhadia* (*Calorhadia*) *pharcida* (Dall, 1898a in 1890–1903) and *Nuculana marieana* (Aldrich, 1897), which Harris (1897b: 52) believed could be the juvenile of *C.* (*C.*) *pharcida*. The straight ventral margin is similar to that of *N. marieana*. The rostral ray is different from either *C.* (*C.*) *pharcida* or *N. marieana* in which the concentric sculpture becomes stronger over the rostrum; here, the smooth rostrum is reminiscent of many species of *Litorhadia* Stewart, 1930. Without more material it will not be named.

Type Information.—Figured specimen: TMM NPL36147, from locality 11-T-13.

Material Examined.—1 specimen (TMM NPL36147), 4.0 mm in length.

Family **YOLDIIDAE** Habe, 1977

Genus ***ADRANA*** H. & A. Adams, 1858

Type Species.—*Leda sowerbyana* Orbigny, 1846a (= *Nucula lanceolata* Lamarck, 1819), by subsequent designation (Stoliczka, 1871 in 1867–1871: 320). Recent, off of the coast of Ecuador.

Description.—Shell elongate, lanceolate, usually with straight dorsal margins; ventral margins smoothly arched; beaks scarcely projecting. Sculpture of concentric to oblique riblets; ends of shell gaping.

Adrana seguinensis n. sp.
Pl. 1, Fig. 8

Description.—Shell elongate; anteriorly weakly rostrate; beaks nearly central. Thinly gaping posteriorly; anteriorly with a small rounded gape. Low rounded depression (sulcus) running from beak to anterior end. Surface sculpture of concentric lines, medially strong, dying out anteriorly just before depression; posterior end smooth. Lunule long, narrow, bisected by sharp raised line; escutcheon narrow, indistinct. Resilium large, slightly depressed below level of base teeth, offset toward posterior direction.

Remarks.—An assignment to *Orthoyoldia* Verrill & Bush, 1897, might also be considered, but that genus is typically not rostrate, has no carina, and has a smooth and shiny surface. The outline of this species is closer to *Adrana exopata* (Pilsbry & Lowe, 1932) than to the typical species of *Adrana* that is usually somewhat produced or rostrate at both ends. The concentric lines on the LV are somewhat stronger and spaced further apart than on the RV. The resilium is similar in character to that of *A. aldrichiana* Harris, 1895a. *Adrana aldrichiana* is reported to come from the Stone City locality 26-T-1, although in over 30 years of collecting, the author has never found a specimen there. However, the species is abundant a short distance downstream at locality 21-T-6, in the Wheelock Member of the Cook Mountain Formation; specimens there show a surface sculpture varying from smooth to finely concentrically ribbed.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37730. Paratype: TMM NPL37731, both from locality 165-T-202. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-202, unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community, 31°02'07.55"N, 96°48'12.08"W, Milam County, Texas.

Material Examined.—6 specimens, the largest (holotype, TMM NPL37730) 18.8 mm in length.

Genus ***YOLDIA*** Möller, 1842

Type Species.—*Yoldia hyperborea* Torell, 1859, by subsequent designation (ICZN Opinion 769 (1966). Recent, Arctic seas.

Description.—Shell wide, flat; umbonal position medial to slightly posterior; anterior dorsal margin smoothly rounded; posterior dorsal margin straight; posterior end truncate. Ends gaping, wider at anterior side. Hinge series subequal; resilial pit large. Pallial sinus deep, wide.

Yoldia kindlei Harris, 1896
Pl. 1, Fig. 9

Yoldia kindlei Harris, 1896: 56, pl. 4, fig. 6; Dall, 1898a in 1890–1903: 594; Harris & Veatch, 1899: 72; Barry in Barry & Leblanc, 1942: 47, pl. 2, fig. 10; Brann & Kent, 1960: 983.

cf. *Orthoyoldia kindlei* (Harris). Palmer & Brann, 1965 in 1965–1966: 226.

Description.—Shell medium-sized, to 46 mm in length, wide, height/length ratio 0.41–0.44, somewhat inflated; dorsal margins almost straight to straight. Lines of growth regular, ventrally covered with fine concentric ridges. Hinge teeth regularly spaced, with anterior series shorter.

Remarks.—The type was defined from an internal cast and Harris noted a few fragments that indicated regular growth lines. Barry (in Barry & LeBlanc, 1942: 48) described a specimen from the upper Midway Group, with concentric ridges on the ventral half of the shell, a sculpture also shown by the figured Seguin specimen. Palmer & Brann (1965 in 1965–1966: 226) questionably reassigned the species to *Orthoyoldia*, a taxon with a characteristic outline described as oblong, blunt, or rounded at both ends with no distinct rostrum. The figured species, although slightly shorter in outline, shows a remarkable resemblance to the type *Yoldia hyperborea*, *cf.* Dautzenberg & Fisher (1912: pl. 11, figs 3–6); the specimen figured by Barry (in Barry & LeBlanc, 1942: 2, fig.10), although encased in matrix, still shows a truncate posterior end, and an outline more allied to *Yoldia* than *Orthoyoldia*. Harris' drawing of the type (Harris, 1896: pl. 4), although idealized, also shows an outline more representative of *Yoldia* than *Orthoyoldia*.

Type Information.—Holotype: PRI 35, from 1.75 mi north of Crainsville, Hardeman County, Tennessee, Midway Group (Paleocene). Figured Seguin specimen: TMM NPL37940, from locality 11-T-101.

Material Examined.—1 specimen (PRI 35), 33.5 mm in length; 1 Seguin specimen.

Subclass **AUTOBRANCHIA** Grobben, 1894
Order **ARCIDA** Gray, 1854
Superfamily **ARCOIDEA** Lamarck, 1809
Family **CUCULLAEIDAE** Stewart, 1930

Genus ***CUCULLAEA*** Lamarck, 1801

Type Species.—*Cucullaea auriculifera* Lamarck, 1801, by subsequent designation (Children, 1823: 318). Recent, Indo-Pacific and seas off China.

Description.—Shell heavy, subtrigonal, rhomboidal to ovoid, with posterior umbonal carina. Hinge taxodont; medial teeth slightly oblique; cardinal area wide. Posterior adductor muscle scar supported by buttress. Sculpture primarily radial; inner ventral margins crenulate.

Cucullaea cf. ***kaufmanensis*** Gardner, 1935

Cucullaea kaufmanensis Gardner, 1935: 129, pl. 7, figs 1–4; Rutsch, 1943, pl. 149; Adegoke 1977: 224.

Description.—Shell small, moderately inflated, elongated transversely; umbones anterior in position, overhanging, prosogyrate; posterior area flattened, delimited by narrow obtuse ridge, with shallow sulcus and fine uniform ornamentation. Sculpture of LV and RV similar; RV with *ca.* 38 radials, very low, flat, with broadest one medially sulcate; LV with slightly more numerous radials. Hinge area narrow, obliquely grooved.

Remarks.—Two fragmentary juveniles were recovered (one with most of the hinge) that are referable to this species. The fine sculptural ornamentation, narrow hinge area, and obliquely grooved hinge teeth of this species distinguishes this from other Paleocene Gulf Coast species. *Cucullaea* has not been reported from the Wills Point upper Midway of Texas or from the Logansport or Marthaville beds of Louisiana, but it is common in the underlying Paleocene formations in both states; it also occurs in the Lower Eocene Nanjemoy Formation in Maryland. It is represented today by a few species in the Indo-Pacific.

Material Examined.—2 specimens in CLG, from locality 11-T-3, the largest (CLG 14866) 3.0 mm in length.

Order **PTERIIDA** Newell, 1965
Superfamily **PTERIOIDEA** Gray, 1847

PTERIOIDEA sp.
Pl. 1, Fig. 14

Description.—Shell moderately inflated; interior nacreous; exterior aragonitic, prismatic. Beak terminal, prosogyrate, moderately inflated; valves flattening out toward ventral margins. Surface smooth with irregular, low, concentric folds, increasing in strength ventrally. Anterior hinge margin strongly thickened, with medial groove; posterior hinge margin very thin.

Remarks.—Thirteen specimens were obtained of this species; most appear to be juvenile, and none are complete. The posterior hinge margin is very thin and is broken in all individuals. Where the aragonitic layer has broken away, the underlying prismatic layer shows the finest of radial grooves impressed upon the radial folds; one such specimen with only the prismatic layer remaining also shows a circular feature where the posterior adductor muscle scar might be expected. No specimen shows any trace of hinge teeth. If the anterior marginal groove had been instead a series of pits, the species could well be an inoceramid, but if this is the case, the vertically prismatic outer layer is also missing. The long ligamental pit is similar to that seen in the genus *Phelopteria* Stephenson, 1952, known from the Upper Cretaceous (Cenomanian) of Texas, Europe, and Africa. That genus has an outer prismatic layer, not internal as in the Seguin material, and has a pitted multivincular ligament in the young stage and quite prominent anterior and posterior wings. The lack of any wing-like projections, any thickening of the posterior margin, and any hinge teeth makes assignment to family Pteriidae also unlikely. A reliable assignment awaits better preserved specimens.

Type Information.—Figured specimen: TMM NPL36144, from locality 11-T-3. Remaining hypotypes in CLG.

Material Examined.—13 specimens, the largest (figured specimen, TMM NPL36144) 17.5 mm in height.

Family **ISOGNOMONIDAE** Woodring, 1925

Genus ***ISOGNOMON*** Lightfoot, 1786

Type Species.—*Ostrea perna* Linnaeus, 1767, by original designation. Recent, Indo-Pacific.

Description.—Shell thin, compressed; interior nacreous; umbo pointing anteriorly. Ligamental area broad flat with regular series of ligamental grooves or pits. Byssal gape below beaks.

Remarks.—Known from the Triassic onward; today the genus is primarily tropical in distribution.

Isognomon (?) sp.
Pl. 1, Fig. 11

Description.—Shell thin, ovate; beak moderately extended; byssal gape broad. Dorsal ligamental area with series of shell thickenings. Surface nacreous; periostracum thin.

Remarks.—One small RV was obtained in a friable matrix. To preserve the specimen, it was necessary to harden the matrix, thus unfortunately obscuring the interior characters. Some clearing of the matrix was, however, successful, thus showing the dorsal edge of the ligamental area and a series of shell thickenings. Some patches of the (now altered) periostracum still adhere to the nacreous layer. A few commarginal lines are seen near the ventral edge of the shell.

Very few species of *Isognomon* have been described from the Paleogene: *I. cornelliana* (Harris, 1896) from the Clayton Formation of Alabama, three from the Paris Basin [*I. bazini* (Deshayes, 1858), *I. wateleti* (Deshayes, 1858), and *I. aviculina* (Deshayes, 1858)], and *I. (Isognomon) tomiyasui* Nagao, 1928, from the Eocene of Japan. In outline, the closest to the present material appears to be *I. bazini*.

Type Information.—Figured specimen: TMM NPL35933, from locality 11-T-3.

Material Examined.—1 RV (TMM NPL35933), 8.7 mm in greatest length.

Order **OSTREIDA** Férussac, 1822
Superfamily **OSTREOIDEA** Gill, 1871
Family **OSTREIDAE** Rafinesque, 1815
Subfamily **OSTREINAE** Rafinesque, 1815

Genus ***OSTREA*** Linnaeus, 1758

Type Species.—*Ostrea edulis* Linnaeus, 1758, by subsequent designation [ICZN Opinions 94 (1926) and 356 (1955)]. Recent, England.

Description.—Medium to large-sized oysters, tending to be orbicular in outline; umbones not prominent, obtusely pointed, sometimes flanked with auricles. RV slightly convex with radial ribs; LV squamose; valve margins not plicated; chomata few and inconspicuous.

Ostrea multilirata Conrad in Emory, 1857
Pl. 2, Figs. 8–9

Ostrea multilirata Conrad in Emory, 1857, pl. 12, figs 1a–d; Heilprin, 1884; 298, pl. 38, figs 1–2 (copying Conrad in Emory, 1857: pl. 12, figs 1a–d); Schuchert *et al.*, 1905: 471; Gardner 1926b: 513–514; 1935: 141; Trowbridge, 1932: pl. 34, figs 1–2, pl. 35, figs 1–2 (copying Gardner, 1923: pl. 31, figs 1–4); Barry in Barry & LeBlanc, 1942: 52, pl. 4, figs 1–4; Wasem & Wilbert, 1943: 188, 192, pl. 31, fig. 1.

Not *Ostrea georgiana* Conrad. Hilgard in Hopkins, 1871: 12 (as in Barry in Barry & LeBlanc, 1942: 52).

?*Ostrea crenulimarginata* Gabb. Harris in Harris & Veach, 1899b: 297, pl. 52, figs. 1, 1a (*fide* Barry in Barry & LeBlanc, 1942).

Ostrea tasex Gardner, 1923: 109, pl. 29, figs 6–7, pl. 31, figs 1–4; 1926b: 513–514; Howe, 1925: 170.

Description.—Shell moderately sized, subequivalve, ovate-trigonal. Each valve sculptured with 15–20 subuniform folds. Umbonal area flat, thick; cardinal fosset long, somewhat curved; lateral margins finely crenate. Adductor scar crescentic; pedal scar obscure. Chomata weak in neighborhood of hinge only.

Remarks.—Gardner (1923: 109) noted that *Ostrea tasex* Gardner, 1923, was probably identical with *O. multilirata*, a species collected from the "Cretaceous of Dry Creek, Mexico," a location not rediscovered since Conrad's time; most authors since Gardner have followed that assignment. *Ostrea multilirata* is distinguished from *O. crenulimarginata* Gabb, 1860, an analogous and similar species from the Midway of Alabama but also in Texas, by the presence of radial folds on both valves; the right valve of *O. crenulimarginata* is smooth. The TNSC collections indicate the transition from Midway to Wilcox (in Bastrop County, the transition from the Will Point beds to the Solomon Creek beds) is marked by the replacement of *O. crenulimarginata* and *O. multilirata* by *Turkostrea*? *multilirata sabinanensis* (Gardner, 1935), a species which grades into *T.*? *duvali* (Gardner, 1927) of the Caldwell Knob beds. *Turkostrea multilirata sabinanensis* was reported from the Tehuacana Member of the Kincaid Formation in Uvalde County, but Yancey (pers. comm., 2011) reported that there is no identifiable Tehuacana Unit that far south, and both the TNSC collections and the author's own field work indicate that *T.*? *multilirata sabinanensis* appears restricted to the Solomon Creek beds, ranging from Bastrop County to an outcrop on the Brazos River. It is difficult to separate *O. multilirata* from *T.*? *multilirata sabinanensis* unless a large group of specimens is available for comparison, because the external sculpture is very similar; however, the chomata of *T.*? *multilirata sabinanensis* extends past the lateral midpoint of the valve margins and so appears to be a good separating character (in *T. duvali,* the chomata extend over the entire valve margins). The one cemented group of fairly large Ostreinae discovered in the Solomon Creek beds at locality 11-T-13 (Table 1: unit DD; Pl. 2, Figs 8–9) do not show the exterior of any right valves, so it is not known if they possess folds. The remaining characters of the specimens place them in a somewhat indeterminate po-

sition between *Ostrea* and *Turkostrea* Vyalov, 1936, but in the author's opinion much closer to *Ostrea s.s.*

Type Information.—Syntypes: USNM 9895, from "Dry Creek, Mexico," Cretaceous. Figured Seguin specimens: TMM BEG9168, from locality 11-T-13. Hypotypes with catalog lot numbers: TMM NPL4690–NPL4694.

Material Examined.—20 specimens, the largest (TMM NPL4688) *ca.* 100 mm in width, 130 mm in length.

Subfamily **CRASSOSTREINAE** Scarlato & Starobogatov, 1979

Genus ***TURKOSTREA*** Vyalov, 1936

Type Species.—*Ostrea turkestanensis* Romanovsky, 1878, by original designation. Paleocene, central Asia.

Description.—Oysters with oval to triangular-ovoid shape. LV with strong but narrow radial ribs. Beaks strongly developed often turning in opisthogyral fashion. RV smooth or foliate; chomata strong.

Remarks.—*Turkostrea* was originally described as a subgenus of *Ostrea*, a placement also followed by Stenzel in Moore (1971: N1139). More recently, it has been used as a full genus by Griffin *et al.* (2005), who also provided evidence the genus originated in the Upper Cretaceous and probably in the South American region. The taxon is known to be widely distributed, from North America, South America, Africa, central Asia, and more recently, also in the Eocene of Indonesia (Hasibuan, 2006).

Turkostrea duvali (Gardner, 1927)
Pl. 2, Figs 1–5

Ostrea duvali Gardner, 1927: 366, figs 1–4.
Ostrea multilirata Conrad var. *duvali* Gardner. Stenzel in Ladd, 1957: 888.
Ostrea (*Turkostrea*) *duvali* Gardner. Stenzel in Moore, 1971: N991–N992, figs J30–J31; Perrilliat & Vega, 2003: 420.
Turkostrea duvali (Gardner). Griffin *et al.*, 2005: 262.

Description.—Shell moderate in size, ovate-trigonal in outline. RV with overlapping concentric lamellae; ventral margin thin. LV with narrow subequal radials, obsolete on attachment surfaces. Ligamental area large, flattened in RV; medial depression in LV broadly U-shaped. Chomata strong, often around entire valve margins. Adductor scars moderate, not usually deeply excavated, approximately medial in position.

Remarks.—All specimens examined are somewhat worn, but still show sufficient characters to assign them to this taxon. *Turkostrea duvali* shows similarities to both *Ostrea multilirata* and *O. crenulimarginata*, but can distinguished from the latter by the pitting on the margin of the RV, which crenulates the entire inner margin, and the lack of radial folds on the RV. *Turkostrea duvali* is distinguished from *O. multilirata* by the finer radial sculpture on the LV and the more offset position of the adductor scar. Gardner (1924: 143) traced *O. tasex* (as *O. multilirata* var. *duvali*) from the Rio Grande valley to the Brazos river outcrops; Perrilliat & Vega (2003) reported the species from the Viento Formation (Defunta Group) in Mexico, regarded as Lower Eocene in age. Of interest is the fact that one oyster spat found attached to a fossil log (cf. Bankiinae sp.) shows strong chomata around the entire valve margin, and another spat shows radially plicate ornament; because this was found in the lower part of the Pond Creek section, this indicates that *T. duvali* or a similar species was already in existence in the lower Seguin. Available TNSC specimens all appear to be adult and very close in size to one another; radial foliations, where not obscured by later shell growth, number between 17 and 25. The left value of *T. duvali* appears almost identical to that of *T. multilirata sabinanensi.*

Type Information.—Lectotype: USNM 638966, from Austin-Elgin Ferry Road, 1 mile north of Austin-Bastrop Highway, Bastrop County, Texas. Figured double-valve Seguin specimen: TMM NPL17721, from locality 11-T-4. Hypotypes with catalog lot numbers: TMM NPL4696–NPL4697, and in CLG from locality 11-T-103.

Material Examined.—More than 100 specimens, the largest (TMM NPL9312) *ca.* 100 mm in length, 120 mm in width.

Order **PECTINIDA** Gray, 1854
Superfamily **ANOMIOIDEA** Gill, 1871
Family **ANOMIIDAE** Rafinesque, 1815

Genus ***ANOMIA*** Linnaeus, 1758

Type Species.—*Anomia ephippium* Linnaeus, 1758, by subsequent designation (Schmidt, 1818). Recent, Atlantic Ocean and Mediterranean Sea.

Description.—Shell ovate, thin, irregular in outline, attached to substratum by byssal plug in foramen of RV. LV convex with three muscle scars.

Anomia rufa Barry in Barry & LeBlanc, 1942
Pl. 2, Fig. 10

Anomia rufa Barry in Barry & LeBlanc, 1942: 55, pl. 3, fig. 9, pl. 6, figs 1–2; Stenzel *et al.*,1957: 100.

Description.—Shell orbicular to slightly vertically elongate in outline. Umbones pointed, medial in position. Surface wrinkled with irregular concentric undulations tending to become more sharply ridged as ventral edge is approached.

Remarks.—One fine large specimen was collected, cemented to a sandstone block, similar in all characters with *A. rufa*. Gardner (1945: 72) reported several localities in the lower Wilcox of Mexico where an *Anomia*, probably *A. malinchae* Gardner, 1945, occurs in a preserved reef. *Anomia malinchae* is superficially similar to *A. rufa,* but can be distinguished by the umbones pointing in the opposite direction, in having the concentric undulations becoming less prominent toward the ventral edge, and being broader in outline. *Anomia lisbonensis* Aldrich in Smith, 1886, is distinguished from *A. rufa* by also being broader in outline, having no (or very weak) concentric undulations, and being sculptured by concentric foliations.

Type Information.—Figured specimen: TMM NPL36146, from locality 11-T-13.

Material Examined.—1 specimen (TMM NPL36146), 27.5 mm in length.

Order **CARDITIDA** Dall, 1889a
Superfamily **CARDITOIDEA** Menke, 1828
Family **CARDITIDAE** Férussac, 1822

Genus ***BALUCHICARDIA*** Heaslip, 1968

Type Species.—*Venericardia* (*Baluchicardia*) *beaumonti* (Archiac & Haime, 1854 in 1853–1854) by subsequent designation (Heaslip, 1968: 83). Maestrichtian and Danian stages, northwestern India and Pakistan.

Description.—Venericards having highly inflated, somewhat elongate shells with marked posterior truncation, ornamented by tripartite radiating costae comprising noded central cord and variously developed paracostals on either side of central cord. Dentition with well-developed right anterior cardinal and strong erect triangular left anterior cardinal. Spiral outline from beak to ventral margin in four segments of decreasing curvature (after Heaslip, 1968: 83).

Remarks.—Heaslip (1968: 83) discussed the status of *Baluchicardia* and noted that because of the lack of a formal diagnosis, the name was previously a *nomen nuden*; nevertheless he still ascribed the taxon to Rutsch & Schenck (1940). Because Heaslip gave the diagnosis, he becomes the author of *Baluchicardia*, notwithstanding his attribution to Rutsch & Schenck. Heaslip noted that *Baluchicardia* appears to be the ancestral stock from which *Rotundicardia* Heaslip, 1968, and *Claibornicardia* Stenzel & Krause in Stenzel *et al.*, 1957, derive and continue on into the Middle Eocene. *Baluchicardia* ranges into the Lower Eocene with *B. wilcoxensis* Dall, 1903 in 1890–1903.

Baluchicardia cf. ***wilcoxensis*** (Dall, 1903 in 1890–1903)
Pl. 2, Figs 11–13

Venericardia alticostata Conrad "var." Harris, 1896: 58 (in part), pl. 4, fig. 12, not of Conrad; Shirmer & Shrock, 1944: 419, pl. 167, fig. 16 [as *alticosta* (*sic*), copying Harris, 1896: pl. 4, fig. 12]; Brann & Kent, 1960: 951, no. 38 only.

Venericardia wilcoxensis Dall, 1903 in 1890–1903: 1426, pl. 54, fig. 12; Schuchert *et al.*, 1905: 690; Harris, 1919: 84, pl. 30, fig. 11; Cooke in G. I. Adams *et al.*, 1926: pl. 93, fig. 4; Semmes, 1929, fig. 51-4; F. B. Plummer in Sellards *et al.*, 1933: 811, pl. 8, figs 3a–b; Gardner, 1935: 163, pl. 14, figs 1 (holotype), 2–3 (copying Cooke in G. I. Adams *et al.*, 1926: pl. 93, fig. 4); Rutsch, 1943: 156; Brann & Kent, 1960: 968; Mancini & Tew, 1989: 449.

Venericardia wilcoxensis tripla Dall, 1903 in 1890–1903: 1426; Gardner, 1935: 164.

Venericardia (*Baluchicardia*) *wilcoxensis* Dall, 1903. Heaslip, 1968: 87–88, pl. 21, figs 2a–c, 3a–c.

Description.—Shell short, high, rounded, with full prosogyrate beaks over small, convex lunule at anterior sixth. Sculpture of thin, sharp, high, serrate or pustulose ribs separated by wider roundly excavated interspaces; few ribs on anterior and posterior slopes more prominently pustulose; ribs *ca.* 26 in number (after Dall, 1903 in 1890–1903). Average width/height ratio *ca.* 0.43; average height/length ratio *ca.* 1.02. Pointed fold on commissural surface of left lunule forming projecting prong fitting into corresponding socket on right lunule (after Heaslip, 1968: 83).

Remarks.—One articulated specimen was found in the TNSC collections. The specimen is rather worn and with a portion of the RV missing, exposing some of the interior matrix. The fact that the underlying Wills Point Formation with abundant *Baluchicardia bulla* (Dall, 1903 in 1890–1903), is exposed in several nearby classic localities in Bastrop County might lead one to expect that this species shows more affinity to *B. bulla* than to *B. wilcoxensis*, which is only reported from the Upper Paleocene Naheola Formation in Alabama. Dall (1903 in 1890–1903: 1425) gave a rib count of 30 for *B. bulla* whereas Heaslip (1968: 86–87) added that *B. bulla* has an average

width/height ratio of 0.51, and height/length ratio of 0.98. The present specimen has 25 (26?) ribs, a width/height ratio of 0.44, and a height/length ratio of 1, so is decidedly nearer to *B. wilcoxensis* than *B. bulla*. Heaslip (1968: 87) noted the unusually thick shell of *B. bulla*, a feature with no parallel in other alticostate venericards; the damage on the present species also exposes a very thick shell of up to 4 mm; whether that feature indicates a closer relationship to *B. bulla* or, as with the case of many Seguin mollusks, the shell thickness is a reflection of the environmental living conditions, is not known. A few small or poorly preserved specimens of a venericard, possibly this species, were found at localities 11-T-101 and 11-T-102, but all are too small to permit reliable identification.

Type Information.—Holotype: USNM 16452, from Matthews Landing, Alabama River, Wilcox County, Alabama. Figured Seguin specimen: TMM BEG37943, from locality 11-T-100.

Material Examined.—26 specimens in the USNM, the largest 29.2 mm in length, 17.5 mm in height.

Superfamily **CRASSATELLOIDEA** Férussac, 1822
Family **ASTARTIDAE** Orbigny, 1844 in 1844–1847

Genus ***VETERICARDIELLA*** Chavan in Moore, 1969

Type Species.—*Astarte crenalirata* Conrad, 1860, by original designation. Upper Cretaceous, Tennessee.

Description.—Shell small, trigonal, slightly inequilateral, with strong radial ribs regularly set off by wide, deeply separated concentric furrows. Lunule large, impressed. Hinge of LV with two strong cardinal teeth; RV with one prominent cardinal and triangular sockets on either side; laterals elongate.

Remarks.—To date, the genus *Vetericardiella* (= *Vetericardia* Conrad, 1872, invalidly proposed) is only known from the Upper Cretaceous to just above the K-Pg boundary (Hansen & Upshaw in Walliser, 1990: 404, 406).

Vetericardiella sp.
Pl. 3, Fig. 11

Description.—Shell small, thick-shelled, moderately inflated. Sculpture of numerous concentric ridges, steepest on upper slope, crossed by weaker radials producing rounded nodes at intersections. Posterior margin with small lateral tooth; RV with prominent triangular cardinal tooth.

Remarks.—Two specimens were seen, both fragmentary, but showing enough detail to determine the genus. This species is close to *Vetericardiella webbervillensis* (Stephenson, 1941), and somewhat less so to the type, *V. crenalirata* (Conrad, 1860), but can be distinguished by its reduced inflation, less prominent radial and concentric ribs (the intersections of the two being more nodular), a more sunken lunule, and the posterior margin of the hinge excavated deeply and ending in a small marginal lateral tooth. One specimen is missing most of the hinge but shows the dorsal part of the typical triangular cardinal tooth that is characteristic of the genus. The species *V. webbervillensis* is abundant at the type locality, and is by far the most common bivalve to be found there.

Type Information.—Figured specimen: TMM NPL37893, LV. Second specimen: TMM NPL36231, both from locality 11-T-13.

Material Examined.—2 specimens, the largest (TMM NPL37893) 3.0 mm in length.

Order **VENERIDA** Gray, 1854
Superfamily **CARDIOIDEA** Gill, 1871
Family **CARDIIDAE** Lamarck, 1809
Subfamily **CARDIINAE** Bronn, 1862

Genus ***ACANTHOCARDIA*** Gray, 1851

Type Species.—*Cardium aculeatum* Linnaeus, 1758, by subsequent designation (Stoliczka, 1870 in 1867–1871: 207). Recent, Mediterranean Sea.

Description.—Shell oblique/quadrate, tumid to inflated. Ribs well developed, often with nodes or spines. Cardinal teeth in LV partially fused.

Remarks.—The genus ranges from the Upper Cretaceous the to Recent in Europe, North and South America, and Asia.

Subgenus ***SCHEDOCARDIA*** Stewart, 1930

Type Species.—*Cardium hatchetigbeens*e Aldrich in Smith, 1886, by original designation. Lower Eocene, Alabama.

Description.—"Less oblique than *Acanthocardia,* spines on ribs weak to obsolete, especially anteriorly" (Moore, 1969: N585).

Remarks.—The genus is known from the Danian to the Upper Eocene, in North America and the Far East.

Acanthocardia* (*Schedocardia*)** cf. ***hatchetigbeense
(Aldrich in Smith, 1886)
Pl. 2, Figs 6–7

Cardium hatchetigbeense Aldrich in Smith, 1886: 39, pl. 4, figs 12, 12a–b; Gregorio, 1890: 216, pl. 33, figs 2–4 (copying Aldrich in Smith, 1886: pl. 4, figs 12, 12a–b); Cossmann, 1893: 10; Harris, 1897b: 59, pl. 12, figs 2, 2a (copying Aldrich in Smith, 1886: pl. 4, figs 12, 12a–b), ?fig. 3; Dall, 1900 in 1890–1903: 1080; Trowbridge, 1932: pl. 39, fig. 8 (syntype); Brann & Kent, 1960: 174 (as *C.* ? *hatchetigbeense*).

Plagiocardium (*Schedocardia*) *hatchetigbeense* (Aldrich). Stewart, 1930: 255.

Description.—Shell rather thick, ventricose, subquadrate. Umbones swollen; beaks elevated. Ribs *ca.* 32, with spines along summits; spines larger on posterior part of shell; ribs and flattened interspaces approximately equal in width. LV cardinal tooth duplex.

Remarks.—Seguin specimens are closely similar to the type, although the rib interspaces are relatively smaller. The type has 32 ribs, the Seguin specimens have between 30 and 32 ribs. A feature not noted by Aldrich but present in both the Seguin specimens and the specimens figured by Toulmin (1977), is the presence of a fine line bordering each side of the ribs. Some specimens also show the rib sculpture to be a regular series of elongated, low, rounded knobs on the summit of the spines, and the bordering lines also to be crenulated. The species is quite common in the sandier sediments of locality 165-T-202, with both valves occasionally present and articulated.

Type Information.—Syntypes: USNM 638802, from Hatchetigbee Bluff, Tombigbee River, Washington County, Alabama. Figured Seguin specimens: TMM NPL37734–NPL37735, from locality 165-T-202. Remaining hypotypes in CLG.

Material Examined.—29 specimens, the largest (CLG 4362) 19.0 mm in length, 17.5 mm in height.

Superfamily **GALEOMMATOIDEA** Gray, 1840
Family **LASAEIDAE** Gray, 1847
Subfamily **BORNIINAE** Bernard, 1983

Genus ***BORNIA*** Philippi, 1836

Type Species.—*Cyclas sebetia* O. G. Costa, 1829 (= *Bornia corbuloides* Philippi, 1836), by subsequent designation (Stoliczka, 1871 in 1867–1871: 266). Recent, Mediterranean Sea.

Description.—Shell shape trigonal to trapezoidal. Surface polished; extremities with radial or punctuate sculpture crenellating inner margin. Lateral teeth present; right anterior cardinal prominent.

Bornia solomonis n. sp.
Pl. 1, Fig. 10

Description.—Shell minute, inflated, rounded-triangular in outline. Anterior somewhat rostrate; posterior smoothly rounded; ventral margin weakly concave. Surface mostly smooth, showing comarginal growth lines and radial lines at both ends; margins crenulated by ends of lines. Two cardinal teeth; anterior one peg-like, much more prominent. Two lateral teeth present; anterior stronger, further from beak than posterior one; resilium sunken.

Remarks.—Only RVs were recovered. The hinge of one specimen was excavated to expose the teeth, but the specimen is too delicate to permit further cleaning. Six other species of *Bornia* are known from the Gulf Coast Paleogene, five from the Middle Eocene. This species is closest to the only Lower Eocene species known, *B. prima* (Aldrich, 1897). The present species can be distinguished from *B. prima* by the greater inflation and more triangular outline.

Etymology.—The specific name *solomonis* refers to Solomon's Creek where the specimens were found

Type Material.—Holotype: TMM NPL37732, from locality 11-T-3. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-3, units BB–DD, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—4 specimens, the largest (holotype, TMM NPL37732) 3.5 mm in length.

Superfamily **MACTROIDEA** Lamarck, 1809
Family **MACTRIDAE** Lamarck, 1809
Subfamily **MACTRINAE** Gray, 1853

Genus ***MACTRA*** Linnaeus, 1767

Type Species.—*Cardium stultorum* Linnaeus, 1758, by subsequent designation (Fleming, 1818: 304). Recent, northeastern Atlantic Ocean and Mediterranean Sea.

Description.—Shell ovate-trigonal, subequilateral. Lunule and escutcheon delimited; ligament separated from resilium by shelly ridge. Oval pallial sinus.

Remarks.—Upper Cretaceous to Recent; worldwide in modern seas.

Subgenus ***EOMACTRA*** Cossmann in Cossmann & Peyrot, 1909b

Type Species.—*Mactra basteroti* Mayer in Studer, 1853, by original designation. Miocene, France.

Description.—Shell small, fragile, triangular in shape, anteriorly rounded, medially convex, posteriorly angular. Umbones small, pointed; lunule and escutcheon excavated. Surface smooth except behind posterior slope where growth lines are regularly wrinkled and rugose; concentric ribs on lunule and escutcheon. Resilium plate not extended beyond hinge teeth.

Mactra* (*Eomactra*) *piscinasina n. sp.
Pl. 3, Figs 8–10

Description.—Shell centrally smooth, with growth lines stronger toward posterior ventral margin. Umbones fairly broadly inflated. Interior with rounded line running from beak to posterior ventral edge, corresponding to exterior posterior slope carina; another broader weaker radiating line posterior to first. RV hinge small with two cardinal teeth; anterior one with sharp upper edge; posterior one bifid; ends splayed; resilium sunken, behind ventral edge. Lateral shelly laminae prominent.

Remarks.—The specimen was originally collected as an articulated specimen and was intended to be figured as such (Pl. 3, Fig. 9, LV, exterior view). During preparation, the upper LV was broken; because repair was virtually impossible, the interior of the lower RV was fully excavated to display the interior and hinge. This is a confusing species to place. On the one hand, it appears to have no provision for an external ligament, the left cardinal tooth is V-shaped, there is a socket-like resilifer, a large oval pallial sinus, and rounded ribs on the escutcheon, suggesting a mactrid. On the other hand, the large size of the pallial sinus, the deep but not well-defined resilifer, the small but prominent lateral tooth in the RV, and the V-shaped cardinal tooth with laminae growing thicker ventrally suggests a tellinid. Subgenus *Eomactra* is more tellinid-like than most Mactridae, with the small resilifer not projecting beyond the margin of the hinge plate. The preponderance of features suggests a mactrid.

The outline is more similar to that of the type, *Mactra* (*Eomactra*) *basteroti*, from the Burdigalian of France, than to the two Eocene species, *M.* (*E.*) *levesquei* Orbigny, 1850, from the Ypresian, and *M.* (*E.*) *semisulcata* Lamarck, 1805 in 1804–1806, from the Lutetian. A comparison with *M.* (*E.*) *levesquei* shows that species to be much more inflated, have an oval-quadrate shape, and much more prominent and prosogyrate umbones. The bifid tooth of *M.* (*E.*) *levesquei* is fused to a greater extent than *M.* (*E.*) *piscinasina* n. sp., otherwise the characters of the hinge in both species is remarkably similar.

Etymology.—The specific name *piscinasina* (Latin, pond) refers to the name of the creek (Pond Creek) from which the specimen was found.

Type Material.—Holotype: TMM NPL37736, RV. Paratype: TMM NPL37737, LV of the holotype (separated), both from locality 11-T-3.

Type Locality.—Locality 11-T-3, units BB–DD, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—2 specimens, the largest (holotype, TMM NPL37736) 13.0 mm in length, 10.0 mm in height.

Superfamily **TELLINOIDEA** Blainville, 1814
Family **TELLINIDAE** Blainville 1814
Subfamily **TELLININAE** Burmeister, 1837

Genus ***ARCOPAGIA*** Brown, 1827

Type Species.—*Tellina crassa* Pennant, 1777, by subsequent designation (Hermannsen 1846 in 1846–1852: 76). Recent, Atlantic coasts of Europe and North Africa.

Description.—Shell large or small, rounded orbicular, moderately inflated; beaks high. Shell surface generally concentric, but sometimes with radial ridges. Two cardinals in each valve; right posterior and left anterior one bifid; two laterals in RV. Pallial sinus ascending, its lower margin entirely free.

Remarks.—I am following Afshar (1969) in treating *Arcopagia* as a full genus. Range Cretaceous?, Eocene-Recent.

Subgenus ***ARCOPAGIA*** Brown, 1827

Description.—Shell medium in size; posterior end rounded and slightly broader than anterior end. Two cardinals in each valve. Ventral margin of pallial sinus entirely free; anterior end

of pallial sinus not connected to the anterior adductor scar by a line (updated from Afshar, 1969: 44–45).

Arcopagia* (*Arcopagia*) *solomonis n. sp.
Pl. 3, Figs 4–5

Description.—Shell medium-sized, orbicular, with anterior end weakly produced. Beak pointed, with slight emargination posteriorly; umbones anterior of midlength. Sculpture of fine irregular concentric lines becoming less prominent near anterior margin. Right cardinals lamellar; right posterior lateral with a deep depression dorsal to tooth.

Remarks.—This species appears to be the direct ancestor of the Lower Eocene *Arcopagia* (?) *bellsiana* (Aldrich, 1921), a species with a similar but more elongate outline, and lacking the lateral depression on the RV. *Arcopagia* (*Arcopagia*) *reveneli* (Conrad in Morton, 1834), the probable continuation of the *A.* (*A.*) *solomonsis—A.* (?) *bellsiana* line, has a similar but higher orbicular outline, is a much more robust shell, and has sculpture of strong concentric lirae, median umbones, and relatively weaker lateral dentition.

Etymology.—The specific name *solomonis* refers to Solomon's Branch from which the species was found.

Type Material.—Holotype: TMM NPL37740, LV. Paratype: TMM NPL37741, RV, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—10 specimens, the largest (holotype, TMM NPL37740) 18.0 mm in length, 14.5 mm in height.

Subgenus ***JOHNSONELLA*** Afshar, 1969

Type Species.—Tellina fausta Pulteney, 1799, by original designation. Recent, Florida, West Indies, to northern coast of South America.

Description.—Shell small to large, subequilateral, rounded at both ends. Surface sculpture concentric to smooth. Ventral margin of pallial sinus partly coalescent with pallial line; anterior end of pallial sinus connected to anterior adductor scar by line (updated from Afshar, 1969: 46).

Remarks.—Afshar (1969) defined the subgenus as Recent only. Vokes (1972: 34–35) noted the presence of the type species, *Tellina fausta*, in marls as early as the Lower Miocene Chipola Formation.

Arcopagia* (*Johnsonella) seguinensis n. sp.
Pl. 3, Figs 2–3

Description.—Shell medium-sized, subtrigonal to ovate, equilateral; umbones almost central. Surface smooth or with fine concentric lines of growth, more prominent toward ventral edge; some specimens with exceedingly fine radial striae. RV with two cardinal teeth; anterior tooth rounded at end; posterior tooth bifid, flat-ended in ventral direction. Resilifer small, sunken; lateral teeth distant, high, lamellar. Pallial sinus large, rounded, coalescent with pallial line over last 20%; anterior end of pallial sinus connected to anterior adductor by weakly impressed line.

Remarks.—This occurrence extends the range of the subgenus from the Lower Miocene to the Middle Paleocene. The closest Gulf Coast species is *Tellina trumani* Harris, 1897b, but that species can be distinguished by its more elongate form, the lack of the line connecting the pallial sinus to the anterior adductor, and the greater orientation to the horizontal of the pallial sinus. Palmer & Brann (1965 in 1965–1966) listed four species in the subgenus *Arcopagia*. Based on Afshar (1969), it appears that two of them, *T. raveneli* Conrad in Morton, 1834, and *T. trumani*, should be assigned to *Arcopagia* (*Arcopagia*). In the Paleogene of the Paris Basin, Renard & Pacaud (1995), listed 27 species of *Arcopagia*, all of them in the subgenus *Bertinella* Glibert & van der Poel, 1967; this taxon, which is defined as having the hinge of *Arcopagiopsis* Cossmann, 1886, a shape more trigonal than oval, surface smooth or with growth lines, and a long less ascendant sinus, is close to *Johnsonella*. The deciding differences appear to be the combination of a more oval outline, the coalescent pallial line and sinus, and the connecting line to the anterior adductor in *Johnsonella*. Examination of figures in the Deshayes monographs of species placed by Glibert & van der Poel (1967) in *Bertinella*, several differ by only one character in the list of four mentioned, notably *A.* (*B.*) *denudata* (Deshayes, 1857), *A.* (*B.*) *edwardsii* (Deshayes, 1857), *A.* (*B.*) *tenuistriata* (Deshayes, 1824), and *A.* (*B.*) *pseudodonacialis* (Orbigny, 1850). *Arcopagia* (*B.*) *tenuistriata* was available for examination and was found that even though not illustrated on the plate, the connecting line to the anterior adductor was in fact present; in this species, therefore, the only significant difference is in the differing shape. If others in the group should also prove to be similar, then *Johnsonella* should be regarded as a synonym of *Bertinella*.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37738, LV. Paratype: TMM NPL37739, RV, from locality 165-T-202. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-202, unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community, 31°02'07.55"N, 96°48'12.08"W, Milam County, Texas.

Material Examined.—8 specimens, the largest (CLG 14869) 16.4 mm in width, 15.0 mm in height, 3.5 mm in thickness.

Superfamily **VENEROIDEA** Rafinesque, 1815
Family **VENERIDAE** Gray, 1854
Subfamily **CALLOCARDIINAE** Dall, 1895 in 1890–1903

Genus ***PITAR*** Römer, 1857

Type Species.—*Venus tumens* Gmelin, 1791 in 1788–1793, by monotypy. Recent, western coast of Africa.

Description.—Shell oval to subtrigonal, moderately to strongly inflated, with umbones anterior, beaks prosogyrate. Ornamentation smooth or finely lamellate; ribs comarginal; lunule defined by incised line; escutcheon long, poorly defined. RV with two anterior lateral hinge teeth, three cardinal teeth; posterior cardinal tooth (3b) elongate, almost horizontal, bifid. LV with triangular 2b, joined to thin 2a, with 3a and 1 separate. Pallial sinus deep, reaching midlength. Valve margins smooth.

Remarks.—The genus ranges from the Paleocene to the Recent. At least 33 species are described from the Paleogene of the Gulf and Atlantic coastal plains.

Subgenus ***PITAR*** Römer, 1857

Description.—Sculpture absent, or with fine striae. Pallial sinus pointed.

Pitar* (*Pitar*) *nuttalliopsis heilprini (Palmer, 1929)
Pl. 3, Figs 6–7

Pitaria (*Pitaria*) *nuttalliopsis heilprini* Palmer, 1929 in 1927–1929: 14, pl. 2, fig. 8; Brann & Kent, 1960: 702.

Description.—Shell, short, subovate, with umbones high, tumid. Surface with fine concentric striae, often roughly imbricate at basal margin; lunule outlined by impressed line. Hinge and sinus as in genus.

Remarks.—Most specimens are still partially embedded in the sandstone, so the interior cannot be observed. The two specimens found in the shales were prepared to expose the hinge, which was found to be essentially identical to the hinge of *Pitar* (*Pitar*) *nuttalliopsis* (Heilprin, 1881) from the Bashi Marl except for a slight relative lateral compression.

Type Information.—Holotype: PRI 1581, from Wood's Bluff, Tombigbee River, Clarke County, Alabama. Figured Seguin specimens: TMM NPL37742, from locality 11-T-101, and TMM NPL37743, from locality 165-T-202. Remaining hypotypes in CLG.

Material Examined.—22 specimens, the largest (CLG 4366) 22.0 mm in length, 18.0 mm in height, 11 mm in width (single valve).

Subfamily **CLEMENTIINAE** Frizzell, 1936

Genus ***KATHERINELLA*** Tegland, 1929

Type Species.—*Callocalista arnoldi* Weaver, 1916, by original designation. Middle and Upper Oligocene, Lewis County, Washington.

Description.—Shell ovate to suborbicular; umbones anterior, strongly prosogyrate. Lunule large, outlined by impressed line, usually tumid; sculpture of evenly developed concentric lines of growth; radial sculpture absent. Hinge of RV with two anterior lateral teeth and three cardinals; hinge of LV with weak anterior bilateral tooth buttressed under upper margin of hinge plate and three diverging cardinals; nymphs smooth in both valves. Pallial sinus pointed, triangular.

Remarks.—Stenzel in Stenzel *et al.* (1957: 133–141) gave an extensive discussion of the type species and three Middle Eocene species from central Texas. He gave full generic rank to *Katherinella*, which I also follow, supported by the fact that the genus is easily recognizable in the Eocene deposits even when only the shell's surface sculpture is visible. Coan *et al.* (2000: 377) noted the similarity of *Katherinella* to *Compsomyax* Stewart, 1930, and thus indicated that the genus belongs in the Clementiinae.

Katherinella sp.
Pl. 3, Fig. 1

Description.—Shell thin, suborbicular. Ventral margin evenly rounded; beaks rounded, prosogyrate; umbones at *ca.* 0.37 of length of valve. Lunule large, not sunken, margined by fine impressed line; escutcheon smooth, delimited by rounded

obtuse angulation. Surface of fine concentric threads, usually regular, but sometimes interspaced with smoother areas. Hinge as in generic description.

Remarks.—One moderately sized specimen embedded to matrix was recovered, and is figured; all other individuals found are juveniles. All come from the moderately indurated sandy clay of locality 11-T-100. It was possible to prepare the hinge of three juveniles, one RV and two LVs, and it was found that the hinge characters are close to *Katherinella smithvillensis* Stenzel & Krause in Stenzel *et al.*, 1957, from the Weches Formation at Smithville, and figured by Stenzel *et al.* (1957: 135, 137, figs 21–22). The Seguin specimens are closest in outline and external sculpture to *K. smithvillensis*, but can be separated by the more evenly rounded outline, more rounded beaks, and more subdued sculpture. This occurrence extends the first occurrence of *Katherinella* from the Middle Eocene down to the Upper Paleocene. Without an adult showing the hinge characters, it is deemed premature to name the species.

Type Information.—Figured specimen: TMM NPL37744, from locality 11-T-100. Remaining hypotypes in CLG.

Material Examined.—19 specimens, the largest (CLG 14901) 6.0 mm in length.

Order **MYIDA** Stoliczka, 1870 in 1867–1871
Superfamily **MYOIDEA** Lamarck, 1818
Family **CORBULIDAE** Lamarck, 1809

Genus ***VOKESULA*** Stenzel & Twining in Stenzel *et al.*, 1957

Type Species.—*Corbula aldrichi* Meyer, 1885, var. *smithvillensis* Harris, 1895a, by original designation. Eocene, Texas.

Description.—Valves highly inflated; sizes discrepant, much larger RV enclosing left over entire margin. RV with prominent concentric ribs, rostrate posteriorly. LV with fine concentric ribs near umbo, remainder of valve usually smooth or almost so. Lunule and escutcheon absent. Pallial sinus small, nearly vertical. Hinge of LV with bipartite protruding chrondophore (after Stenzel & Twining in Stenzel *et al.*, 1957: 173–174).

Vokesula cf. ***aldrichi*** (Meyer, 1885)
Pl. 4, Figs 2–4

Corbula rugosa Lamarck. Heilprin, 1881: 364. Not Lamarck, 1806b: 467.
Corbula oniscus Conrad. Heilprin, 1881: 364. Not Conrad, 1833c.
Corbula gibbosa Lea. Heilprin, 1881: 364. Not I. Lea, 1833.
Corbula aldrichi Meyer, 1885: 67; Meyer in Smith, 1886: 83, pl. 1, fig. 21; Gregorio, 1890: 234, pl. 37, fig. 21 (copying Meyer in Smith, 1886: pl. 1, fig. 21); Cossmann, 1893: 7; W. B. Clark, 1895: 5; 1896: 74; Harris, 1897b: 67, pl. 13, figs 12–13, 13a; W. B. Clark & Martin, 1901: 163, pl. 32, figs 3, 3a, 4, 4a, 5, 5a, 6, 6a (not of Aldrich as in reference); Harris, 1919: 189, pl. 57, figs 7–9; Shirmer & Schrock, 1944: 431, pl. 172, figs 13–14 (coping Clark & Martin); Brann & Kent, 1960: 255–256.
Corbula (*Cuneocorbula*) *aldrichi* Meyer. Dall, 1898a in 1890–1903: 841–842.
Corbula (*Caryocorbula*) *aldrichi* Meyer. Barry in Barry & LeBlanc, 1942: 73, pl. 10, figs 2–3; Gardner, 1945: 132 (in part).
cf. *Vokesula aldrichi* (Meyer). Stenzel *et al.*, 1957: 174.
Vokesula aldrichi (Meyer). Toulmin, 1977: 201–202, 462, table 2.

Description.—Shell rounded, subtrigonal in outline, posteriorly produced, truncated; rostral ridge prominent. Surface smooth or almost so, with fine impressed radial lines from umbones to approximate start of ventral descending area, with concentric ribs ventrally.

Remarks.—This species is easily distinguished from both *Vokesula smithvillensis smithvillensis* (Harris, 1919) and *V. s. petropolitana* (Stenzel & Twining in Stenzel *et al.*, 1957) by its reduced inflation, more elongate outline, and the proportionately larger smooth surface area. The Seguin specimens are worn and mostly decorticated, but still show the large smooth area and sharp rostral ridge and have a similar degree of inflation to *V. aldrichi s.s.* Stenzel *et al.* (1957: 174) believed *V. aldrichi* to be the earliest known occurrence of *Vokesula*, but the author has collected specimens of an undescribed species from the Paleocene Matthews Landing marl that are much closer to the later Claibornian species than is *V. aldrichi*. *Vokesula aldrichi* appears to be an offshoot leading more toward *Notocorbula* Iredale, 1930, rather than the dominant line of *Vokesula.*

Type Information.—Holotype: GSATC 37, from Wood's Bluff, Tombigbee River, Clarke County, Alabama. Figured Seguin specimens: TMM NPL37745–NPL37746, from locality 11-T-13. Remaining hypotype in CLG.

Material Examined.—3 specimens, one LV, one RV, one double valve.

Genus ***NOTOCOBULA*** Iredale, 1930

Type Species.—*Notocorbula vicaria* Iredale, 1930, by original designation. Recent, off of the coast of New South Wales, Australia.

Description.—RV larger, margins grooved for the insertion of LV; umbones inflated, relatively low or flattened, capped by nepionic valves; both valves posteriorly rostrate into a snout; umbonal keel strong, extending to posteroventral margin with another weaker keel extending to dorsal side of posterior margin; area between keels concave. RV with strong concentric ribbing, with prominently "keeled" anterior cardinal and small resilium pit; LV weaker, with bipartite chondophore. Adductor scars large, prominent; pallial sinus small, almost vertical.

Notocorbula sp.
Pl. 4, Figs. 5–8

Description.—Shell small, heavy, moderately elongated; ventral margins convex. Posterior end of RV moderately rostrate, obliquely truncate; cardinal tooth triangular in cross section, upturned. LV more strongly inflated; rostral end quite sharp. Sculpture of fine concentric ribs on nepionic area, becoming irregular and strong toward ventral margins.

Remarks.—This species shows some affinities with the short form of *Corbula subengonata* Dall, 1898a in 1890–1903, from the Sabine Stage of Woods Bluff (*cf.* Harris, 1919: 185, pl. 56, figs 5–8), but is distinguished by the possession of a primary character of *Notocorbula*, the weak netionic cap. The middle Claibornian *N. texana* (Gabb, 1860) almost always has a prominent cap; in the lower Claibornian representative *N. marquezensis* Garvie, 1996, the cap is less prominent but the flattened nepionic area, the sharp boundary bearing an impressed groove between it and the later growth stage, is very apparent. The cap attachment area must be a line of weakness because the cap is often missing, leaving a recognizable, smooth polished surface. These Seguin "*Corbula*" representatives are placed tentatively in *Notocorbula* because one specimen has a low flattened cap, and the others show the flattened polished area where the cap presumably was located. The Seguin species can be separated from *N. texana* by its less inflated form, fine regular concentric ribs on the nepionic area, and larger, more irregular ribbing on the remaining surface.

Type Information.—Figured specimens: TMM NPL37769–NPL37770, from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—19 specimens, the largest (CLG 14906) 5.0 mm in length.

Genus ***CARYOCORBULA*** Gardner, 1926a

Type Species.—*Corbula alabamensis* I. Lea, 1833, by original designation. Claibornian Eocene, Gulf and Atlantic Coastal Plain.

Revised Description.—Shell small to moderate in size, moderately to acutely keeled posteriorly, slightly inequivalve; both valves with concentric sculpture varying from fine lineations to strongly rugose in character; sculpture of RV in some species stronger and more regular than on LV; radial sculpture usually microscopic in character but occasionally developed as fine lines, particularly on posterior keel; ligament, dental muscle scar, and sinus characters similar to those of *Corbula s.s.*

Remarks.—An emended description is necessary because Gardner's diagnosis of *Caryocorbula* (Gardner, 1926a: 46; repeated by Gardner, 1935: 190) noted that the sculpture characterizing this taxon is almost exclusively concentric in character with at most microscopically fine radial lineations, particularly on the posterior keel. Yet later, in the same publication (Gardner, 1935: 192–194, pl. 19, figs 7–9), she figured a new species, *C. coloradoensis*, with radial sculpture stronger than microscopic in character, and covering the entire disk. This emended description now encompasses both groups.

cf. ***Caryocorbula coloradoensis*** (Gardner, 1935)
Pl. 4, Fig. 9

Corbula (*Caryocorbula*) *coloradoensis* Gardner, 1935: 192, pl. 19, figs 7–10.

Description.—Shell small, tending to trigonal in outline, robust, moderately inflated; ventral RV margin slightly overlapping that of LV. Umbones prosogyrate, high, slightly anterior; anteriorly rounded, posteriorly rostrate; sculpture of growth lines, strongest near ventral margin and impressed regular surface and subcutaneous radial striae over entire surface. RV with deep resilifer and short, horizontally compressed cardinal tooth with upcurved tip.

Remarks.—One RV was recovered similar to this species, which is readily recognizable due to the stronger radial sculpture, a feature not seen in any other Gulf or Atlantic Coastal Plain *Caryocorbula* species. The type locality of *C. coloradoensis* is the Wills Point Formation, in the upper part of the Midway Group; this Seguin specimen shows the radial sculpture even more strongly developed than in those found in the lower Wills Point Formation. The hinge area was carefully excavated and the cardinal tooth was found to be as Gardner (1935: 192–193) noted: "short, horizontally compressed, upcurved at the pointed tip and not very prominent." As with many

Corbulidae, the outer layer with the sculptural features is weakly attached to the remainder of the shell and is frequently detached; this specimen had lost part of the outer layer and the remainder was stabilized with a consolident.

Type Information.—Figured specimen: TMM NPL36149, from locality 11-T-101.

Material Examined.—1 specimen (figured specimen, TMM NPL36149), 9.8 mm in length.

Superfamily **PHOLADOIDEA** Lamarck, 1809
Family **TEREDINIDAE** Rafinesque, 1815
Subfamily **BANKIINAE** Turner, 1966

cf. **BANKIINAE** sp.

Remarks.—One large piece of a fossil log was recovered from the lower section of the exposure at Pond Creek, oval in outline probably due to compaction. The wood is black, appears virtually unaltered, and has teredo tubes covering the outer surface but not extending much into the interior; the tubes are swollen near the valve end. Some shell material is seen but the sediment is so hard that matrix removal is impossible without breakage; a few tube ends were fractured and two broken pieces showed the denticulated ridges that are characteristic of the valves of *Bankia* Gray, 1842. The earliest *Bankia* species is known from the Paleocene of Iraq (Elliott, 1963), which is also the earliest record of the parent subfamily Bankiinae. The wood and attached teredo species is so well preserved that the log is left in a substantially unaltered state for future investigation to determine the morphology of any internal pallets, perhaps by microsectioning the tubes.

Type Information.—Seguin specimen: TMM NPL37733, from locality 165-T-200.

Material Examined.—The log (TMM NPL37733) 48 cm by 33 cm, with numerous teredo tubes and attached oyster spat.

Order **PHOLADOMYIDA** Newell, 1965
Superfamily **THRACIOIDEA** Stoliczka, 1870 in 1867–1871
Family **PERIPLOMATIDAE** Dall, 1895 in 1890–1903

Genus ***COCHLODESMA*** Couthouy, 1839

Type Species.—*Anatina leana* Conrad, 1831, by subsequent designation (Hermannsen, 1847a in 1846–1852: 266). Recent, northeastern coast of North America.

Description.—Lenticular, subequilateral; lithodesma present, chondrophore buttressed. Surface smooth or minutely scabrous, with fine epidermis.

Cochlodesma cf. ***howei*** (Barry in Barry & LeBlanc, 1942)
Pl. 4, Fig. 1

Periploma howei Barry in Barry & LeBlanc, 1942: 58, pl. 6, figs 6–7; Wasem & Wilbert, 1943: 102.

Remarks.—All specimens recovered are embedded in matrix, but with characters close to those described and figured by Barry (in Barry & LeBlanc, 1942: 58–59, pl. 6, figs 6–7). The smooth shell surface places the species in *Cochlodesma* rather than *Periploma* Schumacher, 1817, which has a granulate surface texture. Lorene Smith of Louisiana State University (pers. comm., 2011) kindly examined the shell surfaces of both the holotype and paratype of *Cochlodesma howei* confirming their smooth character and thus the re-assignment to genus *Cochlodesma* as above.

Type Information.—Figured specimen: TMM NPL36236, from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—3 specimens, the largest (figured specimen, TMM NPL36236) 35.8 mm in length.

Superfamily **POROMYOIDEA** Dall, 1886
Family **POROMYIDAE** Dall, 1886

Genus ***POROMYA*** Forbes, 1844

Type Species.—*Poromya anatinoidea* Forbes, 1844, by original designation. Recent, northern Atlantic.

Description.—Shell ovate to subcircular, inflated, inequilateral, subequivalve. Sculpture of radial rows of fine pustules; posterior slope margined by radial sulcus or ridge; hinge plate strong; pallial sinus vestigial.

Remarks.—The genus ranges from the Cretaceous to Recent.

aff. ***Poromya*** sp.
Pl. 3, Fig. 12

Description.—Shell small, ovate, thin; umbones prosogyrate; with a somewhat flattened posterior dorsal area; margin broadly truncate. Sculpture of exceedingly fine comarginal growth lines and regularly spaced radial striae obsolete posteriorly, stronger and closer together anteriorly; striae weakly

pustulate at intersection with growth lines. Hinge and interior features not observed.

Remarks.—Over the years, while splitting blocks of fossiliferous shale from Eocene localities, the author has occasionally come across very small bivalves that could not be assigned to anything known in the literature; unfortunately the process of splitting almost always resulted in the destruction of the shell, leaving only small fragments showing a sculpture of fine radial striae. Fortuitously, while splitting a piece of shale from the Seguin, a cast was obtained with some adhering pieces of shell now allowing a general determination. The fragments of shell obtained from the middle Claibornian of Texas have the same fine sculpture, so this taxon, or a very close ally thereof, continues at least into the Middle Eocene. The taxon is likely a septibranch, but even the superfamily cannot be definitely established; several Cuspidariidae had fine widely spaced radial striae but also have an extended rostrum, which this species lacks. Another possibility might be an assignment in Verticordiidae in which a taxon such as *Lyonsiella* Sars, 1872, might be considered, because species in the latter taxon possess a thin shell and widely spaced radial lines; however, the quadrate shape, highly incurved umbones, and nacreous interior precludes that assignment. Because not all characteristics can be correlated with any published generic description, the assignment is the closest that the author could find.

Type Information.—Figured specimen: TMM NPL36148, from locality 11-T-101.

Material Examined.—1 specimen (TMM NPL36148), attached to a block of matrix, 3.0 mm in length.

Order Uncertain (*fide* Bieler *et al.* in Bouchet & Rocroi, 2010)
Superfamily **HIATELLOIDEA** Gray in Sabine *et al.*, 1824
Family **HIATELLIDAE** Gray in Sabine *et al.*, 1824

Genus ***PANOPEA*** Menard, 1807

Type Species.—*Mya glycymeris* Born, 1778, by subsequent designation (Schmidt, 1818: 177). Recent, Mediterranean Sea.

Description.—Shell usually large, inflated, equivalved; beaks central, usually gaping at both ends. Surface smooth or concentrically furrowed. Ligamental nymph large, high. Single prominent conical tooth in each valve; pallial sinus wide, deep.

Panopea sp.
Pl. 3, Fig. 13

Description.—Shell short, thin, strongly inflated. Hinge line straight; anterior gape wide; weak ridge running from umbo to anterior dorsal margin.

Remarks.—All specimens obtained are fragmentary and to a large extent encased in rock from which they are impossible to extract. However they are a short, moderately to highly inflated species. The ridge running from the umbo to the dorsal margin is a feature also shown by the Lower Eocene *Panopea bellensis* Aldrich, 1921. That species, however, has a compressed shell, unlike the Seguin specimens in which the outline is closer in form to the Upper Cretaceous *Panopea decisa* Conrad, 1853. Without better material, further comparisons appear pointless.

Type Information.—Figured specimen: TMM NPL36237, from locality 11-T-13. Remaining hypotypes in CLG.

Material Examined.—3 specimens, the largest (broken, CLG 16658) 11.0 mm in length.

Class **SCAPHOPODA** Bronn, 1862
Order **DENTALIOIDEA** Costa, 1776
Family **DENTALIIDAE** Gray, 1847

Genus ***DENTALIUM*** Linnaeus, 1758

Type Species.—*Dentalium elephantium* Linnaeus, 1758, by subsequent designation (Montfort, 1810 in 1808–1810: 23). Recent, off of Amboyna and the Philippine Islands.

Description.—Shell as enlarging curved tube. Sculpture of longitudinal ribs at posterior end commonly extending entire length of shell; apical (posterior) opening usually with slit or notch, sometimes modified by longitudinal ribs.

Dentalium aff. ***mediaviense*** Harris, 1896
Pl. 4, Figs 16–17

Dentalium minutistriatum Dall, 1892 in 1890–1903: 438 (in part). Not Gabb, 1860: 386.
Dentalium mediaviense Harris, 1896: 73, pl. 7, figs 1, 1a; Pilsbry & Sharp, 1898 in 1897–1898: 209; Gardner, 1935: 197; Brann & Kent, 1960: 319; Steiner & Kabat, 2004: 615.
Dentalium (*Graptacme*) *mediaviense* Harris. Shirmer & Shrock, 1944: 523, pl. 214, figs 24–25 (copying Harris, 1896: pl. 7, figs 1, 1a).

Description.—Adult shell large, moderately tapering, increasingly curved anteriorly. Juvenile with longitudinal, alternating

fine and coarse lines. Adult thick-shelled, with fine annulations.

Remarks.—One well-preserved individual is allied to *Dentalium mediaviense*, but with the longitudinal striae stronger and not so prominently alternating as in that species. The concentric annulations (fine striae) are also closer and more regular in the Seguin species. On the apical end, 12 ribs are present whereas at the apertural end, this has increased to 20. One might compare this with *D.* (*Antalis*) *blandum* Gregorio, 1890, a Gosport Sand species that has been doubtfully reported from the Lower Eocene at Woods Bluff, but that species has at least 16 ribs at the apical end and the ribs occur in an alternating series of three sizes, not two as in the present species. One large fragment has the almost smooth surface with almost smooth surface with obsolete annulations, as is typical of this species.

Type Information.—Figured specimens: TMM NPL36143 and NPL36184, from locality 11-T-101.

Material Examined.—2 specimens, the larger (figured specimen, TMM NPL36143) 13.9 mm in length.

Dentalium spp.

Description.—Smooth *Dentalium* species except for concentric growth lines and exceedingly fine impressed stria.

Remarks.—Only two fragments were obtained of a large *Dentalium*, probably allied with the common Midway species *D. mediaviense* Harris, 1896. A second species, probably juvenile, shows growth lines set at an oblique angle to the axis, reminiscent of *Fustiaria* (*Episiphon*) *acicula* Hodgekinson, 1974, but because the apex has no off-central shell-wall thickening, it is probably also a *Dentalium* species. In any case, all specimens are too small for proper identification.

Type Information.—Specimens in CLG, from locality 11-T-101.

Material Examined.—6 specimens, the largest (CLG 14886) 12.9 mm in length.

Genus ***FUSTIARIA*** Stoliczka, 1868 in 1867–1871

Type Species.—*Dentalium circinatum* J. Sowerby, 1823, by subsequent designation (Pilsbry & Sharp, 1897 in 1897–1898: 127). Eocene, Paris Basin.

Description.—Shell minute to large, slender, slightly arched, commonly smooth, with growth lines only, rarely annulated, lacking longitudinal ribs. Apical orifice simple with short notch on concave side, or rarely with apical plug and projecting medial pipe.

Fustiaria (?) spp.
Pl. 4, Figs 14–15

Description.—Attenuated *Fustiaria* with no surface sculpture; apical end circular. Growth lines set at angle to axis with forward edge on concave side of shell.

Remarks.—Two or more species of *Fustiaria* appear to be present in the Seguin. Even though very small, no unbroken apex is available so the subgenus cannot be reliably determined, although *Episiphon* Pilsbry & Sharp, 1897 in 1897–1898, appears the most likely for all but one of the specimens. One specimen has a long groove on the convex side stretching back from the anterior aperture for three-quarters of the shell length, which if it were a slit would indicate a position within *Fustiaria s.s.*; no changes were observed in any other characters from the remainder of the specimens. Eight species have been reported from the Gulf and Atlantic coast Paleogene, three from the Oligocene, two from the Upper Eocene, and three from the Middle Eocene, none so far from the Paleocene. The present species can be readily distinguished from two Eocene species, *E. acicula* Hodgekinson, 1974, and *E. gracilis* Garvie, 1996, by the triangular cross section of the shell and the off-central position of the orifice with respect to the outer outline. The third Middle Eocene species, *E. leroyi* Hodgekinson, 1974, can be separated from the present Seguin species by being straighter, and possessing low, irregularly spaced annular wrinkles. *Fustiaria* is known from the Middle Triassic to Recent, and is cosmopolitan in distribution (Emerson, 1962: 471), so it is surprising that so few species have been reported from the Gulf Coast Paleogene. Hodgkinson (1974: 23–24) reported them abundant from many of his localities in Texas and the author has collected several hundred from numerous localities including the Upper Cretaceous Kemp Clay of Texas, the Lower Eocene of Alabama, and the Middle Eocene of Texas and Alabama; with the exception of the Seguin, they appear to be conspicuously absent from the Gulf Coast Paleocene.

Type Information.—Figured specimens: TMM NPL36181–NPL36182, from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—9 specimens, the largest (TMM NPL14900) 7.5 mm in length.

Order **GADILIDA** Starobogatov, 1974
Family **GADILIDAE** Stoliczka, 1868 in 1867–1871

Genus ***CADULUS*** Philippi, 1844

Type Species.—*Dentalium ovulum* Philippi, 1844, by monotypy. Recent, Mediterranean Sea.

Description.—Shell small to medium-sized, with circular cross-section, more or less arcuate with maximum inflation near median or closer to anterior end. Aperture usually constricted; surface smooth, vitreous or transparent with minute longitudinal striae or annular rings; apical orifice with 2–4 notches.

Cadulus cf. ***phoenicea*** Gardner, 1935
Pl. 4, Figs 10–11

Cadulus phoenicea Gardner, 1935: 199, pl. 20, fig. 2; Steiner & Kabat, 2004: 630.

Remarks.—The one Seguin individual is slightly more inflated than *Cadulus phoenicea*, otherwise no differences were detected. Gardner's (1935) description did not mention that there are two shallow notches at the apical orifice; she stated that *C. phoenicea* is from the Kincaid Formation at Webberville. The Colorado River bluff at Webberville exposes the Kemp Clay Formation of Upper Cretaceous age, however, the closest Kincaid Formation exposures first outcrop on the Colorado River several kilometers downstream (Deussen, 1924: 43; Zachos *et al.*, 2005: 319).

Type Information.—Holotype: USNM 370996, type locality uncertain (see Remarks). Figured Seguin specimen: TMM NPL37771, from locality 11-T-13.

Material Examined.—1 specimen (figured specimen, TMM NPL37771) 2.8 mm in length.

Subgenus ***GADILA*** Gray, 1847

Type Species.—*Dentalium gadus* Montagu, 1803, by original designation. Recent, English Channel.

Description.—Shell small, slender, strongly curved; outline convex on one side, concave on other, more or less swollen near middle or toward aperture, tapering toward apex; surface smooth; apical orifice simple, without slit.

Remarks.—Distributed worldwide, Cretaceous to Recent.

Cadulus (***Gadila***) cf. ***palmerae*** Hodgekinson, 1974
Pl. 4, Figs 12–13

Cadulus (*Gadila*) *palmerae* Hodgekinson, 1974: 11, 17–18, pl. 1, fig. 15, fig. 8v–w; Fast, 1978: 44; Steiner & Kabat, 2004: 626.

Description.—Shell arcuate, with maximum inflation just anterior to midpoint, there locally swollen; posterior orifice round, simple; aperture reniform, normal to shell axis.

Remarks.—One specimen was obtained showing an essentially identical outline to *Cadulus palmerae*, and the length is within the range of 3.43–4.94 mm given by Hodgekinson (1974). The Seguin species is slightly more compressed in the dorsoventral axis and the apertural opening's ventral side is not strongly concave as in *C. palmerae*, but is flat or very weakly concave. More specimens might allow separation of the species on the orifice shape alone, but would be time-consuming from a practical basis.

Type Information.—Figured specimen: TMM NPL36185, from locality 11-T-13.

Material Examined.—1 specimen (TMM NPL36185), 4.8 mm in length.

Class **GASTROPODA** Cuvier, 1797
Clade **VETIGASTROPODA** Salvini-Plawen & Haszprunar, 1987
Superfamily **TROCHOIDEA** Rafinesque, 1815
Family **CALLIOSTOMATIDAE** Thiele, 1924
Subfamily **CALLOTROCHINAE** Szabó, 2011

Genus ***TYLOTROCHUS*** Koken, 1896

Type Species.—*Trochus konincki* Hörnes, 1856, by original designation. Triassic, Austria.

Description.—Shell moderate in size, moderately elevated. Whorls flat to weakly convex; sculpture smooth or with weak spiral lines and collabral threads. Body whorl with rounded carina; base flattened; with false umbilicus or umbilical chink. Outer lip thin, prosocline, with anteriorly weakly notched. Columella thickened, partially reflected over umbilical depression.

Tylotrochus extremus n. sp.
Pl. 5, Figs 6–8

Description.—Shell medium-sized; overall shaped as oblique cyrtoconoid cone; protoconch not available. Whorls smooth

or with growth lines; outline weakly inflated, bicarinate; upper and lower carinae defining edge of flat areas bordering sutures; median part of whorl weakly concave between carinae. Sutures deeply impressed. Base well defined by basal carina, smooth, rounded, with weak medial line. Aperture quadrate; outer lip thin; columella slightly thickened; abaxial edge thinly reflected over upper part of umbilicus.

Remarks.—The overall characters place this species provisionally within the Trochidae but a more exact placement is difficult due to the lack of any similar figured taxa in modern or Cenozoic faunas. As with all of the Seguin species extracted from the indurated boulders, the shells are well preserved with unaltered shell material, and show no trace of nacreous layers either on the inner surface of the shell, or as with many trochid taxa, on the outer surface; that precludes assignment within the Gibbulinae in which the other shell morphology could have placed it. Nacreous material is present in the sediment, as pieces of nautiloid extracted from the same boulders show nacreous material in a seemingly unaltered state. The lack of a nacreous layer, and the small or absent umbilicus, precludes assignment to *Calliostoma* Swainson, 1840. Outside of the Trochidae, placement within the Cerithiinae Fleming, 1822, might be considered because those taxa are non-nacreous; most Cerithiinae species have an entire aperture, are small, and have an umbilicus set off by a thickened or ornamented cord. One could consider the species to be an aberrant *Turritella*, but that genus has an entire aperture, no umbilicus, and a bent and weakly twisted columella. Closely similar in morphology is *Tylotrochus*, a genus that Wenz (1944 in 1938–1944: 278) cited from the Middle to Upper Triassic and placed in the Calliostomatinae, reassigned to the Proconulinea by Cox (in Knight *et al.*, 1960b: 247) and implicitly returned to the Calliostomatinae by Hickmann & McLean (1990: 108–109), who gave the range as Triassic to Cretaceous. Szabó (2011: 39) erected a new subfamily Callotrochinae for *Tylotrochus*, *Callotrochus* Kutasy in Schindwolf, 1938, and similar trochoidean gastropods possessing a simple shell morphology, because Gründel (2000) raised the rank of the subfamily Proconuline to family level and restricted it to *Proconulus* Cossmann, 1918, and closely related forms. The closest Cretaceous species known to the author is *Tegula? simplex* (Quintero & Revilla, 1966), figured by Kiel (2001: 22–23, pl. 4, fig. 1) from the Campanian of Spain, but that species differs by its much smaller size, prominent axial cords, and a weakly denticulate aperture; the apertural features alone point to the fact that this species and that in the Seguin are in different families.

Etymology.—The specific name *extremus* (Latin, end point) refers to the late temporal end point of the taxon.

Type Material.—Holotype: TMM NPL37782. Paratype: TMM NPL37783, both from locality 11-T-13. Remaining hypotype in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—3 specimens, the largest (holotype, TMM NPL37782) 27.7 mm in length (estimated original length 33–34 mm).

Clade **CAENOGASTROPODA** Cox, 1960b
Clade **SORBEOCONCHA** Ponder & Lindberg, 1997
Superfamily **CERITHIOIDEA** Fleming, 1822
Family **PACHYMELANIIDAE** Bandel & Kowalke, 1999

Genus ***PACHYMELANIA*** E. A. Smith, 1893

Type Species.—*Nerita aurita* Müller, 1774, by original designation. Recent, off of the coast of West Africa from Senegal to Angola.

Description.—"Shell solid, turreted with a sculpture of axial folds, sometimes obsolete in the adult, with spiral threads, carinae, tubercles or nodules. Aperture small, outer lip sigmoid, retracted above and at the base; columella thickened" (after Pilsbry & Bequaert, 1927: 266).

Remarks.—This genus today is restricted to West Africa, prefers brackish water of rather high salinity, and is extremely abundant in mangrove swamps and mudflats. Three species are recognized.

Pachymelania penrosei (Harris, 1895)
Pl. 6, Figs 8–9

Cerithium penrosei Harris, 1895a: 79, pl. 9, fig. 4; 1896: 107, pl. 11, fig. 4 (copying Harris, 1895a: pl. 9, fig. 4); Gardner, 1935: 317, not Midway as in Harris.

Description.—Shell medium-sized to large, solid; whorls rounded and with prominent oblique, arcuate elongated costae, more prominent anteriorly, which on early whorls range from suture to suture, gradually becoming shorter, more tubercular on later whorls; early whorls with numerous (12 or more) costae, on body whorl of larger individuals 4–6. Whorls with subsutural swollen collar, concave shoulder, ornamented with 14–18 spiral lines, strongest in tubercular region; base with fewer but more prominent spiral lines; columella con-

cave; outer lip anteriorly produced. Costae tending to be arranged axially in lines on early whorls.

Remarks.—This genus had a wider distribution in the Cretaceous, because Sohl & Koch (1984) noted its presence in the Upper Cretaceous Escondido Formation of Maverick County, Texas, and the Owl Creek Formation in Mississippi. The genus is also known from the Cretaceous of Wyoming, Utah, North and South Dakota, and Idaho (Schultz, 1918; Henderson, 1935; Erickson, 1974; Feldmann & Kammer, 1976). A closely similar species was figured by Toulmin (1977) as *Elimia* cf. *trigemmata* (Conrad, 1860), from the Midway of Alabama. *Elimia* was proposed by H. & A. Adams (1854 in 1853–1858) for a group of 16 species, many of which are now considered to be in different genera, without type designation. As noted by Pilsbry & Rhoads (1896), most species belong in *Goniobasis* I. Lea, 1862; the former authors designated the first valid species in the H. & A. Adams' list, *E. acutocarinata* I. Lea, 1841, as the type species of *Pachymelania*. *Goniobasis* has a turreted shell, with inflated whorls, usually prominent spiral cords, bent axial ribs, and sculpture usually weaker on the body whorl. The type *E. acutocarinata* is a short conical non-nodular shell, rather thick, with spire whorls centrally carinate, body whorl rounded and not very carinate, an elliptical aperture, and indented columella. Neither of these last two shells show much affinity with *E.* cf. *trigemmata*, which more readily should be assigned to *Pachymelania*. Harris' (1895a: pl. 9, fig. 4) figure of the holotype of *P. penrosei* shows a portion of a whorl with three nodes; the type in the TNSC now only shows one node but two paratypes constituting small portions of a spire identify the species. Gardner (1935: 318) noted that *P. penrosei* is a dependable guide fossil for the lower Wilcox. Collections in the TNSC show that when it does occur, it occurs abundantly, but is rarely found even partially complete. The largest specimens examined are estimated to have been to 70–80 mm in length, nothing near the 250 mm mentioned by Harris (1895a).

Type Information.—Holotype: TMM BEG35654, from locality 165-T-2. Figured Seguin specimens: CLG 4379 and TMM BEG37900, from locality 11-T-13.

Material Examined.—More than 20 specimens, the largest (figured specimen, TMM NPL37900) 66.0 mm in length (estimated original length 100 mm).

Family **MELANOPSIDAE** H. & A. Adams, 1854

Genus ***TEXMELANATRIA*** Palmer, 1942

Type Species.—*Cerithium texanum* Heilprin, 1891, by original designation. Eocene, Texas and Mexico.

Description.—Shell large, turreted; sides of whorls straight; sculpture of longitudinal folds. Body whorl spirally lirate; earlier whorls much smoother. Aperture ovate, with small posterior notch, anteriorly produced, with large well-defined notch. Parietal callus medium-sized; outer lip sinuous; edge thickened in adult.

Remarks.—*Texania* was originally named by Palmer (1937), but being preoccupied by *Texania* Casey, 1909 (a coleopteran), was renamed *Texmelanatria*; she placed the genus questionably in the family Melanopsidae due to the similarity with *Melanatria fluminea* (Gmelin, 1790 in 1788–1793) a taxon from Madagascar with similar external sculpture. Palmer also noted that *Texania* differed fundamentally in the absence of the prominent, deep, posterior notch of *Melanatria*. That conclusion had to have been based on the lack of good material, which is supported by all published figures of this species; the species is rare and is usually found as fragments in all but one exposure in the Texas Claibornian. At this one exposure in the Stone City Member, Cook Mountain Formation at Rock Creek, *Texmelanatria texanum* (Heilprin, 1891) is very common and over 60 specimens have been found, some very well preserved. These specimens reveal that this species does indeed have a prominent, deep posterior notch. It is also worth noting that all specimens recovered have lost the initial whorls of the spire, the tip closed with a growth of shell, a condition often seen in freshwater gastropods. The Rock Creek exposure suggests a fluvial environment given the large amounts of fossil wood, lack of glauconite, and a very depauperate fauna, which appears to be the preferred environment of the species. Gardner (1945: 156) placed the genus in family Cerithiidae due to the association of the South Texas and Mexican specimens with a marine fauna, but the poor quality of her material also precludes a more conclusive analysis.

Texmelanatria contracta n. sp.
Pl. 6, Figs 10–11

Description.—Shell large, slender; spire angle of *ca.* 8°; whorls straight or slightly inflated, with wavy subsutural collar, below that a depression, and *ca.* 9 vertical axial ribs per whorl. Columella strongly concave.

Remarks.—Two partially decorticated specimens are available, but the slender shape alone can immediately distinguish this species from *Texmelanatria texanum*, which has a spire angle of 18–22°, and *T. angeloi* Gardner, 1945, with a spire angle

of *ca.* 19°. One specimen had indications of strong, widely spaced spiral lines on the base, as does the type *T. texanum*.

Etymology.—The specific name *contracta* (Latin, contracted) refers to the slim conical form of the species.

Type Material.—Holotype: TMM NPL37818, from locality 11-T-13. Paratype: TMM NPL37573, from locality 11-T-100.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—2 specimens, the largest (holotype, TMM NPL37818) 62.0 mm in length (estimated original length 82 mm).

Texmelanatria brevis n. sp.
Pl. 7, Figs 1–3

Description.—Shell medium-sized, cyrtoconoid in outline; early whorls with axial ribs (each approximately as wide as interspaces), and 3 impressed spiral lines. First one, then 2 series of rows of tubercles develop through ontogeny; by adult body whorl, these become two duplex nodular spiral lines; growth lines arcuate; suture impressed, wavy due to low ribs; base of body whorl with 4 (?) spiral lines; aperture ovate; columella concave.

Remarks.—No complete individual is available, therefore several syntypes were used to build a complete description of the species. The vertical ribs, apertural shape, arcuate shape of the growth lines, and general resemblance to a nodular *Texmelanatria texana* makes the generic assignment likely. The taxon appears common in rocks of lower Wilcox age according to the TNSC collections, but almost always in a fragmentary condition. The sediments in which this species is found appear to be fluvial in origin due to the considerable amount of fossil plant remains, similar to that seen at Rocky Creek, Stone City Member, Cook Mountain Formation, where *T. texana* is common. The adult whorls of *T. brevis* n. sp. show some resemblance to those of *Melania trigemmata* (Conrad, 1860), which Palmer & Brann (1966 in 1965–1966: 642) placed in *Elimia*, a genus in Pleuroceridae. This species has 3 spiral lines, nodular where they cross the ribs, and has no differing early sculpture as in *T. brevis* n. sp. According to Wenz (1939 in 1938–1944: 698), the Pleurocerinae are characterized as often having a corroded apex, a holostomous aperture, a thin outer lip, and somewhat twisted columella; none of these features is noted on the specimens available, so the adult sculptural resemblance is probably fortuitous.

Etymology.—The specific name *brevis* (Latin, short) refers to the short compressed form of the species.

Type Material.—Holotype: TMM NPL12654, from locality 94-T-1. Paratypes: TMM NPL12651, from locality 11-T-13, NPL35890 from locality 94-T-1. Remaining hypotypes in TNSC collections.

Type Locality.—Locality 94-T-1, New Berlin, Guadeloupe County, Texas. Exact locality lost but could be one mile NE of the town.

Material Examined.—15 specimens, the largest (paratype, TMM NPL35890) 40.7 mm in length.

Family **PACHYCHILIDAE** Fisher & Crosse, 1892

Genus ***MELANATRIA*** Bowdich, 1822

Type Species.—Buccinum flumineum Gmelin, 1790 in 1788–1793, by original designation. Recent, freshwater of Madagascar.

Description.—Shell medium-sized to large, high conical; initial whorl outline often coleoconoid; early whorls ribbed, later ones also shouldered or stepped; carina usually nodular with posterior termination of ribs; whorls with fine spiral lines, stronger on body whorl; aperture oval, *ca.* ⅓ of shell length, posteriorly often somewhat notched and extended; columella weakly twisted.

Remarks.—The genus is known from the Paleocene onward. The Recent species are associated with fluvial environments.

Melanatria? sp.
Pl. 7, Fig. 7

Description.— Shell large to very large, conical, solid; apical angle *ca.* 50°; whorl profile initially flat, becoming weakly concave in posterior third; concavity ending in low rounded ridge in center of whorl; suture impressed, appearing to be bounded on later whorls by rounded subsutural cord; largest whorl on one specimen with weak widely spaced oblique folds running from upper suture to carina; early whorls ornamented by *ca.* 4 equally spaced spiral lines and indications of many more finer ones; spiral lines not discernable on later whorls; body whorl rounded, aperture subquadrate; median part of

outer lip carinate; outer lip with one internal, low posterior fold as evidenced by depression on steinkern.

Remarks.—All specimens found are fragmentary. If complete, this would easily be the largest cerithoid species in the Seguin fauna. So far, it has only been found south and west of the Colorado River; it appears always to be associated with the fresh or brackish fauna of *Pachymelania* and Melanopsidae species. All specimens examined were found by early collectors, and are embedded in extremely hard, indurated matrix in which the shells are not easily prepared; the figured specimen had a portion of the matrix removed to ascertain the whorl profile and ornament. Lower Tertiary, smooth, large shells, almost devoid of sculptural features, are rare; one of the few species that this taxon shows some similarity to is *Cerithium*? sp. A, figured as *Melania*? sp. A by Gardner (1923: 114–115, pl. 29, fig. 2). As Gardner (1923) noted, they are all internal casts, the whorls probably angulated in the young, smoothly rounded in the adult, with some showing a suggestion of *Cerithium*-like ribbing. The present species suggests the reverse, smoother in the young and angulated on later whorls, so probably indicates no close relationship between the two species.

Type Information.—Figured specimen: TMM NPL37897. Remaining specimens: TMM NPL37898 and NPL12673, all from locality 94-T-1.

Material Examined.—3 specimens, the largest (figured specimen, TMM NPL37897) 80 mm in length (estimated original length > 90 mm).

Genus ***LOXOTREMA*** Gabb, 1868

Type Species.—*Loxotrema turritum* Gabb, 1868, by monotypy. Eocene, western coast of the U. S. from Washington to California.

Description.—Shell elongate, turreted; spire high; whorls slightly convex on sides, with prominent shoulder, often swollen or tuberculate; suture impressed. Median portion of whorl surface generally smooth; base with spiral lines; early whorls sometimes with spiral lines above and below suture; aperture obliquely subquadrate, holostomous, posteriorly channeled; margin sigmoid; anterior notch almost vertical.

Remarks.—To date, this genus is only known from the Eocene by the type species, which is confined to the western coast of the U. S. (Squires & Saul, 1998) and northwestern Kamchatka (Devyatilova & Volobueva, 1981). The type is a fairly short shell with some variation in the strength of spiral lines and shoulder nodes (Vokes, 1939: pl. 20; Squires & Saul, 1998: 300). Squires & Saul (1998) gave a full discussion of the taxon, plus its inferred brackish-marine environment and paleoclimate. Wenz (1939 in 1938–1944: 685–686), doubtfully placed it as a subgenus of *Pachychilus* I. & H. C. Lea, 1850, but most other authors have regarded it as a full genus.

Loxotrema texana n. sp.
Pl. 7, Figs 4–6

Description.—Shell elongate, multiwhorled, coleoconoid; protoconch not known; early whorls worn on all specimens but early whorl outline straight to concave with fine subsutural swollen collar, sometimes weakly nodular, and few fine spiral striae below; suture deeply impressed; later whorls with 2 stronger lines and very swollen shoulder; growth lines sigmoid on body whorl often cutting shoulder into rounded axial ribs; aperture weakly notched anteriorly, channeled posteriorly; outer lip thickened.

Remarks.—No complete specimen was found, but one specimen shows the transition between the high-spired young and the adult with the swollen shoulder; without the transitional specimen, the two would have undoubtedly have been placed in different taxa. In many features, this is a transitional form between *Melanopsis* (*Lyrcaea*) *dufourii* Férussac, 1823, and *Loxotrema turritum*, but is placed here in an expanded definition of *Loxotrema* due to the spiral ribbing (even though weak), the more prominent sigmoid growth lines, and the oblique rather than vertical posterior apertural channel. Nothing similar to *L. texana* n. sp. has been found in the central and eastern Gulf Coast Paleogene faunas, although the Texas survey collections show that this species is common in the Eocene of the Rio Grande area. Very few Gulf Coast Eocene localities are known with a fresh- or brackish-water faunal component; only the Seguin and the lowest levels of the Stone City Member of the Cook Mountain Formation have produced substantial numbers of specimens. Two other localities in the Wheelock Member of the Cook Mountain Formation have produced melanopsid specimens; the eastern limit appears to be a Trinity River outcrop in Houston County in eastern Texas.

Two Paris Basin species are somewhat distantly related (Cossmann & Pissarro, 1910–1913 in 1906–1913: pl. 19, fig. 117-12, pl. 29, fig. 117-7): *Faunus* (*Melanatria*) *pyreniformis* (Deshayes, 1833), and *F.* (*M.*) *dufresnei* (Deshayes, 1825), both from the Cuisian (Paleocene). One of the figured specimens of *F.* (*M.*) *dufresnei* has a noded subsutural ramp, whereas the ramp is smooth in the other. However, it has long been known that some melanopsid species exhibit considerable polymorphism (Morrison, 1954: 360, 375; Pilsbry &

Bequaert, 1927: 269), with the juvenile sculpture often extended into the adult. That could be the case in *Loxotrema texana* n. sp. (Pl. 7, Fig. 5), in which the swollen shoulder stage indicative of the adult was delayed for so long that the animal died before the terminal adult stage was reached. Taking into account the known variability of most melanopsid species, the many points of similarity between *L. turritum* and the Texas species, it is more reasonable to assign it to the same genus rather than erecting another similar genus particularly in view of the poor preservation of the specimens.

Etymology.—The specific name *texana* refers to the occurrence of the genus in Texas.

Type Material.—Holotype: TMM NPL12659, from locality 11-T-19. Paratypes: TMM NPL12567, NPL37819, P3350, all from locality 94-T-1.

Type Locality.—Locality 11-T-19, Trigg ranch near headquarters of creek, probably south of Bastrop, Bastrop County, Texas.

Material Examined.—8 specimens, the largest (paratype, TMM P3350) 45.8 mm in length.

Family **TURRITELLIDAE** Lovén, 1847

Genus ***TURRITELLA*** Lamarck, 1799

Type Species.—*Turbo terebra* Linnaeus 1758, by monotypy. Recent, Indo-Pacific.

Description.—Spire elongate; protoconch of *ca.* 1½ smooth, glassy, turbinate whorls. Teleoconch whorls usually straight-sided, sometimes somewhat concave or convex, always ornamented with spiral lirae; basal lirae sometimes forming strong carina or collar; outer lip sinuous.

Remarks.—The genus ranges from the Cretaceous to Recent.

Turritella polysticha Stenzel & Turner, 1940
Pl. 5, Figs 1–3

Turritella turneri F. B. Plummer in Sellards *et al.*, 1933: 583.

Turritella cf. *abrupta* [*sic*] Conrad. F. B. Plummer in Sellards *et al.*, 1933: 815, pl. 10, fig. 6. Not *T. robusta abrupta* Speiker, 1922: 85.

Turritella polysticha Stenzel & Turner, 1940: 837, pl. 47, fig. 11; Stenzel & Turner, 1943 (not 1942, as by Palmer & Brann, 1966 in 1965–1966: 1002), Gastropoda 66, card no. 94, fig. 11 syntypes.

Description.—Shell small; apical spire angle *ca.* 28°; adult spire angle 16–18°. First 3 apical whorls smooth; 2 spiral lines appearing on fourth whorl just above lower suture; third line appearing *ca.* ¼ turn later just below upper suture, followed closely thereafter by fourth one beneath. Spiral lines gradually increasing in number to *ca.* 21 or more, those above and below suture weaker. Approximately 28 adult whorls; early whorls deeply channeled; central part of whorl flat to slightly concave; anterior angulation quite prominent; later whorls becoming progressively more rounded, with concavity migrating toward subsutural position. Growth lines smoothly sigmoid with maximum retraction point in center of concave area; maximum forward point on anterior angulation [revised description from Stenzel & Turner, 1940].

Remarks.— The syntypes figured by Stenzel & Turner (1940) were not found in either the type collection or general collections of the TNSC and are therefore lost, so a neotype (TMM NPL37774) from the same locality is hereby designated. Stenzel & Turner (1940) stated an adult spire angle of 20°, but none of the specimens examined have a spire angle as large as that. From the figure, it appears that the original syntypes came from the "*Turritella polysticha*" bed in which the majority of the individuals are juveniles; no mention is made of larger individuals. The few specimens obtained show that the whorls become progressively more evenly rounded and the spiral lirae subequal in size with age. The closest analog in the Lower Eocene is *T. gilberti* Bowles, 1939, but that species differs by having three strong, revolving cords in the juvenile stage, a prominent central concave area, and a strong basal carina in the adult. Descendants of *T. polysticha* appear to be *T. turneri* F. B. Plummer in Sellards *et al.,* 1933, from the Reklaw Formation, followed by *T. infans* Stenzel & Turner, 1940, from the Cook Mountain Formation. Palmer & Brann (1966 in 1965–1966: 1002) cited 1942 for the publication date of Stenzel & Turner's *Turritella* cards, but according to the Bureau of Economic Geology (Girard, 1959: 115), they were not issued until 1943.

Type Information.—Neotype: TMM NPL37774, from locality 11-T-13. Hypotypes: TMM NPL37775–NPL37779 from localities 11-T-13 and 11-T-101; Remaining hypotypes in CLG.

Material Examined.—More than 100 specimens and fragments, the largest complete specimen (CLG 14881) 16.0 mm in length.

Turritella mortoni crassa n. ssp.
Pl. 5, Figs 4–5

Description.—Similar to *Turritella mortoni mediavia* Bowles, 1939, but with spire apical angle of *ca.* 40°; initial spiral sculpture as in *T. m. mediavia* but unlike that species having the spiral lines becoming rapidly stronger and remaining so; two strong lirae on the shoulder with weak to scarcely less prominent intermediate lines; body whorl secondarily carinated, with numerous strong spiral lines and intermediate weaker ones on base.

Remarks.—*Turritella mortoni mediavia* appears to be restricted to the Midway Group and is widely distributed in the Gulf and southern Atlantic Coastal Plains (Bowles, 1939: 295). This subspecies *T. m. crassa* n. ssp. appears to be intermediate in evolutionary line from *T. m. mediavia* to *T. m. postmortoni* Harris, 1894, from the Lower Eocene Nanafalia and Tuscahoma formations.

Etymology.—The subspecies name *crassa* (Latin, rough) refers to the prominent spiral sculpture of this subspecies.

Type Material.—Holotype: TMM NPL37780. Paratype: TMM NPL37781, both from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—16 specimens, the largest (CLG 14899) 14 mm in length.

Clade **HYPSOGASTROPODA** Ponder & Lindberg, 1997
Clade **LITTORINIMORPHA** Golikov & Starobogatov, 1975
Superfamily **RISSOOIDEA** Gray, 1847
Family **TORNIDAE** Sacco, 1896
Subfamily **VITRINELLINAE** Bush, 1897

Genus ***TEINOSTOMA*** Pilsbry, 1922

Type Species.—*Teinostoma politum*, A. Adams, 1853, by monotypy. Recent, Philippine Islands.

Description.—Shell small, paucispiral, depressed, lenticular, white or translucent in color. Spire low, sometimes covered by last whorl. Umbilicus covered by callus pad connecting with parietal callus. Columella thickened; peristome rounded to sharp.

Subgenus ***IDIORAPHIE*** Pilsbry, 1922

Type Species.—*Cyclops angulatus* Gabb, 1873, by original designation. Miocene, Dominican Republic.

Description.—Distinguished from *Teinostoma s.s.* by having whorls initially enveloping previous; suture at first closely coiled, but deviating abruptly in last whorl.

Teinostoma* (*Idioraphie*) *seguinensis n. sp.
Pl. 5, Figs. 9–11

Description.—Shell small, lenticular; edge carinate, quite sharply rounded. Callus thinly covering umbilicus and most of base at all stages of growth; callus much thicker near columella. Peristome slightly produced. Adult shells smooth or with very fine collabral growth lines.

Remarks.—Young shells are proportionately much higher than the adult and sometimes show rows of elongate punctuate spirals. Two other species are known from the Lower Eocene of the Gulf Coast, *Teinostoma barryi* LeBlanc in Barry & LeBlanc, 1942, and *T.* (*Idioraphie*) *harrisi* Palmer, 1937. *Teinostoma barryi* has a heavier coating of callus, a rounded aperture, and sometimes well-defined spiral lines; *T. harrisi* has a rounded aperture and an enveloped spire. *Teinostoma seguinensis* n. sp. can be differentiated from the last two and others in the middle Claibornian by the produced peristome, which is closer to the type, *T. politum*, than are the other Paleogene Gulf Coast forms.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37784, from locality 11-T-3. Remaining specimens in CLG.

Type Locality.—Locality 11-T-3, units BB–DD, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—8 specimens, the largest (CLG 7822) 2.4 mm in diameter.

Genus ***COCHLIOLEPIS*** Stimpson, 1858

Type Species.—*Cochliolepis parasitica* Stimpson, 1858, by original designation. Recent, Caribbean and Gulf of Mexico.

Description.—Shell small, thin, strongly depressed, widely umbilicate; apex not projecting; aperture oblique; surface smooth, except for weak growth lines.

Remarks.—Despite the specific name *parasitica*, D. R. Moore (1972: 100–112) has shown that this snail is not parasitic on its host worm, but is a herbivore or detritus feeder. The genus is known from the Miocene to Recent of the southern and eastern U. S.

Subgenus ***TYLAXIS*** Pilsbry 1953

Type Species.—*Cochliolepis virginica* Pilsbry, 1953, by original designation. Miocene, Petersburg, Virginia.

Description.—Differing from *Cochliolepis s.s.* by its more erect form, basally thickened columella, and flattened columellar walls.

Cochliolepis* (*Tylaxis*) *palaeocenica n. sp.
Pl. 5, Figs 15–17

Description.—Shell small, discoidal, erect; outline a low cone; whorls to 3¾; protoconch of 2½ smooth-rounded whorls, with no clear demarcation between protoconch and teleoconch; teleoconch whorls rounded, with slight shoulder at margin of umbilicus and columella flattened within; sculpture of quite strong, irregular collabral growth striae; suture impressed with subsutural flattened band margined by impressed line; umbilicus wide; aperture extended above, sharp-edged, slightly thickened below.

Remarks.—This new species extends the range of the genus *Cochliolepis* to the Paleocene. Prior to this report, the earliest published example was the type of the subgenus *Tylaxis*, *C. virginica* from the Miocene. Wenz (1939 in 1938–1944: 643, figs 1819–1821) listed three subgenera of *Cochliolepis*, all sharply keeled, all now given full generic rank by most authors, and yet uncharacteristically for Wenz, he did not figure *Cochliolepis s.s.*, which is very different in sculpture with its smoothly rounded, thin-shelled form. *Cochliolepis palaeocenica* n. sp. is distinguished from *C. virginica* by its sculpture of irregular growth striae and its more erect outline. Other *Cochliolepis s.s.* species are all distinguished by their more discoidal form, depressed nuclear whorls, and rounded umbilical profiles. *Tubiola* A. Adams, 1863, a member of the Skeneinae with two Gulf Coast Eocene species, *T. nautiloides* (Aldrich, 1910b) and *T. gracilis* Garvie, 1996, although similar to *Cochliolepis* is even more erect in form, has a very thin shell, often with spiral sculpture, very deeply impressed sutures, and a much less oblique aperture.

Etymology.—The specific name *palaeocenica* refers to the first occurrence in the Paleocene.

Type Material.—Holotype: TMM NPL36140. Paratype: TMM NPL36141, both from locality 11-T-101. Remaining specimens in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—4 specimens, the largest (holotype, TMM NPL36140) 2.6 mm in diameter.

Superfamily **TURBINOIDEA** Rafinesque, 1815
Family **TURBINIDAE** Rafinesque, 1815
Subfamily **SKENEINAE** W. Clark, 1851

Genus ***SOLARIORBIS*** Conrad, 1865a

Type Species.—*Delphinula depressa* I. Lea, 1833, by subsequent designation (Dall, 1892 in 1890–1903: 414). Gosport Sand, Eocene, Alabama.

Description.—Shell small, depressed, moderately thick-shelled; nucleus small but fairly prominent, smooth, shiny, paucispiral; surface smooth or with punctuate spiral lines; aperture holostomous; peristome angulated, slightly sulcate at commissure; parietal wash heavy; umbilicus small, partially covered by thickening of umbilical carina.

Solariorbis velarum n. sp.
Pl. 5, Figs 12–14

Description.—Shell small, discoidal; whorls weakly carinate posterior to periphery, otherwise smoothly rounded; protoconch of 2¼–2½ smooth whorls; teleoconch initially with punctuate spiral lines over entire surface from suture to umbilical callus, with 2 subsutural lines stronger and more widely spaced than remainder; lines progressively obscured with shell growth by thin coating of callus, usually leaving only 2 stronger subsutural lines showing; sutures not visible in later adult stage, whorl edge being defined by ragged callus edge; umbilicus small, deep, almost entirely covered by thick callus pad; surface with few low radial folds.

Remarks.—This species is intermediate in characters between *Solariorbis proius* Gardner, 1935, from the Kincaid Formation, and *S. liniferous* Aldrich, 1897, from the Lower Eocene, Hatchetigbee Formation. *Solariorbis proius* differs in having only 4 or 5 punctuate spiral lines on the top surface (rather than over the entire surface) and having a carina at the periphery. *Solariorbis liniferous* is distinguished by being larger, with nonpunctate spiral lines (visible at all stages of

growth), and a larger umbilicus. Another Lower Eocene species also with some characters in common is *S. subangulatus smithi* (Aldrich, 1921), which differs in being nonumbilicate, also possessing punctate spiral lines but with a wide smooth band on the upper surface; only the spirals near the suture become obscured with age.

Etymology.—The specific name *velarum* (Latin, cover) refers to the callus covering earliest whorls.

Type Material.—Holotype: TMM NPL37786. Paratype: TMM NPL36139, both from locality 11-T-101. Remaining specimens in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—10 specimens, the largest (holotype, TMM NPL37786) 3.7 mm in diameter.

Solariorbis sp.

Description.—Solariorbis with moderately high profile; periphery smoothly rounded; umbilicus almost completely closed with callus; spiral lines absent.

Remarks.—All specimens are juvenile but are distinct from *Solariorbis velarum* n. sp. The higher profile, smooth surface sculpture, and almost closed umbilicus will separate the two forms. It generally resembles *S. discoides* Garvie, 1996, from the Middle Eocene Reklaw Formation, but that species is flatter and possesses a subsutural narrow depression. Because adult individuals are lacking, it will not be specifically named here.

Material Examined.—2 specimens in CLG, from locality 11-T-101, the largest (CLG 16679) 1.4 mm in diameter.

Superfamily **NATICOIDEA** Guilding, 1834
Family **NATICIDAE** Guilding, 1834
Subfamily **NATICINAE** Guilding, 1834

Genus ***NATICA*** Scopoli, 1777

Type Species.—Nerita vitellus Linnaeus, 1758, by subsequent designation (Anton, 1838: 31). Recent, Indo-Pacific.

Description.—Shell small to medium-sized, moderately elongate; spire elevated; shoulder narrowly channeled; umbilicus open, without umbilical callus; inner lip reflected; slender cord spiraling up umbilicus from thickened anterior inner lip; shell smooth or with fine spiral striae.

Subgenus ***CARINACCA*** Marwick, 1924

Type Species.—Ampullina waihaoensis Suter, 1917, by original designation. Eocene, New Zealand.

Description.—Shell of moderate size, ovate, smooth or sometimes with weak to moderate collabral grooves, widely umbilicate; spire low; suture sometimes impressed but generally tangential; aperture semilunate; outer lip straight but strongly retracted to suture, inclined 25–30° from vertical; inner margin straight with short, fairly thick parietal callus; umbilicus with obsolete funicle on long apertural margin (sometimes absent altogether), bounded by broad ridge formed by thickening of apertural margin at anterior corner.

Remarks.—I follow Marincovich (1977), MacNeil & Dockery (1984), and Pitt & Pitt (1992), among others who treat *Carinacca* and *Naticarius* Duméril, 1806, as subgenera. A feature not mentioned by authors in *Carinacca* is that the growth lines enter the umbilicus with almost no change of direction and spiral up into the umbilicus. In the confusingly similar subgenus *Naticarius*, the growth lines change direction more or less sharply at the boundary of the umbilicus, and then continue on into the umbilicus at a steeper angle; worn specimens of *Natica* (*Naticarius*) *canrena* (Linnaeus, 1758), the type of *Naticarius*, shows this feature particularly clearly. *Carinacca* is also distinguished from *Naticarius* by the impressed sutures, sometimes deeply so. Palmer & Brann (1966 in 1965–1966) placed *Natica reversa* Whitfield, 1865, in *Naticarius*, but the edge of the umbilical band, deeply impressed sutures, and character of the growth lines in the umbilical area suggest an assignment to *Carinacca*. The other species that Palmer & Brann (1966 in 1965–1966) questionably assigned to *Naticarius* is *Natica "*(*Naticarius*)*" semilunata* I. Lea, 1833, and on the basis of the character of the growth lines and the weakly impressed suture does fit well in *Naticarius*.

Natica* (*Carinacca*) *seguinensis n. sp.
Pl. 6, Figs. 1–2

Description.—Shell small to medium-sized, flattened globose, smooth; suture deeply impressed; aperture semicircular, *ca.* ¾ of shell length. Umbilicus defined on left side by elevated ridge, its junction with basal lip defined by thickened callus pad; parietal callus moderate in size.

Remarks.—The three species *Natica* (*Carinacca*) *reversa*, *N.* (*C.*) *seguinensis* n. sp., and *N.* (*C.*) *moffitti* Garvie, 1996, form

a group distinguished by their flatter outlines, proportionately larger apertures, and less prominent spiral ridges than the other two species.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37813. Paratype: TMM NPL37815, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—25 specimens, the largest (CLG 14891) 13.0 mm in length.

Subfamily **POLINICINAE** Gray, 1847

Genus ***POLINICES*** Montfort, 1810

Type Species.—*Polinices albus* Montfort, 1810, by original designation. Recent, West Indies.

Description.—Shell small to large, globose to ovate; whorls inflated to flattened, smooth except for incremental growth lines and microscopic spiral costellae; suture slightly to deeply impressed. Umbilicus narrowly to broadly open; funicle weak to absent; umbilical callus slender, broad to massive, often with shallow groove or dimple where umbilical and parietal callus meet; parietal callus thin to thick.

Remarks.—The genus *Polinices* ranges from the Upper Cretaceous to Recent.

Subgenus ***POLINICES*** Montfort, 1810

Description.—Shell small to medium-sized, sturdy, thick-shelled; sutures slightly impressed. Umbilical callus broad, massive, nearly closing umbilicus; parietal callus average to thick.

Polinices* (*Polinices*) cf. *onustus (Whitfield, 1865)
Pl. 6, Fig. 7

Natica (*Polinices*) *onusta* Whitfield, 1865: 264; Harris, 1896: 118, pl. 12, fig. 17; Whitfield, 1899: 172 (as *Polynices*); Brann & Kent, 1960: 583; Forney & Nitecki, 1976: 117, 174.

Natica (*Neverita*) *onusta* Whitfield. Dall, 1892 in 1890–1903: 368; Harris, 1899a: 89 (in part), not pl. 11, figs 24–26; Brann & Kent, 1960: 583.

Neverita onusta (Whitfield). Gardner, 1945: 173, pl. 14, fig. 14 (holotype).

Polinices sp.(Whitfield). Toulmin, 1977: 223, pl. 28, figs 1–2.

Description.—Shell obliquely elliptical; whorls somewhat flattened above, rounded below; suture slightly channeled; aperture large, semilunate; callus large, usually completely obscuring umbilicus; shell surface smooth or with fine growth lines.

Remarks.—The large Seguin specimen is worn but is seen to be intermediate between the Paleocene form of Whitfield's species and the Sabine Stage species assigned by Palmer & Brann (1966 in 1965–1966) to *Polinices* sp. (Harris, 1899a: pl. 11, fig. 25). The outline is that of the Sabine species with the ramped whorls, whereas the umbilical characters are similar, if a little less pronounced, to the Paleocene form. The callus deposit is proportionately much larger in the adult shell but is larger at all stages of growth than in *Polinices* (*Polinices*) *eminulus* (Conrad, 1833b), and lacks the bisecting callus groove of *Neverita limula* (Conrad, 1833b).

Type Information.—Holotype: CNHM UC 24518, from Matthews Landing, uppermost Porters Creek Formation, Wilcox County, Alabama. Figured Seguin specimen: TMM NPL37817, from locality 11-T-13. Remaining Seguin hypotypes in CLG.

Material Examined.—3 specimens, the largest (figured specimen, NPL TMM37817) 14.6 mm in length.

Polinices* (*Polinices*) *eminulus (Conrad, 1833b)
Pl. 6, Figs 3–4

Natica eminula Conrad, 1833b in 1832–1835: 46 (reprint Harris, 1893: 72); Conrad in Morton, 1834: 4; H. C. Lea, 1849: 102; Orbigny, 1850: 346; not Conrad in Emory, 1857: 141 [as *Lemulus sic*] = "*Natica*" sp.; Harris, 1895b: 18; Harris, 1896: 119; Shirmer & Shrock, 1944: 485.

Natica parva I. Lea, 1833: 106, pl. 4, fig. 89; H. C. Lea, 1849: 102; Gregorio, 1890: 149, pl. 15, fig. 3 (copying I. Lea, 1833: pl. 4, fig. 89), not figs 1a, b, 2 (*Lunatia*); Dall, 1892 in 1890–1903: 371 (as *Lunatia*); Cossmann, 1893: 26; Harris, 1895b: 33 = "var." of *N. eminula.*

Lunatia eminula (Conrad). Conrad, 1865a: 26; 1866a: 15.

Polynices (*Lunatia*) *parva* (I. Lea). Dall, 1892 in 1890–1903: 371.

Not *Natica eminula* Conrad [var.]. Harris, 1896: 119, pl. 12, fig. 20; not Brann & Kent, 1960: 581.

Natica (*Lunatia*) *parva* (I. Lea). Cossmann, 1925 in 1895–1925: 139.

Not *Polinices harrisi* Gardner, 1935: 307, pl. 26, fig. 15.

Polinices eminulus (Conard). Palmer, 1937: 121 (in part), pl. 12, figs 2, 4, 9, 13, pl. 80, fig 14 (holotype of *Natica parva* I. Lea); *cf.* Harris & Palmer, 1947 in 1946–1947: 248, 250, pl. 29, figs 12–15; Brann & Kent, 1960: 725–726.

Euspira marylandica (Conrad) var. Toulmin, 1977: 212, pl. 25, fig. 18.

Polinices eminulus (Conrad). Toulmin, 1977: 294, pl. 49, fig. 4.

Description.—Shell elongate-oval; spire outline straight, without shoulder; suture appressed; umbilicus and umbilical callus moderate in size; callus thin, with sharp margin and rib of fold at posterior margin to aperture; umbilical rib or notch absesnt.

Remarks.—*Polinices eminulus*, first described by Conrad (1833a in 1832–1835) for a Gosport Sand naticid, was also recognized from the Matthews Landing marl by Harris (1896: 119). The species becomes much more elongate in form through time. Examination of specimens from Claiborne Bluff and Matthews Landing reveals very few differences between specimens of the same size; the Claiborne Bluff specimens have a slightly more prominent shoulder, slightly less callosity that sometimes shows a more or less prominent transverse callus depression, and the umbilicus is slightly smaller. Harris (1899) surmised that the differences in the prominence of the callus notch and the amount of callus are due to different environments. This supposition is supported by examination of contemporaneous specimens of *P. eminulus* from the Gosport Sand of Little Stave Creek where one finds that the specimens show no sign of the callus depression and smaller specimens have the same elongate outline as the larger specimens at Claiborne Bluff. A Jackson Group specimen from Techeva Creek, Mississippi, that could also be referred to *P. eminulus*, takes these characters further in being even more elongate, showing less callus, and a more prominent transverse callus depression. Yet if we accept that *P. eminulus* continued as a valid species from the Porters Creek Paleocene until the Jackson of Arkansas (cf. Harris, 1896) and Mississippi, then it is reasonable to accept that the species must also occur in the Sabine Stage beds. However Harris (1899a: 89) referred the Sabine *P. eminulus* to a distinct variety and Palmer & Brann (1966 in 1965–1966) reassigned it as *Polinices* sp. I have collected several specimens of *P. eminulus* from Bells Landing that agree well with the Gosport Sand form, so the species also existed in the Sabine beds. The only constant character that might separate the Upper Eocene specimens from the Lower Eocene and Paleocene ones is the fairly flat outline of the first few whorls, which then suddenly changes to the rounded whorl form; the Paleocene specimens have no initial flat phase. The Paleocene specimens might be accorded varietal rank, but I believe the difference is small enough to assign both groups to *P. eminulus*. The Seguin specimens are close to the Matthews Landing specimens, although very slightly shorter in form. Another species of Paleocene *Polinices* from Texas is *P.? julianna* Palmer & Brann, 1965 in 1965–1966 (= *P. harrisi* Gardner, 1935), which has a thicker shell, is more ovate in form, and has a larger, more open umbilicus.

Type Information.—Lectotype: ANSP 15172, from Claiborne Bluff, Alabama River, Clarke County, Alabama. Figured Seguin specimen: TMM NPL37816, from locality 11-T-13. Remaining Seguin hypotypes in CLG.

Material Examined.—77 specimens, the largest (CLG 4367) 14.0 mm in length.

Subgenus ***EUSPIRA*** Agassiz in Desor, 1837

Type Species.—*Natica glaucinoides* J. Sowerby, 1812, by subsequent designation (Bucquoy *et al.*, 1883 in 1882–1886: 143). Eocene, England.

Description.—Shell small to medium-sized, globose to globose-elongate, with open umbilicus (never closed); umbilical callus usually slender; parietal callus thin to moderate.

Remarks.—I follow Marincovich (1977) and Pitt & Pitt (1992) in treating *Euspira* as a subgenus of *Polinices*, emphasizing its relationship with that taxon, rather than with some other authors who treat the taxon as a full genus.

Polinices* (*Euspira*) *perspecta texana n. ssp.
Pl. 6, Figs 5–6

Description.—Shell oblique, medium-sized, smooth, quite solid; protoconch minute; whorls 5 or 6 in largest individuals; spire low to medium; suture impressed; umbilicus large; funicle indistinct to absent; umbilicus smooth or with faint axial lines spiraling into interior; anterior edge of umbilical area defined by one larger impressed line.

Remarks.—The impressed (rather than channeled) sutures and the impressed line defining the umbilical anterior edge will distinguish the Seguin subspecies from *Polinices* (*Euspira*) *perspecta* (Whitfield, 1865). Some individuals show a swollen area anterior to the impressed line.

Etymology.—The specific name *texana* refers to Texas, the state from which the species was found.

Type Material.—Holotype: TMM NPL37793. Paratype: TMM NPL37794, both from locality 165-T-200. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-200, Pond Creek, approximately 200 meters upstream from highway FM 2027, 31°01'19.84"N, 96°48'31.60"W, Milam County, Texas.

Material Examined.—6 specimens, the largest (CLG 11685) 14.1 mm in length.

Natica spp.

Remarks.—At least one other species of naticid exists in the Seguin deposits, but the specimens are so poorly preserved that a reliable determination cannot be made. One badly damaged specimen does appear to be a *Neverita* species allied to *N. limula*.

Informal Group **PTENOGLOSSA** Ponder & Lindberg, 1997
Superfamily **EPITONIOIDEA** Berry, 1910
Family **EPITONIIDAE** Berry, 1910

Genus ***RUGATISCALA*** Boury, 1913

Type Species.—*Scalaria levesquei* Boury, 1887: 49, by original designation. Eocene (Cuisian), Paris Basin, France.

Description.—Shell small, solid, not umbilicate; whorls inflated with deeply impressed sutures; ornament of bent axial ribs and nonpunctate, somewhat widely spaced spiral lines; basal disk concave, showing weak continuation of teleoconch axials, margined with noded cord; aperture oval; outer lip duplex; apertural varix present.

Remarks.—With this occurrence, the genus ranges from the Upper Paleocene to the Miocene. Two genera that might be confused with *Rugatiscala* in the Gulf Coastal Plain are: *Rudiscala* Boury, 1909, and *Opalia* H. & A. Adams, 1853. Wenz (1943 in 1938–1944: 792) placed the former in synonymy with *Turriscala* Boury, 1890, which can be distinguished by its channeled suture, crowded spiral lines, and a duplex line defining the basal disk. *Opalia* has tightly wound whorls, varix-like axials, and crowded punctate spiral lines.

Rugatiscala sp.
Pl. 6, Figs 12–13

Description.—Whorls at least 7, strongly inflated with flattened shoulder; ornament of *ca.* 18 curved axials on later whorls and numerous faint spiral lines in interspaces. Basal disk concave, margined with weakly noded spiral cord, showing continuation of the axials from last whorl. Apertural features obscured in all specimens.

Remarks.—Three partial specimens obtained; the two larger specimens are embedded in matrix, but enough characters were discernable for generic assignment. This species is distinguished from the two Reklaw *Rugatiscala* spp., *R. cooperi* Garvie, 1996, and *R.*? sp. (Garvie, 1996: 66, pl. 12, fig. 7) by the shouldered whorls, the more numerous axials, finer spiral lines, and the lack of spiral lines on the basal disk. MacNeil & Dockery (1984: 76, pl. 2, figs 8, 16–17) described and figured an Oligocene Red Bluff Formation species *Confusiscala* (*Funiscala*) *durhami* MacNeil, 1984, which appears to belong to the same group as the three above-mentioned *Rugatiscala* spp. The assignment to *Funiscala* appears incorrect, given that that taxon is umbilicate, has a bifid character of the rib crests, and a duplex outer lip; *C.* (*F.*) *durhami* shows none of those features. *Funiscala* Boury, 1890, belongs more naturally to the *Rudiscala-Rugatiscala-Opalia* group, rather than with *Confusiscala* Boury, 1909, which is primarily a Cretaceous genus displaying a lamellose character on the crest of the axials, is not umbilicate, and has a simple outer lip which is often weakly reflected. *Confusiscala* (*F.*) *durhami* is readily distinguished from the three *Rugatiscala* spp. by the more evenly rounded whorls, the strong axials on the basal disk, and the straight (rather than curved) axials on the spire. Except for the simple outer lip, *C.* (*F.*) *durhami* could also be placed in *Rugatiscala*; perhaps the animal died before terminal varix ever formed. So far, *C.* (*F.*) *durhami* is the youngest species known from the Gulf Coastal Plain, however on the western coast of the U. S., *Rugatiscala* is known from the Miocene (Anderson & Martin, 1914: 56; Durham, 1937: 505–506) in which *R. cowlitzensis* Durham, 1937, is not too dissimilar to *C.* (*F.*) *durhami*.

Type Information.—Figured specimens: TMM NPL37789–NPL37790, from locality 11-T-13. Remaining hypotypes in CLG.

Material Examined.—8 specimens, the largest (figured specimen, TMM NPL37789) 13.7 mm in length.

Clade **NEOGASTROPODA** Cox, 1960a
Superfamily **PSEUDOLIVOIDEA** Bouchet in Bouchet & Rocroi, 2005
Family **PSEUDOLIVIDAE** Depley, 1941
Subfamily **PSEUDOLIVINAE** Gregorio, 1880

Genus ***PSEUDOLIVA*** Swainson, 1840

Type Species.—*Buccinum plumbeum* Dillwyn, 1817, by original designation. Recent, off of the coast of West Africa.

Description.—Shell thick, oval, oliviform, ventricose, with prominent periostracum when alive. Spire pointed; protoconch smooth, inflated. Surface smooth or with fine axial or longitudinal sculpture; suture impressed. Lower part of body whorl with impressed furrow or band ending in denticle or small spine at outer lip. Aperture elongate oval; columella concave, twisted clockwise, thickened with callus, furrowed anteriorly, posteriorly notched.

Pseudoliva ostrarupis Harris, 1895a
Pl. 7, Figs 8–10

Pseudoliva ostrarupis Harris, 1895a: 75, pl. 8, figs 3, 3a; 1896: 99, pl. 9, figs 18–19; Cossmann, 1901 in 1895–1925: 192; Gardner, 1935: 316–317; 1945: 195.

Description.—Protoconch of 3 smooth whorls; tip scarcely inflated, followed by 2 whorls of axial riblets, finally fine longitudinal spiral lines; riblets swinging sharply forward by sixth whorl just below suture, gradually developing into prominent foliations seen on adult; adult shell quite strongly shouldered, with surface usually smooth, sometimes showing longitudinal and axial lines, longitudinal ones stronger on and just below shoulder. Aperture elongate ovate; columella strongly concave below, straighter above, with thick deposit of callus, notched below. Body whorl with prominent "*Pseudoliva*-groove," strongly lirate below.

Remarks.—The prominent foliations, shouldered outline, and heavy shell distinguishes this species easily from all other species of *Pseudoliva*. The only other Texas species of *Pseudoliva* showing any foliations is *P. santander* Gardner, 1945, from the Reklaw Formation, but there this feature appears as the leading edge of the callus deposit prior to enveloping the spire. *Pseudoliva santander* also shows the early whorl lineation and ribbing seen in *P. ostrarupis* and could well be the descendant of that species.The holotype was reported missing (Palmer & Brann, 1966 in 1965–1966: 854), and further search by the author at the TNSC has not located the specimen. A neotype is therefore selected.

Type Information.—Neotype: TMM NPL37821. Figured juvenile Seguin specimen: TMM NPL37822, both from locality 11-T-13. Remaining Seguin hypotypes in CLG.

Material Examined.—45 specimens, the largest (CLG 4355) 40.1 mm in length.

Pseudoliva globosa n. sp.
Pl. 7, Figs 11–13

Description.—Whorls at least 4(?) in larger specimens. Globose outline in adult; spire low, no shoulder. Protoconch eroded in all examples; early whorls with rounded, widely spaced ribbing; later whorls with fine, widely spaced axial lines defining growth resting stages, and fine even spiral lines. "*Pseudoliva*-groove" represented by flat band where growth lines swing sharply forward forming narrow adapertural U; longitudinal lines stronger and more widely spaced below band. Aperture lozenge-shaped; no umbilicus; columella excavated; siphonal fasciole narrow.

Remarks.—The available large specimens are all worn and so it cannot be ascertained whether the axial and spiral sculpture of the juvenile is continued in the adult stage. One medium-sized specimen does show some remnants of the lineation on the body whorl. The shape is similar to smaller specimens of *Pseudoliva santander* prior to the deposition of the callus that covers much of the later whorls of that species. Young specimens of *P. globosa* n. sp. can be distinguished from *P. santander* by the lack of any umbilical depression and the lack of the "*Pseudoliva*-groove." Adult specimens of *P. santander* all have heavy callus deposition over the spire and the upper part of the body whorl. This species has some affinities to *Lisbonia* Palmer, 1937, in possessing the ribbing on the early whorls and the weak development of the groove but is decidedly nearer to *Pseudoliva*. The same type of "*Pseudoliva*" band seen in this species is also seen in the Recent *P. plumbeum* (Dillwyn, 1817) in which a similar band ends in a small pointed spine on the outer lip. *Pseudoliva vetusta* (Conrad, 1833c) and other species with a groove do not have that feature, but the convex end of the U points toward the interior of the shell and the outer lip at that point ends in a thickened denticle or deposit of callus on the inside edge of the outer lip.

Etymology.—The specific name *globosa* (Latin, spherical) refers to the shape of the body whorl.

Type Material.—Holotype: TMM NPL37823. Paratype: TMM NPL37824, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—8 specimens, the largest (CLG 4369) 35.7 mm in length.

Pseudoliva sp.
Pl. 7, Figs 16–17

Description.—Shell short; spire erect; early whorls with longitudinal ribbing on spire; ribbing becoming stronger and tubercular on carina. Body whorl smooth, slightly swollen under suture, followed by weakly concave shoulder terminating in relatively sharp carina. "*Pseudoliva*-groove" deep, prominent.

Remarks.—Two specimens of this unnamed *Pseudoliva* species were collected—a larger individual with a basally damaged body whorl and only *ca.* ¼ of the previous whorl remaining, and one juvenile individual. The juvenile shows the longitudinal ribbing on the spire, and compressed tubercles most prominent at the carina, whereas the larger specimen, although missing the spire, shows the penultimate whorl with similar but more subdued ribbing, most prominent at the previous carina. Nothing appears very close to this species; distantly related is *P. bocaserpentis* Maury, 1912, from the Midway, Soldado Rock Formation, Trinidad, which has a similar but more carinated whorl outline, but also has short plications, which as Maury noted places that species somewhere between *P. scalina* Heilprin, 1881, and *P. ostrarupis*. Two other tubercular species are the Lower Eocene *P. tuberculifera* Conrad, 1860, which has a more rounded whorl profile and axial ribbing not tending to be tubercular, and the Paleocene *P. unicarinata* Aldrich in Smith, 1886, which has a more depressed spire, is broader in outline, and has subsutural deep pits adjacent to the axial ribs. The early whorls of this species are reminiscent of those of an effaced *P. vetusta linosa* Conrad in Gabb, 1860, and that feature together with the smooth body whorl probably places the species near *P. vetusta*.

Type Information.—Figured specimens: TMM NPL37827 and NPL36145, from locality 11-T-13.

Material Examined.—2 specimens, the largest (figured specimen, TMM NPL37827) 17.8 mm in length.

Genus ***LISBONIA*** Palmer, 1937

Type Species.—*Ancillaria expansa* Aldrich in Smith, 1886, by original designation. Claibornian Eocene, Alabama.

*Descript*ion.—Spire elevated in young, with longitudinal folds on apical whorls decreasing rapidly in strength on succeeding whorls; indented area below suture with retral growth lines. Adult whorl large, globose; columella smooth with posterior callus deposit (after Palmer, 1937: 294–295).

Remarks.—Palmer (1937), Palmer & Brann (1966 in 1965–1966), and Wenz (1943 in 1938–1944) all placed *Lisbonia* in the Nassariidae. Allmon (1990) believed that it is not reasonable to include the genus in the *Bullia* Gray in Griffith & Pidgeon, 1834, group (Nassariinae) and also noted that *Pseudoliva* Swainson, 1840, resembles both *Lisbonia* and the "*Bullia altilis*" (Conrad, 1832) complex, and that some authors, including Gardner (1945: 199) suggested that the two are closely related. However, Allmon (1990) did not observe the "*Pseudoliva*-groove" (spiral groove encircling the lower half of the body whorl) in any species of *Lisbonia* available to him and doubted a relationship between the two. The author however has collected two juvenile specimens of *Lisbonia* from the Gosport Sand of Little Stave Creek in Alabama, plus an undescribed species of *Lisbonia* from the Weches Formation of Texas, and the Seguin species; all display a groove, change in color, or growth-lines cusp corresponding to the "*Pseudoliva*-groove" position. Wenz (1943 in 1938–1944) and Davies (1971) separated the Pseudoliviinae with their oval, rounded-pyriform shape, spiral furrow or demarcation forming a callus deposit where it meets the labrum, and concave columella, from the Nassariinae with their buccinifom to turreted shape, short, bent canal, deep oblique notch, and columella margined by an obliquely twisted fold. *Lisbonia* with the groove or demarcation, posterior apertural callus deposit, and retral growth lines appears to form a natural grouping with *Pseudoliva* so it is placed here within the subfamily Pseudolivinae.

Lisbonia pauper (Harris, 1895)
Pl. 7, Figs 14–15

Pseudoliva ostrarupis pauper Harris, 1895a: 76, pl. 8, fig. 4; 1896: 99, pl. 9, fig. 20; Trowbridge, 1923: 96; Gardner, 1935: 317; 1945: 195; F. B. Plummer in Sellards *et al.*, 1933: 581.

Description.—Tip bulbous, minute; remainder of protoconch of 2–2½ smooth whorls; basally weakly carinate, merging gradually into early adult sculpture of longitudinal ribs; fine spiral lines visible covering entire whorls by third adult whorl. Axial and longitudinal sculpture covering entire surface of teleoconch spire on small specimens, continuing to "*Pseudoliva*" demarcation band on body whorl. Band usually fairly indistinct, defined by growth lines making shallow U within band, or sometimes by change in surface texture or color. Below band longitudinal lines absent and spiral lines stronger, more widely spaced. Suture with callus deposit and retral growth lines. Aperture elongate-ovate; columella concave with weak posterior callus deposit; no columellar fold although slight swelling discernable in some specimens. Older specimens often showing considerable callus deposits over later whorls.

Remarks.—Because the species was originally only defined by a figure, a description is provided here.

Gardner (1945: 195) remarked "*P. ostrarupis pauper* could scarcely be included under the limits of species *ostrarupis*," and close examination of over 80 specimens shows that it should not even be included in the genus *Pseudoliva*. Lacking is the "*Pseudoliva*-groove," the protoconch is different from typical *Pseudoliva* in which the apex of the protoconch is bulbous and the tip fairly flat, and the shape is more elongate than in any other known species. There are several Buccinidae genera that might be considered: *Buccinanops* Orbigny, 1841 in 1835–1847, *Monoptygma* I. Lea, 1833, and *Lisbonia* Palmer, 1937; all have a similar elongate outline, particularly in the young, and all show longitudinal ribs on the early whorls, and a "*Pseudoliva*"-like band in which the growth lines change direction. On close inspection, it is observed that in Eocene species of *Monoptygma* and *Buccinanops*, both the ribs and the growth lines just below the suture become prosocyrt in character and swing sharply back; in *B. cochlidium* (Dillwyn, 1817), the type of *Buccinanops*, the same character is observed on the early whorls. In *L. pauper* and other species of *Lisbonia*, the growth lines are opisthocyrt and swing forward. All three genera are doubtless closely related; I have a specimen of *B. cochlidium* in which the "*Pseudoliva*" band is defined by a brownish-violet ribbon and one well-preserved specimen of *L. pauper* also shows a similarly colored band. Trowbridge (1923: 96) noted the occurrence of *L. pauper* (as *P. ostrarupis pauper*) in the middle Claibornian of the Rio Grande region of Texas; it remains unverified, and no other occurrences have been reported from the Middle Eocene. There is some observed variation in the shape of specimens of *L. pauper*; a few are quite stout, and one is a much more slender individual; most specimens have had considerable wear so it is difficult to say whether this is a species that has continuous variation in body shape or that more than one subspecies is here grouped together.

Type Information.—Holotype: TMM BEG35590, from locality 165-T-2. Figured specimens: TMM NPL37825–NPL37826, from locality 11-T-13. Remaining hypotypes in CLG.

Material Examined.—84 specimens, the largest (CLG 4363) 23 mm in length.

Superfamily **BUCCINOIDEA** Cossmann, 1906
Family **BUCCINIDAE** Fleming, 1822
Subfamily **BUCCININAE** Bouchet in Bouchet & Rocroi, 2005

Genus ***TEREBRIFUSUS*** Conrad, 1865a

Type Species.—*Buccinum amoenum* Conrad, 1833b, by monotypy. Claibornian Eocene, U. S.

Description.—Shell small, narrow; protoconch conical with *ca.* 3 smooth whorls. Suture impressed; sculpture of axial ribs crossed by spiral lines. Body whorl and aperture large, with short neck, prominent siphonal fasciole, and notch. Columella straight with numerous folds.

Remarks.—Based on available data, the genus is restricted to the Gulf Coast Eocene (and now Paleocene) represented by two species, *Terebrifusus amoenus* and *T. multiplicatus*, and to the Bartonian Talara Formation of Peru where at least one and possibly two species are known, *T. placidus* (Olsson, 1930), and doubtfully *T.*? *lepus* (Olsson, 1930).

Terebrifusus aff. ***amoenus*** (Conrad, 1833b)
Pl. 8, Fig. 1

Buccinum amoenum Conrad, 1833b in 1832–1835: 45 (reprint by Harris, 1893: 71); Conrad in Morton, 1834: 5; H. C. Lea, 1849: 96; Harris 1895b: 5; Pace, 1902: 52.

Terebra gracilis I. Lea, 1833: 166, pl. 5, fig. 171; H. C. Lea, 1849: 106; Harris, 1895b: 21 = *Buccinum amoenum* Conrad.

Mitra elegans H. C. Lea, 1841: 102, pl. 1, fig. 22; 1849: 101; de Gregorio, 1890: 77, pl. 5, fig. 62 *Terebrifusus*; Harris, 1895b: 17 = *Buccinum amoenum* Conrad; Pace, 1902: 79.

Buccinanops amoenum (Conrad). Orbigny, 1850: 369.

Terebrifusus amoena (Conrad). Conrad, 1865a: 28; 1866a: 14 *amoenus*.

Mitra (*Terebrifus* [*sic*]) *amoena* (Conrad). de Gregorio, 1890: 76, pl. 5, fig. 61 (copying I. Lea, 1833: 166, pl. 5, fig. 171).

Mitra (*Terebrifusus*) *elegans* H. C. Lea. de Gregorio, 1890: 77, pl. 5, fig. 62 (copying H. C. Lea, 1841: 102, pl. 1, fig. 22).

Buccimitra amoena (Conrad). Harris, 1895b: 5 (no reference, probably found as museum label).

Terebrifusus amoenus (Conrad). Cossmann, 1893: 37, pl. 2, fig. 14; not Aldrich, 1895b:10, pl. 1, fig. 15 = *Terebrifusus* sp.; not Harris, 1899a: 59, pl. 7, fig. 13 = *Terebrifusus* sp.; Cossmann, 1901 in 1895–1925: 161, pl. 6, fig. 12; Palmer, 1937: 307, pl. 53, figs 6–7, 9–10, 13, 15–16, pl. 88, fig. 10 (type of *Mitra elegans* H. C. Lea), 13 [type of *Terebrifusus amoenus* (Conrad)], 14 (type of *Terebra gracilis* I. Lea); Wenz, 1941 in 1938–1944: 1178, figs 3349 (copying Cossmann, 1901: pl. 6, fig. 12), 3350 (copying Palmer, 1937: pl. 53, fig. 6); Harris & Palmer, 1947 in 1946–1947: 354, pl. 45, figs 1–2; Brann & Kent, 1960: 853–854; Glibert, 1963: 65; Dockery, 1980: 104, pl. 18, fig. 7; Garvie, 1996: 73.

Description.—Whorls 7; protoconch of 3 whorls, with first two smooth, third with finer riblets. Suture impressed; sculp-

ture of 7–8 elongated ribs and fine spiral lines, interspaces between lines with fine thread. Columella weakly curved into neck, with 3 columellar folds, anterior two closer together than third; anterior notch prominent.

Remarks.—All specimens appear to be juveniles, so if adults were discovered, there would be more than 7 whorls. Were it not for the lesser number of columellar folds, this species could be placed confidently under typical *Terebrifusus amoenus*. As Palmer (1937) noted, adult *T. amoenus* has 8 or more fine plications on the columella, fewer in young specimens. In the author's collections (CLG), it is seen that the middle Claibornian specimens have numerous fine plications whereas ancestors in the Weches and even more particularly in the Cane River Formations usually show 4 prominent folds, so there appears to be a general increase in columellar folds through time.

Type Information.—Holotype: ANSP 5847, from the Gosport Sand, Claiborne Bluff, Alabama River, Clarke County, Alabama. Figured Seguin specimen: TMM NPL37828, from locality 11-T-101. Remaining Seguin hypotypes in CLG.

Material Examined.—6 specimens, the largest (figured specimen, TMM NPL37828) 5.6 mm in length.

Subfamily **PISANIINAE** Gray, 1857

Genus ***CANTHARUS*** Röding, 1798

Type Species.—*Buccinum tranquebaricum* Gmelin, 1790 in 1788–1793, by subsequent designation (Cossmann, 1889: 509). Recent, Tranquebar, eastern coast of India.

Description.—Shell broadly biconical; whorls moderately to strongly inflated, sculptured with axial ribs and finer spiral ornament. Body whorl inflated, constricted, merging into short canal. Aperture ovate to elongate, posteriorly channeled; siphonal fasciole present. Outer lip usually with terminal varix, inside with lirae or crenules.

Remarks.—Vermeij (2001) reviewed the pre-Oligocene members of the Pisaniinae and grouped the members into three morphological groups, of which the *Cantharus* group is the oldest, dating back to the Albian (late Lower Cretaceous).

Cantharus seguinensis n. sp.
Pl. 8, Fig. 2

Description.—Shell small to medium-sized, biconic in outline, with somewhat cyrtoconoid spire; whorls *ca.* 7 (protoconch missing in available material). Sculpture of *ca.* 10 narrow rounded ribs, strongest medially, diminishing in strength on shoulder; collar and posterior suture rendered wavy by folds; entire surface covered with subequal spiral lines, stronger near peripheral carina, weakening toward end of canal. Aperture elongate-oval, with narrow posterior gutter; outer lip thickened behind edge, with 13–14 denticles, medially straight, posteriorly angulated adaxially toward gutter, anteriorly constricted toward short anterior canal. Columella concave with few flattened denticles primarily posteriorly; weak siphonal fasciole; shallow anterior notch.

Remarks.—Four specimens were obtained, the two smaller ones juvenile and approximately half the size of the larger ones. The smaller specimens are relatively unworn (although all have lost the protoconch) and the outline is a little more angular than the larger specimens, which have had more surface wear; the aperture is also more angular in the holotype than in the other small individual in which the aperture was excavated to examined the interior features; the preserved shell, however, was so soft that some unavoidable damage did occur, making the outer lip appear more evenly rounded that it was originally. None of the four other Paleogene Gulf coast species are particularly close to *Cantharus seguinensis* n. sp. More closely related species are *C.* (*Eocantharus*) *columbiana* Clark & Durham, 1946, a species from the Eocene of Columbia, with 7 heavy longitudinal ribs, and primary spiral lines with secondary smaller lines in the interspaces, and *C.* (*E.*) *cowliztensis* B. L. Clark, 1938, from the Upper Eocene of California, a species with 9 ribs on the spire whorls but up to 19 on the body whorl, and a smooth inner lip. The two small specimens (9 mm in length) show considerable similarity to *Editharus polygonus* (Lamarck, 1803 in 1802–1806), a species from the Lutetian of the Paris Basin (Vermeij, 2001: 300, figs 3–6), but the specimens of *E. polygonus* figured are almost three times the size of the Seguin specimens; in addition, *Editharus* is defined with appressed, indistinct sutures, spiral cords strongest on the upper portion of the whorls, and a high rounded siphonal fasciole. The adult *C. seguinensis* n. sp. is a much more elongate species.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37829. Paratype: TMM NPL37830, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—6 specimens, the largest (CLG 16541) 19.2 mm in length.

Family **NASSARIIDAE** Iredale, 1916

Genus ***COLWELLIA*** Nuttall & Cooper, 1973

Type Species.—*Colwellia flexuosa* F. E. Edwards in Lowry *et al.*, 1886, by original designation. Upper Eocene, middle Headon beds, Isle of Wight, England.

Description.—Protoconch of *ca.* 2½ smooth whorls; first protoconch whorl small, initially flattened. Teleoconch seldom exceeding 20 mm in size; whorls 6, bucciniform; platform poorly developed or absent; both spiral and collabral sculpture present, with developing first. Aperture broad, slightly constricted anteriorly; columella bent to left with adapical plait. Siphonal fasciole narrow, weakly rugose, with strong adapical fold and adapical ridge. Outer lip often denticulate within.

Remarks.—Previously the genus was restricted to the Middle to Upper Eocene of North America; here the range is extended to the Paleocene. The genus, or a closely related form, might in fact also exist in the Upper Cretaceous as *Nassa vylapaudensis* Stoliczka (1867 in 1867–1871: pl. 12, fig. 4), which displays some similarity to *Colwellia nodulina meta* n. ssp. (see below) with its similar shape, collabral lines on the spire, and fine spiral lines below the suture and on the base.

Colwellia humerosa n. sp.
Pl. 8, Figs 3–4

Description.—Protoconch of 2½ smooth whorls; tip slightly immersed. Teleoconch whorls to 5; first whorl with sharp collabral riblets; axial sculpture developing gradually. Collabral lines initially prominent, sharp, swinging sharply forward (orthocline) just below collar; strong nodes forming where lines cross collar. Concave ramp below collar with very fine spiral lines; anterior margin defined by stronger line. Collar spliting into 2 lines with increasing age; upper one smooth; lower one tending to remain nodular; collabral lines becomeing low folds, dying out just below midsection of body whorl. Aperture broad, moderately constricted anteriorly; outer lip thickened in older individuals, with 4 denticles on interior. Columella concave, with one elongate denticle interiorly, posteriorly with raised callus pad sometimes forming strong denticulations. Siphonal fasciole bounded by strong ridge and moderate adapical fold.

Remarks.—Nuttall & Cooper (1973) assigned three California Eocene species to *Colwellia*: *C. cretacea* (Gabb, 1864), *C. tejonensis* (Dickerson, 1915), and *C. bretzi* (Weaver, 1912); all of these species have straight-sided whorls and fairly strong collabral sculpture continuing past the middle of the body whorl. *Colwellia bilineata* Garvie, 1996, was described from the Middle Eocene of Texas, but that species is less than half the size, much smoother, and lacks the concave ramp of *C. humerosa* n. sp. There is also some similarity to the only species of *Nassarius* known from the Paleocene-Eocene of the Gulf and Atlantic Coastal Plain, *N. exilis* (Conrad, 1860), but the latter species is much larger, more elongate, and has coarser ribbing.

Etymology.—The specific name *humerosa* refers to the strong humeral angle of the shoulder.

Type Material.—Holotype: TMM NPL37831. Paratype: TMM NPL37832, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—19 specimens, the largest (CLG 4376) 19.6 mm in length.

Colwellia nodulina n. sp.
Pl. 8, Figs 5–6

Description.—Shell small, elongate, rounded; protoconch of 3½–3¾ whorls followed by ¼ whorl of fine collabral lines, then developing spiral lines of gradually increasing strength; adult sculpture of sinuous collabral ribs overridden by 3 subsutural lines, with weakest forming small collar; 2 larger lines forming prominent nodes where intersecting with ribs. Body whorl with central area lacking spiral sculpture; base with fine raised spiral lines. Aperture elongate ovate; columella excavated; siphonal fasciole as in generic description.

Remarks.—This common species shows such a wide variation in the strength of the spiral lines, and the strength and number of ribs, that it seemed advisable to split it into two related groups. The present group of *Colwellia nodulina* n. sp., tends to have a more elongate shape, rounded whorls, and a medial area on the body whorl lacking spiral sculpture; a second group, described below as *C. n. meta* n. ssp., has flatter-sided whorls with a more angular base, and collabral and spiral sculpture more equal in strength. The second group is described as a subspecies, emphasizing the close relationship

between both. The two groups do approach each other closely, but in the available material, there is no overlap, in particular there is no continuous variation from the medially smooth body whorl of *C. nodulina* n. sp. to the spiral ornament of *C. n. meta* n. ssp. It appears likely that *C. nodulina* n. sp. is the ancestor of the Reklaw species *C. bilineata* Garvie, 1996, and differs primarily in its more elongate form, less inflated whorls, and somewhat stronger collabral ribbing. Due to the preservation in indurated rock, it cannot be ascertained if the outer lip is thickened internally or beaded. Juvenile specimens of this species show some similarity to juvenile *Buccitriton texanum* (Gabb, 1860), but can be easily separated by the lack of the strong ridge that defines that species' junction between the siphonal fasciole and the base of the body whorl.

Etymology.—The specific name *nodulina* refers to the nodular collar of the species.

Type Material.—Holotype: TMM NPL37833. Paratypes: TMM NPL37834 and NPL37857, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—More than 100 specimens, the largest (CLG 7817) 9 mm in length.

Colwellia nodulina meta n. ssp.
Pl. 8, Fig. 7

Description.—Differing from the preceding species by the following: Protoconch to 4½ smooth whorls. Teleoconch with flat or weakly inflated whorls; spiral and collabral lines usually similar in strength and often covering entire surface; medially smooth or cancellate, with intersections sometimes weakly beaded.

Remarks.—The flat-sided whorls and more sharply rounded base of the body whorl shows much more similarity to the three Californian *Colwellia* spp. discussed under *C. humerosa* n. sp., than does *C. nodulina meta* n. ssp. In all of these related species, the collabral sculpture is stronger, the aperture is narrower, and the adapical ridge of the siphonal fasciole more prominent.

Etymology.—The subspecific name *meta* (Latin, mark) refers to the lines marking the whole surface of the shell.

Type Material.—Holotype: TMM NPL37858. Paratypes: TMM NPL37859–NPL37860, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—29 specimens, the largest (CLG 16665) 10 mm in length.

Genus ***TRITIARIA*** Conrad, 1865a

Type Species.—*Buccinum mississippiensis* Conrad, 1848, by monotypy. Oligocene, Mississippi.

Description.—Shell small, elongate, with short neck. Protoconch of 2–3 rounded smooth whorls and final whorl with fine opisthocline riblets. Sculpture of axial ribs and spiral lines; aperture oval; columella with parietal fold; siphonal fasciole low.

Remarks.—*Tritiaria* is known from the Eocene and Oligocene of North and South America; this record extends the age to the Paleocene. As Haasl (2000) noted, the *Tritiaria* group, which also includes *Buccitriton* Conrad, 1865a, comprises species that resemble both the photines and nassarines in possessing an abbreviated siphonal canal and terminal columellar fold, and could be ancestral to both.

Tritiaria*? *seguinensis n. sp.
Pl. 8, Figs 8–9

Description.—Shell small, with whorls to *ca.* 5, moderately inflated, with shoulder, weakly carinated, bucciniform to fusiform; protoconch large, conical, of 3 whorls; first two whorls smooth, last with fine opisthocline riblets. Sculpture of line axial ribs and spiral lines, one defining carina and two below; shoulder area with 4 spiral threads. Neck short; columella smooth with terminal columellar swelling; siphonal fasciole and notch weak; outer lip internally lirate with 6–7 strong lirae.

Remarks.—This species exhibits the characters that one would expect in an ancestral *Tritiaria* with most of the definitive characters present but in reduced form: a terminal columellar swelling rather than a fold, and a weakly defined siphonal notch and fasciole. The protoconch is characteristic of the group. It is not known if these specimens are juveniles but because many came from different levels in the outcrop, current size-sorting is unlikely.

Etymology.—The specific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL46599. Paratype: TMM NPL46600, both from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—21 specimens, the largest (CLG 14914) 5 mm in length.

Family **COLUMBELLIDAE** Swainson, 1840

Genus ***METULA*** H. & A. Adams, 1853

Type Species.—*Buccinum metula* Hinds, 1845 (cited by H. & A. Adams, 1853, as *Metula hindsii*) by tautonomy. Recent, Pacific coast of Panama.

Description.—Shell medium-sized, moderately to very slender; whorls with no or only slight sutural constriction; body whorl very long. Nucleus stout, consisting of almost 2 smooth whorls. Aperture very long, narrow, elliptical, tapering to acute angle at posterior end to form short, wide, slightly recurved, moderately emarginated canal. Siphonal fasciole low. Edge of inner lip forming definite edge along pillar and parietal wall. Outer lip varicose; inner edge bearing broad denticles that can be expanded into short lirations (after Woodring, 1928: 285).

Metula reticulata n. sp.
Pl. 8, Figs 10–11

Description.—Shell small, high; whorls at least 7, moderately inflated; protoconch of at least 2 whorls, first one (two?) smooth, final with arcuate riblets; whorl sculpture of 6 strong spiral lines and axial ribs, with intersections nodular or prickly; occasional varices of *ca.* 1 per whorl, swinging forward as they approach suture; suture impressed; body whorl with *ca.* 18 spiral lines and numerous axial ribs; ribs dying out soon after maximum whorl diameter; occasional interstitial lines on larger spire whorls, always on body whorl; aperture elongate; columella with 2 folds; outer lip thickened, with interior terminal lirae.

Remarks.—This is a unique taxon, easily distinguishable from other Gulf Coast Tertiary species by the strong cancellate sculpture of axial and spiral ribs. This extends the range of the genus from the Lower Eocene where it is represented by *Metula sylvaerupis* Harris, 1899. *Metula harrisi* Dickerson, 1916, from the Eocene Tejon Formation of California, which the author compared favorably with *M. sylvaerupis* Harris, 1899a, has rounded varices, more subdued axial ribs, and spiral lines of equal strength, giving the whorls a reticulated appearance, but lacks the spirals over the humeral slope. It is also a more elongated shell.

Etymology.—The specific name *reticulata* (Latin, net-like) refers to the cancellate sculpture.

Type Material.—Holotype: TMM NPL37862. Paratype: TMM NPL37863, both from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—4 specimens, the largest (CLG 15376) 16.0 mm in length.

Metula? sp.
Pl. 8, Fig. 12

Description.—Shell elongate, robust; ramp with 3 strong subsutural spiral lines, one nearest suture becoming bifid with increasing age; deep spiral grooves below that. Columella almost straight; no columellar folds; outer lip apparently smooth within.

Remarks.—One incomplete specimen was obtained that is assigned to *Metula s.l.* This species is quite different from the closely similar group, *M. sylvaerupis* Harris, 1899, from the Sabine Stage, and *M. gracilis* Johnson, 1899, and *M. brazosensis* Johnson, 1899, from the Claibornian; all of these have evenly rounded cancellate whorls with occasional varices, are fairly thin-shelled, and possess a varicose outer lip. Subsutural spiral lines also occur on the Reklaw species *M. elongatoides* Garvie, 1996, and the type species *M. metula*, which is found in shallow waters off of Panama. The shell is thick in the present species; it is not known whether that is a diagnostic feature of the species or is a result of the inferred nearshore high-energy environment in which it was transported. Given that both the apex and end of the canal are missing, the assignment is somewhat questionable and so no specific name is given.

Type Information.—Figured specimen: TMM NPL37864, from locality 11-T-13.

Material Examined.—1 specimen (TMM NPL37864), 15.0 mm in length.

Family **FASCIOLARIIDAE** Gray, 1853
Subfamily **FASCIOLARIINAE** Gray, 1853

Genus ***PLEUROPLOCA*** Fisher, 1884

Type Species.—*Murex trapezium* Linnaeus, 1758, by monotypy. Recent, Indo-Pacific.

Description.—Shell often large, fusiform; spire elevated; teleoconch whorls stepped; sculpture of spiral lines, periphery often coronated or nodular; aperture elongate with posterior notch; columella concave, with one or more folds at beginning of canal; canal long, often twisted, with acutely angled siphonal fasciole.

Remarks.—Gardner (1935: 246–247) assigned two species from the Midway of Texas to *Fasciolaria* Lamarck, 1799, a genus with smooth sculpture, and a long, bent canal with one strong columellar fold and two weaker ones. In neither of Gardner's two species are columellar folds visible because matrix fills the apertures. The strong coronated or nodose shoulder, relatively shorter canal, and apertural shape make the assignment to *Pleuroploca* more reasonable. According to Snyder (2003), the genus is known from the Cretaceous in Europe, the Eocene of Australia, and Oligocene of Florida. I follow Harasewych in Beesley *et al.* (1998) in definition and assignment within the family. The family Melongenidae, which includes species with peripheral coronation and might be confused with some Fasciolariidae species, is distinguished by species with a smooth, weakly bent columella.

Pleuroploca aff. ***plummeri*** (Gardner, 1935)
Pl. 8, Figs 13–14

Fasciolaria? *plummeri* Gardner, 1935: 246, pl. 22, figs 1–3; Snyder, 2003: 233; Squires & Saul, 2006: 67.
"*Fasciolaria*?" *plummeri* Gardner, 1935. Palmer & Brann, 1966 in 1965–1966: 678.

Description.—Shell heavy, fusoid; maximum diameter at median point; axials rounded, 10–12, ending as coronated nodes; shoulder concave, smooth; 4 axials on body whorl, 5 or 6 on base; aperture obliquely ovate.

Remarks.—Gardner's (1935) description was based on two specimens, each missing the apex, missing the end of the canal, and with apertural characters obscured due to matrix. The Seguin specimen, which is from the Caldwell Knob *Ostrea duvali* zone, is crushed both laterally and longitudinally, but shows the apertural and sculptural characters well; it has 13 axials and more prominent spiral sculpture than *Pleuroploca plummeri*, shows two columellar swellings well within the aperture, and a strong oblique siphonal fasciole. Squires & Saul (2006: 67, 74, figs 16–19), stated that their new species, *Perrilliata califia*, is most similar to *P. plummeri* but the growth lines of that species are prosocyrt on the medial part of the last whorl, whereas *P. plummeri* has orthocline growth lines rendering a close assignment unlikely. A second small specimen was obtained of a fasciolarid with two(?) protoconch whorls, one rounded whorl with both spiral and axial lines and a final whorl with a smooth concave shoulder and what could be the start of coronated nodes; if not the young of this species, is it close.

Type Information.—Figured specimen: TMM NPL9318, from locality 11-T-74.

Material Examined.—2 specimens, the larger (broken, TMM NPL9318) 28.5 mm in length; CLG 16648, a juvenile from locality 11-T-101.

Genus ***LIROFUSUS*** Conrad, 1865a

Type Species.—*Fusus thoracicus* Conrad, 1833a, by original designation. Claibornian Eocene, United States.

Description.—Fusiform, with prominent shoulder, strong revolving costae, longitudinal raised striae, channeled sutures, no columellar folds; neck small; aperture oval; canal slightly bent, twisted.

Remarks.—The genus includes four species, the type *Lirofusus thoracicus* from the middle Claibornian, *L. subtenuis* (Heilprin, 1881) from the Lower Eocene from Alabama, and two doubtfully assigned species: cf. *Lirofusus* sp. from the Paleocene Aquila Formation of Maryland, and *L. ashleyi* Arnold, 1908, from the San Lorenzo Oligocene of California. Wenz (1944 in 1938–1944: 1170) synonymized the genus with *Pseudoneptunea* Kobelt, 1882, a buccinid, but most workers, including Cossmann (1899 in 1895–1925), Palmer (1937), Palmer & Brann (1966 in 1965–1966), Davies (1971), and Snyder (2003), have recognized the genus as valid and in the Fusininae.

Lirofusus sp.
Pl. 9, Fig. 1

Description.—Shell fusiform; shoulder smooth; suture impressed, with 4 strong revolving cords, 3 just below peripheral

carina, one just above lower suture; *ca.* 14 low costae on final whorl of spire, weakly defined on shoulder, causing suture to be weakly wavy. Body whorl bicarinate, below lower carina to end of short canal with spiral lines tending to alternate in strength.

Remarks.—One specimen was obtained, still partially embedded in matrix. The distinguishing feature is the 4 spiral cords on the spire whorls and the fairly smooth shoulder area. *Lirofusus subtenuis* is perhaps the closest species, but that species has 3 cords below the periphery and a shoulder area strongly ridged by the collabral costae. With only one specimen and that partially decorticated, it is not deemed advisable to name it.

Type Information.—Figured specimen: TMM NPL37864, from locality 11-T-101.

Material Examined.—1 specimen (TMM NPL37864), 15.0 mm in length.

Genus ***PALAEORHAPHIS*** Stewart, 1927

Type Species.—*Fasciolaria pergracilis* Aldrich in Smith, 1886, by subsequent designation (Stewart, 1927: 419). Lower Eocene, Alabama.

Description.—Shell elongate-fusiform; protoconch of 3 smooth whorls; early teleoconch with vertical axial ribs and spiral lines, later whorls much smoother; 2 subsutural revolving grooves; 2 or 3 weak columellar plications far within aperture.

Remarks.—To date, this is a monotypic genus, known only from the Lower Eocene of Alabama. Harris (1899a) questionably placed it in *Mitra* Lamarck, 1798, in Bruguière *et al.*, 1791–1827, due to general ornamentation and shell structure, but noted the columellar characters are not typical of that genus. Stewart (1927), in his definition of the genus, although recognizing the similarity to both the Fasciolariidae and Mitridae, concurred with Harris (1899a) and tentatively kept it in the Mitridae. Both Powell (1966: 145) and Cernohorsky (1970: 65) stated erroneously that Stewart (1927) assigned the species to the Turridae. The discussion by Stewart (1927) is primarily concerned with the assignment of *Exilia* Conrad, 1860, and although he noted that *Palaeorhaphis* has been confused with *Exilia*, it is *Exilia* that he assigned to the Turridae. Wenz (1943 in 1938–1944: 1417) had placed the genus in the Turridae, but Cernohorsky (1970: 65) noted the similarity in morphology of *Palaeorhaphis* to the Cretaceous genus *Graphidula* Stephenson, 1941, and concluded by stating that a more appropriate place would be in the Fasciolariidae. I concur with this; see further discussion below.

Palaeorhaphis palaeocenica n. sp.
Pl. 10, Figs 9–10

Description.—Shell elongate-fusiform; protoconch of 1½ (2?, missing tip in available material) smooth, rounded whorls, followed by one whorl with arcuate axial riblets gradually merging into adult sculpture; teleoconch whorls with broad subsutural collar and slightly opisthocyrt axial cords; collar with subsutural line tending to become twinned on later whorls and another line defining lower margin of collar; widely spaced spiral lines overriding axial sculpture, weaker and more closely spaced on neck; columella with one very weak oblique fold.

Remarks.—The Seguin specimens are smaller than the Lower Eocene type species, and could be juveniles. The largest individual shows one low oblique swelling, the most well preserved specimen (a paratype) shows two low folds entering the aperture at a highly oblique angle. Neither the type species *Palaeohaphis pergracilis* or *P. palaeocenica* n. sp. possesses an anal sinus; there is a wide open U, but no adapertural extension at the apex. The protoconch resembles those of several Texas Eocene *Latirus* spp., particularly *L. moorei* (Gabb, 1860), and is not similar to those of the Mitridae and Volumitridae shown by Cernohorsky (1970: 25, 93, figs 157–179, 190–212) in which no figures replicate the arcuate character of the riblets in *P. palaeocenica* n. sp. It appears likely that *P. palaeocenica* n. sp. is the descendant of a *Graphidula* species; Stephenson (1941: 346–347, pl. 66, figs 13–14) discussed and figured a similar looking species: *G. terebriformis* Stephenson, 1941, from the Nacatoch Sand (Navarro Group) in Texas, which has similar axial and longitudinal early sculpture, becoming primarily axial on the larger whorls. No columellar folds are seen in undamaged specimens, but Stephenson (1941) noted a broken paratype showing two weak folds. The author has collected a *Graphidula* species from the later Owl Creek in Mississippi, coeval with the Kemp Clay in Texas, in which the axial sculpture on the larger whorls is even less prominent than *G. terebriformis*, and is similar to *P. palaeocenica* n. sp. This latter species is easily distinguished from *Graphidula* spp. by the more delicate shell, the smoother later whorls, and the much crisper ornamentation on the early whorls. From *P. pergracilis*, *P. palaeocenica* n. sp. is separated by its shorter aspect, the more gradual change from early to late ornamentation, and the less prominent columellar folds.

Etymology.—The specific name *palaeocenica* refers to the occurrence in the Paleocene.

Type Material.—Holotype: TMM NPL37706. Paratype: TMM NPL36233, both from locality 11-T-101. Remaining hypotype in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—3 specimens, the largest (paratype, TMM NPL36233) 17.1 mm in length.

Subfamily **PERISTERNIINAE** Tryon, 1881

Genus ***LATIRUS*** Montfort, 1810

Type Species.—*Latirus aurantiacus* Montfort, 1810 (= *Murex gibbulus* Gmelin, 1791 in 1788–1793), by monotypy. Recent, Australian waters.

Description.—Anterior canal more or less inflected; columella nearly always with folds; whorls shouldered, rounded carinated; collabral costae solid, blunt; labral profile straight, vertical; umbilicus or umbilical slit present; siphonal fasciole weak to strong; outer lip lirate within; protoconch smooth, conical, with depressed nucleus.

Subgenus ***LEVARLATIRUS*** n. sgen.

Type Species.—*Fusus ostraupis* Harris, 1895, here designated. Upper Paleocene, Texas.

Description.—*Latirus*-like, with very weak or no columellar plications; no umbilicus. Collabral costae strong on spire, weaker on body whorl. Labral profile weakly sinuous.

Remarks.—Members of the Fasciolariinae almost always bear columellar plications, so this subgenus is approaching some Fusinidae in characters, particularly *Streptochetus* Cossmann, 1889, a genus known from the Eocene to Pliocene, which is one of the few members of that subfamily with a weak columellar plication. However, *Steptochetus* has costae that form a twisted line up the spire, an umbilical slit, and internally a smooth labrum. Both *Levarlatirus* and *Streptochetus* can be regarded as connecting links between the Fasciolariinae and Fusininae. A taxon with similar characteristics is *Fusus roperi* Dall, 1898b, from the Pliocene to Recent California coast; Dall regarded it as a section of *Fusus*, whereas Wenz (1943 in 1938–1944: 1250, fig. 3564) questionably gave it generic rank, and Grant & Gale (1931: 643) believed it to be the juvenile form of *Kelletia* (*Kelletia*) *kelletti* (Forbes, 1850). This species has a similar shape and ornament to *Latirus* (*Levarlatirus*) *ostrarupis* (Harris, 1895), with no columellar folds, but a thin, nonlirate outer lip, and is evidently a later relation.

Etymology.—The name *Levare* (Latin, smooth) + *latirus* refers to the absent or weak columellar plications on a *Latirus*-like shell.

Latirus* (*Levarlatirus*) *ostrarupis (Harris, 1895)
Pl. 9, Figs 2–3

Fusus ostrarupis Harris, 1895a: 72, pl. 7, fig. 3; 1896: 88, pl. 8, fig. 13 (copying Harris, 1895a: pl. 7, fig. 3); Koenen, 1896: 166; Gardner, 1935: 54.

Latirus ostrarupis (Harris). Palmer & Brann, 1966 in 1965–1966: 725; Snyder, 2003: 154.

Description.—Shell medium-sized, fusoid; whorls 7; protoconch of 2½ smooth whorls; teleoconch whorls rounded, with impressed sutures, wavy collar, subsutural depression, submedial peripheral carina; sculpture of 10–14 longitudinal costae, tending to die out on subsutural depression, overrun with spiral lines strongest on periphery, lower body whorl, and neck; columella smooth with 1 or 2 incipient swellings not continuing into aperture; umbilical depression sometimes present.

Remarks.—Harris (1895a: 72) mentioned a "rudimentary umbilicus," but both in the type and all remaining specimens examined in both the TNSC collections and those personally collected, an umbilical depression is more accurate. Harris (1895a) also noted 8–10 costae on the body whorl, but in specimens examined, this character is quite variable and as many as 14 have been observed. The holotype is larger than any other specimen seen and has one (two?) columellar swellings, one very weak and the second almost imperceptible; none of the other specimens examined show any trace of columellar plications. The surface of each spire whorl is covered with major spiral lines, 12–13 in number with secondary intermediate lines often present on the shoulder area and below the carina. The holotype has lost the protoconch so the description of "2 smooth and polished, 3 sometimes polished" must have come from other specimens; one specimen with an intact protoconch shows 2½ smooth whorls. The lack of an umbilicus or umbilical slit and the absent or weak columellar folds renders placement in *Latirus s.s.* problematic. To ascertain whether columellar plications might exist within other specimens of *Latirus* (*Levalatirus*) *ostrarupis*, two larger specimens were sectioned; the results did not show any obvious plications, but instead a low columellar swelling where they might be expected to exist. The larger columellar plication that Harris (1895a) noted in his diagnosis of the holotype

does not appear to be a true columellar fold; it begins at the upper edge of the siphonal fasciolar ridge and has the character of an irregularly margined, low pad. As it rotates into the aperture, the angle between it and the columellar axis becomes progressively less acute and therefore it is very unlikely that it continues up into the spire. Examination of a large number of *Latirus* spp. similar *to L. (Levarlatirus) ostrarupis*, reveals that there are three similar but still readily distinguishable species in the Seguin. *Latirus (Levarlatirus) ostrarupis* can be separated from the group by its larger size, spire angle of *ca.* 37°, a well-defined collar on later whorls, costae that usually do not reach the collar and tend to die out on later whorls, a strong siphonal fasciole, and a shallow siphonal notch more or less at right angles to the canal axis.

Type Information.—Holotype: TMM BEG35596. Paratype: TMM BEG35597, both from locality 165-T-2. Remaining hypotypes in CLG.

Material Examined.—39 specimens, the largest (holotype, TMM BEG35596) 31.8 mm in length.

Latirus* (*Levarlatirus*) *undus n. sp.
Pl. 9, Figs 4–5

Description.—Shell broadly fusiform in shape with spire angle of *ca.* 40°; strongly concave shoulder area, tending to become horizontal on early whorls. Whorls with 8 or 9 large rounded costae on each spire whorl and body whorl; costae running from lower to upper suture; sutural line wavy. Suture impressed; collar weakly swollen but otherwise poorly defined. Surface with moderately strong spiral lines, 7 or 8 on spire, often with intermediate lines between major spirals of approximately half that size. Siphonal fasciole weak to moderate in strength; umbilical depression weak to absent; siphonal notch weak to absent, set at acute angle to canal axis.

Remarks.—The spire angle of *ca.* 40° and the solid, large, rounded costae running from suture to suture on the spire, and from the suture to the beginning of the neck on the body whorl distinguish this species from the other *Latirus* spp. in the Seguin. No specimen with an intact protoconch is available for examination. In the material at hand, this species does not reach the size of *L.* (*Levarlatirus*) *ostrarupis*. A sectioned specimen shows a more pronounced columellar swelling than in *L.* (*Levarlatirus*) *ostrarupis*.

Etymology.—The specific name *undus* (Latin, ripple) refers to the rounded costae.

Type Material.—Holotype: TMM NPL37865. Paratype: TMM NPL37866, both from locality 165-T-202. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-202, unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community, 31°02'07.55"N, 96°48'12.08"W, Milam County, Texas.

Material Examined.—14 specimens, the largest (holotype, TMM NPL37865) 26 mm in length.

Latirus* (*Levarlatirus*) *textilis n. sp.
Pl. 9, Figs 6–7

Description.—Shell small to moderately sized, compressed fusiform; spire angle of *ca.* 44°, with 10–12 vertically pinched costae on earlier whorls and usually one less on body whorl. Protoconch conical, of 1½–2 smooth, rounded whorls. Whorls moderately carinated; collar well-defined by sharp change in curvature to concave shoulder. Costae flattening out before reaching collar. Surface covered by numerous spiral lines, usually 12 on spire whorls, strongest at midwhorl. Body whorl with flat ribbon-like area, bounded by 2 stronger lines rotateing around whorl; posterior bounding line confluent with posterior edge of labium; spiral lines stronger and alternating in size on neck. Weak to moderate siphonal fasciole; umbilical depression present; shallow to flat siphonal notch set at acute angle to axis of neck.

Remarks.—This species is readily separated from the other two Seguin *Latirus* spp. by the squatter form, larger spiral angle, and more evenly sized and spaced spiral lines. Three specimens show most of the protoconch; in none is the nucleus complete, but it appears that it was partially immersed. A sectioned specimen shows one very weak columellar plication.

Etymology.—The specific name *textilis* (Latin, textile) refers to the fine even spiral lines.

Type Material.—Holotype: TMM NPL37867. Paratype: TMM NPL37868, both from locality 165-T-200. Figured specimen: TMM NPL37869, from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-200, Pond Creek, approximately 200 meters upstream from highway FM 2027, 31°01'19.84"N, 96°48'31.60"W, Milam County, Texas.

Material Examined.—19 specimens, the largest (holotype, TMM NPL37867) 15.2 mm in length.

cf. ***Latirus*** **(*Levarlatirus*)** sp.

Description.—Shell small, fusiform; spire angle of *ca.* 37°, with 10–12 vertically pinched costae on earlier whorls and usually one less on body whorl. Protoconch conical, of 1½–2 smooth, rounded whorls. Whorls moderately carinated; collar well-defined by sharp change in curvature to concave shoulder. Costae flattening out before reaching collar. Surface covered by numerous spiral lines, usually 12 on spire whorls, strongest at midwhorl. Body whorl with flat ribbon-like area, bounded by 2 stronger lines that rotate around whorl; posterior bounding line confluent with posterior edge of labium; spiral lines stronger, alternating in size on neck. Siphonal fasciole weak to moderate; umbilical depression present; siphonal notch very shallow to flat, set at acute angle to axis of neck.

Remarks.—One specimen in the collections is more elongate, and has a more prominent carina than any of the *Latirus* spp. so far described. It is a juvenile, with an erect protoconch of two rounded, smooth whorls and four teleoconch whorls, the latter with a much more prominent carina, more prominent spiral lines, and sharper axial nodes. The aperture is embedded in rock so the subgeneric assignment is doubtful without being able to observe the columella. It could prove to be a juvenile of *L.* (*Levarlatirus*) *ostrarupis*, because the spire angle of that species is the smallest of this group, but more well-preserved and intermediate-sized specimens would be required to see the range of variation of this species.

Material Examined.—1 specimen (TMM NPL36142), from locality 11-T-13, 7.0 mm in length.

Latirus? aff. ***stephensoni*** Gardner, 1935
Pl. 9, Fig. 8

Latirus? (Polygona) stephensoni Gardner, 1935: 245, pl. 21, fig.11; Snyder, 2003: 192.

Latirus? stephensoni (Gardner). Palmer & Brann, 1966 in 1965–1966: 726.

Description.—Shell small, with elevated spire; shoulder concave, medially carinate with strong axials, 6 in number forming abapical line up spire. Entire surface spirally striate; spirals strongest from carina to lower suture. Aperture obliquely pyriform; columella straight, terminating anteriorly with 2 weak but highly oblique folds, anterior one stronger.

Remarks.—Two specimens of this species (both juveniles) were obtained, one partially embedded in matrix from Solomon's Branch, and the other from the marl at locality 11-T-101, which could be prepared. Unfortunately, both are missing the tip. A close relative is *Latirus? stephensoni*; this species was described from a large (*ca.* 25.0 mm) specimen in which both the tip and anterior canal were broken away, making the assignment to *Latirus* dubious, for the remaining characters show a species with the same general shape, a similar spiral ornament, a similar pyriform aperture, and a basally abruptly constricted body whorl. Although much more elongate, *L. tortilis* (Whitfield, 1865) has much in common with this species: the same number of costae, surface with spiral lines strongest on the largest part of the whorls, and two weak oblique columellar folds. Although not noted in Whitfield's (1865) original description, *L. tortilis* also has a surface rendered scabrous by the incremental growth lines, a feature also seen in *L.*? *stephensoni*; both Seguin specimens have surface wear that might have worn off any scabrous sculpture, but because no trace remains, it is assumed that these specimens did not originally possess it. A few specimens of *L.* (*Levarlatirus*) *ostrarupis, L.* (*L.*) *undus* n. sp., and *L.* (*L.*) *textilis* n. sp. with very little surface wear do show strong incrementals overrunning the spirals, producing a cancellate ornament but nothing to the extent of *L.*? *stephensoni* or *L. tortilis*. *Latirus*? *stephensoni* was originally placed in the subgenus *Polygona* Schumacher, 1817, a placement followed by Snyder (2003); I follow Palmer & Brann (1966 in 1965–1966) and do not believe the evidence warrants assigning it to that subgenus because both the related Seguin species and *L. tortilis* have two very oblique columellar folds, whereas *Polygona* has three less oblique folds.

Type Information.—Holotype: USNM 370986, from Kaufman County, Water Hill, 5 mi NE of Kemp, Texas. Figured Seguin specimen: TMM NPL37870, from locality 11-T-13. Remaining hypotype in CLG.

Material Examined.—2 specimens, the largest (tip broken, TMM NPL37870) estimated to have been 14 mm in length.

Latirus? sp.

Description.—Shell small; protoconch of 3 smooth, bulbous whorls, followed by one whorl of prominent sharp axial ribs, swinging abaperturally (forward) approaching posterior suture. Teleoconch sculpture of *ca.* 10 axials overridden by spiral lines, 5–8 on spire whorls, *ca.* 18 on body whorl. Shoulder area weakly concave, mostly smooth; suture impressed, margined anteriorly with weak co-sutural swollen collar. Canal short.

Remarks.—Only one specimen is available and that with the apertural side embedded in the rock matrix and canal mostly decorticated. It is however quite close to specimens of *Latirus moorei* Gabb, 1860, from the Weches Formation of Texas, the

primary differences being the smooth shoulder area and the sharper axial sculpture.

Material Examined.—1 specimen (CLG 16540), from locality 11-T-3, 7.0 mm in length.

Family **MELONGENIDAE** Gill, 1871
Subfamily **MELONGENINAE** Gill, 1871

Genus ***STREPSIDURA*** Swainson, 1840

Type Species.—*Strepsidura costata* Swainson, 1840 (= *Fusus ficulneus* Lamarck, 1803 in 1802–1806; *Murex turgid* Solander in Brander, 1776), by original designation. Eocene, England, France, and Belgium.

Description.—Shell inflated-pyriform, with short conical spire. Protoconch flattened, with 3 smooth whorls. Columella concave, anteriorly somewhat twisted, with 2 folds, most prominent at siphonal fasciole, weaker one anterior; outer lip internally thickened.

Strepsidura cancellata n. sp.
Pl. 9, Figs 9–10

Description.—Shell small to medium-sized, inflated; whorls 5–6. Sculpture of varix-like axial ribs, 16–18 on body whorl, progressively fewer on previous whorls, 7 or 8 on first? postnuclear whorl; 7 strong spiral lines on spire whorls and 21–25 on body whorl and neck, forming pronounced cancellate pattern; weaker axial lines between axial ribs crowding entire surface. Suture impressed, wavy, margined below with swollen collar and below that with concave area forming short ramp. Aperture ovate; columella straight, margined by prominent fold; second weaker fold posteriorly; anterior notch shallow; siphonal canal slightly twisted, bent abaxially; outer lip thickened within, smooth.

Remarks.—Prior to this report, *Strepsidura s.s.* was only known from the Eocene to the Oligocene. Three other genera might be considered for this assignment; the first is the sculpturally close *Peruficus* Olsson, 1929, from the Eocene of Peru; this monotypic genus, with *P. lagunitensis* Olsson, 1929, has equally strong axial and spiral lines and occasional varix-like axial ribs spaced at intervals of one-third of a whorl, two (three?) columellar folds, and a straight siphonal canal. The overall shape, spire angle, size, and type of surface ornament are close and it appears that this Peruvian species could be the direct descendant of *S. cancellata* n. sp. Another more distantly related taxon is *Glyptostyla* Dall, 1892 in 1890–1903; this genus is also regularly cancellate, but as Woodring (1970: 434–435) noted, the folds are not like volutid folds but are situated on a callus pad and are in four or five in number. Thirdly, the Californian genus *Whitneya* Gabb, 1864, could be considered for assignment. Harris (1895a: 71, pl. 7, fig. 1) and Aldrich (1895: pl. 3, figs 1, 1a) each identified specimens as *S. ficus* (Gabb, 1864) (= *W. ficus* Gabb, 1864) from the Queen City and Reklaw formations of Texas as being conspecific with the Californian *S. ficus*, but as Givens & Garvie (1994) showed, the two species are distinct. *Whitneya* is scarcely distinguishable from *Strepsidura s.s.*, although Anderson & Hanna (1925: 53) stated, *Whitneya* is distinguished by the "bald nuclear whorls, cancellated sculpture in the young stage and spiral sculpture in the adult." Gabb (1864) noted two columellar folds; Stewart (1927: 404), is his revision of Gabb's Californian type gastropods, only mentioned one. Dickerson (1915: pl. 9, figs 5a–d) not only figured a smooth form but others with axial folds on the final whorl. The distinguishing characters of *Whitneya* mentioned by Anderson & Hanna (1925) could apply equally well to the type *S. turgida*. The type species has a wide variation in adult sculpture; there are weakly cancellated forms, almost smooth forms, and others with pronounced axial folds. In all specimens examined, a cancellate sculpture in the young and bald nuclear whorls are also constant features. On this basis, it appears prudent to agree with Wenz (1943 in 1938–1944: 1270) and give *Whitneya* no more than subgeneric rank. Three other cancellate species of *Strepsidura s.s.* are known: *S. kerstingi* Adegoke, 1977, from Ewokora, Nigeria, the closely similar *S. indica* Cossmann & Pissarro, 1909, from the upper Ranokot Beds of India, and *S. scobina* Cox, 1930, from the Samana range in India. *Strepsidura cancellata* n. sp. differs from all of those in the character of the axial sculpture, possessing folds instead of thick axial costae, lacking a noded subsutural ridge, a lower position of the body whorl, a straighter siphonal canal, and the presence of a weak second columellar fold.

Etymology.—The specific name *cancellata* (Latin, lattice) refers to the cancellate mesh-like ornament.

Type Material.—Holotype: TMM NPL37871. Paratypes: TMM NPL37872–NPL37873, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—23 specimens, the largest (paratype, TMM NPL37872) 16.8 mm in length.

Genus ***TEXAFICUS*** n. gen.

Type Species.—*Texaficus obesus* n. sp., here designated. Upper Paleocene, Texas.

Description.—Shell pyriform with inflated whorls; spire low to moderately elevated; protoconch conical, of 3 whorls, first 2 smooth, last with fine arcuate riblets; base of body whorl contracted to short anterior canal; surface sculpture of sharp costae overridden by spiral lines. Aperture ovate; columella straight with 2 strong folds, with upper one stronger. Siphonal fasciole strong, cord-like; umbilical notch present; siphonal notch shallow.

Remarks.—Similar genera are (a) *Strepsidura*, with two columellar folds, a strong one that defines the junction between the aperture and beginning of the canal, and a posterior weaker fold, and a moderately long, bent siphonal canal; (b) *Peruficus*, with similar apertural columellar plaits, a long fusoid anterior canal, a contracted body whorl, and surface sculpture strongest on the spire, and (c) *Glyptostyla*, with two columellar folds situated on a callus pad within the aperture, and a regular surface reticulate pattern caused by the axial and spiral ornamentation.

Etymology.—The name *Texaficus* refers to this *Ficus*-like form from Texas.

Texaficus obesus n. sp.
Pl. 9, Figs 11–13

Description.—Shell fusoid, short, squat, with rounded inflated whorls. Protoconch conical, of 3 (4?) inflated whorls, first 2 smooth, last with fine arcuate riblets. Spire sculpture of 9 or 10 strong axial costae crossed by *ca.* 7 spiral lines; body whorl with costae extending from suture to neck; *ca.* 18 strong primary spiral lines and intermediate secondary ones to approximate midwhorl; growth lines strong, causing surface to be somewhat imbricate in appearance. Aperture oval, with 2 strong plaits; outer lip smooth within; siphonal fasciole prominent, umbilicated, siphonal notch shallow.

Remarks.—This species is superficially similar to *Strepsidura contorta* Aldrich, 1895b, but that species is a true *Strepsidura* with a strongly bent and twisted canal and a columellar fold at the beginning of the canal. The one juvenile specimen available shows the neck and canal to be proportionately longer than in the larger specimens, all of which have some wear at the anterior end.

Etymology.—The specific name *obesus* (Latin, swollen) refers to the inflated whorls.

Type Material.—Holotype: TMM NPL37874. Paratype: TMM NPL37875, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—6 specimens, the largest (CLG 4360) 20.0 mm in length.

Genus ***LEVIFUSUS*** Conrad, 1865a

Type Species.—*Fusus trabeatus* Conrad, 1833a, by subsequent designation (Cossmann, 1901 in 1895–1925: 14). Eocene, Gosport Sand, Alabama.

Description.—Shell medium-sized to large, inflated fusiform; spire short, widely conical; protoconch of 1½ smooth whorls; nucleus mammilate and obtuse; teleoconch whorls with concave ramp, often with nodose or spinose keel; outline more cylindrical below; body whorl inflated; aperture wide, with short, bent, somewhat twisted canal; outer lip with internal lirae.

Levifusus pagoda seguinensis n. ssp.
Pl. 10, Figs 1–3

Description.—Shell medium-sized, solid, short fusiform, with spire angle of *ca.* 52°; widest portion of shell below median; median nodular with 9–12 flattened spines or nodes continuing weakly above over concave ramp to wavy suture; ramp smooth or with 1 or 2 very weak spiral lines in lower part. On larger spire whorls, area from noded carina to lower suture ornamented with 3 or 4 spiral lines, strongest over nodes. Body whorl with 8 or 9 spiral lines tending to alternate in strength and die out as they pass into neck area. Juvenile shows whorl shape becoming coleoconoid as apex is approached, ramp disappears, and whorl outline becomes rounded with opisthocline riblets and spiral lines; protoconch missing in available material. Aperture pyriform, carinated at both upper and lower thirds; columella smooth, sinuous, straight below; canal weakly inclined.

Remarks.—The *Levifusus pagoda* lineage appeared in the Paleocene Matthews Landing marl as *L. pagoda* (Heilprin, 1880) var., and can be recognized in many similar forms, until it ends with *L. p. prepagoda* Palmer, 1937, in the Claibornian. The Seguin specimens are closest to the Paleocene *L. pagoda* var. and can be separated from those and all others by the more subdued nodes, and the more numerous spiral lines

overrunning them both above and below the carina; juvenile specimens can be separated by the coleoconoid spire profile with convex juvenile whorls. Another allied species is *L. lithae* Gardner, 1935, from the Wills Point Formation of Maverick County, Texas. As Gardner (1935) noted, the Matthews Landing specimens of *L. pagoda* are higher spired and possess more numerous axials than does *L. lithae*; *L. lithae* has a spire angle of *ca.* 62°, whereas the Matthews Landing specimens each have a spire angle of *ca.* 55°. The larger spire angle and smaller number of spirals separate *L. lithae* from the Seguin Formation subspecies.

Etymology.—The subspecific name *seguinensis* refers to the formation from which the species was found.

Type Material.—Holotype: TMM NPL37876, from locality 11-T-13. Paratypes: TMM NPL37877, from locality 11-T-13; NPL37878, from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—12 specimens, the largest (CLG 4364, imperfect) 22 mm in length.

Levifusus acutocarinata n. sp.
Pl. 10, Figs 4–5

Description.—Shell medium-sized; whorls at least 5 (earliest whorls missing in available material), broadly fusiform, initially carinated; carina turning into sharp flange on later whorls; shoulder smooth, concave, horizontally produced into thin flange overhanging rest of whorl; flange initially smooth, circular, gradually developing blunt spines that are terminations of low folds; sculpture of ramp smooth, with impressed fine opisthocyrt growth lines; strong spiral lines and weaker intermediate ones below flange, all becoming less prominent and more regularly alternating in size toward end of canal. Aperture triangular; columella smooth and straight anteriorly; no trace of siphonal fasciole visible.

Remarks.—This species seems allied to several *Levifusus* species from the Paleocene and Lower Eocene of the Gulf Coast, of which *L. suteri* Aldrich, 1895b, and *L. superplanus* Harris, 1899, can be cited in particular; both of these species show a wide, smooth concave ramp, a spinose periphery that could be regarded as an incipient development of a flange, and a similar apertural and columellar shape. The only other "flanged" gastropod genus-level taxa known to the author are *Fulgurofusus* Grabau, 1904, ranging from the Paleocene to Recent, and *Mayeria* Bellardi, 1872. *Fulgurofusus*, a genus of elongate fusoid shape, with a long straight canal of approximately the same spire length, has little similarity with *Levifusus s.s.*, whereas *Mayeria* from the Upper Cretaceous to Pliocene of Europe, South Africa, and New Zealand, is a taxon that is moderately sized to large, possesses a bicarinate body whorl with a smooth, nonspinose flange, and a well-developed siphonal fasciole. The fact that there are several possible ancestors from the Gulf Coast with characters that could easily evolve into the characters seen in this species makes it more likely one of these is the stem species.

Etymology.—The specific name *acuto* + *carinata* (Latin, sharpened keel) refers to the sharp flange of this species.

Type Material.—Holotype: TMM NPL4676, from locality 11-T-13. Paratype: TMM NPL37792, from locality 165-T-202.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—2 broken specimens, the largest (holotype, TMM NPL4676) 45.0 mm in length (estimated original length 55 mm).

Superfamily **MURICOIDEA** Rafinesque, 1815
Family **TURBINELLIDAE** Swainson, 1835
Subfamily **COLUMBARIINAE** Tomlin, 1928

Genus ***FULGUROFUSUS*** Grabau, 1904

Type Species.—*Fusus quercolis* Harris, 1896, by original designation. Paleocene, Alabama.

Description.—Shell spindle-shaped, thin-shelled, commonly with flange-like peripheral keel; axial sculpture weak, usually restricted to earlier whorls. Protoconch bulbous, deviated, not distinctly differentiated from succeeding whorls. Aperture round to ovate; columella straight, smooth; canal long.

Remarks.—The genus was originally placed in the Fusininae; Harasewych (1983) showed that it belonged in Columbariinae. Four species were previously known from the Paleogene of the Gulf and western coasts of the U. S., *Fulgurofusus quercolis* and *F. rugatus* (Aldrich in Smith, 1886) from the Gulf Coast as well as *F. merriami* (Dickerson, 1916) and *F. washingtonianus* (Weaver, 1912) from the western coast of the U. S. As Harasewych (1983) noted, the disappearance of the

Columbariinae after the Eocene records the retreat of the group into deep water where all of the the Recent columbarine species are found. The similarly spindle-shaped shells in the genus *Falsifusus* Grabau, 1904, are recognized by a conical protoconch of three or four whorls (the first two smooth with oblique riblets on the remainder) and a minute nucleus. The adult sculpture typically has both strong axial and spiral ornamentation. One species—aff. *Falsifusus perobliquus* (Johnson, 1899) from the Cook Mountain Formation—combines the nuclear characters of both *Fulgurofusus* and *Falsifusus*; it has the bulbous deviated protoconch of *Fulgurofusus* with the gradual development of weak arcuate riblets followed by spiral lines seen in *Falsifusus.* This type of protoconch is replicated in the modern species *Fulgurofusus* (*Peristarium*) *aurora* (Bayer, 1971); an adult sculpture of low axial ribs crossed by strong spirals is also seen in both species. Grabau (1904), in his discussion on *Falsifusus*, did not mention aff. *F. perobliquus* perhaps because, as Palmer (1937: 355) noted, only one damaged specimen was available. The author's collection (CLG) contains several complete specimens. The primary character differentiating *Fulgurofusus* from *Falsifusus* is thus the protoconch type: smooth, bulbous, and deviated versus smooth, multispiral, and conical. On this basis, aff. *Falsifusus perobliquus* should be placed in *Fulgurofusu*s and could very likely be the root ancestral stock of the *Peristarium* Bayer, 1971, group.

Fulgurofusus grande n. sp.
Pl. 10, Figs 6–8

Description.—Shell large; spire turreted, with angle between 32° for small specimens and *ca.* 40° for large ones; canal approximately half shell length, initially straight, slightly bent to left for anterior fifth. Whorl profile strongly carinate with peripheral angle of *ca.* 110°; shoulder straight to slightly concave, flattening out toward periphery, with *ca.* 24 tubercles or low swellings. Periphery defined by strong line with 3 more equally spaced ones between it and lower suture; larger whorls sometimes showing medial smaller lines between primary spirals. Axial sculpture limited to low swellings on shoulder and weaker ones below carina. Body whorl with 4 primary spirals, below that with weaker spirals to end of canal.

Remarks.—This species is easily distinguishable from other Tertiary *Fulgurofusus* species by its larger size, the four similarly sized spiral lines below the periphery, and the more subdued peripheral crenulations. The closest species is the type *F. quercolis* that Palmer & Brann (1966 in 1965–1966) cited only from the Paleocene Naheola Formation of Alabama, but that the author has also found in the lower Matthews Landing marl at Dixons Creek; that species has four spirals on and below the periphery (but the upper two much larger than the remainder), a smoother shoulder area, and a more carinate periphery. The two western coast species have upturned spines on the periphery and resemble the Recent subgenus *Histricosceptum* Darragh, 1969, much more than the Gulf Coast species.

Etymology.—The specific name *grande* (Latin, large) refers to the large size of this species.

Type Material.—Holotype: TMM NPL37703. Paratypes: TMM NPL37704–NPL37705, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—22 specimens, the largest (holotype, TMM NPL37703) 61.8 mm in length (estimated original length 95 mm).

Family **VOLUTIDAE** Fleming, 1822
Subfamily **ATHLETINAE** Pilsbry & Olsson, 1954

Genus ***VOLUTOCORBIS*** Dall, 1890 in 1890–1903

Type Species.—*Volutilithes limopsis* Conrad, 1860, by original designation. Paleocene, Porters Creek Formation, Alabama.

Description.—Shell resembling *Volutilithes*, but more slender and without coronated shoulder; sculpture reticulate, nodose or prickly at intersections; sutural sinus less evident than in *Volutilithes*; suture sometimes channeled. Protoconch paucispiral, conical; columellar folds steeply ascending, anterior one strongest.

Remarks.—The genus is well represented in the Paleogene of Europe, the Middle and Far East, and the western coast of the U. S. Although common in the Paleocene of the Gulf and eastern coasts of the U. S., the only Middle Eocene species listed by Palmer & Brann (1966 in 1965–1966) are *Volutocorbis stenzeli* F. B. Plummer in Sellards *et al.*, 1933, from the Reklaw (lower Claibornian) of Texas, and molds of *V. cancellatus* (Whitfield, 1892) from the Shark River Formation, Middle Eocene of New Jersey. The genus does, however, occur in the middle through upper Claibornian of Texas, because the author has collected several specimens of the genus from those deposits and specimens also exist in the TNSC collections from that stratigraphic group.

Volutocorbis olssoni (F. B. Plummer in Sellards *et al.*, 1933)
Pl. 11, Figs 1–4

Plejona (Volutocorbis) olssoni F. B. Plummer in Sellards *et al.*, 1933: 813, pl. 9, fig. 11.
Volutocorbis olssoni, F. B. Plummer. Palmer & Brann, 1966 in 1965–1966: 1020; Beckman, 1941: 33; Zinsmeister, 1977: 179.

Revised Description.—Shell slender; apical angle of 55°, smoothly biconic with maximum diameter occurring at top third of body whorl (maximum diameter/total length = 0.4). Whorls including protoconch to *ca.* 7; protoconch of 3¾ conical whorls; apex flattened, partially immersed; smooth except for last ¼ whorl, which bears fine arcuate riblets. Sculpture of fine axial ribs; interstices often with prominent growth line; *ca.* 28 ribs on penultimate whorl, varying 32–42 on body whorl; ribs crossed by subequal spiral lines, 7 on spire whorls, covering entire teleoconch, forming raised nodes at their intersections with axials. Suture impressed, bounded below with finely noded collar; space between it and first spiral line larger than spacing between remaining spirals. Aperture narrow, posteriorly channeled; outer lip crenulated where spiral lines meet edge; inside continuing as short impressed lirae; columella concave; prominent fold at start of canal, weaker one posteriorly.

Remarks.—The revised description was deemed necessary when, after examining the holotype of *Volutocorbis olssoni*, it was found that the description was significantly at variance with the characters observed. On measuring the spire angle of all specimens of Seguin *Volutocorbis* spp., it was found that there are two distinct sets of similar forms: *V. olssoni* with a spire angle of 55°, and another set with a spire angle of 40°; this more slender form is described below as a new subspecies. The holotype of *V. olssoni* is not an adult, or a complete individual; some flattened but otherwise complete individuals reach 28 mm in length. This species can be distinguished from *V. limopsis* Conrad, 1860, by the more slender form and much more subdued ornamentation, from *V. kerensensis* F. B. Plummer in Sellards *et al.*, 1933, by the weaker sculpture, less numerous columellar folds (two instead of three), and weak, impressed grooves instead of strong lirae, and from *V. stenzeli* F. B. Plummer in Sellards *et al.*, 1933, by the longer spire, weaker ornamentation, and longer, slightly bent canal.

Type Information.—Holotype: TMM P5380. Figured topotypes: TMM NPL37707–NPL37708, all from locality 11-T-13. Remaining hypotypes in CLG.

Material Examined.—41 specimens, the largest (CLG 14882) 24.4 mm in length.

Volutocorbis olssoni gracilis n. ssp.
Pl. 11, Fig. 5

Description.—Distinguished from *Volutocorbis olssoni* by more slender form, spire angle of 40°, maximum diameter near midpoint of shell, and finer, more regular cancellate surface ornamentation.

Remarks.—The specimens available are on average smaller and with one less whorl than *Volutocorbis olssoni*. Whether they are younger or a full-sized small adult is not known.

Etymology.—The subspecific name *gracilis* (Latin, slender) refers to the slender shell form.

Type Material.—Holotype: TMM NPL37574. Paratype: TMM NPL37618, both from locality 11-T-3. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-3, units BB–DD, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—6 specimens, the largest (holotype, TMM NPL37574) 11.5 mm in length.

Superfamily **OLIVOIDEA** Latreille, 1825
Family **OLIVIDAE** Latreille, 1825
Subfamily **OLIVINAE** Swainson, 1835

Genus ***EOANCILLA*** Stephenson, 1941

Type Species.—*Eoancilla acutula* Stephenson, 1941, by monotypy. Upper Cretaceous,Texas.

Description.—Shell with high, smooth, evenly tapering spire; protoconch smooth, blunt, of 2¾ whorls; tip minute, partially immersed; callus band covering approximately lower 70% of spire whorls; columella strongly spirally twisted; fasciolar band with 5–8 oblique narrow lirae, usually posterior ancillid band, and groove; anterior notch deep, internally thickened with callus; small low ridge of callus continuing posteriorly up inside of outer lip for *ca.* ⅓ of its length; small labral denticle present at end of line or kink in growth lines running from posterior end of aperture.

Remarks.—In the discussion of this taxon, I follow Kilburn (1981) for the definition of characters. Sohl (1964), synonymized *Eoancilla* with *Ancillus* Montfort, 1810, the type species of which is *A. buccinoides* Lamarck, 1802 in 1802–1806,

from the Lutetian of the Paris Basin, on the basis of the shared glazed whorls, the blunted apex, and apertural features. Comparing a range of specimens of *A. buccinoides* with *E. acutula* Stephaneson, 1941, one notes several consistent differences, in particular *Ancillus* spreads the callus glaze to the upper suture whereas in *Eoancilla*, only a portion of the spire whorls is covered. *Ancillus* has a much more acuminate spire and a high cylindrical protoconch, the tip of which is more allied to that of *Ancilla* Lamarck, 1799, *s.s.* than the more sharply delineated protoconch of *Eoancilla.* Finally, *Ancillus* lacks the peculiar callus ridge on the inner lip of *Eoancilla*, so I believe that *Eoancilla* is a well-defined genus. *Eoancilla* can be separated from *Ancilla s.s.* by the enamel-like callus covering only a portion of the teleoconch whorl surface, a more multispiral protoconch of 2¾ whorls rather than the typical paucispiral 1½ for most members of the group with the tip blunt, and the callus deposit on the interior of the basal sinus area and lower outer lip. Kilburn (1981) believed that the earliest known true *Ancilla* was probably *A. boettgeri* Martin, 1914 in 1914–1915, a species from the Upper Eocene of Java, which has an extremely long columellar pillar and significantly the fasciolar band is divided into two by a shallow groove; this species in many respects is close to the *A. staminea* group of the Sabine and Claiborne stages of the Gulf Coast and also to *A. canalifera* Lamarck, 1802 in 1802–1806, of the Middle Eocene (Lutetian) of the Paris Basin. Kilburn (1981), followed by Renard & Pacaud (1995), assigned *A. canalifera* to another extinct genus, *Ancillarina* Bellardi, 1882, a junior synonym of *Olivula* Conrad, 1832, which is characterized by a similarly divided fasciolar band but total lack of enamel callus on the spire whorls and sutures. If that were accepted, then I believe that the very similar *A. staminea* group should also be placed within the *Ancillarina* group. With respect to *A. canalifera*, *A. staminea* of the Middle Eocene and *A. staminea maternae* Palmer, 1937, of the Lower Eocene of Alabama have a similarly divided fasciolar band and the same lack of callus on spire and sutures, although large specimens of *A. canalifera* sometimes show the posterior end of the columellar callus extending above the aperture; the author has one large specimen in his collection in which the callus extends almost to the protoconch; however, this is not the same as the enamel-like callus that covers the whorl surfaces as in *Ancilla s.s.*

Curiously Palmer (1937: 428–430) placed both *Ancilla staminea* and *A. s. maternae* in section *Olivula* Conrad, 1832, but made no mention of that later (Palmer & Brann, 1966 in 1965–1966), probably indicating that she did not believe any more that they deserved sectional rank. Cossmann (1899 in 1895–1925: 70), Wenz (1943 in 1938–1944: 1277), and Glibert (1960b: 19), each placed *A. staminea* in the subgenus *Olivula*, whereas Harris (1899a: 30) also placed subspecies *A. maternae* in *Olivula*; Garvie (1996: 87) placed the Reklaw subspecies *A. s. reklawensis* Garvie, 1996, also in the same subgenus. Tracey *et al.* (1996), recognizing the similarity of the *A. staminea* group to *A. canalifera*, placed that species in Conrad's genus *Olivula*. Palmer (1937: 429) noted that *A. canalifera* does not spread the callus in a consistent collar along the suture with the heavy, sagittate lines as in *A. staminea*, and in the list of increasingly older subspecies, *viz. A. s. punctulifera* (Gabb, 1860) from the middle Claibornian, *A. s. reklawensis* from the lower Claibornian, and *A. s. maternae* from the Lower Eocene, one observes a steady decrease in the strength and sagittal angle of the lines, which in *A. s. maternae* have become mere growth lines on a smooth collar band, a condition already closely duplicated in a few Reklaw specimens. Similarly examining a range of *A. canalifera*, one observes a few specimens with an indication of a collar bearing sagittal-shaped growth lines, and so I believe that both the *A. canalifera* species and the *A. staminea* group should be assigned to *Ancillarina*, with perhaps the *A. staminea* group given subgeneric rank in *Olivula* to note the heavy sutural collar of the American species.

It should be noted that some authors, such as Cossmann & Pissarro (1910–1913 in 1906–1913) and Sieber (1957), use *Ancilla (Tortoliva) canalifera* to designate that taxon; *Tortoliva* Conrad, 1865b, was, as Palmer (1937: 435) noted, defined from a probable young shell; the figure is poor, and the type (the only specimen) is now lost, and so as Palmer (1937) suggested, there is no value in perpetuating the name; *Ancillarina* is available as a substitute. *Agaronia* Gray in Beechey, 1839, has been applied to *A. alabamensis* (Conrad, 1833a), *A. bombylis* (Conrad, 1833a), and *A. mediavia* (Harris, 1896); *A. alabamensis* and *A. bombylis* fit well within the taxon with the channeled sutures and whorls free of enamel callus. As López *et al.* (1988: 296) in a review of the genus *Agaronia* noted, where *Ancilla* has the "ancillid" band and fasciolar band separated by the "posterior fasciolar groove," *Agaronia* has the two bands fused together with a slight crest separating the two. Examination of a large number of *A. alabamensis* and *A. bombylis* from the Gosport Sand shows that the band has a range of variation from a swollen crest to a medial depression, the junction area defined by the straight center of the S-shaped growth lines, the anterior end of this line terminating near the abapertural side of the fasciolar notch. This is different from *Ancilla* in which the groove terminates at the adapertural side of the notch. In *A. mediavia* of the Paleocene, this groove is fine but plainly visible, and in all specimens examined, an almost effaced version of the *Agaronia* junction demarcation area is also visible posterior and parallel to the ancillid groove. A second character that can be used to separate the genera is the channeled suture of *Agaronia*; *Ancilla* has at most a fine impressed line and usually the suture is covered with callus. However, *A. mediavia* also has a multispi-

ral protoconch and an enamel callus that covers only a portion of the teleoconch whorls and the lower inner lip callus deposit, and so should be assigned to *Eoancilla*. The author has collected several specimens of *Eoancilla*, or a close relative thereof, from the middle Claibornian Weches Formation, so the genus has a long temporal range from Upper Cretaceous to Middle Eocene. A newly discovered and very well preserved Albian fauna (McCall *et al.*, 2008) from Texas, includes a species that appears to be an ancestral *Ancilla,* the primary differences being a very weak ancillid band and stronger and more regular lirae. *Eoancilla* can therefore be as taken as an ancestral Upper Cretaceous ancillid taxon that by Middle Eocene times had already spread to the Nangulaan Eocene of Java, because *A. songoensis* Martin, 1914 in 1914–1915, is remarkably close to *A. mediavia*, the primary differences being the more prominently stepped whorl profile and the ancillid groove in a lower position within the ancillid band; the one specimen available for study has the lower part of the outer lip missing, but Martin (1914 in 1914–1915: 129, pl. 2, figs 60–61) mentioned and figured a callus ridge, so it should also be assigned to *Eoancilla*. The *Ancillarina* group is different from *Eoancilla* and its ancestor must be looked for elsewhere, probably also in the Upper Cretaceous.

Eoancilla hordea n. sp.
Pl. 11, Figs 6–7

Description.—Shell small, subcylindrical, smoothly rounded, barely contracted at suture; protoconch of *ca.* 2 whorls; tip somewhat oblique, partially immersed, with no demarcation transition to teleoconch whorls; suture defined by impressed line; spire whorls mostly covered with enamel-callus band; aperture slightly larger than ½ shell length; columella spirally twisted; fasciolar band with 6 oblique narrow lirae; ancillid band wide; groove prominent; anterior notch deep, internally thickened with callus; thin line of callus continuing posteriorly up inside of outer lip; labral denticle small.

Remarks.—Distinguished from *Eoancilla acutula* and *E. mediavia* by the more slender form, a smoother, nonstepped, apical whorl outline, and a stronger ancillid groove.

Etymology.—The specific name *hordea* (Latin, barley) refers to its resemblance to a large grain of barley.

Type Material.—Holotype: TMM NPL37709. Paratype: TMM NPL37710, both from locality 11-T-101.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—23 specimens, the largest (holotype, TMM NPL37709) 11.5 mm in length.

Superfamily **CANCELLARIOIDEA** Forbes & Hanley, 1851
Family **CANCELLARIIDAE** Forbes & Hanley, 1851

Genus ***CAVEOLA*** Stephenson, 1941

Type Species.—*Cancellaria acuta* Wade, 1926, by original designation. Upper Cretaceous, Ripley Formation, Gulf Coast.

Description.—Shell medium-sized; spire longer than aperture; whorls rounded, sometimes weakly shouldered; protoconch of 3–4 smooth, rounded whorls; tip somewhat flattened; transition to adult sculpture sharp; sculpture cancellate with 1–3 varices per whorl; aperture sublenticular; siphonal canal short, broad, unnotched; outer lip thickened within, denticulate; columellar callus thin, edge sharply delimited; columella with 3 strong plications, lowest margining edge, sometimes with weaker intermediate plications.

Remarks.—Previously this genus was only known from the Gulf Coast Cretaceous of the U. S.

Caveola ostium n. sp.
Pl. 13, Figs 8–11

Description.—Whorls 6, smoothly rounded; protoconch of 3 smooth, rounded whorls; tip flattened, partially immersed; transition to teleoconch sculpture abrupt, beginning with varix; sutures impressed; sculpture with 5 raised spiral cords, medial 3 strongest, numerous axial cords, noded at intersections; *ca.* 2 varices per whorl; body whorl with *ca.* 17 spiral cords becoming more closely spaced basally; entire surface of teleoconch with fine, regularly spaced, raised collabral striae; aperture elongate; outer lip thickened within, strongly denticulate with short lirae; columellar callus thin; edge well defined; 3 folds spiraling into aperture, with posterior 2 most prominent, third defining lower edge of columella, one smaller fold between columellar edge and central fold not continuing into aperture; canal short, slightly bent to left.

Remarks.—As Sohl (1964: 269) noted, shells of Tertiary age having similar characteristics are usually placed in *Sveltia* Jousseaume, 1887, or *Sveltella* Cossmann, 1889. *Caveola osteum* n. sp. was compared with type species of each of the two preceding genera and found to differ sufficiently to preclude assignment there. *Sveltia varicosa* (Brocchi, 1814), the type of the genus, is moderately slender, has well-defined sharp axial ribs, two columellar folds, and a protoconch of 1½ smooth whorls, the tip enrolled. The type of *Sveltella*,

S. quantula (Deshayes, 1864), is moderately slender, with shouldered whorls, varix-like axial ribs, a canal bent to the left, a protoconch of 2½ whorls, with an umbilical chink in juvenile individuals and a prominent umbilicus in the adult. These taxa, as well as *Uxia* Jousseaume, 1887, and *Bonellitia* Jousseaume, 1887, which could be considered as candidates for assignment, have protoconchs that show a gradual transition to the adult sculpture. *Caveola* is unique in possessing an abrupt protoconch transition to the adult sculpture, a regularly cancellate sculpture, and no trace of an umbilicus or even an umbilical depression, and lacks a siphonal fasciole. The morphology of juvenile *C. ostium* n. sp. (Pl. 13, Fig. 11), lacking a columellar callus and being a relatively shorter shell, tends toward the characters of the genus *Bonellitia*, and might well have been placed there but for the relatively longer aperture and the presence of the collabral striae; the two genera seem to be closely related. This taxon is one of the few Cretaceous genera to survive past the K-Pg boundary event. The species most similar to *C. ostium* n. sp. is the type of the genus, *C. acuta*, which can be distinguished by its larger size, stronger spiral than axial sculpture, less prominent varices, and its weak columellar callus. There are at least two further undescribed species from the Cretaceous Kemp Clay in Texas where the taxon is relatively common that exhibit characters intermediate between *C. acuta* and *C. ostium* n. sp.

Etymology.—The specific name *ostium* (Latin, mouth of creek or river) refers to the locality at the mouth of Dry Creek from which the specimens were found.

Type Material.—Holotype: TMM NPL37853. Paratypes: TMM NPL36192, TMM NPL36234, and CLG 16610, all from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—13 specimens, the largest (paratype, TMM NPL36192) 15.5 mm in length.

Superfamily **CONOIDEA** Wenz, 1938a in 1939–1944
Family **SPEIGHTIIDAE** Powell, 1942

Genus ***CLINUROPSIS*** Vincent, 1913

Type Species.—*Pleurotoma ampla* Briart & Cornet, 1870, by original designation. Paleocene, Belgium and Democratic Republic of Congo; Eocene, Egypt.

Description.—Shell very large, robust, broadly biconic-fusiform, with broadly conical pagodiform spire, strongly tuberculate-carinate just above lower suture, with relatively long, flexed, unnotched anterior canal. Sinus distinct, very broadly U-shaped; apex on shoulder slope nearer to periphery than to upper suture (after Powell, 1966: 25).

Remarks.—The family Speightiidae is placed in Conoidea following Powell (1966), as opposed to "unassigned" within Neogastropoda according to Bouchet & Rocroi (2005). Although Bouchet & Rocroi (2005: 55) attributed Conoidea to Fleming (1822), I recognize Wenz (1938) as the first to define the higher rank term (as Conacea).

Powell (1966) included three Paleocene species in *Clinuropsis*, *Pleurotoma ampla* from Belgium, *C. diderrichi* from the Democratic Republic of Congo, and *P. ingens* Mayer-Eymar, 1896, from the Bartonian of Egypt, a species that Newton (1922: 20) also reported from the Eocene (Lutetian?) of Nigeria. As Adegoke (1977: 187) has noted, this genus serves as a good Paleocene index taxon in West Africa, occurring in Togo, Ghana, Democratic Republic of Congo, and Senegal. In America, the genus has been recognized in the Paleocene of Trinidad (Rutsch, 1943) and now also Texas (herein). The closely similar genera *Speightia* Finlay, 1926, and *Andicula* Olsson, 1929, have been documented from the Middle Eocene of New Zealand (Suter, 1917) and the Lower Eocene of Peru (Olsson, 1929), respectively. Powell (1942: 167) noted the changes in character of the sinus with growth in *Speightia*, a condition replicated in *Clinuropsis*. The sinus is broad and shallowly arcuate with the apex just above the peripheral keel, a type that, as Wrigley (1939: 278) pointed out, is different from the shallow sinus seen in some Fasciolariidae and Buccinidae, two taxa to which some Speightiidae on occasion have been referred.

Clinuropsis yanceyi n. sp.
Pl. 11, Figs 8–11

Description.—Shell large, solid, pagodiform; spire angle *ca.* 58°, whorls to *ca.* 9 in number (protoconch damaged in all specimens). Earliest whorls convex, inflated, with *ca.* 10 opisthocline riblets per whorl; shoulder slope initially small, but increasing to occupying slightly more than half of whorl profile on final whorls. Sculpture of 9 or 10 vertically compressed costae per whorl, with tips horizontally flattened; costae weak on shoulder slope, strong below; suture impressed, wavy due to costae; entire surface covered with spiral lines, tending to alternate in strength, slightly more prominent below carina. Growth lines prominent; sinus distinct, broadly U-shaped with rounded apex, situated on lower third of shoulder. Body whorl strongly bicarinate in small specimens, less so in larger

specimens; labrum smooth within; columella smooth, slightly twisted; callus wash weak; anterior canal long, recurved; anterior notch weak to absent.

Remarks.—As Powell (1966: 25) noted, all genera—*Clinuropsis* from the Paleocene of Belgium and Belgian Congo, *Andicula* from the Peruvian Lower Eocene, and *Speightia* from the Middle Eocene of New Zealand—are allied, the distinguishing features being the position and shape of the sinus, the character of the peripheral nodes, and the presence of a parietal ridge. This species has a more centrally placed carina than either the type *C. ampla* or the Congo species *C. diderrichi*, and sometimes possesses a weak anterior notch, but otherwise the characters fit well within those of the genus. In overall shape and position of the carina, a closer match might be the Peruvian species *A. thompsoni* (Woods in Bosworth, 1922), but that species has a more V-shaped sinus just above the periphery and a spiral columellar parietal ridge entering the aperture. Both *A. thompsoni* and the congener *A. occidentalis* (Woods in Bosworth, 1922) are similar enough to the two Seguin species that the Peruvian species are likely descendants. At the Solomon's Branch locality, this and the next species are abundant and dominate the fauna with regard to shell mass; interestingly, few small or juvenile specimens were found.

Etymology.—The specific name *yanceyi* is named after Professor R. Yancey for his help and interesting discussions over the years in questions of geology and paleontology.

Type Material.—Holotype: TMM NPL37711. Paratypes: TMM NPL37712–NPL37714, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—22 specimens, the largest (CLG 14917, incomplete) 87.0 mm (estimated original length at least 110 mm).

Clinuropsis tuberculata n. sp.
Pl. 11, Figs 12–14

Description.—Shell large, fusiform; spire angle *ca.* 70°; whorls *ca.* 8 in number (protoconch missing in all examples). First two whorls squat, with shoulder occupying most of whorl; first extant whorl with opisthocline riblets, next with rounded tubercles on lower suture; adult sculpture of concave shoulder, carina defined by *ca.* 13 nodes per whorl, nodes effaced below carina; position of carina tending toward medial position on later whorls. Suture impressed; sculpture of fine spiral lines and weaker growth lines; growth lines defining broadly open U-shape with apex just above tubercles. Body whorl initially concave below tubercle, then smoothly sinuous toward short, slightly twisted canal. Columella with thin wash of callus, posteriorly excavated, sinuous toward short canal.

Remarks.—This second species, as noted above, has much in common with *Clinuropsis occidentalis*, the primary difference being the position of the sinus and the doubly carinated body whorl. This is the most common large species in the Seguin Formation. One specimen with a complete outer lip shows the lip prominently produced forward in a large arc below the lower body whorl carina. A similar species is *Levifusus indentus* Harris, 1899, reassigned to the genus *Orthosurcula* Casey, 1904 (Palmer & Brann, 1966 in 1965–1966: 810), from the Lower Eocene of Alabama and the Pendleton Formation of Texas. *Clinuropsis tuberculata* can be differentiated from that species by its shorter aspect, much larger number of spines or nodes that are pinched longitudinally rather than transversely, and a retral sinus the apex of which is consistently on the humeral slope, not migrating toward the carina when in the vicinity of a spine, as is often the case with *Levifusus*. *Clinuropsis tuberculata* is distinguished from the closely similar *C. togoensis* Adegoke, 1977, by the more medial position of the noded carina, the vertical subcarinal whorl profile, and the total lack of spiral sculpture.

Etymology.—This specific name *tuberculata* (Latin, node) refers to the nodiferous character of the carina.

Type Material.—Holotype: TMM NPL37715. Paratypes: TMM NPL37713 and NPL37716–NPL37717, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—88 specimens, the largest (incomplete, CLG 4380) 70 mm in length.

Family **TURRIDAE** H. & A. Adams, 1853
Subfamily **COCHLESPIRINAE** Powell, 1942

Genus ***PRAESURCULA*** n. gen.

Type Species.—*Praesurcula palaeocenica* n. sp., here designated. Upper Paleocene, Texas.

Description.—Shell turreted; protoconch multiwhorled, with last whorl obliquely ribbed; teleoconch whorls with swollen subsutural band, concave ramp, sharply rounded periphery; body whorl with weak to moderate, broad sulcus beneath periphery; adult sculpture of spiral and collabral lines, nodular at intersections, particularly prominent on body whorl, strongest below sulcus; anal sinus as broad open U, with apex sometimes extended, situated above periphery.

Remarks.—When this species was first discovered, only a body whorl was available and the author was intending to place it near *Surculites* Conrad, 1865c, because of the similarity of the body whorl ornamentation to *S. engonatus* (Heilprin, 1881), in spite of the rounded shoulder and somewhat different sinus. However, the later discovery of more specimens with intact spires, and a low multiwhorled protoconch, initially smooth then gradually developing oblique, arcuate, widely spaced riblets and spiral lines, merging gradually into the teleoconch sculpture, precluded that assignment. These nuclear characters are unlike the large smooth, multiwhorled protoconch of *Surculites* in which the spiral lines develop first and the axial sculpture much later. This type of protoconch much resembles that of both *Ancistrosyrinx* Dall, 1881, and *Raphitoma* Bellardi, 1848, but any further comparison with *Raphitoma* appears pointless because the teleoconch sculptures of the two genera are so different. With regard to adult sculpture, the angulated whorls, flexuous axials thickened over the peripheral region, and the whole surface crossed by spiral cords and threads are characteristic of genus *Pleurotomella* Verrill, 1873, and two species of that taxon have been described from the Gulf Coast Paleogene, *P. whitfieldi* (Aldrich, 1895b) and *P. veachi* (Harris in Harris & Veach, 1899b). *Pleurotomella whitfieldi* has obvious points of similarly with the present species, including carinate whorls and similarly flexuous axials and spiral lines, but the shape of the anal sinus is different, there is no observed shoulder swelling, and the protoconch is higher and more globose; *P. whitfieldi* could well be an ancestor of *Surculites.* If the protoconch was smooth, the periphery sharpened, and the axials effaced, the two would be scarcely be distinguishable. *Pleurotomella veachi* from the Lower Eocene has a stouter shell and although the figure (Harris (1899b: pl. 54, fig. 2) shows the axials over the periphery, it does not show the growth lines swinging forward as is characteristic of the genus. the original description did not describe the protoconch, but Harris (1937: 28) doubtfully reassigned the species to *Eopleurotoma* Cossmann, 1889, which if correct would imply that the protoconch is initially smooth followed by a whorl or so of axials, but without the crenulated collar of that genus; I do not believe the assignment is correct. Unfortunately, the syntypes of *P. veachi* are lost (Palmer & Brann, 1966 in 1965–1966: 844), so recourse cannot be made to the types. In any case, I find the assignment to *Pleurotomella* of these two species, and the similar Seguin species to be tenuous at best. *Pleurotomella*, the type of which, *P. packardi* Verrill, 1873, is a Recent deepwater species, is very thin shelled and moderately stout, with a blunt protoconch of 2½ almost-smooth whorls (Bouchet & Warén, 1980: 35), and with strong distant axial oblique ribs, crossed by spiral lines of two orders. Powell (1966: 131–132) assigned numerous species to the genus, and noted that they are characteristic of deep-ocean basins, also noting that the genus has been claimed to occur in the Tertiaries of many regions of the globe, but that critical examination of apices is necessary for confirmation of these claims. Nordsiek (1968: 182) erected a new subgenus (*Majox*) in *Pleurotomella* with type species *P. bairdi* Verrill & Smith in Verrill, 1884, for those forms that are larger and more slender (hardly much of a diagnosis) that Bouchet & Warén (1980: 49) placed under synonymy with *Gymnobela* Verrill, 1884. *Pleurotomella bairdi* is a stout species with carinated whorls, a surculoid anal sinus, and a protoconch that Nordsiek (1968) described as "pleurotomelloid," by which he meant reticulate or cancellate. In conclusion, these species previously placed in *Pleurotomella* should be reassigned to this new taxon, the affinities of which appear to lie closer to *Surculites* and *Ancistrosyrinx*.

Etymology.—The name *Prae* (Latin, before) + *surcula* refers to the prior ancestor of a *Surcula*-like species.

Praesurcula palaeocenica n. sp.
Pl. 13, Figs 5–6

Description.—Shell small to medium-sized; protoconch of 3 broadly conical whorls, third with widely spaced riblets; transition to teleoconch whorls gradual; spiral lines and subsutural collar gradually developing on first teleoconch whorl; remaining whorls showing collabral axials, fairly strong and distinct on subsutural collar, weaker on concave ramp, more prominent again over peripheral area, dying out on body whorl at base of sulcus; axials crossed by fairly weak spiral lines from suture to base of body whorl sulcus, there 2 prominent lines continuing with others that become gradually weaker to base of canal; intersections of spirals and axials distinctly nodose; anal sinus broad; apex U-shaped, extending adapically, positioned just above rounded periphery; columella smooth, straight, weakly bent to left.

Remarks.—The only species that could be confused with *Praesurcula palaeocenica* n. sp. is *Pleurotomella veachi,* which can be distinguished by its larger size, weaker axials, spiral lines of equal strength from suture to periphery, and a more equally rounded anal sinus, the apex situated nearer the suture

than periphery. If *P. veachi* is rediscovered the shorter form and short axials should distinguish that species.

Etymology.—The specific name *palaeocenica* refers to the occurrence within the Paleocene.

Type Material.—Holotype: TMM NPL36191. Paratype: TMM NPL36192, both from locality 11-T-13. Remaining hypotype in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—3 specimens, the largest (incomplete, paratype, TMM NPL36192) 7 mm in length (estimated original length 15 mm).

Genus ***TROPISURCULA*** Casey 1904

Type Species.—*Pleurotoma* (*Drillia*) *caseyi* Aldrich, 1903, by subsequent designation (Harris, 1937: 57). Red Bluff Formation, Oligocene, Mississippi.

Description.—Shell small, fusiform, moderately elongate, with tall, smooth, multispiral protoconch; whorls centrally carinate, with subsutural collar, concave ramp, and axial costae strongest on periphery; spiral lines subequal in strength, low, close-set.

Remarks.—The genus is often confused with *Surculoma* Casey, 1904, but that genus can be distinguished by its paucispiral protoconch and blunt mammilate apex; it is usually much larger and without a pronounced subsutural collar; there appear to be some intermediate forms and a revision of these and similar taxa is needed. Powell (1966: 39) synonymized *Tropisurcula* with *Pleurofusia* Gregorio, 1890, but that genus can be separated by its paucispiral, blunt protoconch with axial riblets on the last quarter turn, and axials overridden by strong spiral lines. I consider the differences sufficient for separation.

Subgenus ***EODRILLIA*** Casey, 1904

Type Species.—*Pleurotoma depygis* Conrad, 1833b, by subsequent designation (Cossmann, 1906 in 1906–1913: 223). Eocene, Gosport Sand, Alabama.

Description.—Shell smooth or finely spirally striate; protoconch conical, smooth, of 3–3½ whorls; ribs well-developed, not crossing fasciolar surface; sinus broadly U-shaped, with apex near middle of fasciolar surface; subsutural collar prominent; aperture short; canal short.

Remarks.—To date, *Eodrillia* has only been applied to seven taxa from the Claibornian Eocene of the Gulf Coast. Harris (1937), and Palmer & Brann (1966 in 1965–1966) gave *Eodrillia* full generic rank; Wenz (1943 in 1938–1944: 1398) and Powell (1966: 45) regarded it as a synonym of *Eopleurotoma*. Garvie (1996: 95–96) discussed the taxonomy and concluded that it deserves no more than subgeneric rank under *Tropisurcula*.

Tropisurcula**?** (***Eodrillia***) ***cingula*** n. sp.
Pl. 12, Figs 6–7

Description.—Shell moderately wide, fusiform; protoconch of at least 3 smooth whorls; transition to teleoconch distinct; teleoconch whorls 5–6, with broad crenulated band-like collar and concave ramp anterior to that equal or slightly larger in size; sculpture of *ca.* 16 low opisthocline folds, stronger on earlier whorls, terminating posteriorly abruptly at ramp, continuing to lower suture; entire teleoconch surface ornamented with close-set, fine, spiral lines, those on collar stronger; sinus orthocline on collar, sometimes becoming prosocyrt at upper suture; narrow extended U on ramp; apex slightly below center; aperture narrowly oval; canal short, obliquely terminated.

Remarks.—None of the available specimens have an undamaged protoconch; the most complete has two smooth whorls appears to be missing the first whorl and the tip, and clearly shows an abrupt transition to the teleoconch. However without an intact protoconch, one hesitates to assign definitely to *Eodrillia*. Only one species, *Tropisurcula* (*E.*) *planus* Garvie, 1996, from the Reklaw Formation of Texas, appears at all close; this species is much more elongated, the spiral sculpture is much smoother, the collar is thin and defined by a double line, the costae are more nodular, and on early whorls, the costae also continue into the ramp area. Powell (1966) figured several species that exhibit a similar external morphology: *Campylacrum* Finlay & Marwick, 1937, from the New Zealand Paleocene, which has a polygyrate, conic, four-whorled protoconch and a bluntly triangular sinus with the apex just above peripheral nodes; *Oxyacrum* Cossmann, 1899, from the Eocene of Europe and England, which differs from *Campylacrum* primarily by its protoconch of 4½ smooth whorls plus a whorl of riblets; and finally *Buridrillia* Olsson, 1942, from the Pliocene of Panama and Costa Rica the teleoconch characters of which appear identical to those of *Eodrillia* excepting a large, broad, thickened columellar fold at the end of the aperture. The common Texas Claibornian

species, *T.* (*E.) texana* (Conrad, 1865a) is very likely the descendant of *T. cingula* n. sp. via *T. planus*, the line ending with *T. caseyi*, whereas it appears that the more primitive characters of *T. cingula* n. sp. continue on in another line, with so far unknown intermediate species, ending with *Buridrillia*.

Etymology.—The specific name *cingula* (Latin, belt) refers to the broad subsutural band.

Type Material.—Holotype: TMM NPL37722. Paratype: TMM NPL37723, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—21 specimens, the largest (CLG 14920) 15 mm in length.

Genus ***ORTHOSURCULA*** Casey, 1904

Type Species.—*Pleurotoma longiforma* Aldrich, 1897, by subsequent designation (Gardner, 1935: 215). Red Bluff Formation, Oligocene, Mississippi.

Description.—Shell medium-sized to large, fusiform, with long, straight, unnotched anterior canal; periphery rounded; shoulder excavated; protoconch of 3–3½ smooth, conical whorls followed by ¾ whorl of arcuate riblets; protoconch-teleoconch transition sharp; surface sculpture primarily smooth, or with some spiral lineation; axial sculpture weak to absent; sinus deep, rounded, with apex situated in lower part of shoulder; lower edge confluent with forward sweep of outer lip. Anterior canal straight to feebly notched.

Remarks.—Casey (1904) erected *Orthosurcula* and stated that the "types" were *Pleurotoma longiforma*, *Surcula transversaria* Lamarck, 1804a in 1802–1806, and the Recent *Pleurotoma australis* Roissy, 1805 (= *Murex australis* Gmelin, 1791 in 1788–1793). *Surcula transversaria* is now placed in *Turricula* Schumacher, 1817 (Glibert, 1960a, Brébion, 1992), and *S. australis* in *Turricula* (Yen, 1942), in *Fusosurcula* Taki, 1951 (Shikama, 1964), and in *Nihonia* MacNeil, 1960, by Powell (1969), leaving *Orthosurcula longiforma* as the sole remaining representative of *Orthosurcula*. Casey (1904: 151) stated that *Orthosurcula* is "completely devoid of ribbing," but an examination of a large suite of *O. longiforma* from the type locality shows that weak peripheral ribbing is not uncommon on the earlier whorls, a condition also noted by Harris (1937: 48), and sometimes even seen on adult whorls emphasized by stronger-than-usual growth lines. True *Orthosurcula* does seem to have a European analog; Gürs (1983) figured the generically similar *O. regularis* (Koninck, 1837) from the Lower Oligocene of Weinheim, Germany.

MacNeil & Dockery (1984: 179) discussed the status of *Orthosurcula* and paraphrased Casey (1904: 151) as stating that *Orthosurcula* is "distinguished from *Turricula*, mainly by its long, straight siphonal canal without any trace of a ridge or swelling along the siphonal fasciole." If that were the only difference, then I would agree that their treatment of *Orthosurcula* as a subgenus of *Turricula* could be justified, but *Turricula* is also additionally distinguished by the protoconch of 2–2½ smooth whorls, and a slight to moderately flexed, notched anterior canal.

Wenz (1943 in 1938–1944: 1384) had *Turricula* ranging from the Upper Cretaceous (Maestrichtian) to the Recent; no Cretaceous Gulf Coast specimens of the genus have been reported, and possible candidates examined by the author from the Kemp, Owl Creek, Ripley, and Coffee Sand units all show a strong columellar fold at the start of the canal and so are not *Turricula*.

The Paleocene and Lower Eocene group of orthosurculids are a close and easily recognizable group of species that, with the exception of *Orthosurcula? longipersa tobar* Gardner, 1935 (which has a gradual protoconch/teleoconch transition), show similar protoconchs, similarly smooth or spirally sculptured whorls, and axial sculpture restricted to a few postnuclear whorls that are continued in some species as weak peripheral nodes; being so easily separable, I prefer to treat *Orthosurcula* as a full genus. Considering only teleoconch characters, *Orthosurcula* appears quite close to some species in the Paleocene Keasey Formation of Oregon that Hickman (1976) referred to *Turricula*; unfortunately she noted that protoconchs were missing in all available specimens, so it cannot be decided if they belong to *Orthosurcula*.

MacNeil & Dockery (1984) made the suggestion that *Orthosurcula* is descended from *Protosurcula* Casey, 1904; this appears unlikely because no *Protosurcula* species is known prior to the Claibornian Reklaw species *P. aurora* Garvie, 1996, with the possible exception of a doubtfully assigned Seguin species described below. The multiwhorled protoconch of *Protosurcula* is very different from that of *Orthosurcula* with the spiral sculpture already developing prior to the gradual protoconch/teleoconch transition; the converse appears more likely. It should be noted that Casey (1904: 144–145), in his definition of *Protosurcula*, mentioned the genus as "sometimes having a strong plica above the middle"; this I believe is due to misidentified specimens—I have examined well over one thousand *Protosurcula* specimens from the Gulf Coast, Texas, to Alabama, and none shows any trace of a columellar plication. However, with worn apical whorls, specimens

of *Turricula* (*Plentaria*) *plenta* (Aldrich & Harris in Harris, 1895a), can be easily mistaken for *P. gabbi* (Conrad, 1865a)-like forms, particularly those from the Weches formation of Texas, a fact confirmed by examination of several lots in museum collections in which a similar misidentification has occurred. Aldrich & Harris (in Harris, 1895a) and Gardner (1945) both placed *T.* (*P.*) *plenta* in *Borsonia* Bellardi, 1839. Casey (1904: 145) placed *T.* (*P.*) *plenta* in *Protosurcula* noting "columella straight … sometimes having a strong plica above the middle." Harris (1937: 59–60), then stated: "this shell belongs to the surculoid branch and not near *Borsonia*, and on account of its general form and ornamentation" placed it as a subgenus of *Turricula*. On account of the probable misidentification, I follow Powell (1966: 58) who stated "the main diagnostic feature of the borsonids is the presence of pillar plaits" and placed *Plentaria* in the Borsoniinae (= Clathurellinae H. & A. Adams, 1858, *fide* Bouchet & Rocroi, 2005: 256). *Plentaria*, now a clathurellid, cannot therefore be placed under *Turricula* and should be used as a full genus to avoid confusion.

Orthosurcula anacona (Harris, 1895)
Pl. 12, Figs. 8–9

Pleurotoma (*Pleurotomella*) *anacona* Harris, 1895a: 56, pl. 4, fig. 4; Kennedy, 1895: 145, 147.

Pleurotoma anacona Harris, 1896: 14, Texas ms.

Pleurotoma (*Pleurotomella*?) *anacona* Harris, 1896: 77, pl. 7, fig. 12 holotype (as *Surcula* in plate caption).

Coronia anacona (Harris). Gardner, 1935: 316; Palmer & Brann, 1966 in 1965–1966: 605.

Description.—Shell medium-sized; spire high, conical; tip flattened; protoconch of 4 smooth whorls, followed by ½ whorl with fine arcuate riblets; adult sculpture starting abruptly; first spire whorl with low, inclined, axial ribs; remaining whorls concave, smooth, or with fine spiral striae; basal carina weakly nodular, with few moderately strong spiral lines from just above carina to suture, below suture with few stronger spiral lines that rapidly weaken anteriorly; sinus U-shaped, broad, deep; apex below midpoint of whorl; body whorl with spiral lines of alternating strength from suture to end of canal; aperture elongate; columella smooth, concave, siphonal fasciole weak.

Remarks.—Gardner (1935: 316) noted that the species had not been recognized in later collections and indeed it appears to be restricted to the lowest Wilcox. Neither Gardner (1935) or Palmer & Brann (1966 in 1965–1966) could have had a specimen for examination. because the sinus and protoconch characteristics in no way resemble those of *Coronia.*

Type Information.—Holotype: TMM BEG35577, from locality 165-T-2. Remaining hypotypes in CLG.

Material Examined.—12 specimens, the largest (CLG 16634) 24 mm in length.

Orthosurcula cf. ***longipersa*** (Harris, 1896)
Pl. 12, Fig. 10

Pleurotoma longipersa Harris, 1896: 78, pl. 7, fig. 15; Brann & Kent, 1960: 716; Tucker, 2004: 572.

Orthosurcula longipersa (Harris). Gardner, 1935: 216; Harris, 1937: 48, pl. 9, fig. 24; LeBlanc in Barry & LeBlanc, 1942: 148, pl. 18, figs 19–22; Wasem & Wilbert, 1943: 193; Gardner, 1945: 233; Brann & Kent, 1960: 629 (read holotype for hypotype; read *Pleurotoma* for *Surcula*); Powell, 1966: 39; Toulmin, 1977: 166, pl. 6, fig. 9.

Description.—Shell *ca.* 8 whorls; spire angle between 33° and 38°; protoconch small, conical, of 4 whorls, first 3 smooth, last with axial riblets; transition to teleoconch sharp; teleoconch whorls initially weakly crenulate on peripheral area, all with spiral subsutural band on which is single revolving line sometimes becoming multiple on later whorls; ramp concave with numerous close-set spiral lines; spirals becoming larger on and below periphery; smaller intermediate lines tending to develop; sinus broadly V-shaped, with rounded apex, situated middle of shoulder slope; columella and canal straight, long (modified after Harris, 1896: 78).

Remarks.—The holotype comes from the Porters Creek Formation, upper Midway Group of Alabama, but the species has also been found in the Logansport and Naheola formations of Alabama, and the Wills Point Formation of Texas. *Orthosurcula longipersa* can be distinguished from *O. persa* (Whitfield, 1865) by the coarser spiral lines and prominent subsutural band, from *O. adeona* (Whitfield, 1865) by the lack of oblique peripheral nodes, and from both by the smaller spire angle. The Seguin specimens show the well-defined subsutural band, which unlike on the holotype tends to efface on later whorls, and also coarse spiral lines. Two specimens show rather stronger postnuclear sculpture and are also doubtfully referred to this species.

Type Information.—Holotype: PRI 92. Figured Seguin specimen: TMM NPL37724, both from locality 11-T-102. Remaining hypotypes in CLG.

Material Examined.—7 specimens, the largest (figured specimen, TMM NPL37724) 24.0 mm in length.

Orthosurcula cf. ***adeona*** (Whitfield, 1865)
Pl. 12, Fig. 11

Pleurotoma adeona Whitfield, 1865: 262; 1899: 173.
Pleurotoma (*Surcula*) *adeona* Whitfield. Harris, 1896: 76, pl. 7, figs 9–10; Brann & Kent, 1960: 715.
Pleurotoma (*Strombina*) *adeona* Whitfield. Gregorio, 1890: 27.
Orthosurcula adeona (Whitfield). Gardner, 1935: 216, pl. 20, fig. 20; 1945: 233–234, pl. 25, fig. 8 (holotype); LeBlanc in Barry & LeBlanc, 1942: 129, pl. 19, figs 1–2; Palmer & Brann, 1966 in 1965–1966: 809; Toulmin, 1977: 165, pl. 6, fig. 14.

Description.—Shell fusiform; spire moderately high; protoconch of *ca.* 3 smooth whorls, followed by ¼–1 whorl of axial riblets; transition to teleoconch sharp; teleoconch whorls concave on upper side, carinate on periphery with oblique nodes, *ca.* 15 on body whorl, rounded below; columella long, straight, with aperture more than half of shell length; entire surface with fine spiral striae, crossed by lines of growth; sinus as broad U, occupying most of shoulder slope, with apex medial (modified after Whitfield, 1865: 262).

Remarks.—Harris (1896: 78) noted that "the species shows considerable variation as regards carinations and strengths and form of spines," and also figured two forms of the species, one larger, with a larger spire angle, and with less prominent nodes (form A) than the other (form B), in which he even noted that "others are broader and more sharply carinate." Examination of a suite of specimens from the Porters Creek Formation of Alabama (including the type locality) shows a further range of variation in protoconch characters, in which the strength of the riblets varies considerably, being in a few specimens so weak as to be seen with difficulty under magnification. The specimens from the Seguin Formation vary from a typical form B type to a large broad form with a low peripheral position on the whorl and fairly weak nodes; most of the specimens extracted from the boulders at Solomon's Branch are all of the large broad form, but this form is also found in other locations with their different environments. One juvenile shows nodes even on the earliest teleoconch whorls, a character also seen in *Orthosurcula phoenicea* Gardner, 1935, but not in Porters Creek specimens; however, all specimens have the whorls initially smooth with the peripheral nodes developing later. Not having transitional Seguin specimens (all others are missing the earliest whorls), whether the two belong to the same species cannot be reliably decided; if this proves to be a constant character, then perhaps the Seguin *O. adeona* group should be given subspecific rank.

Type Information.—Holotype: CNHM UC 24523, from Matthews Landing, Porters Creek Formation, Alabama River, Wilcox County, Alabama. Figured Seguin specimen: TMM NPL37748, from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—14 specimens, the largest (incomplete, TMM NPL37748) 27.5 mm in length.

Genus ***PROTOSURCULA*** Casey, 1904

Type Species.—*Surcula gabbii* Conrad, 1865a, by original designation. Middle Eocene, Texas.

Description.—Shell moderately large, elongate-fusiform; protoconch multiwhorled, with first few whorls smooth, gradually developing axial riblets, followed by interspaced spiral lines; transition to teleoconch abrupt; early teleoconch whorls with fasciolar surface bounded above and below with strong spiral lines, sometimes crenulate on early whorls; later whorls with much more even ornamentation, collar and peripheral area lines tending to remain slightly more prominent; no axial sculpture beyond first whorls; anal sinus as deep U; apex in center of fasciolar band; columella long, straight; aperture and canal together equaling spire length; fasciolar band prominent, at end of canal; outer lip sharp.

Remarks.—True *Protosurcula* has not been found before the Middle Eocene, its place seemingly taken by *Orthosurcula* in the Paleocene and Lower Eocene, although the next described species appears to be a transitional form. See Remarks under the genus *Orthosurcula* for more comments on *Protosurcula*.

aff. ***Protosurcula*** sp.
Pl. 13, Figs 3–4

Description.—Protoconch conical, of *ca.* 4 smooth whorls; transition to teleoconch with elongated swelling. Teleoconch initially smooth, continuing with ¾ whorl of arcuate riblets, transitioning into duplex subsutural line; shallow concave fasciolar surface and rapidly disappearing oblique axial folds on and just below rounded carina. Rounded peripheral carina on lower third of whorl. Entire surface covered with fine close-set spiral lines.

Remarks.—Three undoubted specimens were obtained of this taxon, two of them juveniles. Although many more were seen during preparation from the boulder layer, they were usually so worn with predepositional wear as to be unworthy of collection. The adult specimen shows the same type of whorl profile and sculpture as *Protosurcula aurora*, which also has a duplex subsutural line, a fairly shallow fasciolar surface, and a similar position of the peripheral carina. The primary dif-

ferences from *P. aurora* are the character of the protoconch and a finer sculpture. The anal sinus is the same as in typical *Protosurcula*. The differences between this and *Orthosurcula* is the narrower and more extended anal sinus, its higher position on the periphery, and the early axial sculpture. The position of the anal sinus will reliably distinguish this species from worn specimens of *Eopleurotoma molineuxae* n. sp., the outline of which is then similar. More complete specimens are needed before a definite assignment can be made.

Type Information.—Figured specimens: TMM NPL36189–NPL36190, both from locality 11-T-13. Remaining hypotypes in CLG.

Material Examined.—3 specimens, the largest (incomplete, TMM NPL36189), 9.7 mm in length (estimated original length 14 mm).

Genus ***SURCULOMA*** Casey, 1904

Type Species.—*Pleurotoma tabulata* Conrad, 1833b, by original designation. Eocene, United States Gulf Coastal Plain.

Description.—Shell small to medium-sized, elongate-fusiform; protoconch paucispiral, mammilate; whorls angular, with oblique axial folds, medially carinated, below carina with close-set spiral lines; anal sinus broadly U-shaped, with apex in middle of shoulder slope; canal unnotched.

Surculoma sp.
Pl. 13, Fig. 7

Description.—Shell medium-sized, turreted; spire *ca.* 50% of shell length. Teleconch whorls medially carinated, with swollen collar and concave ramp. Sculpture of prominent axial folds, strong spiral lines, and weaker collabral growth lines. Intersection of two sets of lines generating reticulate pattern. Canal moderate in size, bent to left.

Remarks.—Two specimens, large for the genus, were obtained, both crushed, but showing similarity to *Surculoma penrosei* (Harris, 1895a), the primary difference being the much stronger spiral sculpture of the Seguin species. The protoconch is not available so it is not known whether this species belongs to the subgenus *Volutapex* Garvie, 1996, or not. This occurrence extends the range of this genus down from the Lower Eocene to the Paleocene.

Type Information.—Figured specimen: TMM NPL36187. Hypotype: TMM NPL36188, both from locality 11-T-13.

Material Examined.—2 specimens, the largest (figured specimen, TMM NPL36187) 26 mm in length.

Genus ***APIOTOMA*** Cossmann, 1889

Type Species.—*Pleurotoma pirulata* Deshayes, 1834, by original designation. Eocene, France.

Description.—"Shell large, 18–63 mm, elongate-fusiform, with a tall spire and a long straight unnotched anterior canal. Protoconch smooth, globose to narrowly conic, of 1½ to 2½ whorls, with a small asymmetric tip. Spiral sculpture of weak to moderate threads or cords; axials mostly subobsolete or confined to the early spire whorls. Whorls weakly angulated above midlength. Shoulder slope slightly sunken. Sinus broadly arcuate but deep, occupying most of the shoulder slope" (Powell, 1966: 36).

Remarks.—The genus ranges from the Paleocene to the Recent, from Europe, India, Australia, and the Far East. It is also known from the Californian Upper Paleocene with *Apiotoma andersoni* (Dickerson, 1914) and Eocene with *A. californica* Squires, 1987. *Apiotoma californica* is larger and has more subdued spiral sculpture than the type species *A. pirulata*, but is otherwise quite similar.

Subgenus ***LAVAROTOMA*** n. sgen.

Type Species.—*Apiotoma* (*Lavarotoma) alva* n. sp., here designated. Upper Paleocene, Texas.

Description.—Similar to *Apiotoma* but shell broadly fusiform; both axial and spiral sculpture stronger on earlier whorls, obsolete on body whorl; sinus as broadly open V, with apex above periphery.

Remarks.—The sinus is rather wider in *Lavarotoma* n. sgen. than in *Apiotoma*, reminiscent of the sinus shape in several Cretaceous genera, *viz. Remnita* Stephenson, 1941, *Amuletum* Stephenson, 1941, and *Scalaturris* Brébion, 1954. No species of *Lavarotoma* n. sgen. are known later than the Sabine Stage (Lower Eocene) in the Gulf Coast. The species aff. *Pleurotoma capex* Whitfield, 1865, also belongs in this subgenus.

Etymology.—The name *Lavaro* (Biblical, large vessel) + *toma* is a modification of *Pleurotoma*, referring to its broad whorls.

Apiotoma* (*Lavarotoma*) *alva n. sp.
Pl. 12, Figs 12–13

Description.—Shell broadly fusiform; whorls 7 or 8; protoconch of 3(?) whorls, first two smooth, followed by partial whorl of riblets; whorls with subsutural fold; concave shoulder smooth, broad, deep, comprising *ca.* ½ whorl, weakly convex below periphery; early whorls with 2 strong spiral lines, one on periphery, second below with weaker medial intermediate lines; teleoconch axial sculpture of moderately oblique costae, constant in strength from periphery to lower suture, rapidly dying out on shoulder; body whorl with both axial and spiral sculpture obsolete, weakly carinate basally; neck with strong spiral lines and intermediate weaker ones.

Remarks.—This is a puzzling species to place; the sinus is so shallow that one could contemplate an assignment in Fasciolariidae, but following the reasoning Wrigley (1939: 283) used in analyzing the character of the sinus-growth lines, this species is likely turrid in character. This species can be separated from aff. *Pleurotoma capex* Whitfield, 1895, by its narrower form, sharper medial carina, and prominent submedial spiral lines.

Etymology.—The specific name *alva* (Latin, belly or beehive) refers to the swollen body whorl.

Type Material.—Holotype: TMM NPL37749. Paratype: TMM NPL37750, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—36 specimens, the largest (paratype, TMM NPL37750) 18.3 mm in length.

Subfamily **TURRINAE** Powell, 1942

Genus ***CORONIA*** Gregorio, 1890

Type Species.—*Pleurotoma childreni* I. Lea, 1833 [= *P. acutirostra* (Conrad in Morton, 1834), by subsequent designation (Palmer & Brann, 1966 in 1965–1966: 607). Middle Eocene, Gosport Sand, Alabama.

Description.—Shell turriculate; spire generally longer than aperture; whorls straight to inflated with medial carina; protoconch of 2 or more smooth, rounded whorls, followed by 2 or slightly more with arcuate riblets; tip partially immersed, set at acute angle; transition from protoconch to teleoconch whorls gradual; whorls with spiral lines, with one prominent line defining subsutural collar, weaker below, stronger again over carina often making carina duplex in nature, finally with at least one stronger line between carina and lower suture; sinus broad, deep, with apex situated on carina; columella smooth, concave; short canal bent to left; outer lip without internal lirae.

Remarks.—The taxon *Coronia* Gregorio, 1890, was instituted as a subgenus for a diverse group of denticulate turrids, some dissimilar; Harris & Palmer (1947 in 1946–1947: 418) and Palmer & Brann (1966 in 1965–1966: 607) gave accounts of its taxonomic history. The genus is similar to *Gemmula* Weinkauff, 1875, so several authors have doubted its validity or usefulness; Harris (1937), Casey (1904), and Brann & Kent (1960) all used *Gemmula* exclusively to describe that group of denticulate turrids. Wenz (1943 in 1938–1944) synonymized it under *Hemipleurotoma* Cossmann, 1889; Harris & Palmer (1946–1947) gave it subgeneric rank under *Gemmula* for nine species; Gardner (1935, 1945), Powell (1966), Toulmin (1977), Dockery (1977, 1980), MacNeil & Dockery (1984), and Garvie (1996) each gave the taxon full generic rank. Tracey (1996: 74–75) expressed the view that *Coronia* should be placed in synonymy under *Gemmula*, because the distinguishing characters listed by Gardner (1945: 32) and Harris & Palmer (1947 in 1946–1947: 417–418) are too broadly defined and do not apply to all American species. The genus has been used for species in the Paleocene through Upper Eocene of the Gulf and eastern coasts of the U. S., and in combination with subgenus *Coroniopsis* MacNeil in MacNeil & Dockery,1984, for species in the Oligocene. Tracey (1996: 90–92) also used *Coroniopsis* as a subgenus of *Gemmula* for an English Middle Eocene species. To date, the earliest known *Coronia* is *C. mediavia* (Harris, 1896) from the Paleocene, Naheola Formation, but *Coronia* has now also been found in the Upper Cretaceous Kemp Clay in Texas (CLG).

That the American species of the *Coronia-Gemmula* group has been so taxonomically unstable prompted a review of many of the relevant species. For *Coronia*, specimens of the following species were examined: *C. mediavia* (Harris, 1896), *C. taylori* (Garvie, 1996), *C. childreni* (I. Lea, 1833), *C. carodenta* (Harris, 1937), *C. genitiva* (Casey, 1904), *C. alternata* (Conrad, 1833b), *C. conjuncta* (Casey, 1904), *C. margaritosa* (Casey, 1904), *C. lerchi* (Vaughan, 1896), *C. ancilla* (Casey, 1904), *C. lancea* (Casey, 1904), *C. nodulina* (Casey, 1904), *C. casteri* (Harris, 1937), and *C. carodenta* (Harris, 1937). Under *Gemmula*, in addition to the type species *G. hindsiana* Berry, 1958 [*cf.* Berry (1958: 86, and Keen (1971: 707)], the following species were examined: *G. constricta* (F. E. Edwards, 1861), *G. aspera* (F. E. Edwards, 1861), *G. denticulata* (Basterot, 1825), *G. plebian* (J. de C. Sowerby, 1850), *G. callifera* (F. E. Edwards, 1861), *G. monilifera* (F. E. Edwards, 1861) from the Eocene of England, *G. wateleti* (Deshayes,

1865) from the Cuisian (Paleocene) of France, *G. odontella* (F. E. Edwards, 1861) from the Oligocene of England, and from the Miocene of Germany: *G. zimmermanni* (Philippi, 1847), *G. spiralis* (Serres, 1829), *G.* cf. *boreturricula* (Kautsky, 1925), *G. coronata* (Münster, 1844), *G. badensis* (Hörnes, 1875), *G. denticulata borealis* (Glibert, 1954), and *G. hinschi* (Anderson, 1964).

Concentrating on differences between the two genera, the protoconch of *Gemmula* is multispiral, smaller, and more conical than that of *Coronia*, with 2–4 smooth whorls followed by 1–3½ with arcuate riblets; the sides are flatter and with a more pronounced curvature near the lower suture; the transition from protoconch to teleoconch is sharp; of the "*Gemmula*-like" species examined, the tip is never at an angle. *Coronia* always has a subsutural collar bearing one or two prominent spiral lines, a central carina rendered nodular by axials, and one or more spirals lines near the lower suture of approximately equal strength to the collar lines; typically in *Gemmula*, the peripheral carina is submedial in position, causing any subcarinal lines to be hidden under the next whorl, or often the lines cover most of the subperipheral area with no smoother section as in *Coronia*. The sinus of *Gemmula* is similar to that of *Coronia* near the suture, and when anteriorly distant from the periphery down the body whorl, but over the peripheral region the apex of the sinus, is moderately to strongly extended, causing a double change in the rate of curvature, always on the subsutural area and sometimes also below the periphery; the sinus of *Coronia* is always more gently rounded. Finally, *Coronia* never has lirae within the outer lip.

Restricting *Coronia* to the characters described above, one finds after examination that the following American species should be placed in *Gemmula*: *C. taylori*, *C. margaritosa*, *C. ancilla*, *C. alternata*, and *C. genitiva*. This leaves in *Coronia* the type, *C. childreni*, and *C. conjuncta*, *C. carodenta*, *C. lancea*, *C. mediavia*, and *C. casteri*. The Upper Cretaceous *Coronia* has the typical protoconch of that genus, an anal sinus and sculpture of squarish peripheral nodules that is continued in the Middle Eocene *C. childreni* and *C. carodenta*, but so far not known in the Paleocene. A second *Coronia* group, probably predating *C. mediavia* in the Paleocene, is apparently continued with *C. conjuncta* and *C. weisbordei* in the Upper Eocene, defined by a more rounded periphery with arcuate costae. It appears that the American *Gemmula* lineage might have diverged sometime after the Cretaceous because the Reklaw (lower Claibornian) species *G. taylori* exhibits the typical adult sculpture of squarish peripheral nodules framed by strong lines, continued with *G. margaritosa* and its allies.

No European *Gemmula* species are here assigned to *Coronia* because that should await a fuller investigation, but the Cuisian (Paleocene) species *G. wateleti* and a London Clay species (coeval to lower Claibornian) in the CLG could well be assigned to *Coronia*.

Coronia vallare n. sp.
Pl. 12, Figs 1–3

Description.—Shell small, fusiform; whorls 8–9 (?), with moderately inflated collar, convex shoulder, and prominently medially inflated whorls; protoconch with 2 smooth and 2 ribbed whorls; tip at acute angle to shell axis; suture impressed; sculpture of numerous brevic axials on periphery; axials rapidly dying out on shoulder, terminating below at first larger spiral line; spiral lines covering entire teleoconch, stronger on subsutural collar, on periphery, and between axials and lower suture; sinus broadly V-shaped with rounded apex on periphery; canal straight, relatively short.

Remarks.—No full-sized adult was obtained, so maximum size cannot be ascertained. To date, the only *Coronia* species known in the Gulf Coast Paleocene are *C. mediavia* and *C. m. equiseta* (Harris, 1899) from the Paleocene; those two and another variety in the Lower Eocene all are easily differentiated by their more V-shaped whorl profile and prominent squarish peripheral nodules. The curved brevic axials, thickened at the periphery, and V-shaped sinus are very reminiscent of *Eopleurotoma* Cossmann, 1889, but the present species is placed in *Coronia* because the sinus apex is on the periphery and the protoconch is typical of *Coronia*. The teleoconch sculpture is close to *Epalaxis crenulata* (Lamarck, 1804a in 1802–1806) from the Paris Basin Eocene, but *Epalaxis* Cossmann, 1889, has a different protoconch of 1½ smooth whorls, and the canal is moderately long, flexed, and weakly notched. All three genera—*Eopleurotoma*, *Coronia* and *Epalaxis*—appear closely related. The closest analog to this species is *Pleurotoma harrisi* W. B. Clark, 1895, from the Paleocene Aquia Formation of Maryland, which Palmer & Brann (1966 in 1965–1966) doubtfully assigned to *Eopleurotoma*.

Etymology.—The specific name *vallare* relates to *vallum* (Latin, pallisade) and refers to the almost-vertical peripheral axials.

Type Material.—Holotype: TMM NPL37718. Paratypes: TMM NPL37719 and NPL37747, all from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.
Material Examined.—11 specimens, the largest (holotype, TMM NPL37718) 11.5 mm in length.

Coronia aff. ***mediavia*** (Harris, 1896)
Pl. 13, Fig. 1

Pleurotoma mediavia Harris, 1896: 79, pl. 77, fig. 16; Casey, 1904: 37; Brann & Kent, 1960: 717.
?*Coronia mediavia* (Harris). Gardner, 1935: 214, 220.
Gemmula (*Coronia*) *mediavia* (Harris). Harris & Palmer, 1947 in 1946–1947: 418–419.
Coronia mediavia (Harris). Toulmin, 1977: 150, 409, pl. 16, fig. 1.

Remarks.—Harris (1899a: 11) referred both the Midway and "Lignitic" (Lower Eocene, Wilcox Group) forms to the same species, with the later one given varietal separation mainly due to its larger size, finer spiral striae, and more pronounced peripheral costae. The Seguin specimens are obviously in the developmental line, showing both the strength of the spiral striae and the development of peripheral costae to be midway in strength between those of the Midway and Wilcox forms. Toulmin (1977: pl. 6, fig. 1) figured a species that he referred to *Coronia mediavia* but it is probably not that species. The author has not examined Toulmin's specimen, but from the figure, the apex of the anal sinus appears to be above the periphery, the periphery is close to the lower suture, and the spire angle is close to 40°. In all specimens of *C. mediavia* in the author's collection (CLG), as well as from the figures by Harris (1896), and by Harris (1899a) for *C. mediavia* var., the spire angle is at or close to 30° and the peripheral carina is medial, so Toulmin's (1977: pl. 6, fig. 1) figure is unlikely to be *C. mediavia* and is probably not a *Coronia*.

Type Information.—Figured specimen: TMM NPL36186, from locality 11-T-13. Remaining hypotype in CLG.

Material Examined.—2 specimens, the largest (missing part of the canal, figured specimen, TMM NPL36186) 10.0 mm in length.

Coronia? sp.
Pl. 13, Fig. 2

Description.—Shell turreted, *Coronia*-like, with peripheral carina submedial and defined by row of indistinct squarish nodules. Spiral lines very fine, almost effaced on shoulder, stronger below peripheral nodules and on body whorl.

Remarks.—This species, missing the apex in all individuals available, but otherwise like *Coronia*, is present in the Seguin deposits. They are allied to *C. mediavia*, but both the spiral lines and peripheral costae are much finer and tend to form indistinct squarish nodules; also, the peripheral carina is not so pronounced. The general aspect of the species with the peripheral nodules are reminiscent of those of the *C. childreni* group. Without further specimens, no more definite assignment can be made. If it is a *Coronia*, it would only be the third *Coronia* in the Paleocene of the Gulf and Atlantic coasts together with *C. mediavia* and *Coronia* sp. (Clark & Martin, 1901: 127, pl. 20, figs 10–11) from the Aquia Formation of Maryland.

Type Information.—Figured specimen: TMM NPL36235, from locality 11-T-13. Remaining hypotype in CLG.

Material Examined.—2 specimens, the largest (figured specimen, TMM NPL36235) 6.2 mm in length.

Genus ***EOPLEUROTOMA*** Cossmann, 1889

Type Species.—*Pleurotoma multicostata* Deshayes, 1834, by original designation. Lutetian (Eocene), Paris Basin.

Description.—Shell moderately sized, elongate fusiform; spire slightly longer than aperture; protoconch initially smooth then with up to one whorl of curved riblets; surface sculpture of spiral lines and collabral ribs, strongest at periphery; sinus broad, open, with apex at or just above periphery; aperture narrowly ovate; canal short, slightly bent to left.

Remarks.—Among the characters by which Cossmann (1889: 81) noted that *Eopleurotoma* can be separated from similar genera is the paucispiral obtuse "embryo" (protoconch). However, as Tracey (1996: 62) noted, among the list of species that he included in the genus are several with multispiral protoconchs; Tracey explicitly included both species with paucispiral and multispiral protoconchs in his revised diagnosis of the genus. Harris (1937: 26–27) and Harris & Palmer (1946–1947: 426–427) placed more importance on other characteristics such as the "short peripheral costae or crenulations" and the "more or less evident crenulations on the subsutural collar" in assigning species to the genus. Certainly the American Eocene species include both paucispiral and multispiral protoconch representatives. Tracey (1996) synonymised the New Zealand genus *Eoturris* Powell, 1966, with *Eopleurotoma* because its only difference was the multispiral protoconch, thus extending the Tertiary range of the genus to include North and South America, Europe, and the Australasian region. Several European Paleocene representatives were listed by Cossmann (1889: 81), including: *Pleurotoma infraeocaenica* Cossmann, 1889, and *P. seelandica* Koenen, 1885. In the U. S., the only Paleocene representative doubtfully recognized by Palmer & Brann (1966 in 1965–1966) was cf. *Eopleurotoma potomacensis* (Clark & Martin, 1901) from the Aquia Formation of Maryland. The author has collected an *Eopleurotoma* species

from the Paleocene Matthews Landing beds of Alabama and a taxon very similar, if not identical, to *Eopleurotoma* also occurs in the Upper Cretaceous Kemp Clay Formation of Texas, so the ancestor of the lineage must be looked for even earlier.

Eopleurotoma molineuxae n. sp.
Pl. 12, Figs 4–5

Description.—Shell medium-sized, moderately fusiform; spire between 56% and 58% of shell length; protoconch of 2 smooth whorls followed by ½–¾ whorl of riblets; tip not immersed; transition to teleoconch distinct; teleoconch whorls moderately inflated medially, with broad collar and concave ramp; suture deeply impressed; surface sculpture of short collabral costae running from just below peripheral area to upper suture, rendering collar weakly crenulate on early whorls; subequal spiral lines covering entire surface and overriding axials, with one or 2 stronger ones on collar, becoming progressively stronger approaching lower suture; spiral lines on body whorl tending to alternate in strength, weaker again and of equal strength on neck; aperture narrowly ovate; columella straight; canal short, bent weakly toward left. Sinus as broad open U with apex situated just above periphery.

Remarks.—This is the most common turrid species in the Seguin exposures. There appear to be two similar groups under this taxon, one being very slightly broader in outline, and showing a little stronger and lower axial costation on the first few whorls, but otherwise similar; the difference is not deemed sufficient even for varietal separation. With the exception of the undescribed Matthews Landing species noted above and the variety described in the next section, no other species known to the author has the combination of characters seen in this species.

Etymology.—The specific name *molineuxae* is named after Dr. Ann Molineux, Curator and Collections Manager at the Texas Natural Science Center, whose indefatigable work at the institution is making the collections again accessible to researchers.

Type Material.—Holotype: TMM NPL37720. Paratype: TMM NPL37721, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.
Material Examined.—118 specimens, the largest (CLG 4395) 27.0 mm in length.

Eopleurotoma sp.

Description.—Shell slender; protoconch of 3½ smooth whorls followed by *ca.* ½ whorl of fine riblets; tip not immersed; transition to teleoconch distinct; teleoconch whorls moderately inflated medially, with broad collar and concave ramp; suture deeply impressed; surface sculpture of prominent collabral costae running from below peripheral area to upper suture, rendering collar nodular; subequal spiral lines covering entire surface; spiral lines of similar strength on body whorl and neck; aperture narrowly ovate; columella straight; canal short, bent toward left. Sinus as broad open U with apex situated just above periphery.

Remarks.—Two juvenile specimens, the largest with a damaged protoconch and 3½ teleoconch whorls, were obtained showing some similarity with *Eopleurotoma molineuxae* n. sp. The smaller individual has 3½ smooth whorls followed by ½ whorl of riblets. The shell is more slender, with stronger axial costation running from suture to suture, and a more nodular collar. Without more material, whether they should be given separate specific rank cannot be detremined.

Material Examined.—2 specimens in CLG, from locality 11-T-101, the largest (CLG 14909) 6 mm in length.

Family **CONIDAE** Fleming, 1822
Subfamily **MANGELIINAE** Fisher, 1883

Genus ***CRASSAURIS*** n. gen.

Type Species.—*Crassauris seguinensis* n. sp., here designated. Upper Paleocene, Texas.

Description.—Shell small, short; aperture *ca.* 50% of shell length. Protoconch of 3¼ smooth, inflated whorls. Teleoconch generally smooth, with prominent ramp, swollen subsutural collar, and sculpture of strong collabral ribs on ramp swinging forward to suture, which on body whorl die out before midsection; spiral sculpture very weak or absent except on base of body whorl. Outer lip expanded, thickened, with or without interior denticles, with stromboid-type notch. Anterior canal short, twisted, shallowly notched.

Remarks.—Were it not for the prominent anal notch on the shoulder, this species could well be assigned to the Nassariidae. Confusingly, prior to the final strong U-shaped notch, the growth lines defining previous notch positions are quite shallow. The smooth multiwhorled protoconch, the sinus on the shoulder slope, and the outer lip with denticles suggest an assignment in the Mangeliinae. This genus shares some simi-

larity to several other genera, notably the *Guraleus* Hedley, 1918, group, but although the shape, sculpture, and number of protoconch whorls is similar, the protoconchs of that group are all finely sculptured and do not possess the thickened expanded outer edge. Another New Zealand Miocene genus—*Mangaoparia* Vella, 1954—has at least a smooth protoconch, similar sculpture, but the canal is not twisted and the outer lip is not thickened. Geographically, if not coevally, are the similar genera *Nannodella* Dall, 1919, *Brachycythara* Woodring, 1928, and *Pachycythara* Woodring, 1928; they can all be distinguished by a subsidiary surface sculpture of microscopic "frosted" spiral threads, a straight anterior canal, and a nonvaricose outer lip. Several species of *Nannodella* have strong lirae on both outer and inner lips, and Woodring (1928: 194), remarked on the size of the anal notch being extraordinarily large for this size of shell, a character also shared by *Crassauris*. All of the previously mentioned genera have two or three of the primary characters found in *Crassauris*, but none possess all of them and might be probable descendants. The earliest presently known mangelid genera are the European Eocene *Buchozia* Bayan, 1873, and *Ambyacrum* Cossmann, 1889, but both appear further removed from *Crassauris* than the previous ones mentioned. The present genus extends the range of the Mangeliinae to the Upper Paleocene.

Etymology.—The name *Crass* (Latin, thick) + *auris* (Latin, ear) refers to the ear-like resemblance of the aperture and outer lip.

Crassauris seguinensis n. sp.
Pl. 14, Figs 1–2

Description.—Primary characters as in generic description. Teleoconch beginning with ¼ whorl of curved arcuate riblets; ramp generally developed by end of first whorl; body whorl of older individual showing ribs more numerous and weaker than on earlier whorls, and midsection almost devoid of axial or collabral sculpture.

Remarks.—Superficially, these specimens might be taken as allied to *Dorsanum scalatum* (Heilprin, 1891) on the basis of body shape and axial ribs, but the genus *Dorsanum* lacks an anal notch and its canal and neck are not extended as in *Crassauris*. Among American Paleogene Mangeliinae in the Gulf Coast, Atlantic, and West Coast faunas, there appears to be nothing similar. Searching further afield, there is an allied species in the Recent Antarctic fauna, *viz*. *Beladora striatula* (Thiele, 1912) (cf. Dell, 1990: 236–237, text-figs 421–422), a member of the Mangeliinae; this species also has a three-whorled protoconch, similar whorl shape, axial ornament, and a deeply concave sinus occupying the sutural ramp. *Beladora striatula* is a common species in the Ross Sea and thus also near the New Zealand faunal province (Dell, 1990: 238). It has already been noted that there is a connection between the New Zealand Paleogene and the American equivalent (Garvie, 1996: 58), with the genus *Carinacca* Marwick, 1924, so it appears that this could be another connection with an ancestor of *B. striatula.*

Etymology.—The specific name *seguinensis* refers to the formation from the species was found.

Type Material.—Holotype: TMM NPL37751, from locality 165-T-202. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-202, unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community, 31°02'07.55"N, 96°48'12.08"W, Milam County, Texas.

Material Examined.—8 specimens, the largest (CLG 16633) 8 mm in length.

Clade **HETEROBRANCHIA** Haszprunar, 1985
Informal Group **"LOWER HETEROBRANCHIA"**
Superfamily **ACTEONOIDEA** Cossmann, 1906
Family **ACTEONIDAE** Orbigny, 1843 in 1842–1843

Genus ***ACTEON*** Montfort, 1810

Type Species.—*Voluta tornatilis* Linnaeus, 1758, by original designation. Recent, European seas.

Description.—Shell usually small to very small; profile ovate to elliptical; protoconch usually not entirely visible, with tip enrolled; whorls rounded; suture impressed, sometimes channeled; sculpture of punctuate or incrementally latticed spiral grooves; aperture long, contracted above, basally expanded and rounded; outer lip thin; labrum with one fold, which is continuation of basal edge.

cf. ***Acteon*** sp.
Pl. 14, Fig. 3–4

Description.—Shell elongate; protoconch of at least 2 smooth whorls; tip missing in available material; teleoconch whorls shouldered; suture impressed; sculpture of closely spaced, flat-topped, spiral cords, somewhat wider spaced near posterior suture; interstitial spaces with fine axial threads. Body whorl of larger individual with cords and interstitial spaces of approximately same size.

Remarks.—Two specimens of this species were found that do not appear to correspond to any known species. Both individuals are embedded in hard matrix with the apertural features hidden. Impressions in the matrix of missing shell material show no impressions of lirae within the labrum, so the taxon cannot be assigned to *Tornatella* Conrad, 1860, a taxon usually exhibiting coarser sculpture than *Acteon*. Nothing known from the Paleocene or Eocene appears close to this species; only in the Oligocene, with *Acteon* (*Kleinacteon*) *puteatus* MacNeil in MacNeil & Dockery, 1984, does one find a species with similarly coarse sculpture.

Type Information.—Figured specimens: TMM NPL37752–NPL37753, from locality 11-T-13.

Material Examined.—2 specimens, the larger (figured specimen, TMM NPL37752) 12.1 mm in length.

Genus ***EOACTEON*** Stephenson, 1955

Type Species.—*Solidulus lineatus* Conrad, 1858, by original designation. Owl Creek Formation (Maestrichtian), Mississippi.

Description.—Shell ovate to elongate-subovate; spire ¼–⅓ of shell length; sculpture of fine to moderately broad incised grooves of regular or irregular spacing crossed by fine collabral threads; suture channeled; aperture elongate; inner lip callus thin; columella bearing one plication, not visible at aperture (after Sohl, 1964: 288).

Remarks.—Prior to this report, the genus was only known from the Upper Cretaceous Ripley, Monmouth, and Owl Creek formations of Tennessee, Maryland, and Mississippi. The author has also collected specimens of an *Eoacteon* species from the Kemp Formation in Texas.

Eoacteon sp.
Pl. 14, Fig. 5

Description.—Shell with 2 remaining whorls in available material; whorls weakly inflated; body whorl elongate, with anterior end slightly produced; suture deeply impressed, with subsutural ramp; sculpture of prominent raised spiral lines, one strong one defining edge of ramp; spirals slightly weaker below periphery; collabral growth lines appearing as minute threads within interstitial grooves; aperture narrowly elliptical; columella concave; callus wash thin; no plication visible.

Remarks.—The ramp defined on one side by the suture and the other by a raised line appears much like a channeled suture as seen in the genotype, *Eoacteon lineatus*. The closely similar genus *Fictoacteon* Stephenson, 1952, from the Cenomanian of Texas, is defined with form and spiral ornamentation like typical *Acteon*, but with no columellar fold, and thus scarcely differing from *Eoacteon*, one of the primary defining characters of which is a columellar fold that is not visible in the aperture. The original generic diagnosis of *Eoacteon* also mentioned a second weaker fold situated lower on the columella but that was not substantiated by Sohl (1964: 289). The ratio of spire length to shell length also cannot be used to differentiate the two genera because the five species of *Fictoacteon* (Stephenson, 1952: pl. 43, figs 18–27) show the ratio ranging from 0.26–0.37, and so overlap the range defined for *Eoacteon*, *viz.* 0.25–0.33. Stephenson mentioned that if a fold is present, it must be well back from the aperture, but no broken specimens were mentioned by him or anyone else that might confirm its presence; he did, however, note a swelling on the columella on two of his species, so it appears that it is just a matter of degree. Except for the fact that Sohl (1964: 289–290) corroborated the existence of the hidden folds on *Eoacteon*, one would place *Eoacteon* in synonymy with *Fictoacteon* because there would be no character to distinguish the two; they are in any case so close that I believe *Fictoacteon* deserves no more than subgeneric rank under *Eoacteon*. Stephenson (1952) noted that the Eocene genus *Semiacteon* Cossmann, 1899, could be considered for assignment, and one species is known from the Texas Eocene, *S. texanum* Garvie, 1996, but that genus has a weak columellar fold, an umbilical slit, and a regularly cancellate pattern generated by the spiral and axial ornament. Without more specimens, or a complete individual, I do not believe that one should yet give it a name. This adds to the small list of genera that cross the Cretaceous-Tertiary boundary.

Type Information.—Figured specimen: TMM NPL37754, from locality 11-T-13.

Material examined.—1 specimen (broken, TMM NPL37754), 4.5 mm in length.

Superfamily **ARCHITECTONICOIDEA** Korobkov, 1955
Family **ARCHITECTONICIDAE** Gray, 1850

Genus ***ARCHITECTONICA*** Röding, 1798

Type Species.—*Trochus perspectivus* Linnaeus, 1758, by subsequent designation (Gray, 1847: 151). Recent, Indo-Pacific.

Description.—Shell solid, umbilicate, subdiscoidal to flat; first whorl of protoconch inverted, with only final smooth inflated volution visible on apical surface; whorls numerous, regularly increasing in size; periphery carinate or rounded to flat; sculp-

ture usually of spiral cords, often beaded; aperture elliptical to subquadrate; outer lip thin, sharp.

Remarks.—The genus is known from the Upper Cretaceous with a maximum number of species during the Eocene.

Subgenus ***DINAXIS*** Aldrich, 1895a

Type Species.—*Architectonica alabamensis* (Dall, 1892 in 1890–1903), by subsequent designation (Bieler, 1985: 239). Paleocene, Gulf Coast.

Description.—Spire flattened, with circumference of shell forming periphery; umbilicus wide, nearly funicular, with spiral ribbing or smooth; umbilical carina smooth or finely nodose, forming base of shell.

Remarks.—Aldrich (1895a: 1) noted that Dall added a new section [subgenus] of *Solarium* (= *Architectonica*) to him by letter, which however was never published by Dall. Aldrich repeated Dall's diagnosis and so becomes the author. To date, it has not been used in the literature, but it is useful to be able to separate out those *Architectonica* species with characters as stated above, particularly those with a flat top and a wide, cone-shaped umbilical area. Aldrich (1895a) included *A. alabamensis* (Dall, 1892 in 1890–1903) and *A. planiformis* (Aldrich, 1892) in the "new section," to which *A. huppertzi* (Harris, 1895a) should also be included.

Architectonica* (*Dinaxis*)** cf. ***planiformis (Aldrich, 1895a)
Pl. 6, Figs 15–17

Solarium planiformae Aldrich, 1895a: 2, pl. 1, figs 4–6.
Architectonica planiformis (Aldrich)? Gardner, 1935: 301.

Description.—Shell flat; whorls 6, with apical one smooth. Side of body forming acute angle; edge beaded, margined on both sides by granulated line; two subsutural spiral lines; edge of body whorl slightly convex, forming nearly right angle with base. Basal keel beaded, margined by few spiral lines; umbilicus wide, with 2 or 3 beaded lines. Aperture wedge-shaped (after Aldrich, 1895a).

Remarks.—The specimens obtained from the Seguin are all juveniles, but agree quite well with the published description and figures of *Architectonica planiformis*; the relative proportions and spacing of the lines vary somewhat in the Seguin material, but is likely due to the species being juvenile.

Type Information.—Holotype: USNM 638919, from type locality near Rosebud post office, Wilcox County, Alabama. Figured Seguin specimen: TMM NPL36137, hypotype TMM NPL36138, both from locality 11-T-101. Remaining hypotypes in CLG.

Material Examined.—7 specimens, the largest (figured specimen, TMM NPL36137) 4.2 mm in length.

Genus ***SPIROLAXIS*** Monterosato, 1913

Type Species.—*Pseudomalaxis centrifuga* Monterosato, 1890, by monotypy. Recent, Atlantic Ocean.

Description.—Shell discoidal; nucleus anastrophic; whorls polygonal, biconcave, detached at some point of growth cycle; sculpture of crenulated ridges at whorl edges.

Remarks.—The original diagnosis of Monterosato (1890) restricts whorls to being quadrate in cross section and includes species with initially attached whorls that later become detached. There seem to be some disparate species included in this taxon; Wenz (1939 in 1938–1944: 669), Monterosato (1913: 363), Woodring (1928: 358–359), and Bieler (1984: 68) all noted a quadrate whorl profile as part of the generic diagnosis, yet Bieler (1985: 77) assigned *Spirolaxis* subgeneric rank under *Pseudomalaxis* Fisher, 1885, and included *Homalaxis cornuammonis* (Melville & Standen, 1903) in the taxon, a species with a five-sided whorl profile. Woodring (1928: 358) stated that *Spirolaxis* has the "last whorl or more uncoiled," for those species in which whorls are initially attached and then become detached. The problem is in recognizing this taxon when the shell is young and the whorls are still at the attached stage. Laws (1944: 308, pl. 44, fig. 22) figured *S. cohaerentia* Laws, 1944, from the Miocene of New Zealand, noted that it resembled *Pseudomalaxis* in the absence of uncoiling, and stated "this not infrequently characterizes only the later whorls of *Spirolaxis*" without, however, giving any citations to verify the statement. Bieler & Petit (2005: 70) re-assigned *Discohelix texana* Aldrich, 1911, a Middle Eocene species, to *Spirolaxis*; this species has a flat upper surface and concave basal surface and shows no sign of uncoiling. None of the 12 species mentioned by Palmer (1937: 177–178) or the two by Garvie (1996: 108–109), many of which have biconcave whorls, have been reported to have whorls initially in contact and later free. Without being able to recognize the growth stage of the shell, two courses are available: (1) restrict the genus to shells in which the teleoconch whorls are detached from the beginning; or (2) include in the genus all those with both detached and nondetached whorls with both upper and basal surfaces biconcave. In this case, some more common Eocene species such as *P. plummerae* Palmer, 1937, and *P. reklawensis* Garvie, 1996, would have to be transferred

to *Spirolaxis*, and would include species with affinities obviously closer to *P. rotella* (I. Lea, 1833), which is clearly not a *Spirolaxis*. The author has examined over 200 specimens of *P. plummerae* and *P. reklawensis*, with up to seven teleoconch whorls and both species with biconcave whorls, and observed no sign of the whorls becoming free. Because detached whorls are such an unusual occurrence, it seems preferable to separate those out under *Spirolaxis* and place the remainder under the genus *Pseudomalaxis*. This should cause no problems because the type species of *Spirolaxis* is an uncoiled shell whereas that of *Pseudomalaxis* (*P. zancelaea* Philippi, 1844) is a shell with attached whorls. The type *S. centrifuga* is a sublittoral species found in depths between 14 and 250 m (Engl, 1999).

Spirolaxis sp.
Pl. 6, Fig. 14

Description.—Shell very small; protoconch of 2½ smooth whorls ending in flange; nucleus anastrophic. Teleconch widely uncoiled, quadrate in cross section; outer rim vertical; sculpture of crinkled growth lines; outer edges with cord, noded where growth lines cross; inner edge (only top one visible) with minutely wrinkled cord.

Remarks.—One juvenile specimen was obtained, showing the anastrophic nucleus. Only one definitely uncoiled *Spirolaxis* species appears to be known from the Tertiary, *S. exquisita* (Dall & Simpson, 1901), which is also in the Recent fauna off of Puerto Rico. The closest Recent species appears to be *S. exornatus* Bieler, 1993, which like the present species is widely coiled, and shows collabral wrinkles and noded outer whorl edges. Most *Spirolaxis* and *Pseudomalaxis* species have smooth whorls surfaces between the edge ornamentation; in the Gulf Coast Cretaceous, several species show this feature, of which *P. paterniformis* Stephenson, 1955, can be mentioned. The lower Claibornian Reklaw species *P. reklawensis* Garvie, 1996, shows some collabral wrinkling, as does an undescribed Middle Eocene Claibornian species in the author's collection (CLG). The published figure of *S. cohaerentia* also shows a wrinkled surface.

Type Information.—Figured specimen: TMM NPL36193, from locality 11-T-13.

Material Examined.—1 specimen (TMM NPL36193), 0.8 mm in maximum diameter.

Superfamily **MATHILDOIDEA** Dall, 1889b
Family **MATHILDIDAE** Dall, 1889b
Genus ***GEGANIA*** Jeffreys, 1884

Type Species.—*Gegania pinguis* Jeffreys, 1884, by monotypy. Recent. Cape Modego, eastern Atlantic.

Description.—Shell small, coleoconoidal; nucleus blunt, immersed, partially covered. Whorls bluntly carinate, with deeply impressed sutures; sculpture of spiral lines and fine oblique growth lines. Body whorl equal or larger than remainder; base inflated. Aperture essentially circular, almost holostomatous; outer lip oblique; columella smooth, straight, or feebly concave; inner lip callus partially covering umbilicus.

Remarks.—The genus ranges from the Upper Cretaceous to Recent.

Gegania sp.
Pl. 5, Figs 18–20

Description.—*Gegania* with inflated whorls, 6 spiral lines on spire whorls, impressed suture, small umbilicus, and spire angle of *ca.* 32°.

Remarks.—Both *Gegania* and *Mathilda* Semper, 1865, have spiral lines or raised ribbons and oblique axial threads between the lines. The nuclear whorls of *Gegania* are partially immersed and set at an angle of *ca.* 45°, whereas in *Mathilda*, they are at an acute angle to the shell axis, erect, and visible. In the three specimens available, one is only a fragment of two whorls and the others are set in the matrix and have lost much of the shell material so that nuclear whorl characters cannot be determined. The only Paleocene *Gegania* species described to date is *G. marylandica* (Clark & Martin, 1901), which, with its large spiral cords and narrow interstices, has little in common with this species. Aldrich (1897) described *Tuba* (*Mathilda*) *leana* from the Greggs Landing Marl Member of the Tuscahoma Sand, a species with a spire angle of 35° and six spiral lines.

Type Information.—Figured specimens: TMM NPL37787–NPL37788 and CLG 11667, all from locality 11-T-13.

Material Examined.—3 specimens, the largest (figured specimen, TMM NPL37788) 13.7 mm in length; one is a fragment of two whorls.

Superfamily **PYRAMIDELLOIDEA** Wenz, 1938a
in 1938–1944
Family **PYRAMIDELLIDAE** Gray, 1840
Subfamily **PYRAMIDELLINAE** Gray, 1853

Genus ***PYRAMIDELLA*** Lamarck, 1799

Type Species.—*Trochus dolabratus* Linnaeus, 1758, by original designation. Recent, off of the coast of Florida and the West Indies.

Description.—Shell elongate-conic; whorls increasing regularly in size; columella with 1–3 folds; shell usually strongly polished and porcellaneous in luster (after Dall & Bartsch, 1904: 8).

Remarks.—The genus ranges from Paleocene to Recent. I follow the Dall & Bartsch (1904) grouping of pyramidellid genera and subgenera.

Subgenus ***SYRNOLA*** A. Adams, 1860

Type Species.—*Syrnola gracillima* A. Adams, 1860a, by original designation. Recent, off of the coast of Korea.

Description.—Shell slender, medium-sized, with one columellar fold, no umbilicus; surface marked by fine lines of growth and microscopic spiral lines; axial sculpture lacking; protoconch heterostrophic; postnuclear whorls increasing regularly in size.

Remarks.—Two species of *Syrnola* have been reported from the Gulf Coast Eocene of the U. S., one each by Garvie (1996: 117) and Palmer & Brann (1966 in 1965–1966: 867–869), and three from the western coast of the U. S. (Keen & Bentson, 1944: 276); none so far are reported from the Paleocene. In Europe, Cossmann & Pissarro (1910–1913 in 1906–1913), who treated *Syrnola* as a full genus with several associated subgenera, reported six species of *Syrnola s.s.* from the Paleocene of the Paris Basin.

Pyramidella* (*Syrnola*) *bilineata n. sp.
Pl. 14, Fig. 6

Description.—Shell small; protoconch heterostrophic; whorls almost straight; surface polished, microscopically spirally striated, with 2 stronger spirals in middle of whorl; growth lines elongate-sinuous, sometimes generating microscopic low axial folds and microscopically puckering posterior margin of whorl; body whorl basally rounded with somewhat stronger spiral striae; aperture suboval, with one highly oblique weak fold; columellar depression present.

Remarks.—Two specimens were available for study, one larger (holotype) missing the protoconch, and a second, smaller but with an intact protoconch, that was unfortunately lost after examination. This extends the range to the Paleocene in the U. S.; it cannot be confused with any of the other presently known Eocene species; the stronger double spiral lines and low folds are unique in character. The axial sculpture, although weak and microscopic, placed this species near the limits of what might define *Syrnola* according to Dall & Bartsch (1904), but it is still closer to this taxon than to any others previously defined, so is placed here.

Etymology.—The specific name *bilineata* refers to the two stronger spiral striae.

Type Material.—Holotype: TMM NPL37755 (missing the protoconch), from locality 11-T-13. Remaining hypotype in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—2 specimens, the largest (holotype, TMM NPL37755) 3.8 mm in length.

Subfamily **TURBONILLINAE** Bronn, 1849

Genus ***TURBONILLA*** Risso, 1826

Type Species.—*Turbonilla costulata* Risso, 1826, by subsequent designation (Hermannsen, 1852 in 1846–1852: 136). Pliocene, France.

Description.—Shell elevated, with prominent longitudinal ribs, sometimes also with spiral ornamentation; suture strongly impressed; aperture rounded-rhombohedral; columella with single low plication just visible within aperture; protoconch heterostrophic, considerably elevated.

Remarks.—The genus is known from the Paleocene to the Recent.

Subgenus ***CHEMNITZIA*** Orbigny in Webb & Berthelot, 1839

Type Species.—*Melania campanella* Philippi, 1836, by subsequent designation (Dall & Bartsch, 1904: 7). Recent, Mediterranean Sea.

Description.—Shell elevated; surface sculpture of strong axial ribs and intercostal grooves terminating posteriorly at peripheral collar; base smooth or with axial ribs sometimes continued obsoletely over base; intercostal spaces sharply terminating before produced line of suture.

Remarks.—Laws (1937) treated the taxon as a full genus and described many species ranging from the Eocene to Recent in the New Zealand region. One Recent species, *Turbonilla* (*Chemnitzia*) *aequalis* (Say, 1827) is known from Vineland Sound on the U. S. eastern coast, and another, *T.* (*C.*) *papillosa* Trask, 1855, is from the Pleistocene of Santa Barbara.

Turbonilla* (*Chemnitzia*) *obliqueata n. sp.
Pl. 14, Fig. 7

Description.—Shell small; protoconch heterostrophic; whorls flat to weakly convex; suture deeply impressed; subsutural collar inflated; sculpture of numerous, axial, opisthocline ribs bending to left as approach upper suture, there forming weak nodes; body whorl basally smooth; aperture ovate; columella straight, with strong plication close to junction with body whorl.

Remarks.—This appears to be the earliest record for the taxon *Chemnitzia*. Wenz (1940 in 1938–1944: 870) had the taxon ranging from the Eocene to Recent, and almost worldwide in distribution.

Etymology.—The specific name *obliqueata* (Latin, slanting) refers to the slanting ribs.

Type Material.—Holotype: TMM NPL37756, from locality 165-T-202. Remaining hypotype in CLG.

Type Locality.—Locality 165-T-202, unnamed branch of Pond Creek crossing dirt road near Mt. Zion Cemetery in Woodal Farm community, 31°02'07.55"N, 96°48'12.08"W, Milam County, Texas.

Material Examined.—2 specimens, the larger (holotype, TMM NPL37756) 5.5 mm in length.

Subfamily **ODOSTOMIINAE** Pelseneer, 1928

Genus ***ODOSTOMIA*** Fleming, 1818

Type Species.—*Turbo plicatus* Montagu, 1803, by subsequent designation (Gray, 1847: 159). Recent, off of the British Isles.

Description.—Shell small to very small, high, conical. Protoconch low, considerably immersed. Whorls usually smooth, occasionally with spiral sculpture. Aperture not holostomous; labrum sometimes lirate; columella concave with one strong fold; sometimes umbilicate.

Remarks.—The genus is known from the Upper Cretaceous to the Recent.

Subgenus ***DOLIELLA*** Monterosato, 1880

Type Species.—*Odostomia* (*Doliella*) *nitens* Jeffreys, 1870, by subsequent designation (Dall & Bartsch, 1909: 15). Recent, Mediterranean Sea off of Sicily.

Description.—Postnuclear whorls sculptured similarly throughout; no varices present; shell polished with no axial sculpture; spiral sculpture consisting of more-or-less conspicuous spiral ridge.

Remarks.—To date, the genus has been recognized from the Eocene to the Recent.

Odostomia* (*Doliella*) *deprimere n. sp.
Pl. 14, Fig. 8

Description.—Whorls 6; protoconch > 50% immersed; initial teleoconch whorls flat to weakly inflated; last teleoconch whorl and body whorl with medial sulcus; sculpture smooth; summit of whorls with weak revolving line; aperture ovate-lunate; one prominent fold on upper part of columella; base smoothly rounded.

Remarks.—The only other species of *Doliella* in the Gulf Coast Paleogene is *Odostomia* (*Doliella*) *ova* Garvie, 1996, which is separated by the carinated base, more elongate form, and no medial sulcus.

Etymology.—The specific name *deprimere* (Latin, depression) refers to the medial sulcus.

Type Material.—Holotype: TMM NPL37757. Paratype: TMM NPL46620, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—7 specimens, the largest (holotype, TMM NPL37757) 4.8 mm in length.

Superfamily **RINGICULOIDEA** Philippi, 1853
Family **RINGICULIDAE** Philippi, 1853
Genus ***RINGICULA*** Deshayes in Lamarck, 1838

Type Species.—*Auricula ringens* Lamarck, 1804b in 1802–1806, by subsequent designation (Gray, 1847: 140). Eocene, Paris Basin.

Description.—Shell small, oval to globose; spire moderate in extent. Protoconch heterostrophic, deviated; nucleus partially immersed. Whorls inflated. Ornament usually of punctuate spiral striae; sutures impressed. Aperture auriform, contracted above, notched basally. Outer lip varicose, dentate; labrum thickened, toothed above; columella with 2 folds, lower one defining basal edge.

Ringicula alabamensis Aldrich, 1897
Pl. 14, Fig. 9

Ringicula alabamensis Aldrich, 1897: 9, pl. 2, figs 8, 8a; H. J. Plummer, 1933: 54, 61–62; F. B. Plummer in Sellards *et al.*, 1933: 566; *cf.* Gardner, 1935: 210 (similar).

Description.—Shell small; apex blunt; whorls 5, first two smooth, others spirally grooved, grooves fine, close-set; aperture long, narrow; border of posterior notch reaching beyond suture; outer lip reflected, flattened, anteriorly faintly striated; columellar callus posteriorly strong, with 2 posterior folds at acute angle from one another and third stronger one defining base of columella.

Remarks.—Within the spiral grooves, one observes a finer version of the zigzag pattern so characteristic of the Cretaceous species *Ringicula anfractolineata* Stephenson, 1941; the pattern is still detectable, but is much fainter on *R. butleriana lignitifera* Aldrich, 1897, on which the pattern might also be described as punctuate. Some Seguin specimens are slightly more slender than *R. alabamensis* from the Matthews Landing beds, and also show this zigzag pattern, but the latter is intermediate in strength between that of *R. alabamensis* from the Matthews Landing beds and *R. b. lignitifera* from the Lower Eocene, Sabine Stage; the difference is not regarded as needing even varietal separation.

Type Information.—Holotype: USNM 638797, from Matthews Landing, Alabama River, Wilcox County, Alabama. Figured Seguin specimen: TMM NPL37758, from locality 11-T-101. Remaining Seguin hypotypes in CLG.

Material Examined.—17 specimens, the largest (figured specimen, TMM NPL37758) 2.5 mm in length.

Informal Group **OPISTHOBRANCHIA**
Milne-Edwards, 1848
Superfamily **PHILINOIDEA** Taylor & Sohl, 1962

Family **CYLICHNIDAE** H. & A. Adams, 1854

Genus ***CYLICHNA*** Lovén, 1846

Type Species.—*Bulla cylindracea* Pennant, 1777, by subsequent designation (Hermannsen, 1852 in 1846–1852: 42). Recent, off of the British Isles.

Description.—Shell small to very small, elongate to cylindrical; whorls posteriorly truncated with apical concavity; apex sometimes umbilicated; aperture length of body whorl, narrow posteriorly, expanded anteriorly; columella short, thickened, with one oblique fold; sculpture of fine spiral lines, sometimes smooth.

Remarks.—Only a few species of *Cylichna* have been reported from the Middle Eocene and earlier from the Gulf and Atlantic Coastal Plains, *viz*. *C. vetusta* W. B. Clark, 1895, from the Paleocene and Lower Eocene of Maryland, *C.* (*Cylichnopsis*) *acrotoma* Cossmann, 1893, from the Middle Eocene of Alabama, and *C. (?) conica* (Whitfield, 1892), from the Middle Eocene of Alabama and New Jersey. The genus becomes increasingly common from the Oligocene onward. The genus is probably more common than the literature would suggest; the author has noticed superficially similar *Cylichna* species mixed in with lots of *Retusa* (*Cylichnina*) *galba* (Conrad, 1833a) in museum and other collections.

Subgenus ***CYLICHNOPSIS*** Cossmann, 1904

Type Species.—*Cylichna* (*Cylichnopsis*) *acrotoma* Cossmann, 1904, by original designation. Claibornian Eocene, Alabama.

Description.—Shell subcylindrical, posteriorly truncated forming almost flat surface; apical umbilicus covered by callus; labrum thickened posteriorly; sculpture of growth lines and spiral striae; aperture narrow, widening anteriorly; columella thick; umbilical chink almost entirely covered by oblique fold.

Cylichna* (*Cylichnopsis*) *bicarinata n. sp.
Pl. 14, Figs 10–11

Description.—Shell small, elongate-conic; labrum broadly rounded basally, extended into blunt point above body whorl; apical truncated area sharply carinated at edge; callus covering *ca.* 50% of apical umbilical area; edge also sharply carinate, with line of both carinae terminating at point; columella progressively widening into flat band as it spirals into aperture with weak fold rotating into aperture from just under body

whorl; columellar edge impressed; umbilical depression present.

Remarks.—No U. S. *Cylichnopsis* species were previously known from the Paleocene. Two Eocene species are known: the type, *C. acrotoma*, which is separated by its shorter form, a weak posterior extension of the outer lip, and only a few spiral striae anteriorly; and *Cylichna*? (*Cylichnopsis*) *compara* Vokes, 1939, from the Californian Eocene, which has the extension of the outer lip, but the apex is perforate and the columellar callus is reflected over the base of the shell. Decidedly more closely related are two species, both from the Upper Cretaceous of Texas: *Cylichna secalina* Shumard, 1861, and *Cylichna incisa* Stephenson, 1941. Stephenson (1941) did not assign the taxa to subgenera; both are spirally striate throughout, both more ovate than *Cylichna bicarinata*, and both with an open apical umbilicus. *Cylichna secalina*, in common with *C. bicarinata*, also has the wide umbilical band and a very small or closed umbilicus; but for the open apex, they would be placed in *Cylichnopsis*.

Etymology.—The specific name *bicarinata* (Latin, double line) refers to the double apical carinae.

Type Material.—Holotype: TMM NPL37759. Paratype: TMM NPL37760, both from locality 11-T-101. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—6 specimens, the largest (CLG 14916) 5 mm in length.

Genus ***MNESTIA*** H. & A. Adams, 1854

Type Species.—*Bulla marmorata* A. Adams in G. B. Sowerby II, 1849, by subsequent designation (Cossmann, 1895 in 1895–1925: 99). Recent, Philippine Islands.

Description.—Shell ovately cylindrical, spirally striated; lines stronger and wider apart at ends; spire inconspicuous, immersed in deep apical umbilicus; aperture narrow, acuminately produced above and below; outer lip solid; columella short, concave, reflected against basal whorl.

Mnestia ovata n. sp.
Pl. 14, Figs 12–13

Description.—Shell small, subovate, conically tapering posteriorly above widest point; columella straight, oblique, parallel with outer lip, moderately reflected over umbilical slit or depression; sculpture of spiral lines over entire surface, slightly weaker in wide area above median.

Remarks.—This record extends the range of the genus from the Eocene to the Paleocene. The two lower Claibornian Reklaw species, *Mnestia rotunda* Garvie, 1996, and *M. confusa* Garvie, 1996, are closest to this species. *Mnestia confusa* is more rotund, has smooth whorls, and a large umbilicus; *M. rotunda* is more conical posteriorly and more slender, and has smoother whorls. *Mnestia ovata* n. sp. is also much larger than either Reklaw species.

Etymology.—The specific name *ovata* (Latin, ovate) refers to the ovate outline of the species.

Type Material.—Holotype: TMM NPL37761. Paratype: TMM NPL37762, both from locality 11-T-101. Remaining hypotype in CLG.

Type Locality.—Locality 11-T-101, dry creek at mouth with Colorado River, 30°10'58.53"N, 97°28'22.62"W, Bastrop County, Texas.

Material Examined.—3 specimens, the largest (paratype, TMM NPL37762) 3.6 mm in length.

Family **RETUSIDAE** Thiele in Kukenthal & Krumbach, 1925

Genus ***RETUSA*** Brown, 1827

Type Species.—*Bulla obtusa* Montagu, 1803, by original designation. Recent, off of the coast of the British Isles.

Description.—Shell small, cylindrical-pyriform; spire low, sunken or involute; aperture length of body or more, posteriorly narrow, anteriorly flaring; columellar fold weak to absent; body whorl smooth or with fine spiral striae; labrum usually opisthocline at suture.

Subgenus ***CYLICHNINA*** Monterosato, 1884

Type Species.—*Cylichnina laevisculpta* Grillo, 1877, by original designation. Recent, western Mediterranean Sea.

Description.—Shell small to very small, cylindrical to ovate; spire depressed; previous whorls not visible; body whorl posteriorly rounded, usually spirally striate, at least anteriorly;

aperture narrow, extending posteriorly beyond the apex; columella excavated usually with fold.

Retusa* (*Cylichnina*) *bastropensis n. sp.
Pl. 14, Figs 14–15

Description.—Shell very small; central part of whorls subcylindrical, more constricted anteriorly; posteriorly perforated; apex somewhat produced in young, rounded in adult; outer lip extending slightly above body whorl in adult, proportionately more so in young; aperture weakly broadening anteriorly; columella thickened with incipient fold just anterior to umbilical chink; surface smooth with fine spiral lines covering entire surface, slightly finer medially.

Remarks.—A similarly sculptured Paleocene species is *Retusa* (*Cylichnina*) *emoryi* Gardner, 1935, which can be separated by its more conical-ovate outline and almost flat posterior extremity. Another Paleocene species is *R.* (*C.*) sp. (= *Bullinella* Newton, 1891, sp. of LeBlanc in Barry & LeBlanc, 1942), from the middle Midway of Louisiana; from the figure (LeBlanc in Barry & LeBlanc, 1942: pl. 19, fig. 14), this species is more regularly cylindrical and also similarly flat-topped as *R. emoryi*. A *Retusa* (*Cylichnina*) sp. from the Paleocene Naheola Formation of Alabama and originally doubtfully referred (Harris, 1896: 75, fig. 7) to the common Claibornian species *R.* (*C.*) *galba* (Conrad, 1833a) has the typical elongate-oval outline of *R. galba* but only has spirals lines on the base. The author has collected an undescribed species with similar spiral sculpture that appears to be the precursor of *R. bastropensis* n. sp. and also *R. emoryi*, from the Kincaid Formation along the Brazos River, but it is sufficiently different in other respects to deserve its own specific designation.

Etymology.—The specific name *bastropensis* refers to the county from which the species was found.

Type Material.—Holotype: TMM NPL37763. Paratype: TMM NPL37764, both from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—38 specimens, the largest (CLG 14915) *ca.* 4.0 mm in length.

Class **CEPHALOPODA** Cuvier, 1797
Subclass **NAUTILOIDEA** Agassiz, 1847
Order **NAUTILIDA** Agassiz, 1847
Superfamily **NAUTILACEAE** Blainville, 1825
Family **HERCOGLOSSIDAE** Spath, 1927

Genus ***CIMOMIA*** Conrad, 1866a

Type Species.—*Nautilus burtini* Galeotti, 1837, by monotypy. Eocene, near Brussels, Belgium.

Description.—Shell subglobular to discoidal, nautiloconic; umbilicus small; umbilical shoulders low, broadly rounded; surface smooth except for growth lines; suture with broad, shallow ventral saddle and lateral lobe, narrower and higher rounded lateral saddle near umbilical shoulder; siphuncle small, never marginal.

Cimomia contraria n. sp.
Pl. 15, Figs 1–6

Description.—Shell large, wide; venter smoothly rounded, flattening out below; below that, curving smoothly again into umbilicus; suture with shallow lateral lobe and slightly more pronounced lateral saddle; suture curving strongly in adapertural direction over venter; internal outline reniform, smoothly rounded.

Remarks.—The strongly adaperturally curved growth lines on the venter is unique for this genus; only in *Cimomia vaughani* Gardner, 1923, is there any similarity. *Cimomia vaughani* shows that feature to a much lesser extent, and then only in the largest whorls of an adult; it also differs in not flattening out below the venter. At locality 11-T-13, fragments of nautiloids and juveniles of this species were not uncommon; larger specimens were no doubt broken by the Paleocene current and wave action. All larger individuals come from locality 165-T-202 at which, apart from one specimen of *Volutocorbis olssoni* F. B. Plummer in Sellards *et al.*, 1933, they were the only species found there.

Etymology.—The specific name *contraria* (Latin, contrary) refers to the suture shape over the venter.

Type Material.—Holotype: TMM NPL37765, from locality 165-T-201. Paratypes: TMM NPL37766, from locality 165-T-201; NPL37767–NPL37768, juveniles, from locality 11-T-13. Remaining hypotypes in CLG.

Type Locality.—Locality 165-T-201, Pond Creek, 1 mile upstream from highway FM 2027, 31°01'19.55"N, 96°49'18.90"W, Milam County, Texas.

Material Examined.—10 specimens, the largest (holotype, TMM NPL37765) 166 mm in maximum diameter.

Genus ***ANGULITHES*** Montfort, 1808

Type Species.—*Nautilus triangularis* Montfort, 1802, by original designation. Upper Cretaceous, England and France.

Description.—"Conch very involute, generally compressed, whorl sides slightly convex, strongly convergent, venter narrowly rounded to angular; suture moderately sinuous with a narrowly rounded ventral saddle, a broad lateral lobe, a narrow, rounded saddle, and a small lobe on the umbilical shoulder; siphuncle small and located near the dorsum" (Kummel, 1956: 453–454).

Angulithes*? *palaeocenica n. sp.
Pl. 16, Figs 1–4

Description.—Whorl large, compressed, smooth; sides convex to straight; venter rounded to flattened; suture weakly sinuous; ventral lobe and saddle very broad; umbilical shoulder lobe moderately sized; umbilicus small; siphuncle near periphery.

Remarks.—The whorl shape is like that of *Angulithes* but the position of the siphuncle is not typical. The siphuncle position is more typical of some *Hercoglossa* Conrad, 1866b, species, particularly *H. gardnerae* Stenzel, 1940, or *H. orbiculata* (Tuomey, 1854), but in these species, the whorl shape is subglobular to subdiscoidal, and shows a more prominently sinuous sutural line. No specimens available show the umbilical details well. Museum labels state that these specimens came from locality 11-T-13, but the matrix shows that they probably derive from the ironstone indurated layer, which is *ca.* 9.5 m below the concretionary boulder layer and represents a quieter depositional environment.

Etymology.—The specific name *palaeocenica* refers to the presence of the genus in the Paleocene.

Type Material.—Holotype: TMM BEG35561-3. Paratypes TMM BEG35561-1 and BEG35561-2, all from locality 11-T-13.

Type Locality.—Locality 11-T-13, unit EE, small side branch of a creek *ca.* 152 m from the cattle pond, 30°15'51.23"N, 97°25'02.03"W, Solomon's Farm, Bastrop County, Texas.

Material Examined.—3 specimens, the holotype (TMM BEG35561-3) 230 mm in diameter.

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PLATES

PLATE 1

Figure

1. Locality 11-T-13, section of fossiliferous indurated matrix with an embedded 4-cm quartzite pebble. 10

2–3. *Nucula* (*Gibbonucula?*) *seguinensis* n. sp., locality 11-T-3, left valve, holotype (TMM NPL37725), 3.9 mm length; 2.9 mm height. 13
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3. Interior view.

4–5. *Nuculana milamensis* (Harris, 1895). 14
4. Locality 165-T-2, exterior view, right valve embedded in matrix, broken holotype (TMM BEG35671); 12.3 mm valve length; 6.2 mm valve height.
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6–7. *Nuculana corpulentoides* (Aldrich, 1985), locality 11-T-3. 14
6. Exterior view, left valve (TMM NPL37728) embedded in matrix; 14 mm valve length; 8 mm valve height.
7. Interior view, right valve (TMM NPL37729), 13.5 mm length; 7.8 mm height.

8. *Adrana seguinensis* n. sp., locality 165-T-202, exterior view, right valve, holotype (TMM NPL37730); 18.8 mm length; 6.5 mm height. 15

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11. *Isognomon* (?) sp., locality 11-T-3, exterior view, right valve (TMM NPL37733) embedded in matrix; 6.4 mm valve length; 8.7 mm valve height. 17

12. *Calorhadia diminutia* n. sp., locality 11-T-3, exterior view. right valve (TMM NPL37894) embedded in matrix; 8.85 mm valve length; 7.02 mm valve height. 15

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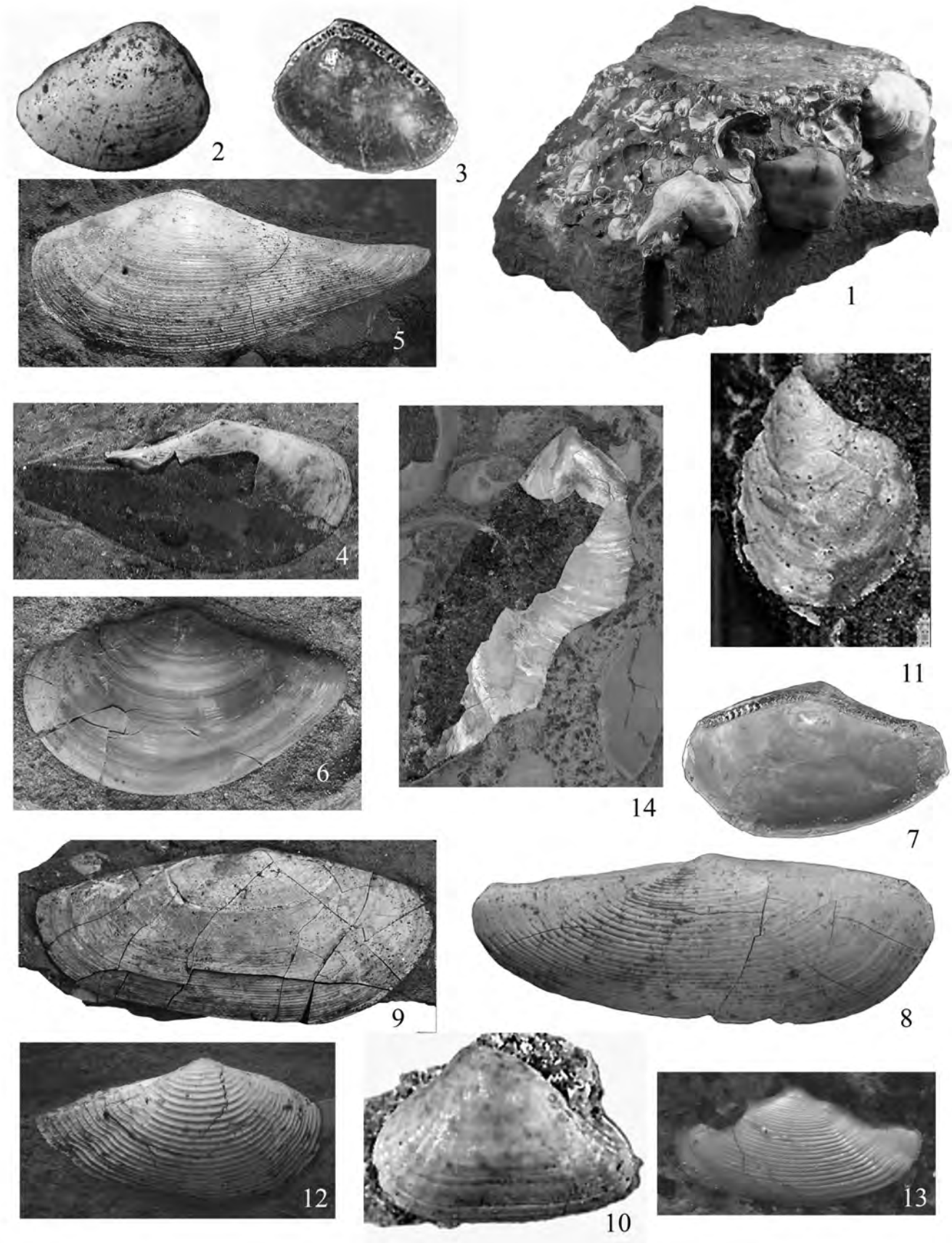
14. PTERIOIDEA sp., locality 11-T-3, exterior view, left? valve (TMM NPL36144) embedded in matrix; 17.5 mm valve height. 17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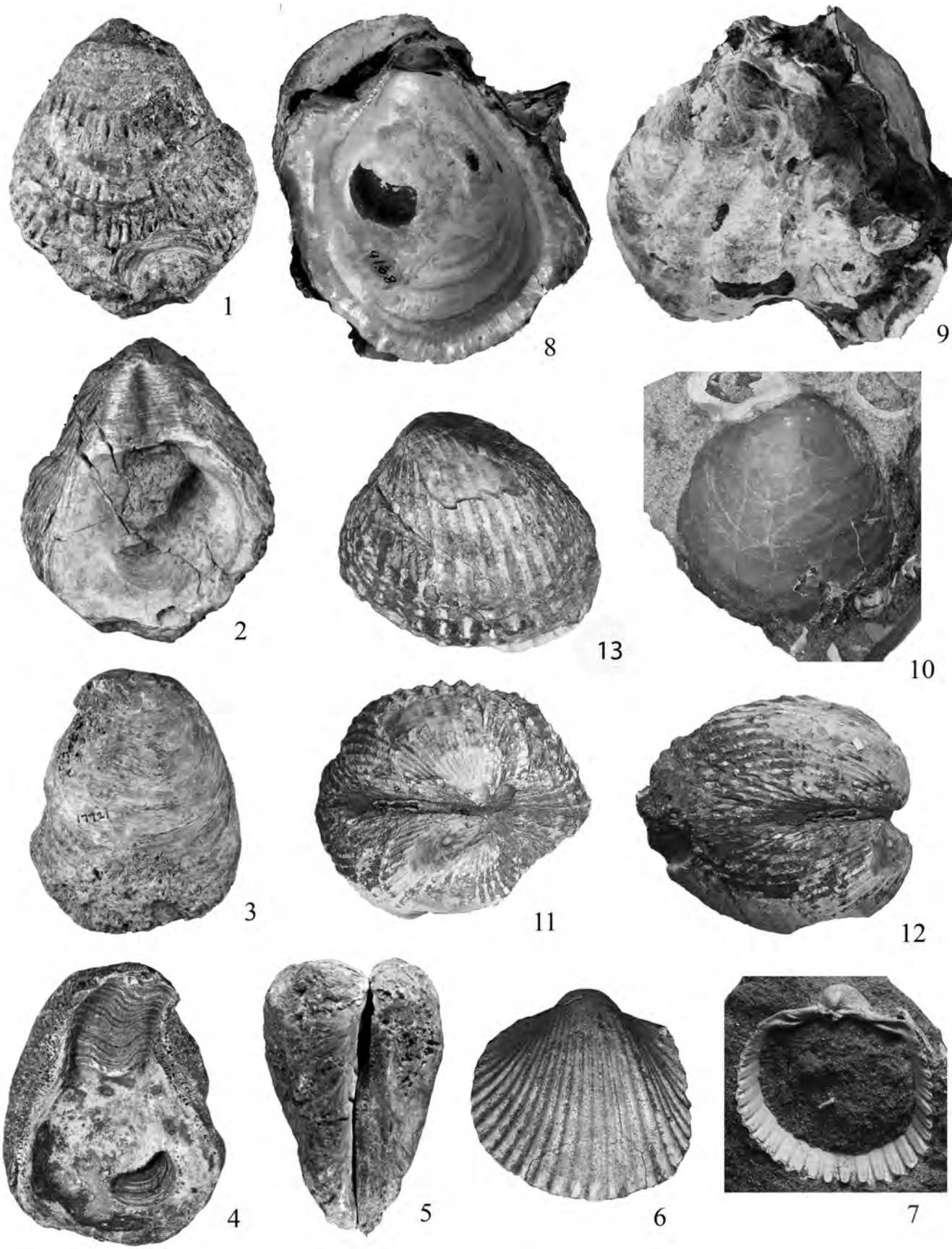
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Plate 2

Figure

1–5. *Turkostrea duvali* (Gardner, 1927), locality 11-T-4; 60.0 mm length; 62.1 mm height. 19
1–2. Left valve.
1. External view.
2. Internal view.
3–4. Right valve.
3. External view.
4. Internal view.
5. View of both valves in locked position.

6–7. *Acanthocardium* (*Schedocardia*) cf. *hatchetigbeense* (Aldrich in Smith, 1886), locality 165-T-202. . . 22
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8–9. *Ostrea multilirata* Conrad in Emory, 1857, locality 11-T-3. 18
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12. Umbonal view.
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PLATE 3

Figure

1. *Katherinella* sp., locality 11-T-100, exterior view, left valve (TMM NPL37744); 6.0 mm length; 5.0 mm height. 25

2–3. *Arcopagia* (*Johnsonella*) *seguinensis* n. sp., locality 165-T-202. 24
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4. External view, left valve embedded in matrix, holotype (TMM NPL37740); 18.0 mm valve length; 14.5 mm valve height.
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7. Locality 165-T-202, interior view, right valve fragment prepared to show hinge details and pallial sinus (TMM NPL37743); 21.7 mm length; 17.4 mm height.

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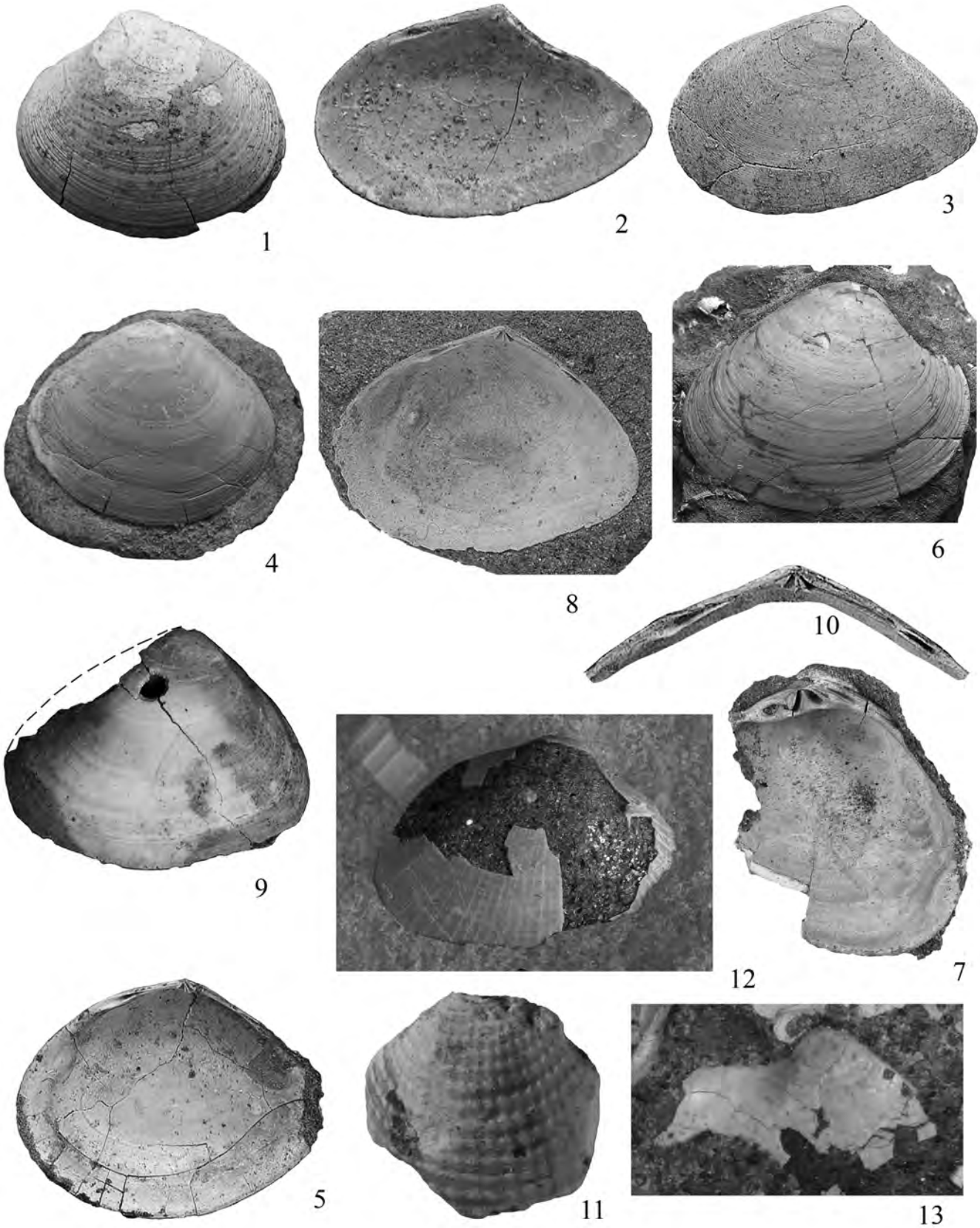
12. aff. *Poromya* sp., locality 11-T-101, exterior view (TMM NPL36148) embedded in matrix; 3 mm valve length. 28

13. *Panopea* sp., locality 11-T-13, exterior view (TMM NPL36237) embedded in matrix; 9 mm valve length. 29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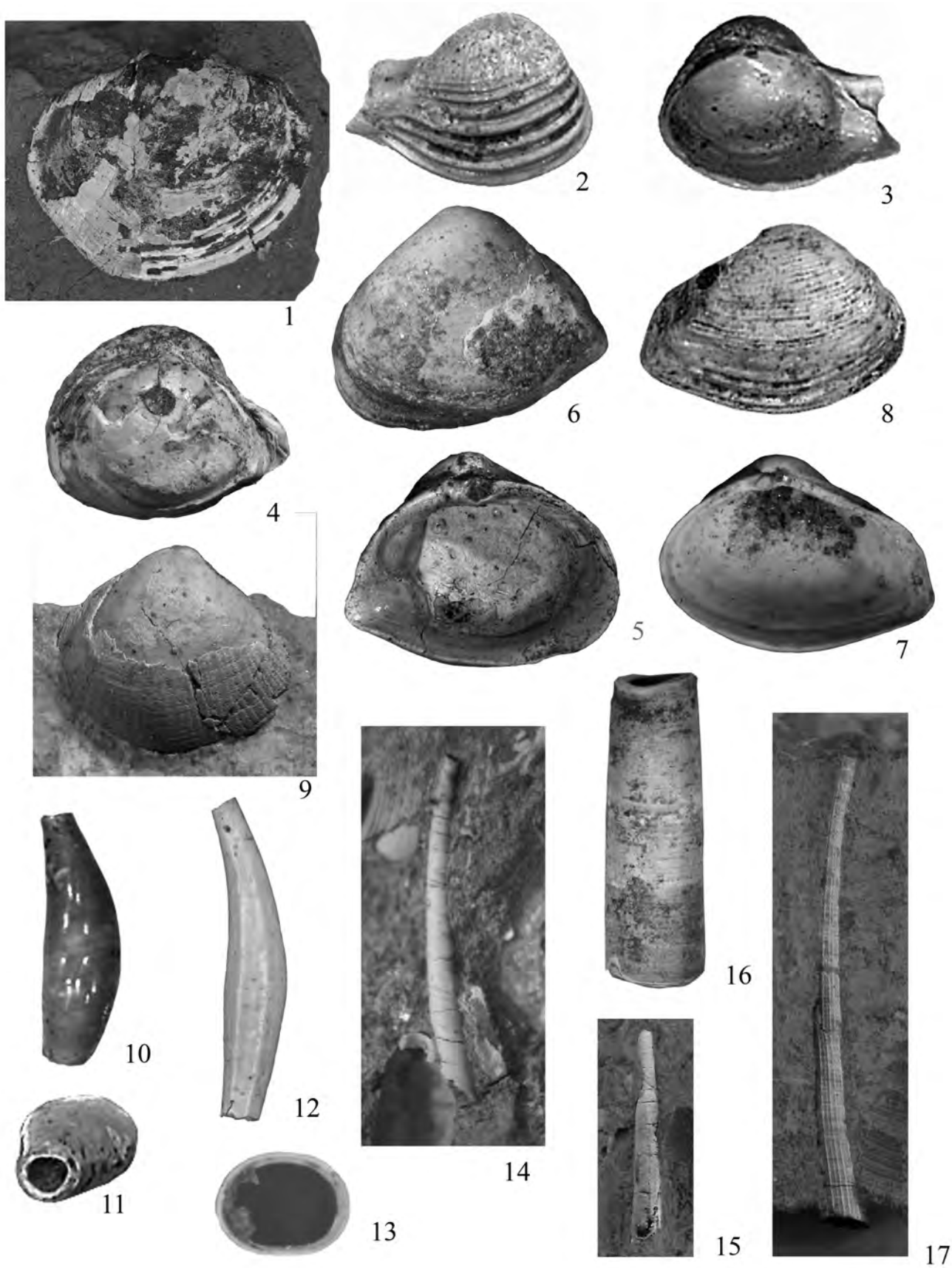
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Plate 4

Figure

1. *Cochlodesma* cf. *howei* (Barry in Barry & LeBlanc, 1942), locality 11-T-101, exterior view, right valve embedded in matrix, Seguin specimen (TMM NPL36236); 35.8 mm valve length. 28

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3. Interior view.
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12–13. *Cadulus* (*Gadila*) cf. *palmerae* Hodgekinson, 1974, locality 11-T-13. 31
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16–17. *Dentalium* aff. *mediaviense* Harris, 1896, locality 11-T-101. 29
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PLATE 5

Figure

1–3. *Turritella polysticha* Stenzel & Turner, 1940. 36
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4–5. *Turritella mortoni crassa* n. ssp., locality 11-T-101. 36
4. Apertural view, paratype (TMM NPL37781), juvenile; 3.8 mm length.
5. Apertural view, holotype (TMM NPL37780) embedded in matrix; 9.1 mm shell length.

6–8. *Tylotrochus extremus* n. sp., locality 11-T-13. 31
6. Apertural view, holotype (TMM NPL37782); 30 mm length.
7. Apertural view, specimen (CLG 4353) with more evenly rounded whorls; 25 mm length.
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9–11. *Teinostoma* (*Idioraphie*) *seguinensis* n. sp., locality 11-T-13, holotype (TMM NPL37784); 1.9 mm maximum diameter. 37
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12–14. *Solariorbis velarum* n. sp., locality 11-T-101, holotype (TMM NPL37786); 3.7 mm maximum diameter. 38
12. Apical view.
13. Basal view.
14. Apertural view.

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18. Dorsal view, broken specimen (TMM NPL37787) showing external sculpture; 6.0 mm length.
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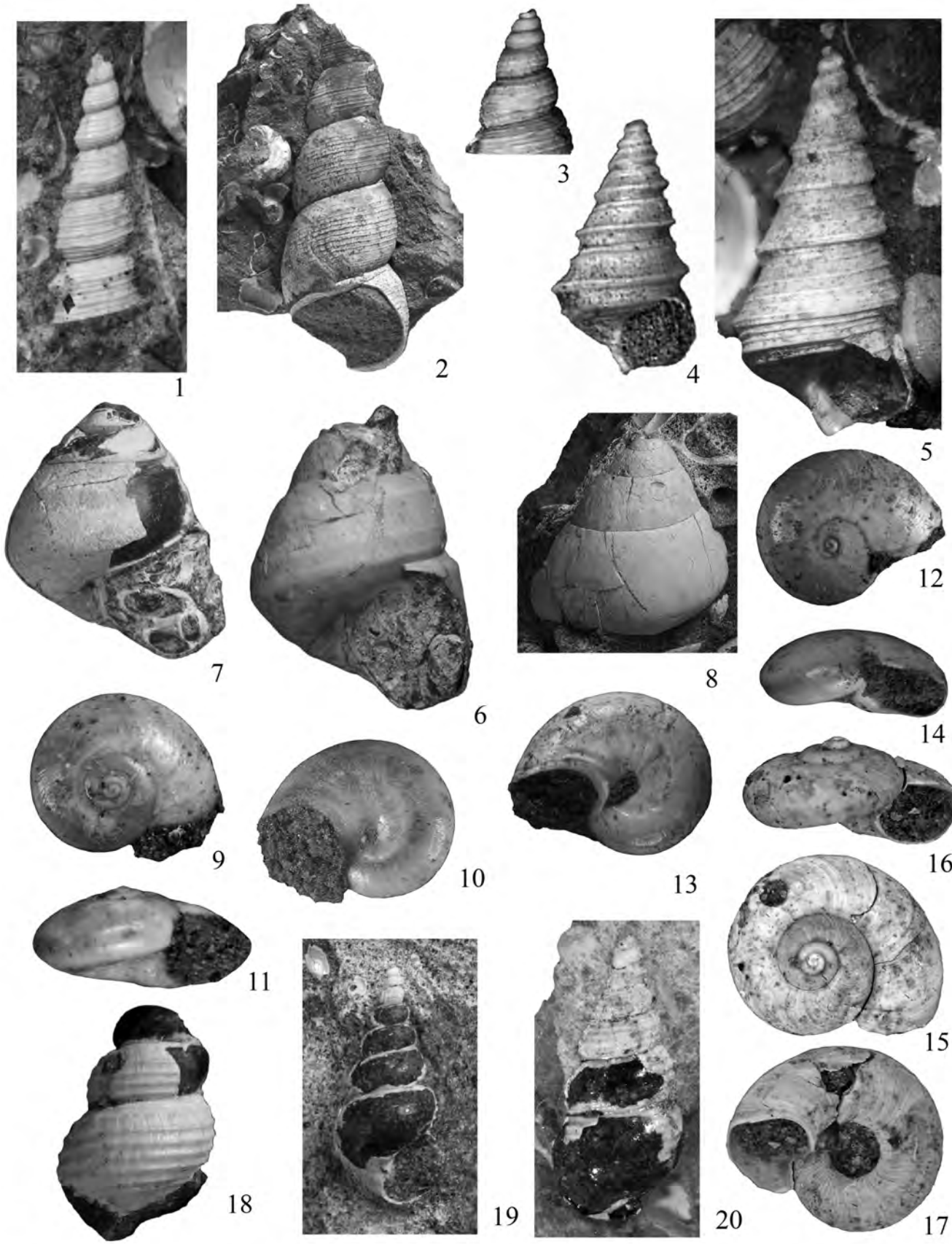
20. Dorsal view, specimen missing most of last two whorls of shell surface (CLG 11667) embedded in matrix; 7.6 mm shell length.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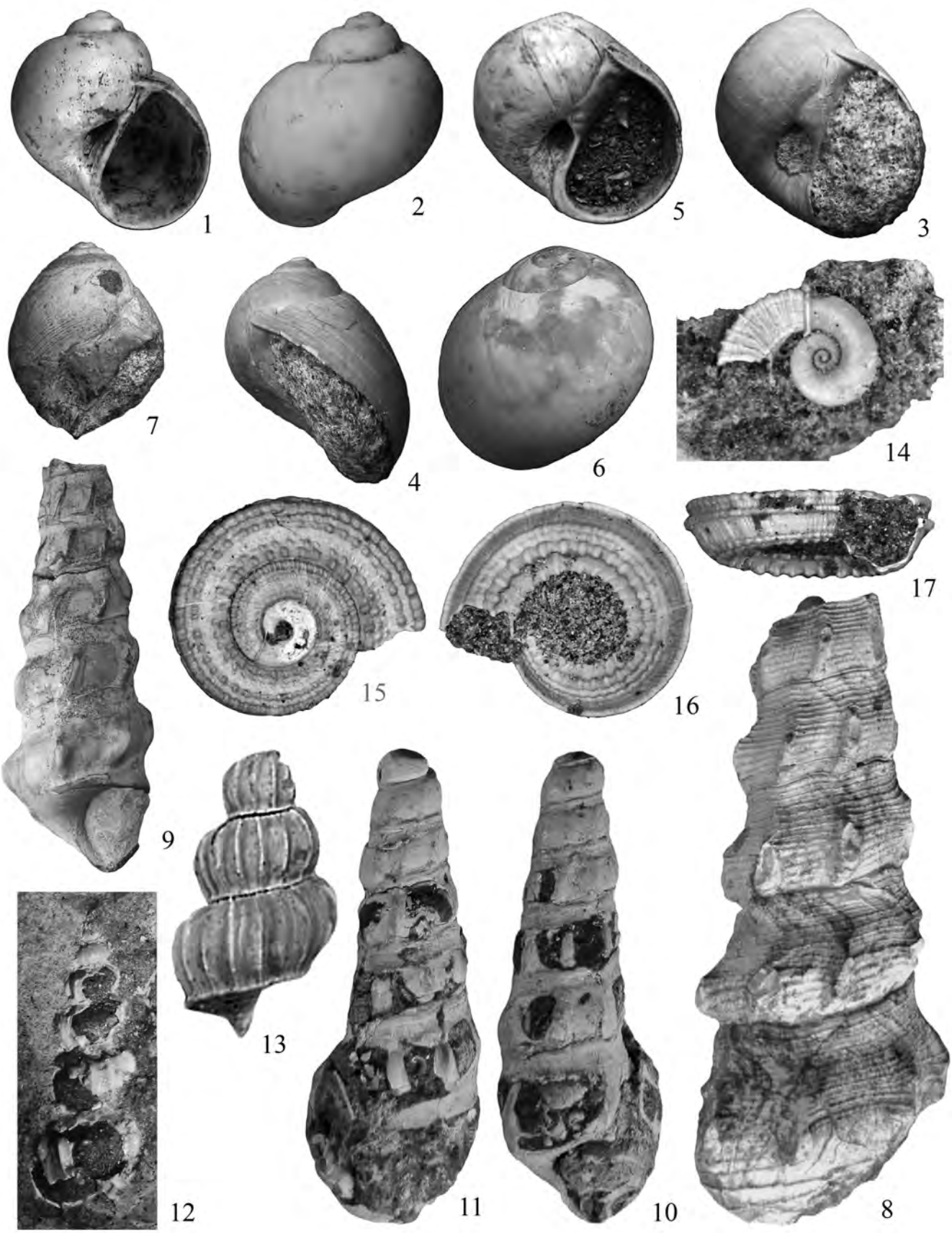
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Plate 6

Figure

1–2. *Natica* (*Carinacca*) *seguinensis* n. sp., locality 11-T-13, holotype (TMM NPL37813); 7.5 mm length. 39
1. Apertural view.
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3–4. *Polinices* (*Polinices*) *eminulus* (Conrad, 1833b), locality 11-T-13, Seguin specimen (TMM NPL37816); 13.0 mm length. 40
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6. Dorsal view.

7. *Polinices* (*Polinices*) cf. *onustus* (Whitfield, 1865), locality 11-T-13, apertural view, Seguin specimen (TMM NPL37817); 14.6 mm length. 40

8–9. *Pachymelania penrosei* (Harris, 1895), locality 11-T-13. 32
8. Dorsal view, substantially complete specimen (TMM BEG37900) showing details of the axial and spiral sculpture; 66.0 mm length.
9. Apertural view, specimen with worn surface (CLG 4379), but showing apertural details; 57.0 mm length.

10–11. *Texmelanatria contracta* n. sp., locality 11-T-13, holotype (TMM NPL37818); 62.0 mm length. 33
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11. Dorsal view.

12–13. *Rugatiscala* sp., locality 11-T-13. 42
12. View of specimen missing most of the shell surface (TMM NPL37789), embedded in matrix; 13.7 mm shell length.
13. Dorsal view of three whorls of a juvenile specimen (TMM NPL37790); 2.6 mm length.

14. *Spirolaxis* sp., locality 11-T-13, apical view of a juvenile specimen (TMM NPL36193) embedded in matrix; 0.8 mm maximum diameter. 77

15–17. *Architectonica* (*Dinaxis*) cf. *planiformis* (Aldrich, 1895a), locality 11-T-101, Seguin specimen (TMM NPL36137); 4.27 mm length. 76
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16. Basal view.
17. Apertural view.

PLATE 7

Figure

1–3. *Texmelanatria brevis* n. sp., locality 94-T-1. 34
1. Apertural view, holotype (TMM NPL12654) showing transition from early axial ribs to nodular ornamentation; 35.5 mm length.
2. Apertural view, paratype (TMM NPL12651); 28.3 mm length.
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4–6. *Loxotrema texana* n. sp. 35
4. Locality 11-T-19, apertural view, holotype (TMM NPL12659); 45.5 mm length.
5. Locality 94-T-1, apertural view, paratype (TMM NPL12567) embedded in matrix, showing early whorls; 45.8 mm shell length.
6. Locality 94-T-1, apertural view, paratype (TMM NPL37819) showing transitional sculpture between young and adult; 34.5 mm length.

7. *Melanatria*? sp., locality 94-T-1, dorsal view, large partially prepared syntype (TMM NPL37897); 63.4 mm length. 34

8–10. *Pseudoliva ostrarupis* Harris, 1895a, locality 11-T-13. 43
8. Apertural view, neotype (TMM NPL37821); 38 mm length.
9. Apical view, paratype (NPL37617); 10.1 mm maximum diameter.
10. Dorsal view, juvenile (TMM NPL37822) showing spiral sculpture, 8.9 mm lengrh.

11–13. *Pseudoliva globosa* n. sp., locality 11-T-13. 43
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12. Dorsal view.
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14–15. *Lisbonia pauper* (Harris, 1895), locality 11-T-13. 44
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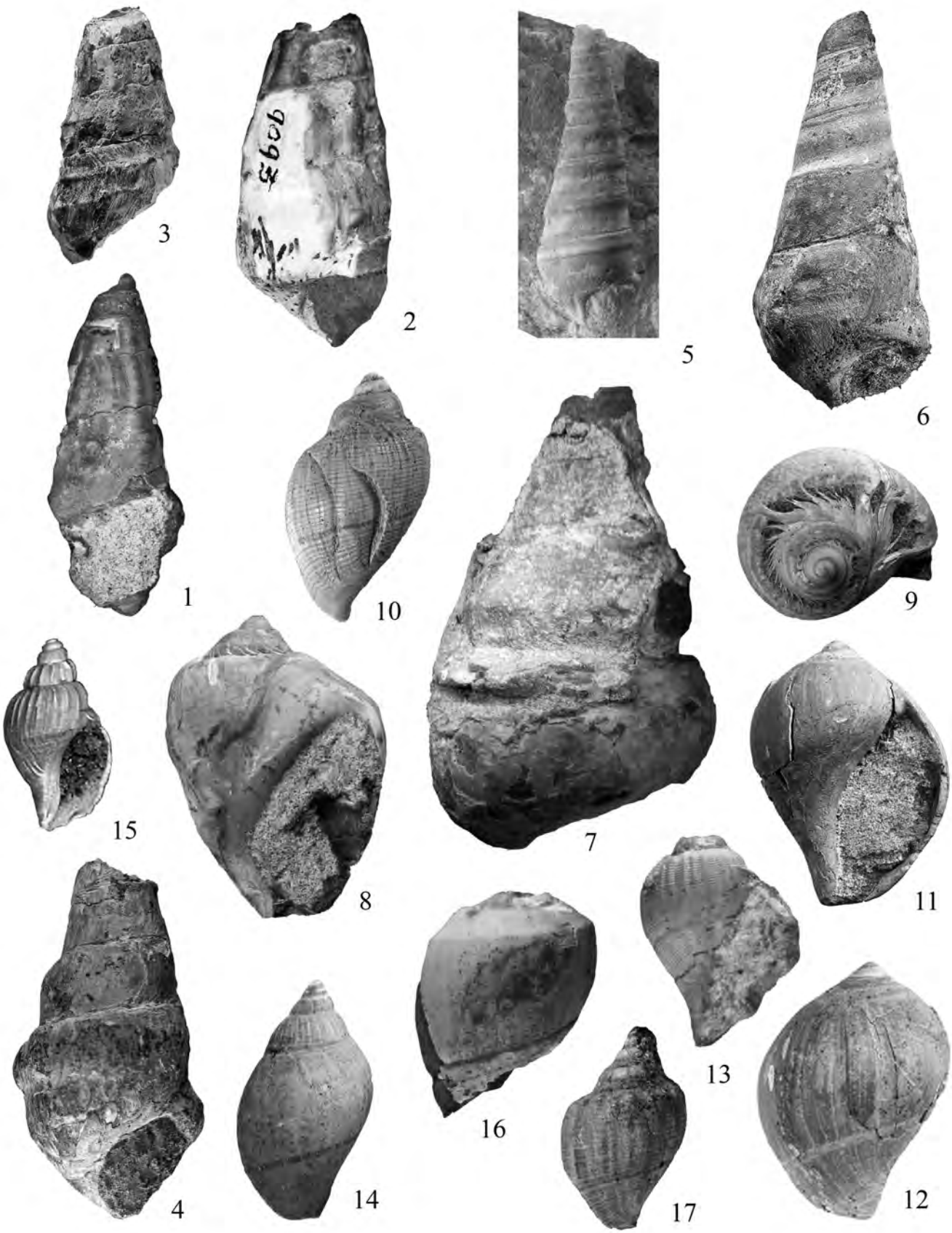
16–17. *Pseudoliva* sp., locality 11-T-13. 44
16. Dorsal view, specimen missing most of spire and end of base (TMM NPL37827); 17.8 mm length.
17. Dorsal view, juvenile (TMM NPL36145) showing early ornamentation; 9.8 mm length.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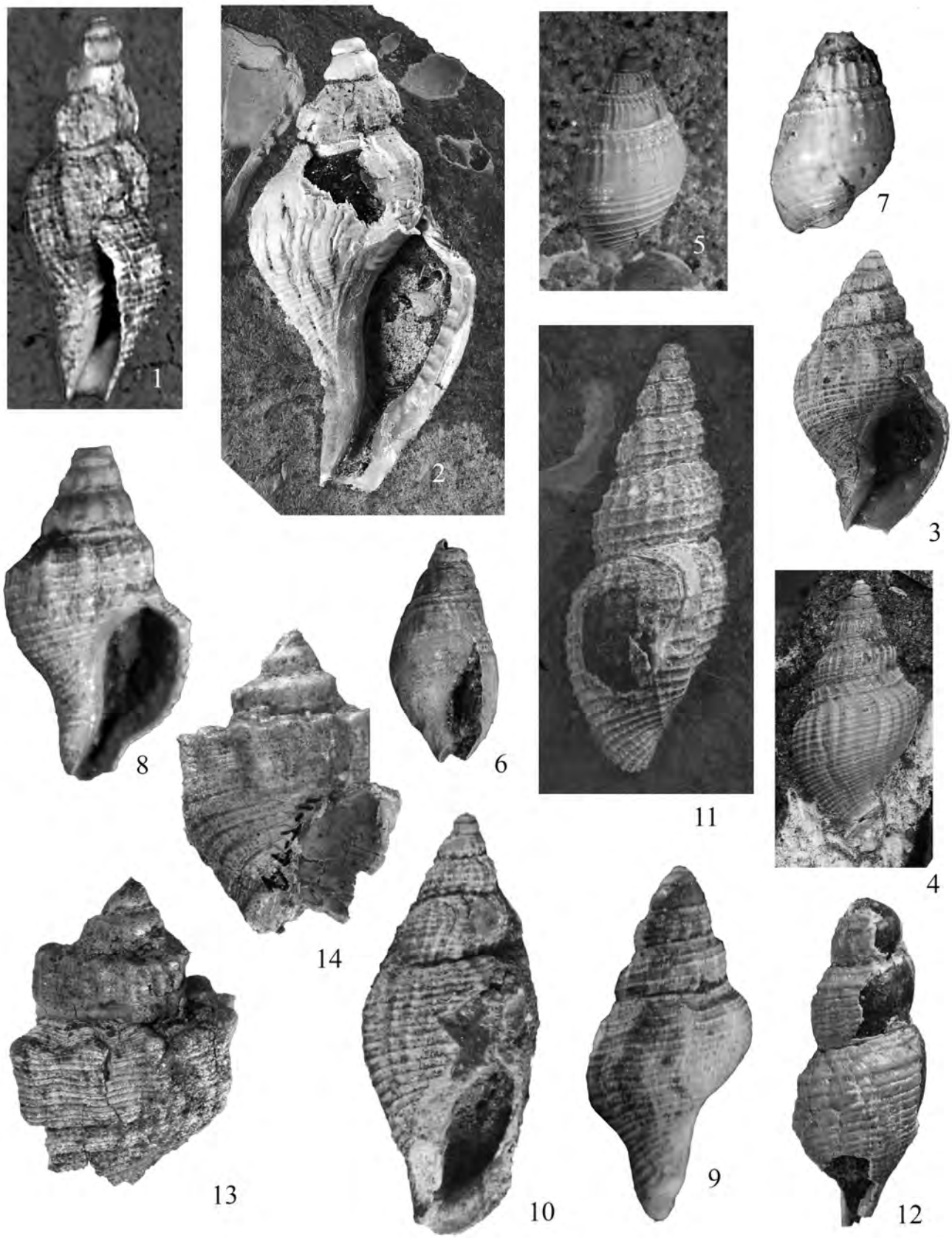
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Plate 8

Figure

1. *Terebrifusus* aff. *amoenus* (Conrad, 1833b), locality 11-T-101, apertural and slightly lateral view, young individual (TMM NPL37828) embedded in matrix; 5.6 mm length. 45

2. *Cantharus seguinensis* n. sp., locality 11-T-13, apertural view, holotype (TMM NPL37829) embedded in matrix; 18.7 mm length. 46

3–4. *Colwellia humerosa* n. sp., locality 11-T-13. 47
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4. Dorsal view, paratype (TMM NPL37832) embedded in matrix; 13.4 mm length.

5–6. *Colwellia nodulina* n. sp., locality 11-T-13. 47
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8–9. *Tritiaria*? *seguinensis* n. sp., locality 11-T-101. 48
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9. Dorsal view, paratype (TMM NPL37861); 4.7 mm length.

10–11. *Metula reticulata* n. sp., locality 11-T-101. 49
10. Apertural view, holotype (TMM NPL37862); 10.2 mm length.
11. Dorsal view, paratype (TMM NPL37863) embedded in matrix; 12.2 mm length.

12. *Metula*? sp., locality 11-T-13, dorsal view, specimen (TMM NPL37864); 15.0 mm length. 49

13–14. *Pleuroploca* aff. *plummeri* (Gardner, 1935), locality 11-T-74, Seguin specimen (TMM NPL9318); 28.5 mm length. 50
13. Dorsal view.
14. Apertural view.

PLATE 9

Figure

1. *Lirofusus* sp., locality 11-T-101, dorsal view, specimen (TMM NPL37864) embedded in matrix; 15.0 mm length. 50

2–3. *Latirus* (*Levarlatirus*) *ostrarupis* (Harris, 1895), locality 165-T-2, holotype (TMM BEG35596); 13.8 mm length. 52
2. Apertural view.
3. Dorsal view.

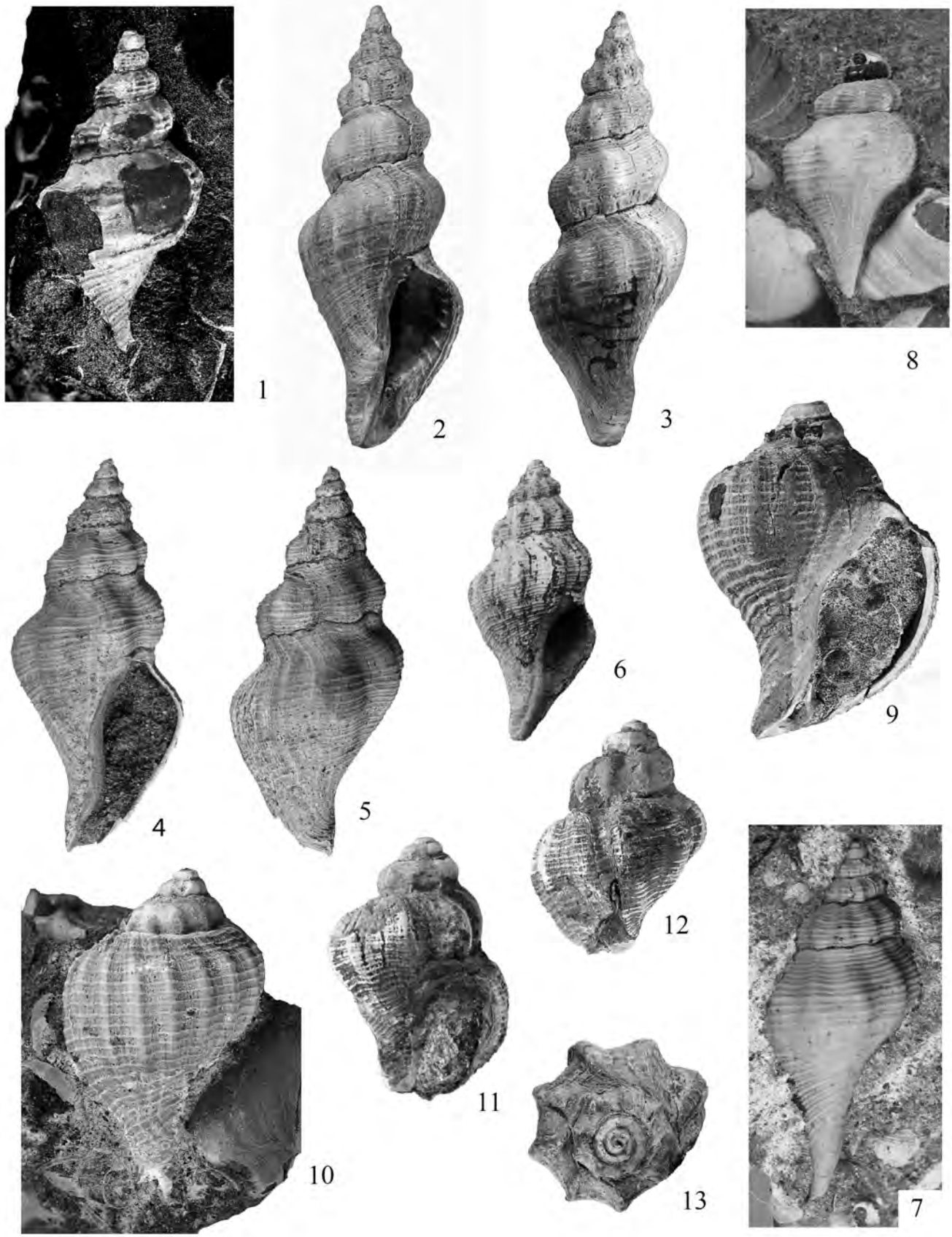
4–5. *Latirus* (*Levarlatirus*) *undus* n. sp., locality 11-T-202, holotype (TMM NPL37865); 26.0 mm length. 53
4. Apertural view.
5. Dorsal view.

6–7. *Latirus* (*Levarlatirus*) *textilis* n. sp. 53
6. Locality 165-T-200, apertural view, holotype (TMM NPL37867); 15.2 mm length.
7. Locality 11-T-13, dorsal view, specimen (TMM NPL37869) embedded in matrix; 14.8 mm length.

8. *Latirus*? aff. *stephensoni* Gardner, 1935, locality 11-T-13, dorsal view, incomplete specimen (TMM NPL37870) embedded in matrix; 12.3 mm length. 54

9–10. *Strepsidura cancellata* n. sp., locality 11-T-13. 55
9. Apertural view, holotype (TMM NPL37871); 16.5 mm length.
10. Dorsal view, paratype (TMM NPL37872) embedded in matrix; 16.8 mm length.

11–13. *Texaficus obesus* n. sp., locality 11-T-13. 56
11–12. Holotype (TMM NPL37874); 19.4 mm length.
11. Apertural view.
12. Dorsal view.
13. Apical view, paratype (TMM NPL37875); 14.3 mm length.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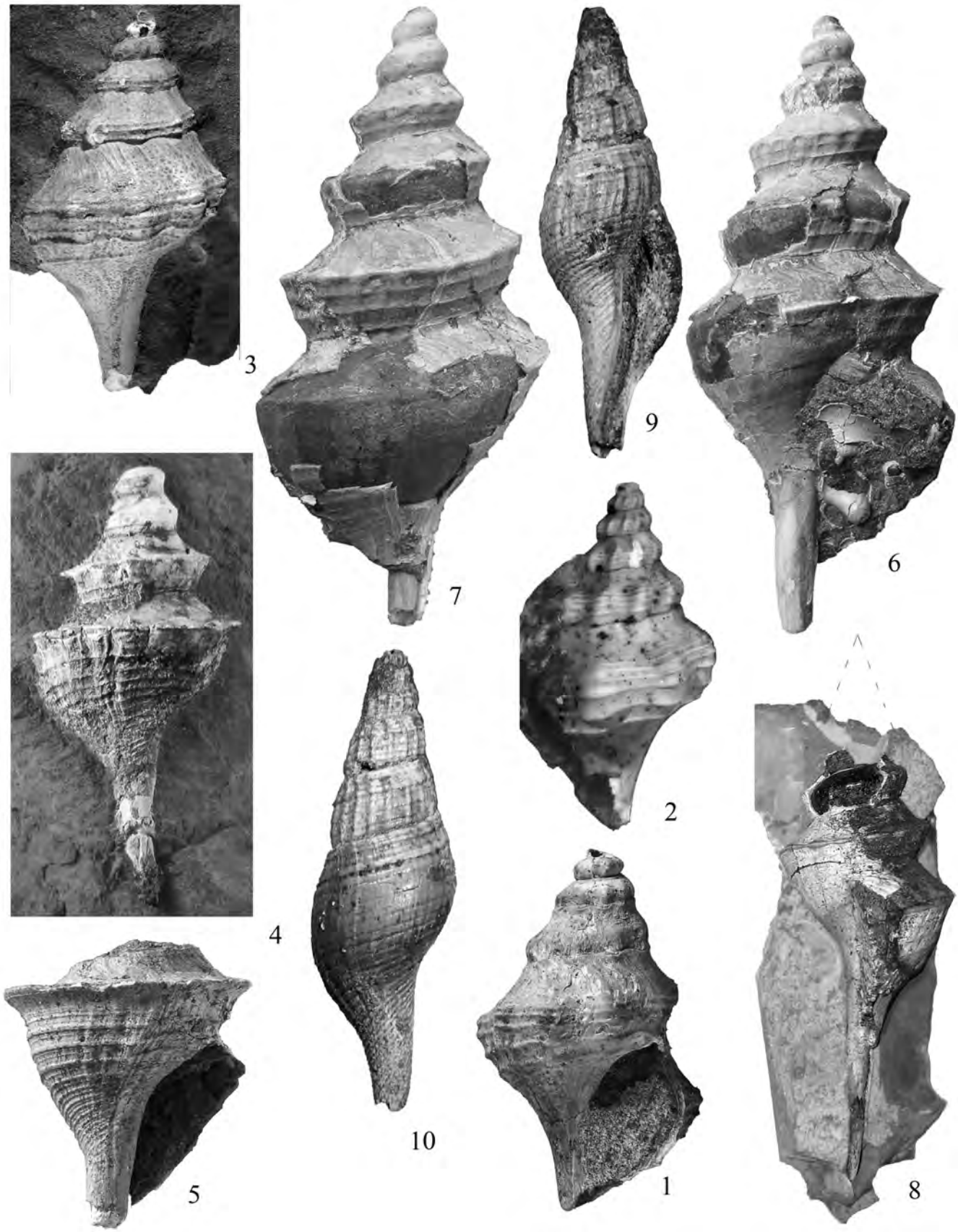
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Plate 10

Figure

1–3. *Levifusus pagoda seguinensis* n. ssp. 56
1–2. Locality 11-T-13.
1. Apertural view, holotype (TMM NPL37876); 21.4 mm length.
2. Dorsal view, paratype (TMM NPL37877), juvenile attached to matrix; 10.6 mm length.
3. Locality 11-T-101, apertural view, paratype (TMM NPL37878) embedded in matrix; 18.5 mm length.

4–5. *Levifusus acutocarinata* n. sp. 57
4. Locality 11-T-13, dorsal view, holotype (TMM NPL4676) embedded in matrix; 45.0 mm length.
5. Locality 165-T-202, apertural view, paratype (TMM NPL37792); 19.5 mm length.

6–8. *Fulgurofusus grande* n. sp., locality 11-T-13. 59
6-7. Holotype (TMM NPL37703); 65.0 mm length.
6. Apertural view.
7. Dorsal view.
8. Apertural view, paratype (TMM NPL37704), broken specimen embedded in matrix, showing relatively extremely long canal; 55.0 mm length.

9–10. *Palaeorhaphis palaeocenica* n. sp., locality 11-T-101, holotype (TMM NPL37706); 12.3 mm length. 51
9. Apertural view.
10. Dorsal view.

PLATE 11

Figure

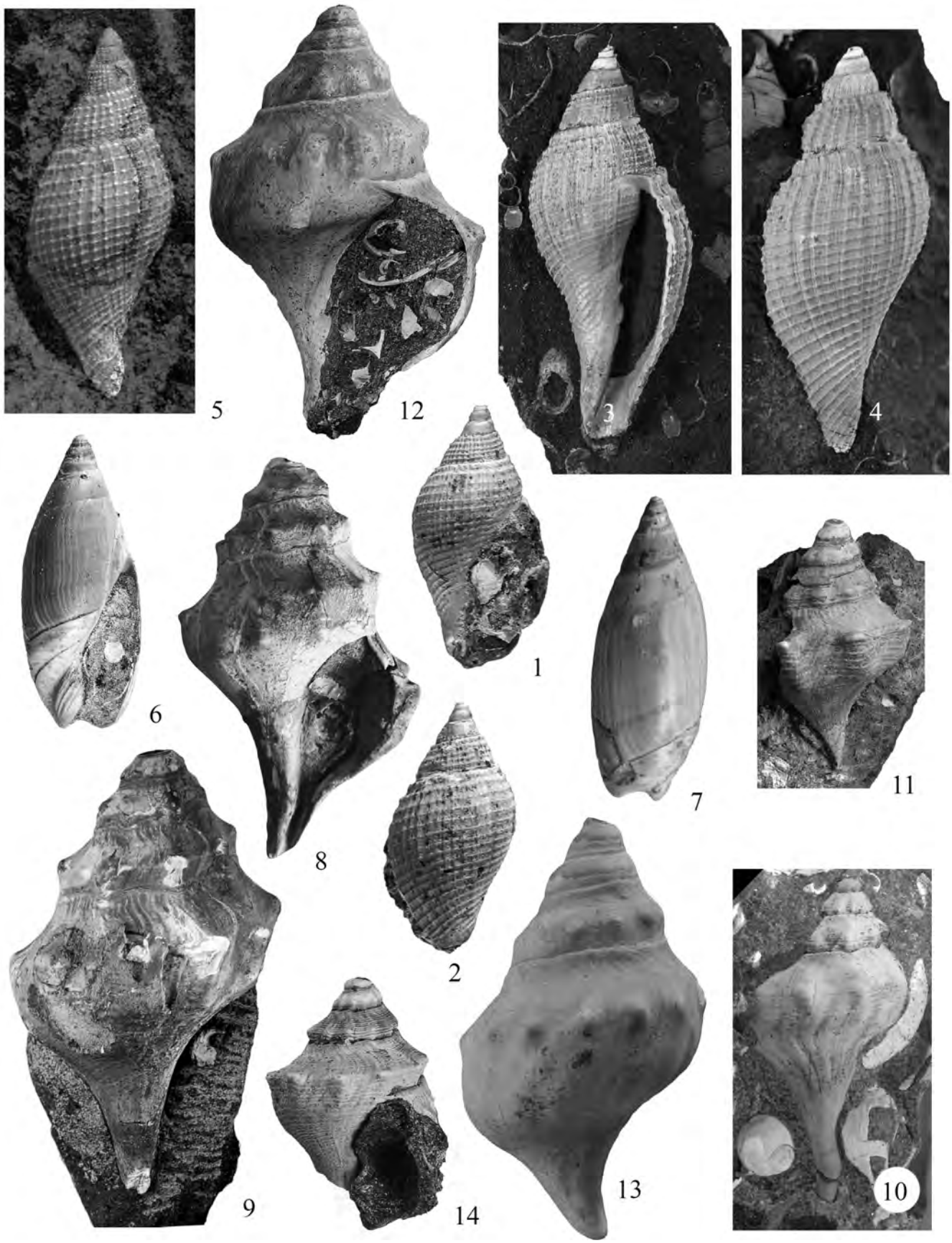
1–4. *Volutocorbis olssoni* (F. B. Plummer in Sellards *et al.*, 1933), locality 11-T-13. 59
1–2. Holotype (TMM P5380), juvenile missing part of canal; 12.7 mm length.
1. Apertural view.
2. Dorsal view.
3. Apertural view, topotype (TMM NPL37707), adult partially embedded in matrix; 19.6 mm length.
4. Dorsal view, topotype (TMM NPL37708), adult partially embedded in matrix; 15.7 mm length.

5. ***V****olutocorbis olssoni gracilis* n. ssp., locality 11-T-13, dorsal view, holotype (TMM NPL37574) embedded in matrix; 11.5 mm length. 59

6–7. *Eoancilla hordea* n. sp., locality 11-T-101, holotype (TMM NPL37709); 11.5 mm length. 61
6. Apertural view.
7. Dorsal view.

8–11. *Clinuropsis yanceyi* n. sp., locality 11-T-13. 62
8. Apertural view, holotype (TMM NPL37711); 67.2 mm length.
9. Dorsal view, paratype (TMM NPL37712), large individual partially attached to matrix; 68.0 mm length.
10. Dorsal view, paratype (TMM NPL37713), young specimen embedded in matrix showing entire canal; 23.9 mm length.
11. Dorsal view, paratype (TMM NPL37714), juvenile specimen showing early teleoconch details, embedded in matrix; 29.2 mm length.

12–14. *Clinuropsis tuberculata* n. sp., locality 11-T-13. 63
12. Apertural view, holotype (TMM NPL37715); 41.8 mm length.
13. Dorsal view, paratype (TMM NPL37716), large individual; 69.5 mm length.
14. Apertural view, broken juvenile (TMM NPL37717) showing early teleoconch details; 14.2 mm length.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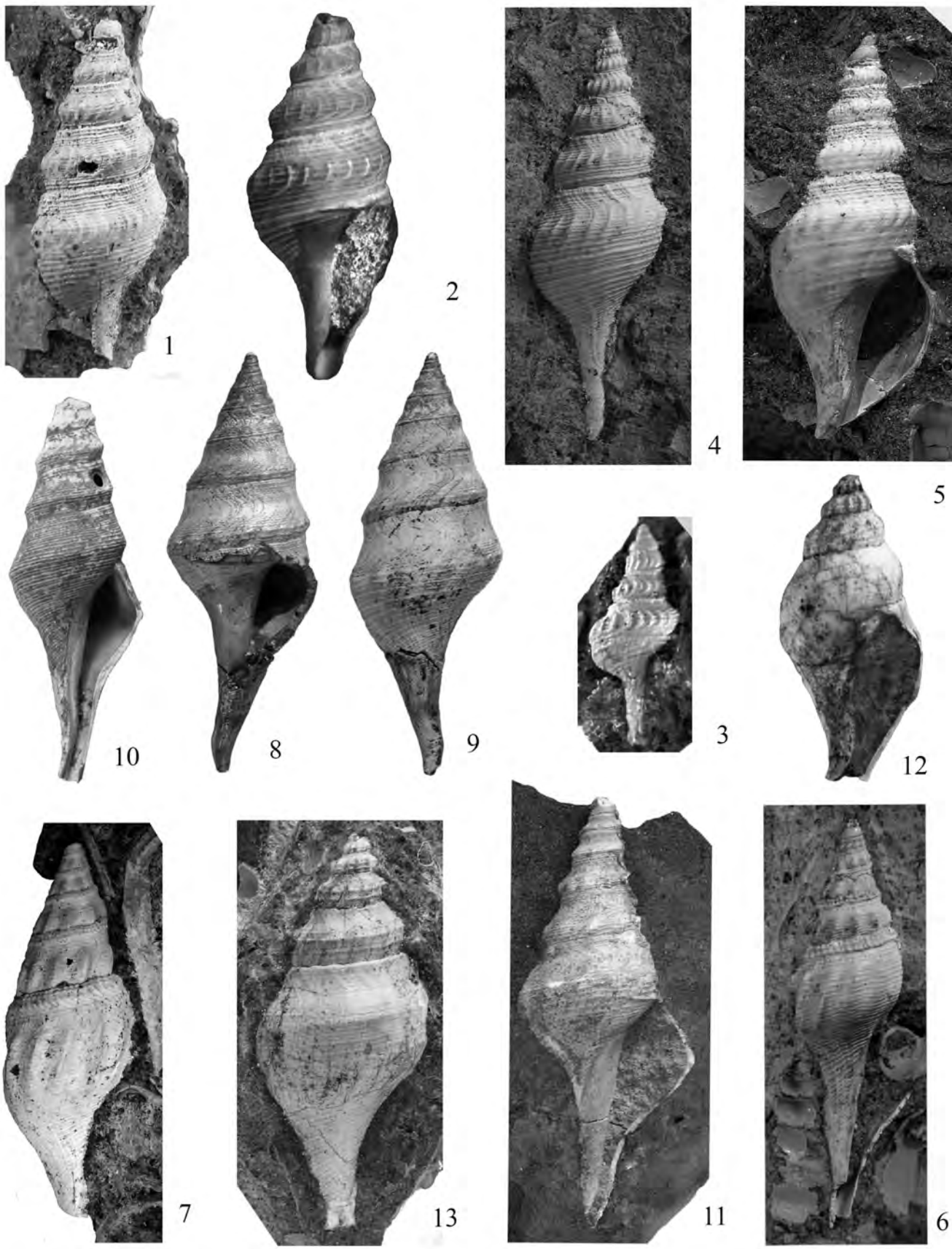
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Plate 12

Figure

1–3. *Coronia vallare* n. sp., locality 11-T-13. 71
1. Dorsal view, holotype (TMM NPL37718) partially embedded in matrix; 11.5 mm length.
2. Apertural view, paratype (TMM NPL37719); 7.8 mm length.
3. Dorsal view, juvenile (TMM NPL37747) showing protoconch and first teleoconch whorl, embedded in matrix; 5.0 mm length.

4–5. *Eopleurotoma molineuxae* n. sp., locality 11-T-13. 73
4. Dorsal view, holotype (TMM NPL37720) partially embedded in matrix; 14.6 mm length.
5. Apertural view, paratype (TMM NPL37721) partially embedded in matrix; 21.1 mm length.

6–7. *Tropisurcula*? (*Eodrillia*) *cingula* n. sp., locality 11-T-13. 65
6. Apertural view, holotype (TMM NPL37722) embedded in matrix; 11.7 mm length.
7. Dorsal view, paratype (TMM NPL37723) partially attached to matrix; 13.5 mm length.

8–9. *Orthosurcula anacona* (Harris, 1895), locality 165-T-2, holotype (No. 35577 BEG); 12.0 mm length. 67
8. Apertural view.
9. Dorsal view.

10. *Orthosurcula* cf. *longipersa* (Harris, 1896), locality 11-T-102; apertural view, Seguin specimen (TMM NPL37724); 24.0 mm length. 67

11. *Orthosurcula* cf. *adeona* (Whitfield, 1865), locality 11-T-101, apertural view, Seguin specimen (TMM NPL37748) embedded in matrix; 26.5 mm length. 68

12–13. *Apiotoma* (*Lavarotoma*) *alva* n. sp., locality 11-T-13. 69
12. Apertural view, holotype (TMM NPL37749); 17.1 mm length.
13. Dorsal view, paratype (TMM NPL37750) embedded in matrix; 18.3 mm length.

PLATE 13

Figure

1. *Coronia* aff. *mediavia* (Harris, 1896), locality 11-T-13, dorsal view, juvenile (TMM NPL36186) partially embedded in matrix; 4.1 mm length. 72

2. *Coronia*? sp., locality 11-T-101, apertural view, specimen (TMM NPL362350); 6.2 mm length. . . . 72

3–4. aff. *Protosurcula* sp., locality 11-T-13. 68
3. Apertural view, specimen (TMM NPL36189); 9.7 mm length.
4. Lateral view, juvenile (TMM NPL36190); 4.1 mm length.

5–6. *Praesurcula palaeocenica* n. sp., locality 11-T-13. 64
5. Dorsal view, body whorl of paratype (TMM NPL36192) embedded in matrix; 7.0 mm length.
6. Dorsal view, holotype (PL 36191), young individual; 6.5 mm length.

7. *Surculoma* sp., locality 11-T-13, apertural view, partially crushed specimen (TMM NPL36187); 26.0 mm length. 69

8–11. *Caveola ostium* n. sp., locality 11-T-101. 61
8–9. Holotype (TMM NPL37853); 6.0 mm length.
8. Apertural view.
9. Dorsal view.
10. Apertural view, larger individual (CLG 16610) embedded in matrix; 9.6 mm length.
11. Apertural view, juvenile (TMM NPL36234); 3.1 mm length.

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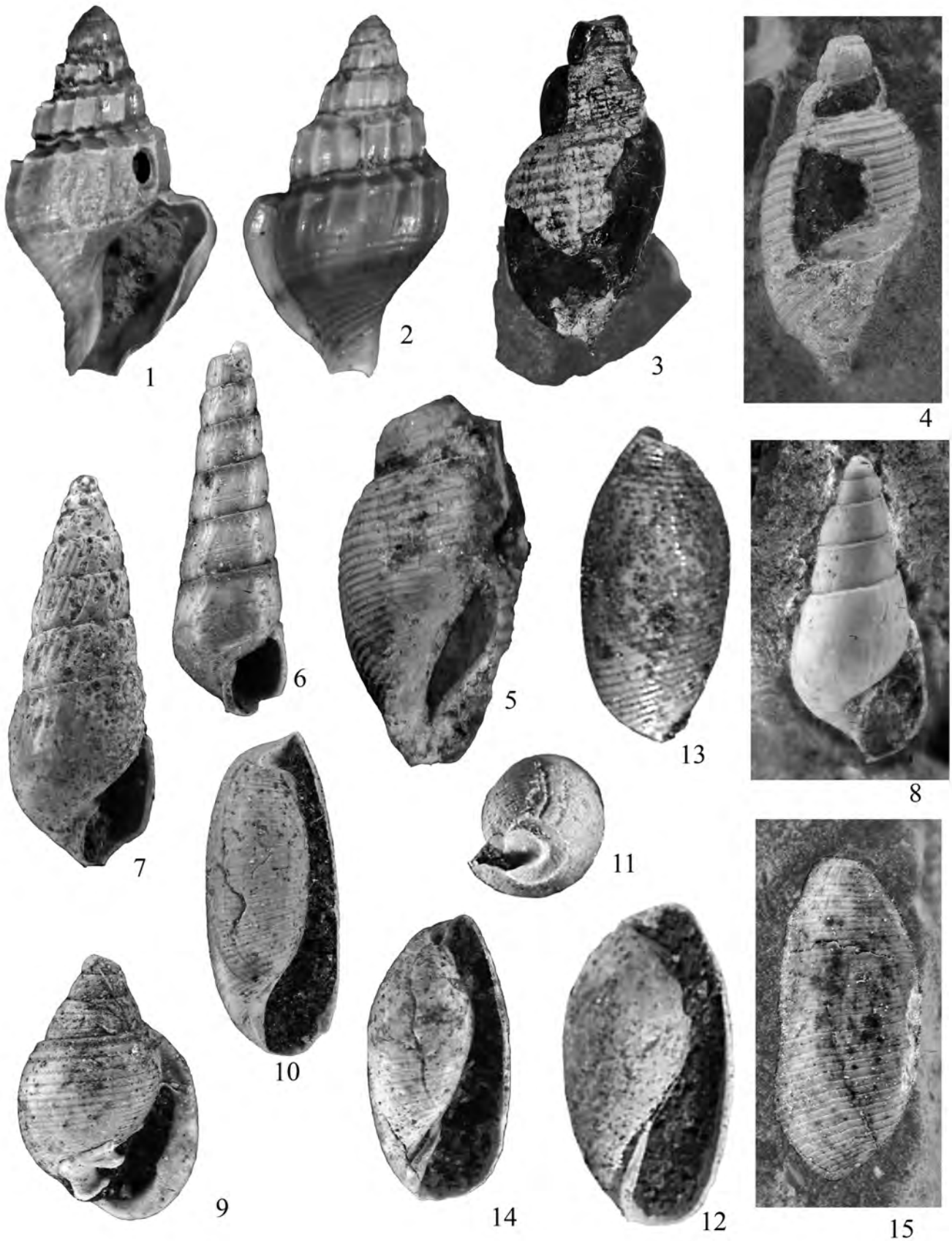
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Plate 14

Figure

1–2. *Crassauris seguinensis* n. sp., locality 165-T-202, holotype (TMM NPL37751); 4.7 mm length. . . . 74
1. Apertural view.
2. Dorsal view.

3–4. cf. *Acteon* sp., locality 11-T-13. 74
3. Dorsal view, partially decorticated specimen (TMM NPL37752) attached to matrix; 12.1 mm length.
4. Dorsal view, partially decorticated specimen (TMM NPL37753) embedded in matrix; 5.0 mm length.

5. *Eoacteon* sp., locality 11-T-13, apertural view, specimen (TMM NPL37754); 4.5 mm length. . . . 75

6. *Pyramidella* (*Syrnola*) *bilineata* n. sp., locality 11-T-13, apertural view, holotype (TMM NPL37755); 3.8 mm length. 78

7. *Turbonilla* (*Chemnitzia*) *obliqueata* n. sp., locality 165-T-202, apertural view, holotype (TMM NPL37756); 5.5 mm length. 79

8. *Odostomia* (*Doliella*) *deprimere* n. sp., locality 11-T-13, apertural view, holotype (TMM NPL37757) embedded in matrix; 4.8 mm length. 79

9. *Ringicula alabamensis* Aldrich, 1897, locality 11-T-101, apertural view, Seguin specimen (TMM NPL37758); 2.4 mm length. 80

10–11. *Cylichna* (*Cylichnopsis*) *bicarinata* n. sp., locality 11-T-101, holotype (TMM NPL37759); 4.5 mm length. 80
10. Apertural view.
11. Apical view, showing the apical characters; 1.8 mm maximum diameter.

12–13. *Mnestia ovata* n. sp., locality 11-T-101. 81
12. Apertural view, holotype (TMM NPL37761); 2.7 mm length.
13. Dorsal view, paratype (TMM NPL37762); 3.6 mm length.

14–15. *Retusa* (*Cylichnina) bastropensis* n. sp., locality 11-T-13. 82
14. Apertural view, holotype (TMM NPL37763); 3.4 mm length.
15. Dorsal view, paratype (TMM NPL37764) embedded in matrix; 3.6 mm length.

PLATE 15

Figure

1–6. *Cimomia contraria* n. sp. 82

1–2. Locality 165-T-201, holotype (TMM NPL37765).

1. Ventral view; 155 mm length.

2. Lateral view; 166 mm maximum diameter.

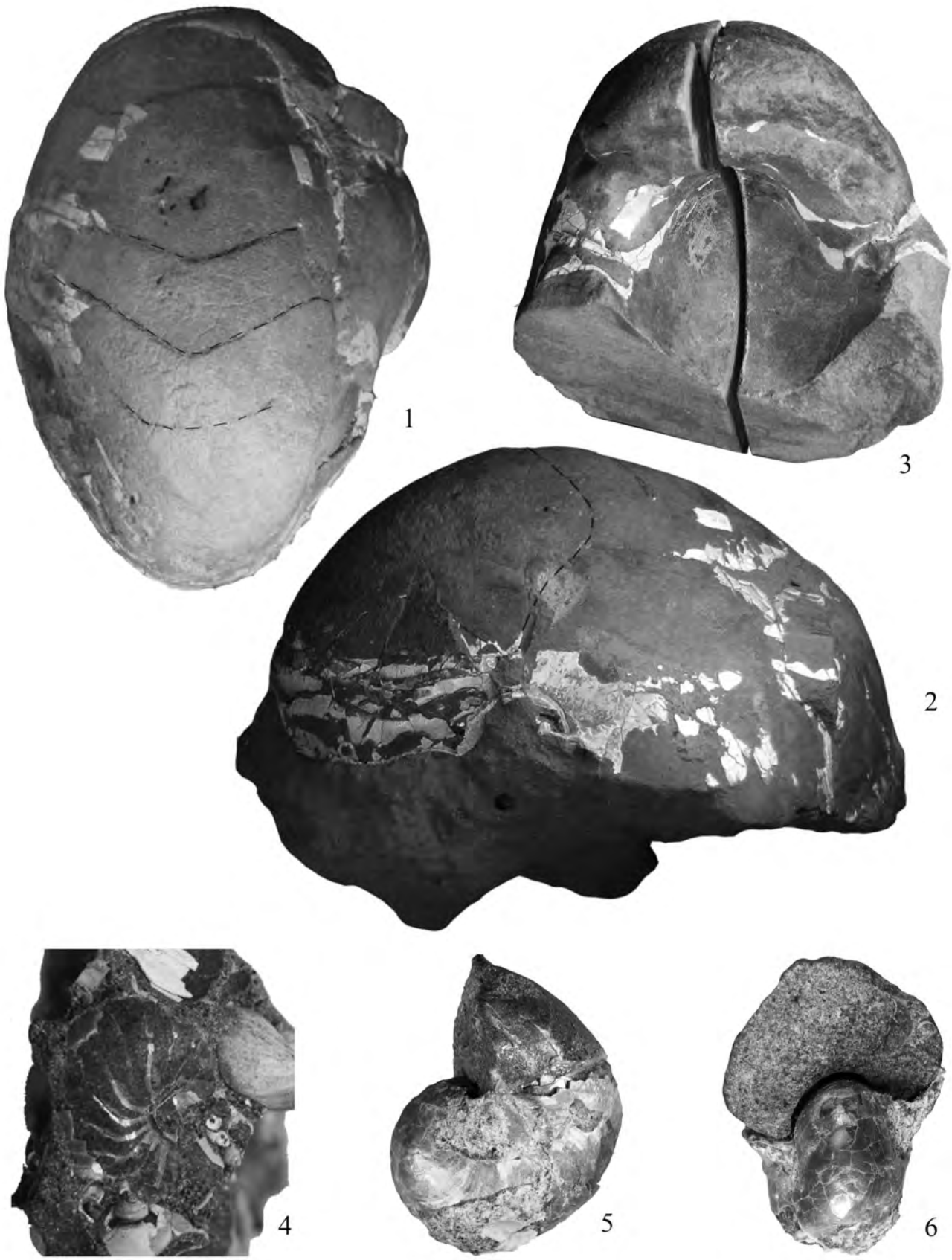
3. Internal view, paratype (TMM NPL37766, specimen cut into two pieces), locality 165-T-201, showing internal sutures and reniform whorl outline; 96.9 mm width.

4. Lateral view, paratype (TMM NPL37767), locality 11-T-13, juvenile showing sutures; 12.3 mm maximum diameter.\

5–6. Locality 11-T-3, paratype (TMM NPL37768), juvenile showing whorl outline; 20.4 mm maximum diameter.

5. Lateral view; 15.5 maximum width.

6. Apertural view.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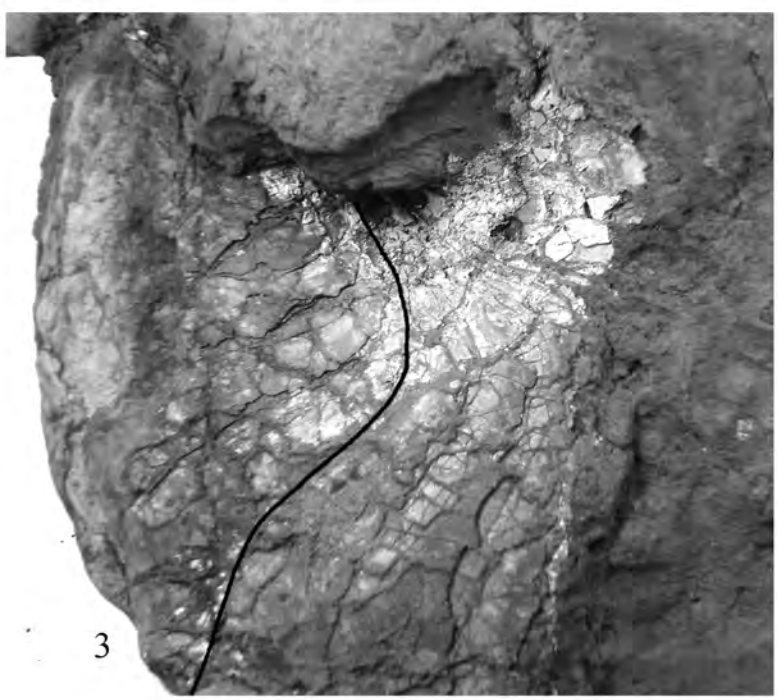

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Plate 16

Figure

1–4. *Angulithes*? *palaeocenica,* n. sp., locality 11-T-13. 83

1–2. Holotype (TMM BEG35561-3); 230 mm maximum diameter.

1. Ventral view.

2. Apertural view.

3. Close-up ventral view, paratype (TMM BEG35561-1); 238 mm maximum diameter, lateral visible portion 122 mm.

4. Whorl cross section, paratype (TMM BEG35561-2) showing position of the siphuncle; , longitudinal visible portion 75 mm.

ADDITIONS TO THE MOLLUSCAN MACROFAUNA OF THE REKLAW FORMATION (EOCENE: LOWER CLAIBORNIAN) AND TWO NEW TAXA FROM THE MIDDLE CLAIBORNIAN IN TEXAS

Christopher L. Garvie
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ABSTRACT

Nineteen taxa new to the Reklaw Formation are recognized, 13 of them new; the new taxa are: Bivalvia: *Modiolus marquezensis, Venericor densata newbyensis, Nemocardium angelinae, Kellia microstriatula, Katherinella plummeri, Cuspidaria textorama*; Gastropoda: *Atlanta funicularis, Phalium* (*Echinophoria*) *cingulae, Xenophora spiralis, Hemisurcula terus, Microdrillia infans reklawensis, Gemmula taylori quadrata,* and *Turbonilla* (*Chemnitzia*) *reklawensis.* One bivalve taxon: *Cuna* sp., and four gastropod taxa are newly recognized from the Reklaw Formation: aff. *Graciliala* sp., *Fulgurofusus perobliquus* (Johnson, 1899), *Fulgurofusus* aff. *rugatus* (Aldrich, 1886), and *Glyptotoma* cf. *crassiplicata* (Gabb, 1860). One new subspecies of gastropod is proposed from the Cook Mountain Formation: *Ectinochilus* (*Cowlitzia*) *texanum stephensoni,* and one new species from the Weches Formation: *Phalium* (*Semicassis*) *marcusi.* In addition, *Ectinochilus texanum* (Harris, 1895) is placed under the subgenus *Cowlitzia* as *Ectinochilus* (*Cowlitzia*) *texanum texanum*.

INTRODUCTION

The original report on the Reklaw faunas (Garvie, 1996) was the result of more than ten years of intensive collection in the Formation; every taxon with at least one well-preserved specimen or with characters deemed unique enough for recognition was discussed. Since that time, further collecting has produced a few new taxa, and some taxa from the original collections that were never described were re-evaluated with a view to publication. It was originally expected that further intensive collecting might result in finding more specimens of these remaining taxa, but the original sandy lenses that produced the bulk of the taxa described in the original report (Garvie, 1996: 10) were of limited areal extent and are now worked out. More importantly, the weather in central Texas has become much drier in recent decades, and the creeks no longer get the regular winter rainfall that would scour the exposures and expose new material. With little expectation that this might improve any time soon, these additional taxa are described here because the original intention was to give as complete as possible a picture of the Reklaw fauna. At the time of the original report, the author only had limited access to the then-named Texas Memorial Museum (now Texas Natural Science Center, henceforth TNSC) collections. Unrestricted access has allowed examination of the quite extensive Reklaw collections and they were found to contain taxa mostly replicating those that the author had personally collected. Three localities represented in the collections did prove to be of particular interest, discussed below under localities.

MATERIAL AND METHODS

This report is based on material not described in the original report (Garvie 1996), a few new taxa collected since, and several hundred specimens from the TNSC collections not examined before. With the exception of careful cleaning and matrix removal from three specimens, no other preparation was necessary. Medium to small specimens were photographed with a 5 Mb pixel digital camera and macro lens. Very small specimens were photographed with a digital camera attached to the microscope eyepiece while using 10X magnification, or attached to the Zeiss Tessovar optical microscope system in the TNSC facility. Multiple images were taken of all specimens at different focal lengths and CombineZM stacking software was utilized to produce a final image. Image quality was then improved by using Adobe Photoshop CS3 to manipulate levels, brightness, and contrast of the image. Photoshop was also used to decrease the contrast and visual impact of the matrix for those specimens that were partially embedded and often of a similar color. I follow Garvie (1996, 2013) in the use of morphological terms, and in the philosophy of assignment of new taxa. Higher taxonomic classifications and treatment order follow Bouchet & Rocroi (2005) for the gastropods and Bieler *et al.* in Bouchet & Rocroi (2010) for the bivalves.

Locality Descriptions

Localities with -T- designations are Texas Bureau of Economic Geology registered localities. Remaining localities are those described by Garvie (1996: 13–16). Coordinates are given as geodetic latitude and longitude.

1-T-6: Magnolia Ferry, left bank of the Trinity River, Anderson County, Texas. The ferry was in the now-abandoned town of Magnolia. Marquez Member of the Reklaw Formation; approximate map coordinates: 31°39.259'N, 95°44.292'W. As indicated by the TNSC collections and from the author's own fieldwork, this is the only locality where well-preserved shells rather than casts occur in the well-known (Deussen, 1914: 45–46; Stenzel, 1953:

34) "*Venericardia* rock" of eastern Texas. The only species found, a large *Venericor* is described below.

21-T-101: Banks of Little Brazos River upstream of the Highway 21 bridge, Brazos County, Texas. Wheelock Member of the Cook Mountain Formation; 30°38'50.10"N, 96°30'55.78"W. For section, see Stenzel (1934: 39–41).

173-T-100: Scraped area used in constructing earthen dam at southern end of Lake Nacogdoches, Nacogdoches County, Texas. Weches Formation grading into Cane River Formation; 31°35.314'N, 94°49.858'W.

197-T-3: Cedar Creek, southeastern corner of Wheelock League, 183 m north of Brazos County line (Old San Antonio Road), 3.2 km east of Wheelock on Cedar Creek. Wheelock Member of the Cook Mountain Formation; 30°54.198'N, 96°21.510'W.

Locality 4: On western side of Ridge Creek *ca.* 888 m south of Missouri, Kansas, and Texas railroad trestle and county road bridge, Bastrop County, Texas. Marquez Member of the Reklaw Formation; 30°00.087'N, 97°15.211'W.

Locality 6 (= 11-T-7): On Ridge Creek, Bastrop County, Texas. Marquez Member of the Reklaw Formation; 29°59.854'N, 97°15.125'W.

Locality 11 (= 11-T-36): Devil's Eye, Colorado River, Bastrop County, Texas. Marquez Member of the Reklaw Formation; 30°01.635'N, 97°13.415'W. Judging from the TNSC collections, this must have been a favorite collecting spot during the time of G. D. Harris, R. A. Penrose, W. Kennedy, and E. T. Dumble near the end of the 19th century, and must also have been very productive. With the exception of a few species described elsewhere, almost all of the taxa figured in the Harris (1893) unpublished manuscript are still in the TNSC collections, and three of them are Devil's Eye gastropods that are discussed below. Some of the new taxa described are from single individuals, sometimes juvenile, but if the taxon is recognizable, it still serves the purpose of giving a complete faunal list of the formation.

Locality 12: On Joe Taylor Branch of Two Mile Creek, just downstream of the county road bridge over the creek, Milam County, Texas. Marquez Member of the Reklaw Formation; 30°48.600'N, 96°39.276'W.

Locality 20 (= 165-T-13): On Joe Taylor Branch of Two Mile Creek, *ca.* 1.26 km downstream from Locality 12, Milam County, Texas. Marquez Member of the Reklaw Formation; 30°48.644'N, 96°39.272'W.

Locality 25 (= 200-T-1): Borrow pit on northern side of U. S. Highway 84 (Rusk-Mount Enterprise Road), Rusk County, on right bank of Angelina River *ca.* 90 m west of river. Newby Member of the Reklaw Formation; 31°52.472'N, 94°56.194'W. Stenzel (1953: 38, 40, 60, 75–76) discussed this locality and gave a detailed section. When the author visited this locality in the 1980s, it was very weathered and overgrown, but the collections show that locality to have been very productive when originally collected by Geological Survey personnel. The faunal content was determined to be much the same as that found in the overlying Marquez Member, although the species are generally much larger. The fauna on the whole is somewhat leached, making identifications sometimes difficult, particularly with regard to the gastropods, but bivalves referred to *Barbatia* sp., venerids, and a *Nemocardium* sp. described in this report were large and well preserved.

Repositories and Abbreviations

CLG: The author's collection. The Non-vertebrate Paleontology Department, Texas Natural Science Center, The University of Texas at Austin, should be contacted for access.

LV: left valve.

PRI: Paleontological Research Institution, Ithaca, New York.

RV: right valve.

TMM: Non-vertebrate Paleontology, Texas Natural Science Center, The University of Texas at Austin. Repository of several collections, including the old Texas Geological Survey collections, the Bureau of Economic Geology collections, and University of Texas collections; each had their own catalog numbering system, often consisting of BEG, NPL, or P, followed by a number. All are now prefixed by TMM.

TNSC: Texas Natural Science Center, Austin.

USNM: United States National Museum (now National Museum of Natural History), Smithsonian Institution, Washington, DC.

SYSTEMATIC PALEONTOLOGY

Phylum **MOLLUSCA** Linnaeus, 1758
Class **BIVALVIA** Linnaeus, 1758
Subclass **AUTOBRANCHIA** Grobben, 1894
Order **MYTILIDA** Férussac, 1822
Superfamily **MYTILOIDEA** Rafinesque, 1815
Family **MYTILIDAE** Rafinesque, 1815

Genus ***MODIOLUS*** Lamarck, 1799

Type Species.—Mytilus modiolus Linnaeus, 1758 [ICZN Opinion 325 (1954)]. Recent, North Atlantic.

Description.—Shell inequilateral, anteriorly rounded, medially inflated. Umbones blunt, not inflated, set back from anterior end. Dorsal margin straight or curved. Sculpture smooth or sometimes comarginally striated. Hinge edentulate, but

sometimes with small dysodont anterior teeth. Interior layer nacreous.

Modiolus marquezensis n. sp.
Pl. 1, Fig. 1

Description.—Shell small, with straight section of dorsal and ventral margins making angle of *ca.* 35°. Dorsal margin slightly curved; postumbonal margin at angle of *ca.* 40° to dorsal margin. Umbonal ridge smoothly rounded. Surface smooth except for comarginal growth lines and microscopically fine, regular, radial striae on posterior slope.

Remarks.—Palmer & Brann (1966 in 1965–1966: 199–201) listed 12 *Modiolus* species from the Paleocene and Eocene of the Gulf Coast, but interestingly, only two of them from the middle and lower Claibornian. This specimen has lost part of the posterior part of the shell, but earlier comarginal growth lines detail the original shape; the external shell characters are closer to the type species, *M. modiolus*, than to those of any of the known Gulf Coast Paleogene species, although *M. julia* I. Lea, 1861, from the Woodbury Clays of New Jersey, appears related; the latter is more elongate and has a more prominent umbonal ridge (Harris, 1919: 31–32, pl. 17, figs 3–4). The typical middle Claibornian representative, *M. cawcawensis* Harris, 1919, is more elongate, and has a sharper umbonal ridge and straight growth lines on either side of the umbonal ridge.

Etymology.—The specific name *marquezensis* refers to the member from which the specimen was found.

Type Material.—Holotype: PRI 64784, from locality 20 (= 165-T-13).

Type Locality.—Locality 20 (= 165-T-13) on Joe Taylor Branch of Two Mile Creek, *ca.* 1.26 km downstream from Locality 12, 30°48.644'E, 96°39.272'N, Milam County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, PRI 64784), 14.6 mm in estimated undamaged length.

Order **CARDITIDA** Dall, 1889
Superfamily **CARDITOIDEA** Férussac, 1822
Family **CARDITIDAE** Férussac, 1822
Subfamily **VENERICARDIINAE** Chavan, 1969

Genus ***VENERICOR*** Stewart, 1930

Type Species.—*Venericardia planicosta* Lamarck, 1799, by original designation. Eocene Paris Basin, France, and Bracklesham beds, England.

Description.—Shell large, heavy; outline trigonocordate. Umbones inflated; anterior extremity short, obliquely rounded; posterior lateral margin slightly truncate. Lunule narrow, long, delimited by groove; escutcheon not defined. Earliest ribbing narrow, sharp, crenate; adolescent and early adult ribs anteriormedially flat-topped, with ribs wider than interspaces; collabral growth lines prominent near margins. Hinge plate high, trigonal; anterior cardinal thin, lamellar, parallel with inner margin of nymph. Pallial line ragged, set back from crenate valve margins.

Venericor densata newbyensis n. ssp.
Pl. 1, Figs 2–6

Description.—Shell large, solid, transversely ovate, cordate-trigonal; maximum length to > 80 mm. Umbones inflated, incurved, prosogyrate. Lunule small, wider in RV than in LV. Rib count most typically 35, but ranging down to 33 for small adults. Umbonal ribs thin, high, with crests minutely nodular; ribs rapidly becoming flat-topped with overhanging interstitial area in adolescent phase; in adult phase, ribs flat, overridden by comarginal growth lines, often obsolescent in central area. Hinge fairly massive; medial cardinal wider than in *Venericor denstata s. s*., with impressed muscle scars. Mean height/width ratios ranging from 1.06 for very small specimens, to *ca.* 0.92 for adults and ranging down to 0.87 for large gerontic individuals. Breadth and umbones/width ratio staying fairly constant (*ca*. 24 mm, *ca.* 0.3, respectively) once adult size achieved.

Remarks.—On the basis of a few fragmentary specimens of *Venericor* sp. from locality 25 (= 200-T-1; Newby Member of the Reklaw Formation) in eastern Texas, Garvie (1996: 34) assigned them to the other known Reklaw subspecies: *V. densata reklawensis* Garvie, 1996. Since that time, the TNSC collections have become accessible and the author was able to examine several drawers containing *Venericor* specimens from the Newby Member. Although showing some similarity to *V. d. reklawensis*, the much greater size and considerably more elongated outline of the Newby Member specimens necessitated a new taxon. With some hesitation, the specimens are assigned as a new subspecies, *V. d. newbyensis* n. ssp. As Gardner & Bowles (1939: 190) noted, typical *V. densata* is closely related to *V. aposmithii* Gardner & Bowles, 1939, from the lower Wilcox, and furthermore, the sculpture and general rib characters of the two forms are very similar. *Venericor d. reklawensis* from the type locality is a much more evenly ovate

form with a rib count of *ca.* 29 and a mean height/width ratio of 0.97. Typical *V. aposmithii* from the sands of the Bell's Landing localities are higher (mean height/width = 1.02), and up to one-third as large again as *V. d. newbyensis* n. ssp., but the high rib count, impressed muscle scars, large medial cardinal tooth, and small umbonal area showing nodular ribs point at a close relationship among the three mentioned taxa. *Venericor d. reklawensis* is characterized by the straight truncated posterior margin and a rib count of *ca.* 29, and is generally higher than *V. d. newbyensis* n. sp.; both have the relatively massive hinge and impressed muscle scars, while in all three taxa, *V. aposmithii*, *V. d. reklawensis* and *V. d. newbyensis* n. sp., the ribs tend to become obsolete towards the ventral margin.

The most massive *Venericor* species always seem to occur in sandy environments, probably explaining the similarity of certain characters between them (*e.g.*, thick shell, impressed muscle scars); this might explain why *Venericor densata pendletonensis* Gardner & Bowles, 1939, from the Pendleton Formation (upper Wilcox), which might be expected to be intermediate in characters between *V. aposmithii* and *V. d. newbyensis* n. sp. instead appears more related to *V. d. reklawensis*. Both are found in clay/shale environments.

Etymology.—The specific name *newbyensis* refers to the member from which the specimens were found.

Type Material.—Holotype: TMM NPL38011. Paratypes: TMM NPL38012 and TMM NPL38013, all from locality 1-T-6, Magnolia Ferry, Anderson County.

Type Locality.—Locality 1-T-6. Magnolia Ferry, left bank of the Trinity River, approximate map coordinates 31°39.259'E, 95°44.292'N, Anderson County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—34 specimens, ranging 50–89 mm in width, and 54–79 mm in height (TMM NPL10060–10065 inclusive).

Family **CONDYLOCARDIIDAE** Bernard, 1896

Genus ***CUNA*** Hedley, 1902

Type Species.—*Cuna concentrica* Hedley, 1902, by original designation. Recent, off Port Kembla, Australia.

Description.—Shell very small, narrowly trigonal, often oblique. Lunule and impressed dorsal area present. Sculpture concentric with overlapping ribs; margin denticulate. Hinge plate broad, flat; LV with 2 cardinal teeth; RV with one rudimentary cardinal and one massive flat-topped triangular tooth; each valve with posterior and anterior laterals.

Cuna sp.
Pl. 1, Fig. 7

Description.—Shell very small, elongate; ventral outline smoothly rounded. Lunule sunken. Lateral valve margins not carinate. Sculpture of pronounced regular concentric ridges with deep interspaces.

Remarks.—One double-valved specimen was recovered from locality 6 (= 11-T-7; Garvie, 1996: 14, 16), at which the environment is believed to be a very nearshore shell accumulation. The specimen is very small, *ca.* 1.5 mm in length or *ca.* 40% of the typical size of the middle Claibornian *Cuna parva* (Lea, 1833). Compared against *C. parva*, the outline of the Reklaw species is much more smoothly rounded, the lunule is sunken, and the lateral valve margins are not sharply ridged. Like in *C. parva*, the sculpture is predominantly concentric but much more pronounced and regular with deeper interspaces. *Cuna parva subparva* (Meyer, 1887) was synonymized with *C. parva* by Palmer & Brann (1966 in 1965–1966: 123–124); the latter is still recognizeable at varietal rank. *Cuna parva* var. *subparva* is generally narrower, flatter, and smaller than *C. parva s. s*. The Reklaw species, even though of similar size to *C. parva* var. *subparva* is distinguished from it by the smooth lateral margins and its broader outline. Viewing the double valve from the ventral end, the denticulate margin can be seen clearly. However, without knowledge of the interior of the valves and dentition, it is not named here. This occurrence lowers the range of this genus from the middle to the lowest Claibornian.

Type Information.—Figured specimen: PRI 64785, from locality 6 (= 11-T-7).

Material Examined.—One double-valved specimen (PRI 64785), 1.5 mm in height.

Order **VENERIDA** Gray, 1854
Superfamily **CARDIOIDEA** Lamarck, 1809
Family **CARDIIDAE** Lamarck, 1809
Subfamily **LAEVICARDIINAE** Keen, 1951

Genus ***NEMOCARDIUM*** Meek, 1876

Type Species.—*Cardium semiasperum* Deshayes, 1858 in 1856–1865, by subsequent designation (Sacco, 1899). Eocene Paris Basin, France.

Description.—Shell thin, inflated. Sculpture of radial ribs and striae, stronger on posterior slope at which they are often nodose or latticed. Valve margins interiorly crenate. Cardinal and lateral teeth usually slender.

Nemocardium angelinae n. sp.
Pl. 1, Figs 8–9

Description.—Shell inflated, oval, truncated posteriorly with straight medial margin. Margin from ventral edge to just anterior of umbonal area evenly and smoothly rounded. Umbones incurved, very weakly prosogyrate. Anterior and medial portion of valves with fine radial threads and overriding concentric growth lines, with concentric sculpture more prominent for approximately first third of medial area from umbones; posterior area with strong rounded radials and interstitial connecting ribs that become nodular and sometimes spinose near posterior margin on adult individuals. Hinge robust, with strongly flattened, upturned cardinal tooth. Posterior muscle scar large.

Remarks.—This species is very different from the common middle Claibornian Texas species, *Nemocardium gambrinum* (Gabb, 1862), which has a regularly rounded margin, a smooth, shiny surface, and no development of nodes on the posterior area. It has a little more in common with *N. nicoletti* (Conrad, 1841) and with its likely precursor (Gardner, 1935: 181) *N. actium* (Gardner, 1935) with its anterodorsally flattened shell and nodal development. However, the shell outline of the latter two species is much more quadrate and the nodes are developed on the radials rather than on the interstitial latticing as in *N. angelinae* n. sp. Perhaps the closest species in outline is *N. salrivale* (Harris, 1919) from the St. Maurice beds of Louisiana, although the latter species lacks the anterodorsal flattened area, is higher, and there is a gradual transition of sculpture type from medial to dorsal areas. *Nemocardium quihi* (Gardner, 1935) can be distinguished by its rounded quadrate outline. *Nemocardium curtum* (Conrad in Cook, 1868) is distinguished by being striated throughout and possessing an abruptly carinate posterior margin. *Nemocardium harrisi* (Dall, 1900 in 1890–1903), a Sabine species, is distinguished by a more quadrate outline and its different type of posterior slope ornamentation in which the beading is along the side rather than the top of the ribs. *Nemocardium lene* (Conrad, 1856) has a very oblique posterior margin, a densely tuberculated postumbonal slope, and a relatively small cardinal tooth.

Etymology.—The specific name *angelinea* refers to the borrow pit by the Angeline River from which the specimens were found.

Type Material.—Holotype: TMM NPL10079. Paratype: TMM NPL10088-1, all from locality 25 (= 200-T-1)

Type Locality.—Locality 25 (= 200-T-1), borrow pit on northern side of U. S. Highway 84 (Rusk-Mount Enterprise Road), on right bank of Angelina River *ca.* 90 m west of river, 31°52.472'E, 94°56.194'N, Rusk County, Texas. Newby Member of the Reklaw Formation.

Material Examined.—Six specimens, the largest (paratype, TMM NPL10088-1) 19.2 mm in height.

Superfamily **GALEOMMATOIDEA** Gray, 1840
Family **LASAEIDAE** Gray, 1842

Genus ***KELLIA*** Turton, 1822

Type Species.—*Mya suborbicularis* Montagu, 1803 in 1803–1808, by subsequent designation (Récluz, 1844). Recent, seas around the British Isles.

Description.—Shell small to very small, ovate, often oblique, moderately inflated. Umbones prosogyrate, more or less medial. Exterior smooth or concentrically striate. RV with cardinal and posterior lateral; LV with 2 cardinals, anterior one pointing dorsally, posterior one ventrally, plus posterior lateral. Pallial line entire.

Remarks.—The family Lasaeidae is known from the Cretaceous to Recent. Modern representatives are epifaunal suspension feeders.

Kellia microstriatula n. sp.
Pl. 1, Figs 10–11

Description.—Shell small, subovate, with posteroventral area slightly extended. LV hinge plate moderately excavated; one broadly triangular, sharply unturned cardinal tooth just anterior to umbones, with moderately deep pit beside that and under hinge; vestigial second cardinal tooth on posterior side of pit; one posterior, elongated lateral tooth parallel to margin. Muscle scars small, ovate. Pallial line entire but indistinct. External surface with moderate growth lines and exceedingly fine, regular comarginal striae.

Remarks.—There appears to be nothing particularly close to this species in the Gulf or eastern coast Paleogene. The only other species assigned to *Kellia* by Palmer & Brann (1966 in 1965–1966: 162) and missing from USNM (*fide* same authors) is *K. interstriata* Aldrich, 1908. The hinge was not figured, but according to Aldrich (1908), it is similar to that of the

type species, *K. suborbicularis*. However, if accurately drawn, his lateral view shows a short lateral tooth that together with the radial sculpture on the medial portion of the valve makes assignment to another genus in the Lasaeidae more likely. The other Lasaeidae species listed by Palmer & Brann (1966 in 1965–1966) and Dockery (1982) are all assigned to either *Erycina* Lamarck, 1805 in 1802–1805, or *Bornia* Philippi, 1836 in 1836–1844; members of both of these genera tend to have radial sculpture and are commonly subquadrate or trigonal; in the case of *Bornia*, the margin is crenellated. It is in the Miocene of Maryland that we first find the species *K. rotundula* Glen in Clark, 1904a–b, which has some similarity to *K. microstriatula* n. sp.; this latter species has a shorter posterior lateral tooth close to the umbo in the left valve, a somewhat truncated posterior end, and faint interior radial markings. *Kellia rotundula* and *K. suborbicularis* appear closer to each other than either is to *K. microstriatula* n. sp. In the Eocene of the Paris Basin, we find *Erycina cailliati* Deshayes, 1858 in 1856–1865, reassigned to *Divarikellia* (Cossmann, 1887: 67–68), a taxon allied to *Kellia* but distinguished primarily by its oblique shape and internal radial lines. The shape and hinge of *K. microstriatula* n. sp. are similar to those of *D. cailliati*, but the valve is more elongate, and the left posterior lateral is short and stubby; there is no trace of the internal radial striae of the latter taxon. The triangular upturned cardinal of *K. microstriatula* n. sp. is different in shape from those of all other species mentioned above.

Etymology.—The specific name *microstriatula* originates from *micro* (Greek, small) + *stria* (Latin, groove) and refers to the surface sculpture.

Type Material.—Holotype: PRI 64786, from locality 20 (= 165-T-13).

Type Locality.—Locality 20 (= 165-T-13) on Joe Taylor Branch of Two Mile Creek, *ca.* 1.26 km downstream from Locality 12, 30°48.644'E, 96°39.272'N, Milam County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One LV (holotype, PRI 64786), 5.3 mm in width.

Superfamily **VENEROIDEA** Rafinesque, 1815
Family **VENERIDAE** Rafinesque, 1815
Subfamily **CLEMENTINAE** Frizzell, 1936

Genus ***KATHERINELLA*** Tegland, 1929

Type Species.—*Callocallista arnoldi* Weaver, 1916, by original designation. Middle to Upper Oligocene, Washington.

Description.—Shell ovate to suborbicular. Umbones anterior, strongly prosogyrate. Lunule large, outlined by impressed line, usually tumid. Sculpture of evenly developed concentric growth lines; radial sculpture absent. RV hinge with 2 anterior lateral teeth and 3 cardinals; LV with weak anterior bilateral tooth buttressed under upper margin of hinge plate and 3 diverging cardinals; nymphs smooth in both valves. Pallial sinus pointed, triangular.

Remarks.—Tegland (1929: 281) pointed out the diagnostic characters of the buttressed anterior lateral tooth, which is in an intermediate position between a cardinal and a lateral tooth, as a means of defining this genus. The genus seems to be widely distributed in the Claibornian of Texas and is also recognized in the Upper Paleocene Seguin Formation (Garvie, 2013: 25, pl. 3, fig 1).

Katherinella plummeri n. sp.
Pl. 2, Figs 1–3

Description.—Shell small, oval-elongate, slightly extended and weakly truncate posteriorly. LV hinge with 3 lamellar cardinals and strong buttressed anterior lateral; RV with anterior and medial cardinals close together, posterior cardinal bifid, and 2 subequal anterior laterals. Pallial sinus long, straight on dorsal margin, obliquely margined anteriorly. Lunule flat, defined by raised line near umbo that becomes impressed near margin. Sculpture of regular concentric impressed lines; interspaces swollen to form evenly rounded ribbons.

Remarks.—Stenzel *et al.* (1957: 135) mentioned individuals collected by F. B. Plummer from Devil's Eye (11-T-36) that they noted were similar to *Katherinella*? *trigonata bastropensis* (Harris, 1919). However, they were unable to recognize the species satisfactorily due to the poor original description that did not describe the hinge characters, and the species could indeed be synonymous with *K. smithvillensis* Stenzel & Krause in Stenzel, Krause, & Twining, 1957. *Katherinella smithvillensis* is distinguished from *K. plummeri* n. sp. by its more circular outline, and the very short anterior lateral teeth of *K. smithvillensis*; the sculpture is similar but with broader ribbons of the latter species. The hinge of *K. plummeri* n. sp. shows more similarity to that of *K. trinitatus* Stenzel & Krause in Stenzel *et al.*,1957, than that of *K. smithvillensis*, but is more delicate and has a much larger left posterior lateral. However, the outline of *K. plummeri* n. sp., like that of *K. smithvillensis*, is more circular and the concentric ribbons are crested rather than rounded as in the latter. The right posterior lateral tooth of *K. plummeri* n. sp. is also longer and thinner than that of *K. trinitatus*. *K. trinitatus*, also known from the Stone City Member in Texas, is very rare in the author's experience, only

one left valve being available for examination; the broadly triangular medial cardinal hinge tooth of that species suffices by itself to separate the species from all others, and externally the sculpture is broader, less regular, and more effaced medially than in other species.

Etymology.—The specific name *plummeri* honors the collector, F. B. Plummer, of these specimens.

Type Material.—Holotype: TMM P11503-1. Paratypes: TMM P11503-2 to TMM P11503-4 inclusive, all from locality 11 (= 11-T-36).

Type Locality.—Locality 11 (= 11-T-36), Devil's Eye, Colorado River, 30°01.635'N, 97°13.415'W, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—Seven specimens, the largest (paratype, TMM P11503-2) 14.9 mm in width.

Order **PHOLADOMYIDA** Newell, 1965
Superfamily **CUSPIDARIOIDEA** Dall, 1886
Family **CUSPIDARIIDAE** Dall, 1886

Genus ***CUSPIDARIA*** Nardo, 1840

Type Species.—*Tellina cuspidata* Olivi, 1792, by original designation. Recent, Adriatic Sea.

Description.—Shell globular, inequilateral, posteriorly rostrate, anteriorly rounded. Surface smooth or with feebly concentric striae or undulations. Hinge weak with posteriorly inclined chondrophore. One posterior lateral tooth in RV.

Remarks.— Modern representatives of *Cuspidaria* are widespread in deep and abyssal seas. Fossil representatives possibly arose even before the Mesozoic (Coan *et al.*, 2000: 547).

Cuspidaria textorama n. sp.
Pl. 2, Figs 4–6

Description.—Shell very small, highly inflated dorsoventrally. Posterior rostrum short, rapidly flattening out. Posterodorsal hinge margin straight. External sculpture smooth over umbones with weak comarginal folds and growth lines more prominent toward ventral margin. LV with proportionately large spoon-shaped chrondophore with swollen edge; RV hinge not available for study. Anterodorsal margin substantially thickened near umbo.

Remarks.—Palmer & Brann (1966 in 1965–1966: 124–125) listed only four species of *Cuspidaria* in the Paleocene and Eocene of the Gulf and eastern coast faunas. Two of these, *Cuspidaria multiornata* (Meyer & Aldrich, 1886) and *C. prima* (Aldrich, 1886), have strong radial ribs and should probably be assigned to *Cardiomya* A. Adams, 1864. *Cuspidaria aequivalvis* (Whitfield, 1885) is a much more elongate species with a long thin rostrum and thus little similarity to *C. textorama* n. sp. *Cuspidaria attenuata* (Aldrich, 1886) is similar with its highly inflated short form, but can be distinguished by its covering of fine concentric lines, lamellar on the dorsal side of the rostrum; the rostrum is rounded on top, and the chrondrophore is minute. The author has collected over 30 specimens of *Cuspidaria* spp. from the middle Claibornian of Texas. One of those species from the Cook Mountain Formation agrees in all aspects with *C. attenuata*, as figured and described by Aldrich (1886), but is significantly less similar to *C. textorama* n. sp., to which the closest published species appears to be the Upper Cretaceous *Cuspidaria* sp. figured by Stephenson (1941: 167, pl. 26, fig. 33).

The septibranchs appear to be a significant component of the shallow water faunas in both the Claibornian and the Upper Cretaceous Maestrichtian of Texas, and are not represented in the deeper water Midway Group in either the author's collection or in the TNSC collections. The fact that modern representatives are all from deep water indicates a retreat from coastal environments sometime after the Eocene.

Etymology.—The specific name *textorama* originates from *textor* (Latin, taylor) + *ramus* (Latin, branch) and refers to the name of the creek (Taylor Branch) from which the specimens were found.

Type Material.—Holotype: PRI 64787, from locality 12. Paratype: PRI 64803, from locality 20 (= 165-T-13).

Type Locality.—Locality 12 on Joe Taylor Branch of Two Mile Creek, just downstream of the county road bridge over the creek, 30°48.600'N, 96°39.276'W, Milam County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—Two specimens, the largest (paratype, PRI 64803) 5.2 mm in length.

Class **GASTROPODA** Cuvier, 1797
Clade **CAENOGASTROPODA** Cox, 1960
Clade **HYPSOGASTROPODA** Ponder & Lindberg, 1997
Clade **LITTORINIMORPHA** Golikov & Starobogatov, 1975
Superfamily **PTEROTRACHEOIDEA** Rafinesque, 1814
Family **ATLANTIDAE** Rang, 1829

Genus ***ATLANTA*** Lesueur, 1817

Type Species.—*Atlanta peronii* Lesueur, 1817, by subsequent designation (Gray, 1847: 149). Recent, Atlantic Ocean.

Description.—Shell small to moderately sized, flattened, disc-shaped. Apical whorls elevated; whorls encircled by keel. Aperture lanceolate; edge sharp.

Remarks.—The Atlantidae are recorded from the Danian of Denmark (Tracey *et al.* in Benton, 1993: 149). Wenz (1941 in 1938–1944: 1015) noted the presence of *Atlanta* in the Cretaceous, but without an attribution. The family is pelagic in distribution.

Atlanta funicularis n. sp.
Pl. 2, Fig. 12

Description.—Shell medium-sized; whorls widely expanding, not in contact. Outer whorl edge thin but flattened at periphery; inner (umbilical wall) area vertically flattened with central, raised, rope-like spiral cord; latter ornamented with fairly regular ribbing continuing over whorls as irregular growth lines. Aperture lanceolate, tending toward sharply pointing adaperturally.

Remarks.— Only two Eocene species were known, *Atlanta eocenica* Palmer, 1937, from the middle Claibornian Stone City beds of Texas, and an undescribed *Atlanta* from the Eocene Orangeburg district of South Carolina (L. D. Campbell, pers. comm., 2012). The Texas species at 8 mm greatest diameter is much smaller than *A. funicularis* n. sp., shows a much rounder aperture, and the initial whorls are sculptured with a reticulate pattern. The top surface of the early whorls of *A. funicularis* n. sp. is broken off and the lower surface cannot be examined, but extant early whorls are much smoother. The shape of *A. funicularis* n. sp. is very close to that of a logarithmic spiral and, although no sign remains of any flange between the expanding whorls, it is possible that that might have existed at one time because the matrix impression between the whorls is flat. Several Recent species have a flat flange connecting the expanding whorls, including both the type *A. peronii* and *A. tokiokai* Spoel & Troost, 1972.
Etymology.—The specific name *funicularis* (Latin, rope) refers to the rope-like spiral cord on the umbilical edge of the whorls.

Type Material.—Holotype: PRI 64788, from locality 20 (= 165-T-13).

Type Locality.—Locality 20 (= 165-T-13) on Joe Taylor Branch of Two Mile Creek, *ca.* 1.26 km downstream from Locality 12, 30°48.644'E, 96°39.272'N, Milam County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, PRI 64788), 15.5 mm in maximum diameter.

Superfamily **STROMBOIDEA** Rafinesque, 1815
Family **STROMBIDAE** Rafinesque, 1815

Genus ***ECTINOCHILUS*** Cossmann, 1889

Type Species.—*Strombus canalis* Lamarck, 1803 in 1802–1805, by original designation. Eocene (Lutetian) Paris Basin, France.

Description.—Shell elongate; whorls high, weakly to moderately inflated; suture impressed. Surface ornament of axial ribs and fine spiral lines; base of body whorl to end of canal spirally striate. Body whorl comprising approximately half of total shell height. Aperture broad, channeled posteriorly, anteriorly drawn out into spike. Columella smooth; outer lip extended, thickened, smooth inside.

Remarks.—This genus is closely similar to *Rimella* Agassiz in J. Sowerby, 1841 in 1837–1844. *Rimella* can be differentiated by the presence of varices, much weaker or absent spiral striation on the spire, the lack of a stromboid notch, and the anterior channeled projection of the outer lip that continues in a straight line almost to the apex.

Subgenus ***COWLITZIA*** Clark & Palmer, 1923

Type Species.—*Cowlitzia washingtonensis* Clark & Palmer, 1923, by original designation. Upper Eocene, Washington State.

Description.—Shell moderately large, subconical. Whorls convex. Ornament smooth or with axial and spiral ribs; former increasing in number up spire. Aperture wide; columella smooth with callous deposit; outer lip thickened, subangulated below midpoint, serrated basally. Columellar callus and outer lip produced to form channeled canal ascending spire, turning abapically at tip; anterior canal broadly and widely notched (modified after Clark & Palmer, 1923: 283).

Ectinochilus* (*Cowlitzia*) *texanum texanum (Harris, 1895)
Pl. 2, Figs 7–8

Rimella texana Harris, 1893: specimen no. 1470; 1895: 78, pl. 9, fig. 1; Gardner, 1945: 164.

Ectininochilus (Macilentos) texanus (Harris). Stewart, 1927: 367.
Ectinochilus texanus (Harris). Palmer, 1937: 245, pl. 33, fig. 3 (holotype).
Ectinochilus texanum (Harris). Wrigley, 1938: 71.

Description.—Shell moderately sized; first 3 whorls more or less smooth with incremental longitudinal and spiral lines, reticulate toward apex; succeeding whorls with sharp folds, 15 on body whorl, 20 or 21 on previous whorl, all dying out before subsutural area, which is flattened and bears 2 stronger spiral lines; folds dying out basally before basal canal where spirals become stronger again. Umbilical depression, callus separated from body whorl on left apertural side; another callus ridge running more or less parallel to callus edge under columellar callus, merging near apex with top ridge of stromboid bar.

Remarks.—The type of *Rimella texanum* is from the Reklaw Formation (Marquez Member) at Devil's Eye on the Colorado River, but Harris (1895: 78), Dumble (1918: 98), and Deussen (1914: 57) cited this species as also occurring in both the Weches and Cook Mountain formations (Stone City and Wheelock members) throughout Texas; Palmer & Brann (1966 in 1965–1966: 641) cited further localities in Louisiana. The type is a single, very well preserved individual (missing the tip) from the Marquez Member, although in the Texas Natural Science Center collections, there are numerous species of *Ectinochilus* from the underlying Newby Sand Member; however, all are so corroded that specific determinations are impossible. Gardner (1945: 164) disagreed with the prior reassignment of *R. texana* to *Ectinochilus* by Stewart (1927: 367; also followed by Palmer, 1937: 245), and kept it under *Rimella*. As part of her reasoning, Gardner agreed with Stewart (1927: 367) on the lesser importance of the presence or absence of varices, and also placed little importance in the looping of the posterior canal in separating the two genera. Her primary character separating *Ectinochilus* from *Rimella* was the absence of the stromboid notch in the latter. That by itself should not be a deciding character, because when examining a suite of specimens of the genotype of *Rimella*, *R. fissurella* (Lamarck, 1803 in 1802–1905), a very shallow but definite retraction of the outer lip is seen just where a stromboid notch would be expected. Thus, it is not a question of the presence or absence of the feature, but just a matter of degree. It seems clear that the U. S. Claibornian specimens cannot be placed in *Rimella* by using the characters of the genotype as a guide, because *R. fissurella* always has varices (even though this feature might not be of importance in similar genera), the position of the weak stromboid notch is posterior to the sharp curve of the outer lip where it curves into the basal notch, and the axial ribs (although growing weaker as they approach the teleoconch) are prominent from suture to suture. In examining specimens of *E. canalis*, the genotype of *Ectinochilus*, the only consistent differentiating feature from *Rimella* appears to be the strong stromboid notch at a lower position, anterior to the widest part of the outer lip.

The author has collected over 150 specimens of *Ectinochilus* spp. from Texas, ranging from the lowermost Weches Formation to the uppermost Claibornian Mt. Tabor Formation. All of these form a natural group with relatively little variation between them, and when preserved, the outer lip shows the anal notch or notches in position below the widest part of the outer lip, as in *Echinochilus s.s.* Many of the larger specimens show a basally serrated, flaring outer lip, which is one diagnostic character of *Echinochilus* (*Cowlitzia*); younger specimens often show just one serration. The existence of multiple anal notches is curious, but perhaps reflects a repositioning of the anal siphon as the animal grows. Clark & Palmer (1923) could not have had specimens of the genotype of *Ectinochilus* for examination, otherwise they should have noticed the minutely serrated edge of the outer lip just anterior to the stromboid notch; that feature also is just a matter of degree. The second distinguishing feature of *Cowlitzia* is the absence of a strombiform sinuosuity, but in the author's opinion, that is not a particularly useful character because the strength of the sinuosity is age-dependant as can be observed by examining prior growth lines. Because the only consistent distinguishing feature between *E.* (*Cowlitzia*) and *E.* (*Ectinochilus*) is the strong stromboid notch of the latter, every other feature being plastic to a remarkable degree, I follow Wenz (1940 in 1938–1944: 932) and place *Cowlitzia* as a subgenus of *Ectinochilus*. In Clark & Palmer's (1923: 283) diagnosis of *Cowlitzia*, they stated "outer lip subangulated slightly posterior to middle" and posterior canal "ascend[ing] 5 whorls of spire and turn[ing] to dorsal side on 5th whorl." As regards the outer lip angulation, the author did not have access to specimens of *Cowlitizia* spp. but examination of published figures (Clark & Palmer, 1923: pl. 51, figs 11–26) shows it to be open to interpretation, moreover the number of whorls that the posterior canal ascends must obviously be age-dependent, and it should be noted varies substantially in other *Ectinochilus* species. A slightly wider interpretation for the subgenus would place the Claibornian species within *Cowlitizia* as suggested here.

The Reklaw holotype of *Ectinochilus* (*Cowlitzia*) *texanum texanum* (TMM BEG35641) shows a combination of characters not seen in their entirety in later descendants of this species, although the author has collected a few Weches specimens that approach it. Gardner (1945: 164) stated that *E.* (*C.*) *texanum* was only known from the Weches Formation, forgetting that the holotype is from the Reklaw. The Weches Formation also contains the subspecies *E.* (*C.*) *t. cherokense* Palmer, 1944, a smooth form with basal spirals. Whether this

is just the end of a line of continuous variation from typical *E.* (*C.*) *texanum* is not known, but the author has collected some individuals that are intermediate between the two taxa. The fact that chronologically later specimens of *Ectinochilus* (*Cowlitzia*) previously assigned to *E.* (*C.*) *texanum texanum* are separable from the Reklaw type must have already been known to Renick & Stenzel (1931: 102) because their list of species from selected localities in Texas includes "*Rimella stephensoni* Stenzel, n. sp.," and on page 99 the statement, "New species mentioned in this report will be described subsequently." Palmer & Brann (1966 in 1965–1966: 882) listed this species as a "*nomen nudum*" because the species was apparently never subsequently described. The type is well characterized by Harris (1895: 78) and Gardner (1945: 164), so their descriptions will not be repeated in their entirety here. Because *E.* (*C.*) *texanum* is readily separable from the later Claibornian representatives, it is given subspecific rank.

Type Information.—Holotype: TMM BEG35641, from locality 11 (= 11-T-36).

Material Examined.—One specimen (holotype, TMM BEG35641), 28 mm in length.

Ectinochilus* (*Cowlitzia*) *texanum stephensoni n. ssp.
Pl. 2, Figs. 9–10

Description.—Similar to *Ectinochilus* (*Cowlitzia*) *texanum texanum* but with the following differences: true axial ribs beginning at *ca.* 6th whorl; subsutural area consisting of 3 ribbons that sometimes bifurcate on later whorls into multiple lines; body whorl with 14–25 sharp, high, axial ribs with proportionally wider interspaces; penultimate whorl with 18–24 more subdued ribs with proportionately smaller interspaces.

Remarks.—There appears to be a general increase in the number of ribs on the last two whorls as the top of the Claibornian is approached. The holotype and paratype were obtained from the lowest part of the Wheelock Formation. For further discussion, see the Remarks section for *Ectinochilus* (*Cowlitzia*) *texanum texanum*.

Etymology.—The subspecific name *stephensoni* was given by Renick & Stenzel (1931: 102) but never validated, and most likely refers to L. W. Stephenson.

Type Material.—Holotype: PRI 64789. Paratype: PRI 64790, both from locality 21-T-101.

Type Locality.—Locality 21-T-101, banks of Little Brazos River upstream of the Highway 21 bridge, Brazos County, Texas. Wheelock Member of the Cook Mountain Formation. For section, see Stenzel (1934: 39–41).

Material Examined.—Over 150 specimens (CLG 187, 5395, 5398, 11183), the largest (holotype, PRI 64789) 36 mm in length.

Family **APORRHAIDAE** Gray, 1850

Genus ***GRACILIALA*** Sohl, 1960

Type Species.—*Anchura* (*Drepanochilus*) *calcaris* Wade. 1926, by original designation. Campanian and Maestrichtian, Gulf and Atlantic Coastal Plains.

Description.—Shell medium-sized. Spire high, turriculate; whorls generally 6–8; sides well-rounded, ornamented by fine spiral threads and numerous, curved, strong, transverse ribs that die out below periphery. Aperture elongate, lenticular, acute posteriorly, drawn out into long, narrow, tapering spur, grooved interiorly with corresponding external ridge that dies out on body whorl. Inner lip with moderately heavy, well-defined callus over entire length (after Sohl, 1960: 97).

Remarks.—Sohl (1960) proposed this genus for a group of Campanian and Maestrichtian species of the Gulf and Atlantic Coastal Plains that most closely resembled *Drepanochilus* Meek, 1864, but without the strong spiral ridges and wider reflexed wing of that taxon. The problem of assigning an unknown aporrhaid to the correct genus is much more difficult without knowledge of the shape of the lip or the basal canal, but although not noted by Sohl (1960), both *Graciliala* and *Drepanochilus* spp. often have varices on the spire, a condition not shown by other Upper Cretaceous or Paleogene aporrhaid genera. *Drepanochilus* is known from several Paleocene deposits in North America, Greenland, and northwestern Europe (Marincovich & Zinsmeister, 1991: 242–246) and from the Lower Eocene of Alabama (Stewart, 1927: 362).

aff. ***Graciliala*** sp.
Pl. 2, Fig. 11

Description.—Shell small; whorls at least 6, moderately inflated. Sculpture of regularly placed axial cords, weakly prosocyrt near upper suture with close-set spiral lines overriding axials; one strong, rounded varix per whorl; transition to basal rounded area abrupt; base with fine spiral lines and varix that is continuation of penultimate whorl varix.

Remarks.—One specimen was recovered, with the canal and tip of the protoconch missing. The lack of any strong basal

cords and the presence of the varices have caused tentative placement in this genus. The two common strombid genera in the Gulf Coast Paleogene are *Calyptraphorus* Conrad, 1858, and *Ectinochilus* Cossmann, 1889, and neither ever shows varices on the whorls. Species of Gulf Coast *Calyptraphorus* spp. have much stronger prosocyrt ribs and a gradual demarcation to the penultimate whorl, whereas *Ectinochilus* spp. are much more slender and have opisthocyrt ribs, particularly basally. *Rimella* often has varices and, in the juvenile state, no extension of the channeled canal ascending the spire, but also has no extension of the last varix onto the basal columellar area.

Both Palmer (1937: 239) and Neave (1939: 556) cited 1857 as the date of *Calyptraphorus*, but although Conrad's paper was read in 1857, the publication date on the cover of the *Proceedings* and as given by Wheeler (1935: 139) is 1858.

Type Information.—Figured specimen: PRI 64791, from locality 6 (= 11-T-7).

Material Examined.—One specimen (PRI 64791), 9.0 mm in length.

Superfamily **TONNOIDEA** Suter, 1913
Family **TONNIDAE** Suter, 1913
Subfamily **CASSINAE** Latrielle, 1825

Genus ***PHALIUM*** Link, 1806 in 1806–1808

Type Species.—*Buccinum glauca* Linnaeus, 1758, by subsequent designation (Dall, 1909: 62). Recent, Indo-Pacific.

Description.—Shell medium-sized. Spire acuminate. Last whorl well-rounded. Both false and true umbilicuses usually open. Parietal shield anteriorly well-developed; outer lip thick, with row of denticles that can be produced into spines at lower end.

Subgenus ***ECHINOPHORIA*** Sacco, 1890

Type Species.—*Buccinum intermedium* Brocchi, 1814, by subsequent designation (Dall, 1909: 62). Oligocene, Italy.

Description.—Shell with columellar callus nearly smooth. Noded spiral sculpture often completely covering whorls, possessing strong raised thread running along dorsal surface of outside of siphonal canal, ending at edge of siphonal notch.

Remarks.—The treatment of *Echinophoria* as a subgenus or genus in the recent literature appears to be in a state of flux. That resolution must await a fuller consideration of the range of characters and classification, so in the meantime, I prefer the more conservative option to keep it as a subgenus of *Phalium*. Two closely related species occur in the lower Claibornian of Texas, one from the Reklaw Formation, Marquez Shale Member, and a second from the Cane River Formation near Nacogdoches in eastern Texas. Both the Reklaw and the younger Weches formations of central Texas grade indeterminably into the Cane River Formation of eastern Texas and Louisiana. In locations where the Cane River specimens occur, many species have characteristics between those of similar taxa found in the Reklaw and Weches formations of central Texas; in the author's opinion, they are decidedly closer to those found in the Reklaw. Because the following two species have no close analogs in the later American Tertiary faunas, they are discussed together here.

Phalium* (*Echinophoria*) *cingulae n. sp.
Pl. 3, Figs 1–2

Description.—Shell moderately large, robust, rounded; whorls 9. Spire weakly acuminate. Protoconch of 2¼ smooth rounded whorls, with transition to teleoconch abrupt. First postnuclear whorl rounded, spirally striate, with 2 lines stronger; lower line rapidly increasing in strength then developing nodes, which by third whorl are horizontally flattened and prominently spinose. Body whorl and preceding whorl each with 9 spines. Entire spire covered with subequal spiral striae and incised growth lines. Suture deeply impressed; sutural collar swollen. Body whorl rounded-tricarinate; upper carina defined by flattened nodes; 2 lower ones margined by weak lines and interstitial swelling; surface otherwise smooth with few irregular spirals. Body whorl with 2 varices, one apertural and one weaker and 180° further back. Aperture leaf-shaped; outer lip thick, smooth, with one weak lira anteriorly. Parietal shield fairly thin with few weak anterior denticles and indications of weak posterior wrinkling. Both false and true umbilicuses present. Siphonal canal strongly bent, with impressed line on dorsal surface, probably weakly notched (damaged at tip in only specimen).

Remarks.—Only one specimen was obtained and is obviously an adult. The protoconch was lightly damaged since initial inspection. No previously comparable Eocene species are known with the possible exception of *Phalium* (*Semicassis*) *taitii* (Conrad, 1834) from the Gosport Sand of Alabama, and in the upper Claibornian Castle Hayne/Santee Limestone, a species that Abbott (1968: 109) noted could be placed either in the subgenus *Semicassis* Mörch, 1852, or *Echinophoria*. Species of *Phalium* (*Semicassis*) can be distinguished from those of *P.* (*Echinophoria*) by the denticulated outer lip, wrinkled columellar shield, and absence of the raised ridge or line on the siphonal canal. Certainly the absence of the spinose

periphery and the denticulated outer lip alone indicate different subgenera for the two species. A close relationship with this species and the next described species is seen and further discussion will take place there.

Woodring & Olsson (1957: 22) described a new cassid genus *Bathygalea* and an associated subgenus *Miogalea* with a rather wide morphological range that appears to encompass *Echinophorea*. Unfortunately, the authors did not compare their new genus and subgenus with any other similar-level taxa in the Cassidae, making assignment of species in these groups very difficult. *Bathygalea,* a taxon so far only known from Recent seas, is very similar to *Phalium* (*Echinophoria*) with its noded sculpture, relatively smooth outer lip, and short asymmetrically placed siphonal canal and fasciole. One of the few differences between the two is the swollen siphonal fasciole limited by a strong narrow ridge in *Bathygalea* versus the strong raised thread on the outside of the fasciole of *P.* (*Echinophoria*). *Bathygalea* (*Miogalea*), from the Miocene of Columbia, appears much the same except that it is thick-shelled and possesses a ridged outer lip. The two groups are obviously very closely related and I concur with Beu (2005: 45) who regarded both *Bathygalea* and *Miogalea* as synonyms of *P.* (*Echinophoria*).

Etymology.—The specific name *cingulae* (Latin, girdle), refers to the girdling spines.

Type Material.—Holotype: PRI 64792, from locality 12.

Type Locality.—Locality 12 on Joe Taylor Branch of Two Mile Creek, just downstream of the county road bridge over the creek, 30°48.600'N, 96°39.276'W, Milam County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, PRI 64792), 52 mm in length, 41 mm in maximum diameter (including spines).

Subgenus ***SEMICASSIS*** Mörch, 1852

Type Species.—*Phalium bisulcatum* Schubert & Wagner, 1829, by subsequent designation (Dall, 1909: 62). Oligocene, Italy.

Description.—Shell somewhat globular, rarely with varices on spire. Outer surface usually with numerous spiral threads or incised lines. Columella shield finely wrinkled. Outer lip with fine denticles and smooth base; siphonal fasciole rounded showing few longitudinal adapertural lines.

Phalium* (*Semicassis*) *marcusi n. sp.
Pl. 3, Figs 3–4

Description.—Shell moderately large, robust, high, with 6–7 whorls. Spire conical; protoconch of 2½ smooth, rounded whorls; transition to teleoconch abrupt; first postnuclear whorl rounded-tricarinate, strongly spirally striate, with 3 lines stronger, lower one rapidly increasing in strength then developing nodes, which by third whorl are horizontally flattened and prominently spinose; upper line developing into strong subsutural cord; middle line obsolete by third whorl. Adult whorls with 7 spines, more on earlier whorls. Body whorl with 2–5 strong spiral cords, often nodose; entire spire surface covered with close spiral striae that override other sculpture; spiral striae on body whorl less regular, tending to group in wide ribbons near canal. Body whorl with terminal varix and rarely one preceding. Aperture oval; outer lip thickly denticulate along entire length, with stronger tooth just anterior to posterior notch; parietal shield fairly thin, lirate along columella, often with one or 2 stronger denticles posteriorly, marking position of previous nodes. Both false and true umbilicuses present. Siphonal canal moderately long, twisted, smooth apart from growth lines.

Remarks.—*Phalium* (*Semicassis*) *marcusi* n. sp. is a common species at the one locality where it has been found, allowing an analysis of the range of variation of this species. Some specimens have a more bicarinate body whorl reminiscent of the outline of species of *Galeodea* Link, 1807 in 1806–1808, a feature that appears to be correlated with a reduction in the strength of the lower carinae. Several specimens of *P.* (*S.*) *marcusi* n. sp. also have nine spines on the body whorl. Genus *Galeodea* is easily separated from *P.* (*Echinophoria*) and *Phalium s.s.* by the long, straight siphonal canal and the strongly bicarinate body whorl. That said, these Reklaw/Cane River taxa can scarcely be separated from each other on the basis of the early whorls, or even from the early whorls of *Galeodea* (*Gomphopages*) *turneri* Gardner, 1939, indicating that the root stock of all of these taxa is not too distant before the Reklaw age.

The third cassid found in some abundance in the Reklaw Formation is *Phalium* (*Semicassis*) *reklawensis* (Garvie, 1996), a more globular species with a lower spire and the early spiral sculpture of which continues unchanged until the body whorl, where nodes finally develop. The Cane River Formation analog of *P.* (*S.*) *reklawensis* from the same locality as *P.* (*S.*) *marcusi* n. sp. is shorter, has triply noded carinae on the body whorl, and appears directly in a line leading to *P.* (*S.*) *taitii* (Conrad, 1834) from the Gosport Sand in Alabama. The latter species was only very briefly described and the type is lost (Moore, 1962: 101); a specimen of *P.* (*S.*) *taitii* has since been rediscovered (Campbell & Campbell, 2003: 349), although its type status was not stated. Harris & Palmer (1947 in 1946–1947: 329) noted that a few rare and usually fragmentary specimens

have been found in the Jackson Eocene, which are referable to *P.* (*S.*) *taitii johnsoni* (Harris & Palmer, 1947 in 1946–1947), the primary difference being the stronger development of the noded spirals on the body whorl.

Juvenile specimens of *Phalium* (*Semicassis*) *marcusi* n. sp. can appear confusingly similar to the young of aff. *P.* (*S.*) *taitii* but *P.* (*S.*) *marcusi* n. sp. has a spire angle of *ca.* 78°, whereas that of *P.* (*S.*) *taitii* is *ca.* 86°. The development of tall, strongly noded *P.* (*Semicassis*) spp. appears not to have continued in the American region, but instead continued on in southern Europe because Sacco (1890: 53, 96, pl. 2, figs 2a–b) figured a quite similar species: *Galeodea echinophora mioturrita* Sacco, 1890, from the Miocene of northern Italy. The canal of *G. echinophora mioturrita*, although elongated, is short in comparison with those of American *Galeodea* spp., and the remaining characters could place *G. echinophora mioturrita* within the genus *Phalium* as it is presently understood.

Etymology.—The specific name *marcusi* honors my son Marcus Garvie who helped me collect the specimens.

Type Material.—Holotype: PRI 64793. Paratype: PRI 64794, both from locality 173-T-100.

Type Locality.—Locality 173-T-100, scraped area used in constructing earthen dam at southern end of Lake Nacogdoches, 31°35.314'E, 94°49.858'N, Nacogdoches County, Texas. Weches Formation grading into Cane River Formation.

Material Examined.—48 specimens, the largest (in CLG) 39.6 mm in length, 30.5 mm in maximum diameter.

Superfamily **XENOPHOROIDEA** Troschel, 1852
Family **XENOPHORIDAE** Troschel, 1852

Genus ***XENOPHORA*** Fisher von Waldheim, 1807 in 1806–1807

Type Species.—*Trochus conchyliophorus* Born, 1780, by subsequent designation (Gray, 1847). Fossil and Recent, eastern America and the West Indies.

Description.—Shell low, conical, usually moderately sized, seldom small, robust. Whorls flat to moderately inflated, often overhanging succeeding whorl; sutures deeply impressed. Sculpture of axial folds and spiral lines upon which objects such as pebbles and other shells are cemented. Base weakly concave, narrowly or not umbilicated. Aperture elongate; columella concave.

Xenophora spiralis n. sp.
Pl. 3, Figs 5–7

Description.—Shell moderately sized, approximating 90° cone. Whorls progressively overhanging succeeding ones. External sculpture (where not covered by attached objects) with growth lines and irregular axial plicae at right angles to upper suture and swinging back strongly adaperturally near lower suture, covered with spiral lines. Base weakly concave, overrun with strong, rounded, raised spiral lines covered near aperture by thin callus; entirely covered with fine comarginal striae. Basal edge very irregular; aperture elongate-elliptical.

Remarks.—This specimen, which Harris (1893) figured in the proof plates of his unpublished manuscript, and that was intended to form part of the Fifth Annual Report of the Geological Survey of Texas, was given the name *Xenophora conchyliophora*. The specimen was located in the TNSC collections, extraneous matrix removed, and found not to be particularly close to *X. conchyliophora*. Dall (1892 in 1890–1913: 360–361) assigned a great many forms, ranging from the Upper Cretaceous Ripley Formation to the Pleistocene and Recent, to *X. conchyliophora,* a conclusion that as Palmer (1937: 144) noted was followed by other authors. I find it hard to accept that a species could survive unchanged through such a time span and variety of environments. After all, if *Turritella* had been in the habit of attaching shells and other pieces of substratum to its surface, and thus obscuring the sculptural features, we might very well have one species of *Turritella*. Dall (1892 in 1890–1913) did point out the two major groupings of *Xenophora*, vis. *Xenophora s.s.* and *Xenophora* (*Tugurium*) Fisher, 1880, the latter an umbilicate group with a smooth, and often inflated base. Judging from the author's collections, that genus or a very close analog thereof was already in existence in the Texas Eocene. Recent *X. conchyliophora* has a small, axially hidden umbilicus, and a flat to concave base with a low, roughly granular surface generated by the comarginal and axial striae. The strong basal lines by themselves distinguish *X. spiralis* n. sp. from *X. conchyliophora*.

A possible descendant of *Xenophora spiralis* n. sp. could be *X. textilina* Dall, 1892 in 1890–1913, from the Chipola Miocene of Florida, which is higher and also strongly basally striated, but in which the basal grooves are cut by strong comarginal lines and the upper surface is closely lirate, the lirae following no consistent direction. The author has a Weches Formation specimen that is intermediate in characters between the two forms. The author has noticed that in illustrations of Recent *X. conchyliophora*, the attachments are always either complete shells or at least large fragments, whereas in the few fossil specimens that the author has found with attachments, the pieces and particularly attachment areas are

quite small. The availability of material in the environment must obviously have an effect on the mollusk's selection, but the author has collected specimens from the same stratum in which one individual has attached only small pieces of bivalve hash, whereas another has attached turrids to the periphery in a spoke arrangement. Generally, it appears that Eocene and Cretaceous specimens have small attachment areas, whereas in Miocene and later fossils, these are proportionately larger.

Etymology.— The specific name *spiralis* (Latin, spiral) refers to the strong basal lines.

Type Material.—Holotype: TMM UT19368, from locality 11 (= 11-T-36).

Type Locality.—Locality 11 (= 11-T-36), Devil's Eye, Colorado River, 30°01.635'N, 97°13.415'W, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, TMM UT19368), 33.7 mm in maximum diameter, 21.4 mm in height.

Clade **NEOGASTROPODA** Wenz, 1938 in 1938–1944
Superfamily **MURICOIDEA** Rafinesque, 1815
Family **TURBINELLIDAE** Swainson, 1835
Subfamily **COLUMBARIINAE** Tomlin, 1928

Genus ***FULGUROFUSUS*** Grabau, 1904

Type Species.—*Fusus quercolis* Harris, 1896, by original designation. Paleocene, Alabama.

Description.—Shell spindle-shaped, thin-shelled, commonly with flange-like peripheral keel. Axial sculpture weak, usually restricted to earlier whorls. Protoconch bulbous, deviated, not distinctly differentiated from succeeding whorls. Aperture round to ovate; columella straight, smooth; canal long.

Fulgurofusus perobliquus (Johnson, 1899)
Pl. 4, Figs 1–2

Fusus perobliquus Johnson, 1899: 72–73.
"*Falsifusus*" *perobliquus* (Johnson). Palmer, 1937: 355, pl. 48, fig. 9 (holotype); Snyder, 2003: 275.
Fulgurofusus perobliquus (Johnson, 1899). Garvie, 2013: 58.

Description.—Shell elongate, fusoid. Protoconch of 3 smooth whorls. Teleoconch whorls with 7 longitudinal ribs and 9 spiral lines, one on periphery, 3 below, 5 above; subsutural line almost obsolete on nearby whorls.

Remarks.—The Reklaw representative of this taxon is almost identical to that of the type from the Stone City Beds of Texas, the minor differences being the slightly broader spire and the marginally more prominent axial folds. Weches Formation representatives are midway in aspect between the Reklaw and Stone City forms. The present specimen is missing the tip of the protoconch, but shows the smooth multiwhorled protoconch that is characteristic of this taxon. In the author's collection, later Claibornian forms allied to *Fulgurofusus perobliquus* are even more slender in aspect, the spiral sculpture becomes more equal in strength, and a subsutural collar develops. The genus is not known in the Oligocene or later Neogene; modern representatives live in deep water and the protoconchs are radically different, making any relationship to the Paleogene forms speculative (M. G. Harasewych, pers. comm., 2012).

Type Information.—Figured specimen: PRI 64795, from locality 20 (= 165-T-13).

Material Examined.—One specimen (PRI 64795), 16.9 mm in length.

Fulgurofusus aff. ***rugatus*** (Aldrich, 1886)
Pl. 4, Figs 3–4

Fusus rugatus Aldrich, 1886: 22, pl. 5, fig. 9; Gregorio, 1890: 81, pl. 6, fig. 13 (copy of Aldrich, 1886); Harris, 1897: 478, pl. 22, fig. 8; 1899: 43, pl. 5, fig. 6; Cossmann, 1901 in 1895–1925: 12; Toulmin, 1977: 213, pl. 25, fig. 13.
Fulgurofusus rugatus (Aldrich). Grabau, 1904: 86, text-fig. 10 (copy of Harris, 1899); 1935: 131, text-fig. 56; Grabau in Agassiz *et al.*, 1907: 766, text-fig. 18; Snyder, 2003: 280.

Description.—Single specimen collected with 6 whorls (missing aperture and canal). Protoconch with 2½ smooth, bulbous whorls and flattened tip; transition to teleoconch defined by raised ridge. Spire whorls with prominent tubercular carina defined by wide raised line; one weaker spiral line below, another much weaker just above lower suture. Axial sculpture of fine raised lines, aligned vertically below carina, running adapically at angle of *ca.* 30° on ramp; intersections of axial and spiral sculpture nodose.

Remarks.—This species appears somewhat distantly related to *Fulgurofusus rugatus* from the Greggs Landing Marl Member of Tuscahoma Sand, middle Sabine Stage, which has a much more concave ramp and more even sculpturing throughout.

Type Information.— Figured specimen: PRI 64796, from locality 12.

Material Examined.—One specimen (PRI 64796), 7.2 mm in length.

Superfamily **CONOIDEA** Fleming, 1822
Family **CONIDAE** Fleming, 1822
Subfamily **CONINAE** Fleming, 1822

Genus ***GLYPTOTOMA*** Casey, 1904

Type Species.—*Pleurotoma crassiplicata* Gabb 1860, by subsequent designation (Gardner, 1945). Claibornian Eocene, Texas.

Description.—Shell small, biconical, robust; spire relatively straight. Protoconch of 3–4 smooth whorls; tip immersed; final quarter whorl with riblets that quickly merge into teleoconch sculpture. Body whorl tapering to slightly flexed, spout-like anterior canal. Adult sculpture of strong nodose spirals and strong growth lines. Sinus V-shaped, with apex broadly U-shaped on peripheral carina. Outer lip lirate; columella with with 2 or 3 prominent wide swellings posteriorly (revised from Casey, 1904).

Remarks.—Gabb (1860) did not give the type locality for the type species. Richards (1968: 119) wrote that it was from Wheelock, Texas, and Dockery (1977: 91) surmised that it came either from the Wheelock Member near Wheelock, Robertson County, Texas, or the Stone City Member of the Cook Mountain Formation at Stone City Bluff, Brazos River. The Wheelock Member appears by far the most likely because whereas the author has only found two specimens of *Glyphotoma crassiplicata* from the Stone City Member, none of them from Stone City Bluff, over 200 specimens of *G. conradiana* (Aldrich, 1895) have been found at the bluff. Numerous specimens of *G. crassiplcata* have been found by the author in the Wheelock Member at locality 21-T-101, a distance of *ca.* 24.5 km from Gabb's inferred Wheelock collecting locality 197-T-3 (Stenzel *et al.*, 1957: 11).

Glyptotoma cf. ***crassiplicata*** (Gabb, 1860)
Pl. 4, Figs 7–8

Scobinella crassiplicata Gabb, 1860: 380, pl. 67, fig. 19; Heilprin, 1891: 395; Kennedy, 1895: 122.
Scobinella? crassiplicata Gabb. Conrad, 1865: 20; 1866: 18.
Glyptotoma crassiplicata (Gabb). Casey, 1904: 141; Cossmann, 1906 in 1895–1925: 220; Wenz, 1943 in 1938–1944: 1416, fig. 4001; Powell, 1966: 65, pl. 10, fig. 1.
Bathytoma (*Glyptotoma*) *crassiplicata* (Gabb). Harris, 1937: 23, pl. 3, figs 27–30; Brann & Kent, 1960: 118.

Description.—As in the generic description.

Remarks.—The Reklaw representative of this species is almost identical to those from the middle Claibornian. The only differences noted are the proportionately larger size of the protoconch and the slightly more squat aspect of the shell. It should be noted that Gabb (1860), in his original diagnosis of the species, mentioned a rudimentary umbilicus; of the almost 500 specimens collected of this genus, none shows evidence of a real umbilicus; an umbilical depression is a more accurate description. *Glyptotoma crassiplicata* can be distinguished from the very closely similar *G. conradiana* by the shorter form, greatest diameter at the middle of the shell, and the proportionately larger nodular spirals in *G. crassiplicata*. This extends the lower range of *Glyptotoma* to the very lowest Claibornian.

Type Information.—Figured specimen: PRI 64797, from locality 12.

Material Examined.—One specimen (PRI 64797), 7.2 mm in length.

Subfamily **CLATHURELLINAE** H. & A. Adams, 1858 in 1853–1858

Genus ***CORDIERIA*** Rouault, 1848

Type Species.—*Cordieria iberica* Rouault, 1850, by subsequent designation (Cossmann, 1896 in 1895–1925). Eocene, Bois d'Arros, France.

Description.—Shell small to medium-sized, ovate-fusiform. Spire tall, conical; whorls convex. Protoconch small, of 1½–2 smooth whorls. Teleconch sculpture of broad axial folds angulated at periphery, overridden by spiral lines. Aperture elongate; outer lip thin; columella with 2 medial folds; canal moderately sized, unnotched.

Cordieria cf. ***biconica*** (Whitfield, 1865)
Pl. 4, Figs 5–6

Mitra biconica Whitfield, 1865: 263; 1899: 172; Aldrich, 1887: 80; Gregorio, 1890: 74; Tucker, 2004: 129.
Pleurotoma (*Borsonia*) *biconica* (Whitfield). Harris, 1893: pl. 18, fig. 2.
Cordieria biconica (Whitfield). Casey, 1903: 275; 1904: 161; Harris, 1937: 61, pl. 11, figs 6, 6a (holotype); Palmer 1937: 415; Powell, 1966: 59; Cernohorsky, 1972: 208.

Description.—Shell slender, fusiform. Spire elevated, with 6 or 7 volutions, slightly convex, with narrow depression just below upper margin. Body whorl somewhat gradually tapering below most convex portion. Aperture long, narrow; columella

strong, with 2 distinct, very oblique folds slightly above mid-length. Surface of volutions marked by strong longitudinal folds, *ca.* 9 on body whorl; entire surface covered with very fine revolving striae.

Remarks.—Harris (1937: 37) recorded in his 1893 manuscript that he could only refer the Texas material to *Cordiera biconica* with some hesitation, because the expressions "shell slender" and "very oblique folds" were scarcely applicable to the Texas form. Palmer & Brann (1966 in 1965–1966: 600) give the range of *C. biconica* as "Middle Eocene, Cook Mountain," but Harris' Texas material included at least one Reklaw specimen, because the *C. biconica* specimen figured in his unpublished manuscript is from the Reklaw Devil's Eye location.

Cordiera biconica is a reasonably common species and examination of over 50 specimens has given a clearer idea of the range of variation. Generally middle Claibornian Cook Mountain specimens are shorter, with more pronounced axial folds, and thus more medial carination, and stronger spiral lines, tending toward subspecies *C. b. curta* Harris, 1937. The morphology of the Weches Formation specimens appears to depend on the depositional environment; those from coarse glauconitic silts and marls are similar to the Cook Mountain Formation specimens, although with slightly less medial carination, whereas those from finer sediments are as slender as Whitfield's type. Constant characters among them are the nine axial folds, a subsutural collar of variable strength with a narrow depression below that, and two columellar folds. The angle at which the columellar folds spiral into the shell interior cannot be a useful morphological feature, because from the geometry, that angle can only depend on the relative whorl-to-spire height; the greater that ratio, the greater the spiral angle. The unique Reklaw specimen differs from all others by being relatively a little shorter, and having the entire surface covered with very fine close-set spiral lines. These differences are not considered sufficient to mandate even subspecific rank. This occurrence extends the range of the taxon *Cordieria* to the lowest Claibornian in America.

Type Information.—Figured specimen: TMM UT18366, from locality 11 (= 11-T-36).

Material Examined.—One specimen (TMM UT18366), 14.8 mm in height.

Family **CLAVATULIDAE** Gray, 1853

Genus ***HEMISURCULA*** Casey, 1904

Type Species.—*Pleurotoma silicata* Aldrich, 1895, by original designation. Lower Eocene, Alabama.

Description.—Shell elongate-fusiform, with tall, straight spire, rounded body whorl, and long, straight, unnotched anterior canal. Protoconch smoothly conoidal, multispiral. Teleoconch whorls subsuturally constricted, smooth, or with spiral lines on upper part of whorls, obsolete below, sometimes with weak axial sculpture on earliest whorls.

Remarks.—As far as is presently known, *Hemisurcula* first appears in the Lower Eocene with the type *H. silicata* and is represented in the middle Claibornian by two species. Its place is taken by the closely similar taxon *Sullivania* Harris & Palmer, 1947 in 1946–1947. Both taxa are very rare in their respective deposits.

Hemisurcula terus n. sp.
Pl. 4, Figs 9–10

Description.—Shell small; extant whorls 6, protoconch unknown (missing or worn in holotype). Remaining whorls 6. Protoconch unknown (missing or worn in holotype). First 4½ whorls showing very weak nodulation; final whorl also with almost obsolescent, widely spaced brevic axials; last 2 whorls with fine impressed spiral striae covering entire whorl and canal, with striae marginally stronger on weakly depressed subsutural area. Suture deeply impressed, becoming channeled on last whorl. Anal sinus broadly and deeply U-shaped with apex just above point of maximum whorl diameter. Columella straight; canal bent slightly to left.

Remarks.—Palmer & Brann (1966 in 1965–1966: 928–929) reassigned all species of *Hemisurcula*, with the exception of the type *H. silicata*, to *Sullivania* mainly on the position of the sinus (higher in *Sullivania*) and the total lack of costation at any stage of growth. *Hemisurcula terus* n. sp. leaves just two species in the taxon *Hemisurcula* in the American Eocene.

The English Eocene species, *Conorbis priscus* (Solander, 1766), which Harris & Palmer (1947 in 1946–1947: 422) noted is a similar form to *Sullivania*, has the sinus in a similar position and also has a total lack of axial costation. However, the protoconch is paucispiral and inflated, with the tip immersed—considerably different from those of both *Hemisurcula* and *Sullivania*.

Etymology.—The specific name *terus* (Latin, rounded) refers to the rounded costation on the spire.

Type Material.—Holotype: PRI 64798, from locality 6 (= 11-T-7).

Type Locality.—Locality 6 (= 11-T-7) on Ridge Creek, 29°59.854'E, 97°15.125'N, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, PRI 64798), 6.1 mm in length.

Genus ***MICRODRILLIA*** Casey, 1903

Type Species.—*Pleurotoma cossmanni* Meyer, 1887, by subsequent designation (Cossmann, 1906 in 1895–1925). Upper Eocene, Mississippi.

Description.—Shell very small, solid. Protoconch multispiral, initially smooth, remainder axially costulate. Teleoconch whorls wholly devoid of axial sculpture, exhibiting only spiral carinae. Anal sinus large, U-shaped on shoulder slope. Aperture oblique; columella without plication; canal short.

Microdrillia infans reklawensis n. ssp.
Pl. 4, Figs 11–12

Description.—Shell very small. Aperture and canal comprising *ca.* 42% of total height. Protoconch of 2½ smooth whorls, followed by 3 costulate whorls. Teleoconch sculpture of one subsutural cord, 2 peripheral carinal lirae, and suprasutural one on later whorls; areas between carinae with overriding growth striae and spiral lines; body whorl striate, with 15 or 16 spiral lines.

Remarks.—The type of *Microdrillia infans* from the Oligocene Red Bluff Formation has much more rounded whorls than this new subspecies; all Eocene species are much more biconical in outline with straighter whorls. This Reklaw subspecies is similar to *M. i. bicincta* Harris, 1937, but is shorter and with fine spiral striae between the spiral carinae. *Microdrillia i. bicincta* is smooth between the carinae and more closely striate on the body whorl and canal. The aperture and canal of *M. i. bicincta* make up about one-third of the total height.

Etymology.—The specific name *reklawensis* refers to the formation from which the specimens were found.

Type Material.—Holotype: PRI 64799, from locality 4. Remaining specimen in CLG.

Type Locality.—Locality 4, on western side of Ridge Creek *ca.* 888 m south of Missouri, Kansas, and Texas railroad trestle and county road bridge, 30°00.087'N, 97°15.211'W, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—Two specimens, the holotype (PRI 64799) 7.5 mm in length.

Family **TURRIDAE** H. & A. Adams, 1853 in 1853–1858

Genus ***GEMMULA*** Weinkauff, 1875

Type Species.—*Pleurotoma gemmata* Reeve, 1843 in 1843–1846, by subsequent designation (Cossmann, 1896 in 1895–1925). Recent, Gulf of Magdelena, California.

Description.—Shell small to large, elongate fusiform with long, straight, unnotched anterior canal. Protoconch multispiral with 1–4 smooth whorls followed by 1–3½ whorls with arcuate riblets; transition to teleoconch abrupt. Teleoconch sculpture of spiral cords and carinae; peripheral carina always nodular, usually duplex. Sinus deep; apex more or less narrow, extended; columella smooth.

Gemmula taylori quadrata n. ssp.
Pl. 2, Figs 13–14

Description.—Shell small, with 7–8 whorls. Protoconch high, of 2 smooth whorls followed by 2 with closely spaced arcuate riblets; transition to teleoconch abrupt. Teleoconch sculpture of strong subsutural keel followed by ramp showing only microscopic growth lines, ending in strong peripheral carina composed of row of widely spaced squarish nodules delineated at top and bottom by spiral lines; area below peripheral keel to lower suture smooth, sometimes showing one fine spiral line developing on later whorls. Sinus broadly U-shaped; apex moderately extended abaperturally. Body whorl with few strong spiral lines, becoming more closely set at end of canal; columella and inner lip smooth.

Remarks.—Following the analysis of Garvie (2013: 70–71), several species previously placed in the genus *Coronia* Gregorio, 1890, have to be reassigned to *Gemmula*, including the Reklaw species *G. taylori* (= *Coronia taylori* Garvie, 1996). This new subspecies appears to be distinct because no intermediate examples have been found between it and *G. taylori s.s*. Compared to *G. taylori s.s.*, *G. taylori quadrata* n. ssp. is shorter and wider with proportionately larger tubercles, and between the periphery and the upper and lower sutures, there is no sign of the fine spiral threading seen in *G. taylori s.s*. Both *G. margaritosa* Casey, 1904, and *G. genitiva* Casey, 1904, also have squarish nodules near the midpoint of the whorl, but each is less carinate, has a proportionately longer spire, and is much more spirally striate and closer to *G. taylori s.s.* than to *G. taylori quadrata* n. ssp.

Etymology.—The specific name *quadrata* (Latin, square) refers to the square nodules defining the periphery.

Type Material.— Holotype: PRI 64800. Paratype: PRI 64801, both from locality 4.

Type Locality.—Locality 4, on western side of Ridge Creek *ca.* 888 m south of Missouri, Kansas, and Texas railroad trestle and county road bridge, 30°00.087'N, 97°15.211'W, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—22 specimens, the holotype (PRI 64800) 6.1 mm in length.

Clade **HETEROBRANCHIA** Hazprunar, 1985
Informal Group **"LOWER HETEROBRANCHIA"**
Superfamily **PYRAMIDELLOIDEA** Gray, 1840
Family **PYRAMIDELLIDAE** Gray, 1840
Subfamily **TURBONILLINAE** Bronn, 1849

Genus ***TURBONILLA*** Risso, 1826

Type Species.—*Turbonilla costulata* Risso, 1826, by subsequent designation (Hermannsen, 1852: 136). Pliocene, France.

Description.—Shell very elevated, with prominent longitudinal ribs, sometimes also with spiral ornamentation. Suture strongly impressed. Aperture rounded-rhombohedral; columella with single low placation just visible within aperture. Protoconch heterostrophic, considerably elevated.

Remarks.—The genus is known from the Paleocene to Recent.

Subgenus ***CHEMNITZIA*** d'Orbigny in Webb & Berthelot, 1839

Type Species.—*Melania campanella* Philippi, 1836 in 1836–1844, by subsequent designation (Dall & Bartsch, 1904). Recent, Mediterranean Sea.

Description.—Shell elevated, basally smooth. Surface sculpture of strong axial ribs and intercostal grooves terminating posteriorly at peripheral collar; basally smooth or with axial ribs sometimes continued obsoletely over base; intercostal spaces sharply terminating before base.

Turbonilla* (*Chemnitzia*) *reklawensis n. sp.
Pl. 3, Figs 8–9

Description.—Shell very small. Protoconch heterostrophic; tip 50% immersed. Whorls flat-convex above and below near sutures. Sculpture of numerous axial, small rounded folds and excavated intercostal areas, *ca.* 20 on body whorl. Body whorl basally smooth. Columella straight with strong sharp plication close to junction with body whorl.

Remarks.—The only species that shows any similarity to *Turbonilla* (*Chemnitzia*) *reklawensis* n. sp. is *T.* (*C.*) *obliqueatum* Garvie, 2013, but the former species is easily differentiated by the more carinate base, and the straight rather than oblique axial folds.

Etymology.—The specific name *reklawensis* refers to the formation from which the specimen was found.

Type Material.—Holotype: PRI 64802, from locality 6 (= 11-T-7)

Type Locality.—Locality 6 (= 11-T-7) on Ridge Creek, 29°59.854'E, 97°15.125'N, Bastrop County, Texas. Marquez Member of the Reklaw Formation.

Material Examined.—One specimen (holotype, PRI 64802), 2.4 mm in length.

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PLATES

PLATE 1

Figure

1. *Modiolus marquezensis* n. sp., locality 20 (= 165-T-13), exterior view, holotype (PRI 64784), attached to matrix; 7 mm length. 133

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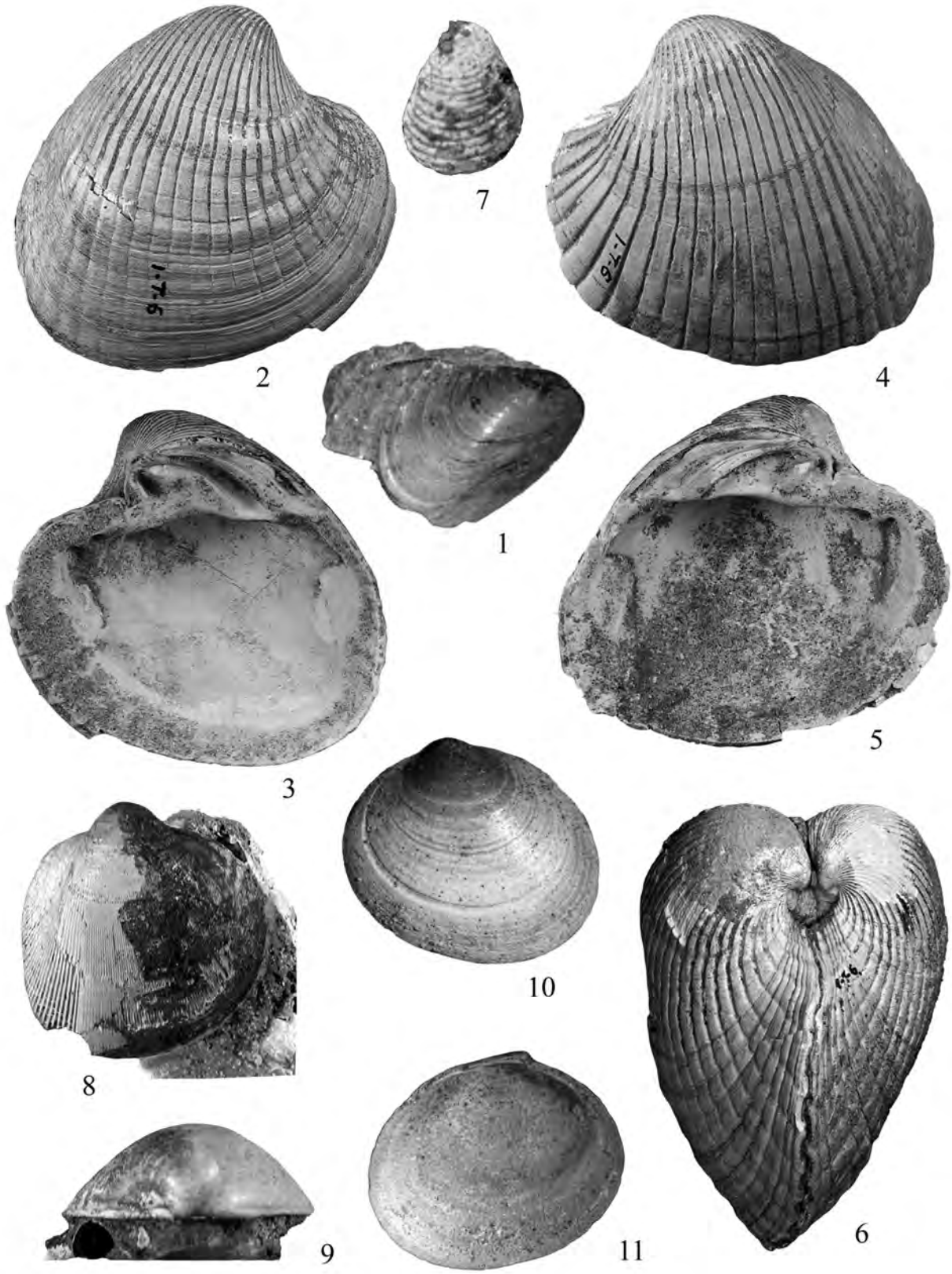
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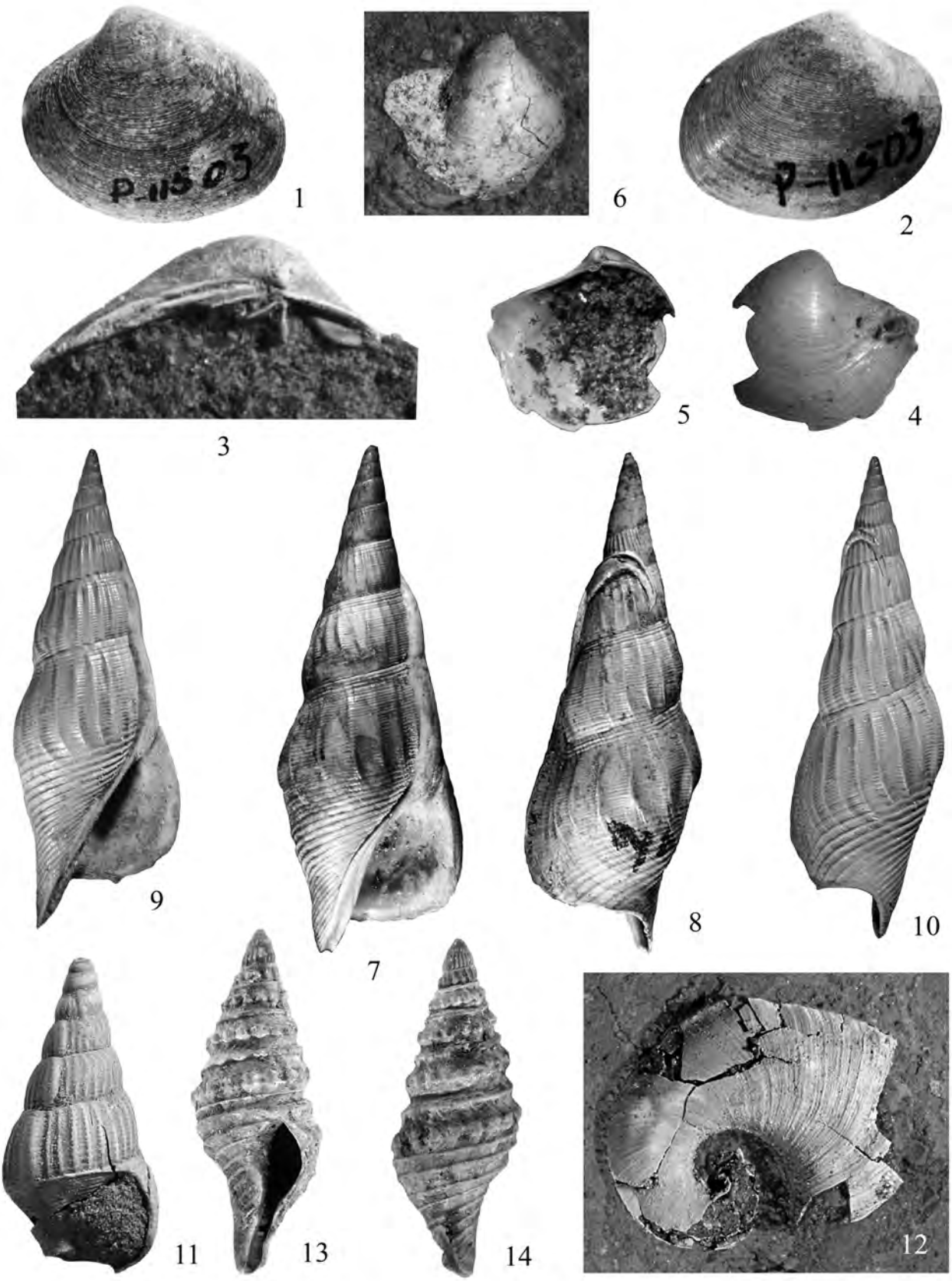
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Plate 2

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10. Dorsal view.

11. aff. *Graciliala* sp., locality 20 (= 165-T-13), apertural view, figured specimen (PRI 64791); 28 mm length. 140

12. *Atlanta funicularis* n. sp., locality 20 (= 165-T-13), apical view, holotype (PRI 64788); 15.5 mm maximum diameter. 138

13–14. *Gemmula taylori quadrata* n. ssp., locality 4, holotype (PRI 64800); 6.1 mm length. 147
13. Apertural view.
14. Dorsal view.

PLATE 3

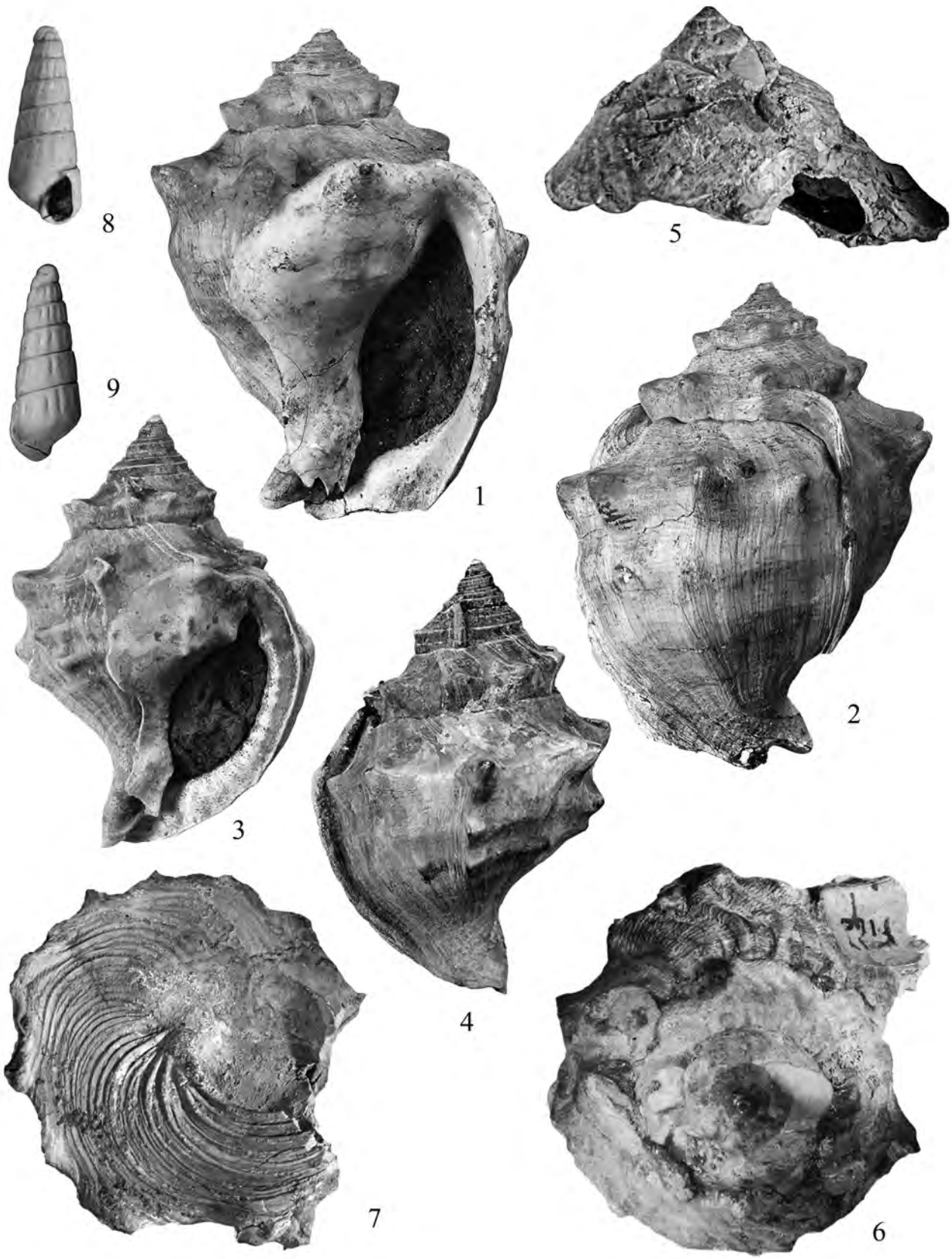
Figure

1–2. *Phalium* (*Echinophoria*) *cingulae* n. sp., locality 12, holotype (PRI 64792); 52 mm length. 141
1. Apertural view.
2. Dorsal view.

3–4. *Phalium* (*Semicassis*) *marcusi* n. sp., locality 12, holotype (PRI 64793); 32.9 mm length. 142
3. Apertural view.
4. Dorsal view.

5–7. *Xenophora spiralis* n. sp., locality 11 (= 11-T-36), holotype (TMM UT19368); 33.7 mm maximum diameter. 143
5. Apertural view.
6. Apical view.
7. Basal view.

8–9. *Turbonilla* (*Chemnitzia*) *reklawensis* n. sp., locality 6 (= 11-T-7), holotype (PRI 64802); 2.4 mm length (the outer lip shows a crack and the fragment lost after photography). 148
7. Apertural view.
8. Dorsal view.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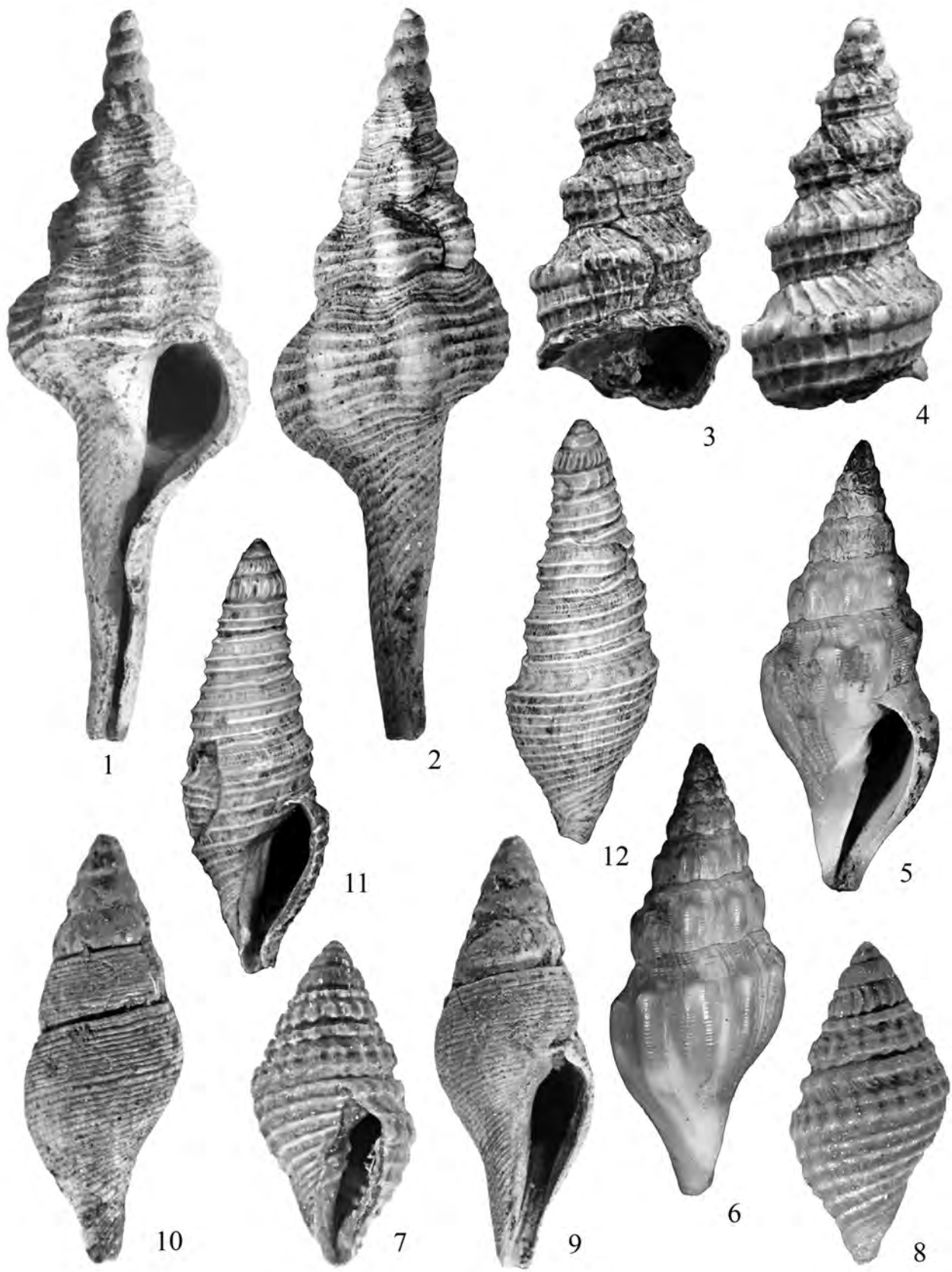
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Plate 4

Figure

1–2. *Fulgurofusus perobliquus* (Johnson, 1899), locality 20 (= 165-T-13), figured specimen (PRI 64795); 16.9 mm length. 144
1. Apertural view.
2. Dorsal view.

3–4. *Fulgurofusus* aff. *rugatus* (Aldrich, 1886), locality 12, figured specimen (PRI 64796); 7.2 mm length. 144
3. Apertural view.
4. Dorsal view.

5–6. *Cordieria* cf. *biconica* (Whitfield, 1865), locality 11 (= 11-T-36), figured specimen (TMM UT18366); 14.8 mm length. 145
5. Apertural view.
6. Dorsal view.

7–8. *Glyptotoma* cf. *crassiplicata* (Gabb, 1860), locality 11 (= 11-T-36), figured specimen (PRI 64797); 14.8 mm length. 145
7. Apertural view.
8. Dorsal view.

9–10. *Hemisurcula terus* n. sp., locality 6 (= 11-T-7), holotype (PRI 64798); 6.1 mm length. 146
9. Apertural view.
10. Dorsal view.

11–12. *Microdrillia infans reklawensis* n. ssp., locality 6 (= 11-T-7), holotype (PRI 64799); 7.5 mm length. 147
11. Apertural view.
12. Dorsal view.

NEW EOCENE MOLLUSCA FROM THE COLLECTIONS OF THE TEXAS NATURAL SCIENCE CENTER

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ABSTRACT

Thirteen new taxa from the Eocene of Texas are described: *Barbatia* (*Cucullaearca*) *kickapooensis*, *Cochlodesma unda*, *Pachychilus fulvus*, *Platyoptera cherokeensis*, *Paraseraphs texanopsis*, *Volutostrombus*, *V. eocenica*, *Cyrtochetus* (*Cyrtochetus*) *augustulus*, *Lacina alveata serpens*, *Oniscidia claibornensis*, *Caricella*? *turboides*, *Surculites venustus*, and *Scaphander* (*Mirascapha*) *smithvillensis*. An updated composite section for the Claibornian Middle Eocene of Texas is given.

INTRODUCTION

While cataloging and identifying the Eocene molluscan material in the Texas Natural Science Center (henceforth TNSC) collections, some new and interesting material has come to light. The TNSC collections include historical Eocene material collected by Shumard in 1855, for the first Texas Geological Survey, by E. T. Dumble, G. D. Harris, and others for the 1892 second Texas Geological Survey, and since 1909, under the auspices of the Bureau of Economic Geology by later workers including F. B. Plummer and H. B. Stenzel. The Eocene material collected during the second Texas Survey is well curated and identified and those species were mostly treated by Palmer (1937). The bulk of the Texas material treated by Palmer (1937) came from only two geographically small areas, one centered around Stone City Bluff on the Brazos River near College Station in Brazos County and the second centered on the Colorado River at Smithville in Bastrop County. The great expanse of Eocene that outcrops in innumerable small roadside and creek side exposures in a wide area in eastern Texas has hardly been examined except by the early surveying parties working primarily in the 1920s and 1930s; their collections comprise the bulk of the TNSC material. Secondly, the band of Eocene that outcrops in the lower Gulf, from Smithville to the Rio Grande River has been examined even less, and judging from the material in the TNSC Museum, much new material will be uncovered. Palmer (1937: 5) mentioned the "great numbers of new material which will be uncovered in the lower Claiborne localities of the Gulf States, particularly Texas and Louisiana …" and her comment is prescient. The present paper reports on a few of these new taxa, many of which are particularly interesting as being very unusual for this area, or extending either their temporal or geographical range. It is the author's intention to describe further new material from both the TNSC and the author's own collections in succeeding papers. The composite section of the Claiborne Stage (Text-fig. 1) is derived from several sources, of which the principal ones are: Guevara & Garcia (1972), Pane (1972), Flores-Espinoza (1983), Dockery (1998), Crabaugh & Elsik (2000), and Aniekwensi (2010).

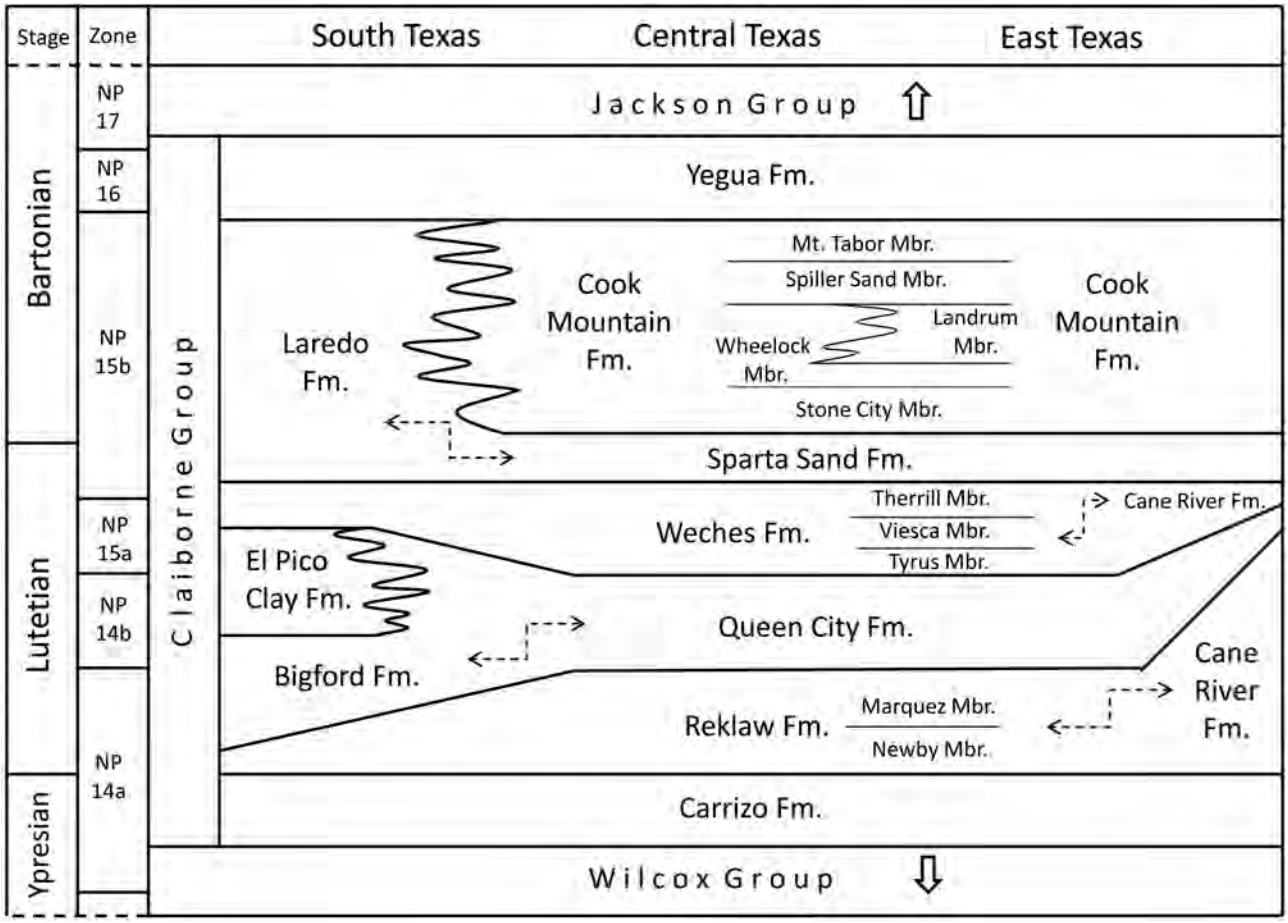
MATERIALS AND METHODS

This study is based on the collections of the TNSC with one additional specimen of *Volutostrombus eocenica* n. gen. & n. sp., from the author's collection, which is designated a paratype. Specimens from the Cook Mountain and Yegua formations are generally very well preserved and needed little to no cleaning. Specimens from the Weches Formation are typically found in a fairly indurated matrix and often must have been weathering for some time before the specimen is exposed; any exposed shell is then liable to abrasion and leaching. Cleaning most often requires the first use of a consolidant on any exposed shell, followed by careful matrix removal with sharp needles.

The geologic unit Cook Mountain Formation is now in general usage by the United States Geological Survey[1] and is therefore used here, superseding the older term, Crockett Formation, which referred to the same unit.

Morphological terms used are those defined by Moore (1960). For bivalves, the orientation follows Stenzel *et al.* (1957) and the morphological terms used are those from Moore (1969). Higher taxonomic classifications and treatment order follow Bouchet & Rocroi (2005) for the gastropods, and Bieler *et al.* in Bouchet & Rocroi (2010) for bivalves.

[1]National Geologic Map Database, http://ngmdb.usgs.gov/Geolex/geolex_qs.html, accessed February 2013.



Text-Fig. 1.—Composite section for the Claibornian (Eocene) record of the Texas Gulf Coastal Plain, including formations, members, nannoplankton zones, and correlation with the European stages. Dotted double arrows indicate unresolved, or poorly known stratigraphic transitions.

Locality Descriptions

The locality descriptions are copied unchanged from the master list of locality cards kept in the TNSC, but with metric distances added. These descriptions in most cases derive from the original survey parties' notes, and often are the only information available on the locality.

11-T-2: bluff on right bank of Colorado River at Smithville, *ca.* 625 ft (190.5 m) downstream from the new bridge on Highway 71, Bastrop County, Texas. Eocene, Weches Formation, Viesca Member. 30°00'45.83"N, 97°09'36.35"W.

26-T-4, northeastern corner of the town of Caldwell, Burleson County, Texas. Eocene, Yegua Formation. Exact locality lost, near 30°32'03.36"N, 96°42'22.26"W.

37-T-4: Grange Hall School, 0.9 mi (1.45 km) south of school on a small creek with waterfall of *ca.* 10 ft (3 m), at crossing of county road, Cherokee County, Texas. Eocene, Weches/Reklaw? Formation. 31°39'36.32"N, 94°58'57.76"W.

89-T-12: bluff along lower part of Nagel Creek, south of the Guadalupe River; northeastern flowing creek paralleling county road from Monthalia to Oak Forest; 1.9 mi (3.1 km) south of Oak Forest, Gonzales County, Texas. Eocene, Cook Mountain Formation. 29°28'33.91"N, 97°35'30.01"W.

113-T-9: Alabama Ferry, east bank of Trinity River, 0.3 mi (0.48 km) below abandoned ferry, 7.5 mi (12 km) west-southwest of Porter Springs, Houston County, Texas. Claiborne Eocene, Cook Mountain Formation, lower Landrum Member. 31°13'37.59"N, 95°43'35.25"W.

113-T-16: Kickapoo Shoals, right bank and flat rocks in bed of Trinity River at sharp bend 1.72–1.17 mi (2.77–1.88 km) upstream from Highway 7 bridge as measured along course of stream, Houston County, Texas. Part of this locality is in Leon County; de la Garza survey. Eocene, Weches Formation, Tyrus Member. 31°20'52.20°N, 95°40'38.62"W.

113-T-20: Rock flat, west of Percilla, Houston County, Texas. Eocene, Weches Formation. Exact locality lost, near 31°32'49.64"N, 95°23'56.81"W.

113-T-202: 0.6 mi (0.97 km), east of Augusta, Houston, County, Texas. Eocene, Weches Formation. 31°31'51.62"N, 95°20'25.18"W.

113-T-203: 0.8 miles (1.29 km) west of Augusta on Augusta-Grapeland Road, Houston County, Texas. Eocene, Weches Formation. 31°31'49.75"N, 95°20'41.38"W.

145-T-52: Two-Mile Creek, 5 bluffs at steel bridge of Leona-Two-Mile School Road near Two-Mile Negro School, 5.24 mi (8.43 km) from Leona, Leon County, Texas. One of the bluffs is on right bank immediately east of bridge, another is on right bank a few feet west of bridge, and the other 3 are upstream from bridge, but below the next fence line. Emma and E. J. Houston's land, near the north corner of the J. L. Landrum Survey. Claiborne Eocene, Cook Mountain Formation, lower Landrum Member. 31°09'17.67"N, 95°52'18.39"W.

173-T-2: 13.8 miles (22.2 km) east of Nacogdoches, Nacogdoches County, Texas. Eocene, Weches Formation. 31°31'30.53"N, 94°22'12.36"W.

197-T-4: bluff on right bank of Cobb Branch, near its head, at ford south of old house, 0.6 mi (0.96 km) northwest of Camp Creek Schoolhouse, Buck McBrides's 134-acre tract, Jose Maria Survey. Eocene, Weches Formation. 31°01'53.60"N, 96°18'54.94"W.

245-T-3: Caro's Bluff on the Trinity River, 1 mi (1.6 km) above the mouth of Boggy Creek, Houston County, Texas. Eocene, Cook Mountain Formation. 31°07'44.22"N, 95°46'21.74"W.

SYSTEMATIC PALEONTOLOGY

Phylum **MOLLUSCA** Linnaeus, 1758
Class **BIVALVIA** Linnaeus, 1758
Subclass **AUTOBRANCHIA** Grobben, 1894
Order **ARCIDA** Gray, 1854
Superfamily **ARCOIDEA** Lamarck, 1809
Family **ARCIDAE** Lamarck, 1809

Genus ***BARBATIA*** Gray, 1840

Type Species.—*Arca barbatia* Linnaeus, 1758, by subsequent designation (Gray, 1847). Recent, Mediterranean.

Description.—Shell usually moderately sized to large, somewhat irregular in outline. Umbones anterior, moderately inflated. Anterior end rounded; posterior end rounded or angulated with keel; posterior slope rounded; byssal gape small. Sculpture usually of beaded radial ribs; cardinal area narrow with 5 or more chevron-shaped grooves. Hinge straight; hinge teeth continuous in juveniles, separated by edentulous gap in adult; ventral margins finely crenulated.

Subgenus ***CUCULLAEARCA*** Conrad, 1865

Type Species.—*Byssoarca lima* Conrad, 1848, by subsequent designation (Stoliczka, 1871 in 1870–1871).

Description.—Elongate to obliquely subquadrate; cardinal area wide, subtrigonal. Ventral gape large. Sculpture of radial riblets and comarginal striae. Distal teeth large, oblique.

Remarks.—Some recent authors use *Cucullaearca* as a full genus, a fact supported by some molecular data that indicate that many taxa assigned as subgenera to *Barbatia* do not appear to be closely related (Mikkelsen & Bieler, 2007; Tunnell *et al.*, 2010). Without confidently being able to have correspondence between hard-shell characteristics and the molecular data, it is however problematic to use such data to separate closely similar fossil taxa. Certainly within the Gulf Coast Eocene, the hard-shell morphology of *Barbatia* and *Cucullaearca* makes them closely related. A conservative approach is therefore followed and this taxon is presently kept as a subgenus, an assignment also supported by some recent authors (Coan *et al.*, 2000; Oliver & Holmes, 2006).

Barbatia* (*Cucullaearca*) *kickapooensis n. sp.
Pl. 1, Figs 1–3

Description.—Shell large, obliquely ovate, with slight medial sulcus. Ornament of overlapping radial lines in lamellae, those on posterior slope tending to bifurcate and become larger. Hinge teeth approximately parallel to dorsal edge; ventral edge not interiorly crenulate.

Remarks.—This new species is much larger, more evenly rounded, and with a more subdued umbonal carina than any other species of the subgenus *Cucullaearca* reported by Palmer & Brann (1966 in 1965–1966) in the Claibornian Eocene. Compared with *Barbatia* (*Barbatia*) *uxoripalmeri* Stenzel & Krause in Stenzel *et al.*, 1957, another species that sometimes becomes quite large, this species is still much larger, the hinge plate is proportionately much larger, and the teeth approach the umbones much more closely. Also in *B.* (*B.*) *uxoripalmeri*, the radial ribs on the posterior slope alternate large and small in size, whereas in *B.* (*C.*) *kickapooensis* n. sp., they are all subequal in strength. A upper Eocene Jacksonian species, *Barbatia* (*Cucucullaraea*) *cuculloides* (Conrad, 1833c), does approach *B.* (*C.*) *kickapooensis* n. sp. in size, but is easily sepa-

rated by the strong posterior umbonal ridge and the differing shell sculpture on either side of the posterior ridge. A close analog of *B.* (*C.*) *kickapooensis* n. sp. and of even larger size has been found by the author in the Wheelock Member of the Cook Mountain Formation, so the large size of this species is not an isolated event.

Etymology.—The specific name *kickapooensis* refers to the type locality (Kickapoo Shoals).

Type Material.—Holotype: TMM NPL6885, from locality 113-T-16.

Type Locality.—Locality 113-T-16, Kickapoo Shoals, right bank and flat rocks in bed of Trinity River at sharp bend 1.72–1.17 mi (2.77–1.88 km) upstream from Highway 7 bridge as measured along course of stream, Houston County, Texas. Eocene, Weches Formation, Tyrus Member.

Material Examined.—Represented by a single well-preserved specimen (holotype, TMM NPL6885), 76.5 mm in length, 49.0 mm in height 13.4 mm in breadth.

Order **PHOLADOMYIDA** Newell, 1965
Superfamily **THRACIOIDEA** Stoliczka, 1870 in 1870–1871
Family **PERIPLOMATIDAE** Dall, 1895 in 1890–1903

Genus ***COCHLODESMA*** Couthouy, 1839

Type Species.—*Anatina leana* Conrad, 1831, by subsequent designation (Hermannsen, 1847a in 1846–1852). Recent, northeastern coast of North America.

Description.—Shell lenticular, subequilateral. Lithodesma present; chondrophore buttressed. Surface smooth or minutely scabrous, with fine epidermis.

Remarks.—A closely similar genus is *Periploma* Schumacher, 1817, which has a granulate surface texture.

Cochlodesma unda n. sp.
Pl. 1, Figs 4–5

Description.—Shell moderately gaping anteriorly; beaks incurved, overhanging. Lunule lenticular, defined by slightly raised line; escutcheon lenticular, with outline defined by rounded ridge. Surface smooth; sculpture of very low, somewhat widely spaced, irregular, comarginal, fine folds, plus few fine radial lines near and anterior to beak.

Remarks.—Most of the shell material has been lost in the single specimen, but the remaining pieces show the surface to have been smooth. Compared with *Periploma claibornensis* Lea, 1833, and *P. collardi* Harris, 1895, *Cochlodesma unda* n. sp. is much more extended posteriorly and has larger but fewer folds. There is another common but so far undescribed species from the Cook Mountain Formation in Texas, but that species can be distinguished by a cross-hatch pattern on the interior of the shell that is also visible on the exterior when worn.

Etymology.—The specific name *unda* (Latin, folds) refers to the low comarginal folds.

Type Material.—Holotype: TMM NPL37887, from locality 245-T-3.

Type Locality.—Locality 245-T-3, Caro's Bluff on the Trinity River, 1 mi (1.6 km) above the mouth of Boggy Creek, Houston County, Texas. Eocene, Cook Mountain Formation.

Material Examined.—Represented by a single double-valve specimen (holotype, TMM NPL37887), 37.5 mm in length, 30.2 mm in height, 15.1 mm in breadth.

Class **GASTROPODA** Cuvier, 1797
Clade **CAENOGASTROPODA** Cox, 1960b
Clade **SORBEOCONCHA** Ponder & Lindberg, 1997
Superfamily **CERITHIOIDEA** Fleming, 1822
Family **PACHYCHILIDAE** P. Fisher & Crosse, 1892

Genus ***PACHYCHILUS*** I. & H. C. Lea, 1850

Type Species.—*Pachychilus graphium* (Morelet, 1849 in 1849–1851), by original designation. Recent, Vera Paz, Guatemala.

Description.—Shell medium-sized, turreted. Apex often corroded; whorls usually smooth or with lines of growth. Aperture entire, ovate, produced below; outer lip usually thickened varix-like; columella concave, robust.

Remarks.—The genus is freshwater in distribution. Wenz (1939 in 1938–1944) cited the genus from the Eocene of the Americas. Perrilliat *et al.* (2008) described species from the Cretaceous and Paleocene of northeastern Mexico.

Pachychilus fulvus n. sp.
Pl. 1, Figs 6–7

Description.—Shell elongate; whorls 8, rounded; suture impressed, with very weak subsutural sulcus. Ornament of almost imperceptible, adapertural, brevic axial folds, stronger on early whorls, *ca.* 15 on body whorl. Aperture entire; outer lip prominently thickened; columella robust. Columella and apertural callus white; remainder of external shell brown.

Remarks.—The broken shell, with corroded early whorls and damaged outer lip, clearly shows the internal white callus layer and the external thinner brown layer, which is probably the mineralized periostracum of this freshwater species.

The source is the Middle Eocene Weches Formation at Smithville, which is regarded as marine in origin but the shell could have been transported from a nearby river or estuary. A few genera regarded as brackish or fluviatile in origin are known from the Claibornian, the most common in Texas being *Texmelanatria texana* (Heilprin, 1891), a species known from brackish or estuarine deposits. The only truly freshwater species known from the Claibornian are *Elimia trigemmata* (Conrad, 1860), a member of the Pleuroceridae, the type locality for which is unknown (although G. D. Harris found it in the Sabine Eocene of Woods Bluff, Alabama; Palmer, 1937: 186), and *Thiara aldrichi* Palmer, 1944, from Claiborne Bluff. With so few freshwater species reported from the early Tertiary and Cretaceous of the Gulf Coast, the identification of this species poses considerable difficulties, particularly because many species have the same general morphology. The Pachychilidae, including the genera *Pachychilus* and *Elimia* H. & A. Adams, 1854 in 1853–1858 (most species of *Elimia* are now placed in *Goniobasis* I. Lea, 1862) have been reported ranging from the Upper Cretaceous to Recent in the Gulf Coast. According to Wenz (1939 in 1938–1944: 684–685), three distinguishing features of *Pachychilus s.s.* are the robust columella and the thickened outer lip, combined with the smooth or weakly sculptured whorls. *Elimia* and *Goniobasis* are usually more strongly sculptured and possess a thin outer lip. *Hemisinus* Swainson, 1840, could also be considered because it has been reported from the Upper Cretaceous to Recent in the Caribbean, Central American, and northern South American regions, but its apertural shape is more elongate with a posterior notch or channel, a thin outer lip, and a more slender columella.

Etymology.—The specific name *fulvus* (Latin, brown) refers to the rufus color.

Type Material.—Holotype: TMM NPL45554, from locality 11-T-2.

Type Locality.—Locality 11-T-2, bluff on right bank of Colorado River at Smithville, *ca.* 625 ft (190.5 m) downstream from the new bridge on Highway 71, Bastrop County, Texas. Eocene, Weches Formation.

Material Examined.—One specimen (holotype, TMM NPL45554), 21.3 mm in length.

Clade **HYPSOGASTROPODA** Ponder & Lindberg, 1997
Clade **LITTORINIMORPHA** Golikov & Starobogatov, 1975
Superfamily **STROMBOIDEA** Rafinesque, 1815
Family **STROMBIDAE** Rafinesque, 1815

Genus ***PLATYOPTERA*** Conrad in Wailes, 1854

Type Species.—*Platyoptera extenta* Conrad in Wailes, 1854, by original designation. Upper Eocene, Mississippi.

Description.—Shell large, stout. Whorls rounded, with weak shoulder area. Aperture lanceolate; columella smooth, sometimes with callus node; callus deposit thin; outer lip expanded into large, thin wing sometimes extending above and over spire. Sculpture of regular spiral ribs splaying out on wing sunburst-like.

Remarks.—Within the Gulf Coast area and prior to this report, the genus was only known from the type species, which is found in the Moodys Branch Formation in Mississippi, Louisiana, and Alabama. Palmer in Harris & Palmer (1947 in 1946–1947: pl. 41, fig. 1) figured the Meyer drawing of the lectotype. Dockery (1977: pl. 4, figs 13a–b, pl. 5, figs 1–2, 5–6, 7–8) figured some remarkably complete specimens, some including the fragile wing, and one taken in ultraviolet light that also shows the color pattern. The genus is also common in the Upper Eocene Ocala Limestone of Florida (D. Campbell, pers. comm., 2012). On the western coast in Baja California Sur, Mexico, *Platyoptera pacifica* Squires & Demetrion, 1990, has been found in both the Capay and Domengine stages (Lower Eocene; Squires & Dimetrion, 1990; Squires, 2001).

Platyoptera cherokeensis n. sp.
Pl. 1, Figs 8–9

Description.—Shell large; whorls 8 (protoconch missing in single known specimen). Spire whorls on apertural side covered with callus for almost 180°; callus deposit on body whorl remaining near aperture, with indications of low axial nodes on adapertural spire side, more prominent anteriorly. Sculpture of low, flat, rounded ribbons margined by weak grooves; interstitial areas *ca.* 25% width of ribbons; *ca.* 12 ribbons on penultimate whorl; all spiral sculpture becoming stron-

ger and better defined toward base. Basal area overrun with prominent collabral threads continuing on wing, dying out anteriorly. Columella with prominent callus ridge running up inside portion of spire.

Remarks.—*Platyoptera cherokeensis* n. sp. has weaker development of the shoulder nodes than in *P. pacifica*, whereas in the type species *P. extenta*, the shoulder is smooth. *Platyoptera pacifica* is further distinguished by its cancellate teleoconch ornamentation. The columella callus ridge seen in *P. cherokeensis* n. sp. appears unique to this species. The deposition of the callus wash over the entire apertural side of the shell is likely an adult feature because if there was deposition earlier, one would observe deposition on the other side of the shell as well.

This specimen was collected by H. B. Stenzel and Turner in July 1938 and has "Cane River" as the formation on the original label, but was later cataloged under the Weches Formation. The Cane River Formation was applied by Ellisor (1929) to beds above the Wilcox Group and below the Reklaw in northeastern Texas and in Louisiana to also include the equivalents of the Weches Formation. Thus, if Stenzel & Turner in 1938 noted Cane River on the label, they might have been referring to beds now known to be of Reklaw age and the possibility exists that this specimen came from these beds. Today, the Cane River in Louisiana is regarded as equivalent to the sequence that includes the Reklaw Formation up to that of the Therrill Formation (= Therrill Member of Weches Formation) beds in eastern Texas (Text-fig. 1).

Etymology.—The specific name *cherokeensis* refers to the occurrence in Cherokee County.

Type Material.—Holotype: TMM NPL6769, from locality 37-T-4.

Type Locality.—Locality 37-T-4, Grange Hall School, 0.9 mi (1.45 km) south of school on a small creek with waterfall of *ca.* 10 ft (3 m), at crossing of county road, Cherokee County, Texas. Eocene, Weches/Reklaw? Formation.

Material Examined.—One specimen (holotype, TMM NPL6769), 37.2 mm in height, 18 mm maximum width (excluding wing).

Genus ***VOLUTOSTROMBUS*** n. gen.

Type Species.—*Volutostrombus eocenica* n. sp. Middle Claibornian Eocene, Texas.

Description.—Shell small, elongate, with offset protoconch and anterior rostrum. Surface smooth, enamel-like. Body whorl with varix. Columella smooth, without folds; outer lip expanded.

Etymology.—The name *Volutostrombus* notes the similarity to members of both the Volutidae and Strombidae.

Volutostrombus eocenica n. sp.
Pl. 1, Figs 13–16

Description.—Shell small, elongate, with high spire and rostrate canal. Protoconch of 3, smooth, rounded whorls; tip flattened; entire protoconch offset at slight angle from shell axis. Teleoconch of 4 moderately inflated whorls; subsutural area flattened to weakly indented; suture impressed. Whorl surface smooth or with very weak axial folds, polished, enamel-like; whole covered with microscopic spiral striae only seen under magnification. Body whorl with single varix that can be terminal. Aperture ovate; columella smooth, excavated; terminal canal moderately long, ending in pointed rostrum.

Remarks.—Nothing similar in the Tertiary appears to have been previously reported; the species shows affinities to some Volutidae as well as some Strombidae. There are a few volutid genera that approach the characters seen in this taxon; all are Recent from the Indo-Pacific, of which *Teramachia* Kuroda, 1931, from Japan, and *Neptuneopsis* G. B. Sowerby III, 1902, from South Africa can be mentioned in particular. Both of these genera are similar in shape although much larger, are primarily smooth, and are with or without weak axial folds; both also lack columella plications, and are weakly rostrate. Neither of these two genera possesses a varix, either terminally or on any previous whorl. All other volutid genera that show some similarity have columella folds, or show a siphonal fasciole or siphonal notch to some degree, and are not rostrate. Within the Strombidae, several Eocene genera are smooth, elongate in shape, and anteriorly rostrate, and have an expanded outer lip, of which the most common in the Gulf Coast area is *Calyptraphorus* Conrad, 1857. However, the latter genus, in common with *Tibia* (*Amplogladus*) *athleta* (Orbigny, 1850) from the Upper Eocene Bartonian of the Paris Basin, has a callus-margined posterior channel running from the posterior anal sinus up the spire, a feature seen in varying degrees in several other Paleogene taxa, *e.g.*, *Ectinochilus* Cossmann, 1889 in 1886–1913, *Tibia* Röding, 1798, *Terebellum* Röding, 1798, and *Seraphs* Montfort, 1810 in 1808–1810, but these taxa are all even less related to *Volutostrombus* n. gen. A taxon of similar shape, smooth, rostrate, and with a terminal varix is *Leiorhinus* Gabb, 1860, a monotypic genus from the Eocene Gosport Sand of Alabama, however this differs from *Volutostrombus* n. gen. in having a striated labrum and a tooth

on the columella. It is much earlier in the Cretaceous, with the strombid *Pugnellus* (*Pugnellus*) *densatus* Conrad, 1858, where we find a more similar species (Sohl, 1960: pl. 14, figs 5, 10). Specimens of *P. densatus* in the early growth stages are smooth, have an expanded outer lip thickened terminally, and a rostrate canal. Sohl's figures show a shallow stromboid notch margined posteriorly with a denticle; this feature could correspond to a thickening of the basal part of outer lip in the holotype of *V. eocenica* n. gen., n. sp. (Pl. 1, Fig. 13). Where *P. densatus* differs is in the strong axial folds on the back of the lip, but even in other species of *Pugnellus*, that feature is of varying strength. Somewhat similar taxa from the Cretaceous of South America and the West Indies, viz. *Perustrombus* Olsson, 1944, and *Perustrombus* (*Orthostrombus*) Olsson, 1944, have the general aspect of *Pugnellus*, but lack the axial sculpture on the rear. The unusual protoconch of *V. eocenica* n. gen., n. sp., is unfortunately of little use in comparison, because to the author's knowledge, no protoconch of a *Pugnellus* species has ever been described. In the author's opinion, the differences between *Pugnellus* and *Volutostrombus* n. gen. are small enough to make the latter a likely descendant of the former even though *Pugnellus* is much larger and has much more callus deposition on the spire and outer lip. However, I do not believe the relationship is yet clear enough to allow an assignment to the Pugnellidae Kiel & Bandel, 1999.

Type Material.—Holotype: TMM NPL46617, from locality 145-T-52. Paratype: TMM NPL38016, from 113-T-9.

Type Locality.—Locality 145-T-52, Two-Mile Creek, 5 bluffs at steel bridge of Leona-Two-Mile School Road near Two-Mile Negro School, 5.24 mi from Leona, Leon County Texas. Claiborne Eocene, Cook Mountain Formation, lower Landrum Member.

Material Examined.—2 specimens: holotype (TMM NPL46617), 10.8 mm in length, and paratype (TMM NPL38016), 7.7 mm in length.

Family **SERAPHSIDAE** Gray, 1853

Genus ***PARASERAPHS*** Jung, 1974

Type Species.—*Paraseraphs tetanus* Jung, 1974, by original designation. Cuisian, Lower Eocene, Paris Basin, France.

Description.—Shell small to large, slender, smooth, involute, with maximum diameter near base. Growth lines prosocyrt anteriorly, opisthocyrt medially, prosocyrt posteriorly. Adapical part of outer lip thickened, extending as posterior canal toward apex. Columella callus thin; outer lip thickened.

Remarks.—The genus *Paraseraphs* is known from the southern Caribbean in the Lower Eocene and from the southern Caribbean and California in the Middle Eocene (Jung, 1974: 10, text-figs 5–6), so the present occurrence is likely a transitional point in its range expansion. *Paraseraphs* is distinguished from the closely similar genus *Seraphs* by its more slender shape and the extension of the adapical part of the outer lip as a canal.

Paraseraphs texanopsis n. sp.
Pl. 1, Figs 10–12

Description.—Shell elongate, quite thick. Whorls at least 5. Callus wash thickest inside outer lip, with thin line of deposit running up anterior part of outer lip forming channel strongest at top where it starts to curve down again (distal end broken off in material examined), basally quite strongly bent to left and strongly notched at acute angle posterior to lowest point. Surface smooth; growth lines weakly prosocyrt.

Remarks.—Because of the sinuous outline of this species, the maximum diameter does not occur near the base, but is near the midpoint.

Only one species of *Paraseraphs* is reported from the Gulf Coast Eocene, that is *P.* cf. *procerus* (Merian, 1844) (Jung, 1974: 39), a species with a type locality in Jamaica. The remaining North American occurrence is *P. erraticus* (Cooper, 1894) from the Eocene of California. Even allowing for the preservation of the specimens, neither of these species is as elongate or as sinuous as *P. texanopsis* n. sp.

Other Seraphidae known from North America are *Seraphs* (*Seraphs*) *belemnitus* Palmer in Richards & Palmer, 1953, which is a large cylindrical species with a straight outer lip, and a *Terebellum* sp. from the Reklaw in Cherokee County which was figured by Harris in his Texas manuscript that was never published. Palmer & Brann (1966: 946) stated that the specimen is presumably in the United States National Museum (= National Museum of Natural History). The author spent some considerable time in October 2010 trying to locate the specimen while on a visit there, but with no success.

The paratype was found at locality 37-T-4 from which *Platyoptera cherokeensis* n. sp. was also found, but unlike that specimen which has Cane River Formation on the accompanying label, this specimen has Weches Formation marked, presumably indicating that it was found higher in the section (see *P. cherokeensis* Remarks).

One specimen of *Seraphs* sp. from the Upper Eocene Moodys Branch Formation was figured by Dockery (1977: 53, pl. 4, fig. 12).

A second smaller specimen with damage to the outer lip shows no sign of callus buildup on the inside of the outer lip and also shows no sign of the posterior canal, and thus could

be a *Seraphs* species. However the aperture-spire and height-width ratios are very similar between the two shells, so the author believes that the smaller is a juvenile in which either the canal is not yet developed or was damaged.

Etymology.—The specific name *texanopsis* refers to its occurrence in Texas.

Type Material.—Holotype: TMM NPL7075, from locality 113-T-202. Paratype: TMM NPL37962, from locality 37-T-4.

Type Locality.—Locality 113-T-202, 0.6 miles (.97 km), east of Augusta, Houston, County, Texas. Eocene, Weches Formation.

Material Examined.—22 specimens, the largest (holotype, with shell material missing from the rear, TMM NPL7075) 53.3 mm in length, 14.2 mm in greatest diameter. The smaller paratype (TMM NPL37962, 25.5 mm in length) with damage to the front shows a portion of a previous whorl. A further 20 specimens were found by F. B. Plummer from locality 173-T-2.

Clade **NEOGASTROPODA** Cox, 1960a
Superfamily **BUCCINOIDEA** Rafinesque, 1815
Family **COLUMBELLIDAE** Swainson, 1840

Genus ***CYRTOCHETUS*** Cossmann, 1889 in 1886–1913

Type Species.—*Buccinum bistriatum* Lamarck, 1803 in 1802–1806, by original designation. Eocene, Paris Basin.

Description.—Shell medium-sized to large, fusoid; spire high. Whorls inflated, rounded to carinate; canal short. Aperture ovate, channeled at junction with body whorl; outer lip with terminal varix; columella smooth; callus deposit truncated at margin.

Subgenus ***CYRTOCHETUS*** Cossmann, 1889 in 1886-1913

Description.—Whorls rounded; suture impressed. Sculpture of numerous spiral lines and sometimes axial ornament on upper part of whorls. Body whorl more than half total shell height. Canal bent to left, weakly notched; labrum smooth or finely lirate, with terminal varix set back from edge. Columella concave, bent below.

Cyrtochetus* (*Cyrtochetus*) *augustulus n. sp.
Pl. 1, Figs 17–18

Description.—Whorls 7 (tip of protoconch missing in single available specimen). Sculpture of 5 strong spiral cords, more prominent below median; interspaces approximately same size as spirals, dying out on base and canal; *ca.* 16 low axial folds on body whorl. Columella smooth; umbilical depression. Outer lip lirate to outer edge. Siphonal fasciole strong; canal bent weakly to the left, basally notched.

Remarks.—The closely similar genus *Mitrella* Risso, 1826, can be distinguished by its total lack of axial sculpture, a proportionately smaller body whorl, no labral varix, and usually columellar denticles or a columellar swelling.

The genus *Cyrtochetus s.s.* has a very meager distribution (Wenz, 1941: 1171) and is known from the Eocene of the Paris Basin (type only), the Miocene of California (Cossmann, 1901 in 1895–1925: 117), the Oligocene of northern Peru (Olsson, 1931: 103), and the Eocene of Antarctica (Stilwell & Zinsmeister, 1991: 122). The French type species has very similar proportions and external sculpture to *C. augustulus* n. sp., but it also has a thickened outer lip, and lacks any axial folds.

Etymology.—The specific name *augustulus* refers to the species' occurrence near the town of Augusta, Houston County, Texas.

Type Material.—Holotype: TMM NPL7101, from locality 113-T-203.

Type Locality.—Locality 113-T-203, 0.8 miles (1.29 km) west of Augusta on Augusta-Grapeland Road, Houston County, Texas. Eocene, Weches Formation.

Material Examined.—One specimen, the holotype (TMM NPL7101), 27.9 mm in length, 14.4 mm in maximum diameter.

Genus ***LACINIA*** Conrad, 1853

Type Species.—*Melongena alveata* Conrad, 1833a in 1832–1835, by original designation. Eocene, Gosport Sand, Alabama River, Alabama.

Description.—Shell large, subglobose, robust. Whorls with 3 or 4 spiral ridges, commonly duplex, one forming shoulder. Early whorls nodose. Columellar callus anteriorly thick to massive; anterior notch prominent; base with spiral lines.

Lacinia alveata serpens n. ssp.
Pl. 2, Figs 1–3

Description.—Differing from *Lacinia alveata* by smaller shoulder area and prominent anterior concave area, by having one or more concentric ridges, with larger but fewer basal lines, and snakeskin-like ornamented pattern generated by intersections of fine oblique spiral lines and axial grooves.

Remarks.—The snakeskin-like pattern begins when early noded sculpture ends.

Conrad (1833c) in error noted the genus in the London Clay Formation in England, but that refers to *Priscoficus smithii* (J. de C. Sowerby in Fitton, 1836) a member of the Ficidae. Palmer (1937: 302) noted only two localities where *Lacinia alveata* has been found; the species or close variants thereof is much more widely distributed than is indicated by those two localities. In the Gosport Sand of Little Stave Creek, near Jackson, Alabama, *L. alveata* is perhaps the most common large gastropod found. In Texas, by examination of the TNSC collections as well as the author's own collecting, it is found to be sparsely but widely distributed in the Eocene of the Rio Grande area, in Burleson, Brazos, and Houston counties, as well as the Queen City locality noted by Palmer. This report extends the range of this genus to include almost the entire Claibornian range.

Etymology.—The subspecific name *serpens* (Latin, snake) refers to the snakeskin-like pattern.

Type Material.—Holotype: TMM NPL7101. Paratype: TMM NPL49880, both from locality 26-T-4.

Type Locality.—Locality 26-T-4, northeastern corner of the town of Caldwell, Burleson County, Texas. Eocene, Yegua Formation.

Material Examined.—Two specimens, holotype (TMM NPL7101), 40.7 mm in height, and paratype (TMM NPL49880), 34.3 mm in height.

Family **FASCIOLARIIDAE** Gray, 1853

Genus ***SURCULITES*** Conrad, 1865

Type Species.—*Surculites annosus* Conrad, 1865, by original designation. Eocene, Shark River Formation, New Jersey.

Description.—Shell medium-sized, high, turreted. Whorls angular, strongly carinated at periphery, which is medial in position. Sculpture smooth or with fine spiral lines, sometimes also with fine axials that then form tessellated surface. Anal sinus straight or weakly curved, occupying entire shoulder slope.

Remarks.—I follow Wrigley (1939: 281–283), Powell (1966: 146–147), and Garvie (1996: 78) and place *Surculites* in the Fasciolariidae, rather than under Turridae as many other authors do. The fact that the type is an internal mold precludes knowledge of the protoconch characteristics, however all specimens of *S. cabezi* Gardner, 1945, *S. engonatus* (Heilprin, 1881), *S. lapillus* Garvie, 1996, and *S. errans* (Solander in Brander, 1766) that were examined by the author and which retained their nuclear whorls had a similar type of protoconch, composed of 2–3.5 smooth, shining whorls, rapidly increasing in size, with the initial nucleus minute and the transition to teleoconch sculpture gradual. It can be assumed that that protoconch type is a characteristic feature of this taxon.

Surculites venustus n. sp.
Pl. 2, Figs 4–5

Description.—Whorls 8; protoconch of 3 smooth rounded whorls; teleoconch whorls sharply carinate, with rounded collar, concave ramp, impressed suture, and concave again below carina. Ornament of 6 spiral lines on ramp, and 6 stronger ones on and below periphery. Body whorl with prominent sharp upper carina and rounded one below; spiral lines most prominent in intermediate concave area, stronger again on canal. Entire teleoconch sculpture overrun with regular comarginal grooves forming elegant recticulate pattern where they cross spirals. Anal sinus broad; apex in top third of ramp; columella straight, smooth; canal weakly bent to left.

Remarks.—This is an elongate species, closer in shape to *Surculites annosus* than any other *Surculites* species, but can be distinguished by the fewer but more prominent spiral lines and the more prominent and higher position of the anal sinus. *Surculites cabezi* is shorter, has sculpture of sharp spiral lirae tending to alternate in strength, is reticulated with axials subequal in strength, and (in both *S. cabezi* and *S. cortezi* Gardner, 1945) the shoulder sculpture becomes obsolete with age. *Surculites engonatus*, a lower Eocene taxon, is shorter and far more evenly sculptured and has the body whorl with lines alternating in strength.

Etymology.—The specific name *venustus* (Latin, elegant) refers to the elegant reticulate pattern.

Type Material.—Holotype: TMM NPL46616, from locality 89-T-12.

Type Locality.—Locality 89-T-12, bluff along lower part of Nagel Creek, south of the Guadalupe River; northeastern flowing creek paralleling county road from Monthalia to Oak

Forest; 1.9 mi (3.1 km) south of Oak Forest, Gonzales County, Texas. Eocene, Cook Mountain Formation.

Material Examined.—One specimen, the holotype (TMM NPL46616), 27.4 mm in height.

Superfamily **MURICOIDEA** Rafinesque, 1815
Family **HARPIDAE** Bronn, 1849

Genus ***ONISCIDIA*** Mörch, 1852

Type Species.—*Oniscia cancellata* G. B. Sowerby I, 1824 in 1820–1824, by monotypy (ICZN Opinion 1040, 1973). Recent, China Sea.

Description.—Shell small to medium-sized, cylindrical; spire conical. Sculpture of sharp, reticulate axial and concentric ribs. Aperture elongate; columella thickened, reflected, plicate or tuberculate. Siphonal canal prominent, recurved, without basal columellar sulcus.

Remarks.—The history and attribution of *Oniscidia* is complicated, being variously ascribed to Swainson, H. & A. Adams, and Mörch. Cernohorsky (1972, 1973) and Maxwell & Beu (1973) can be consulted for a synopsis of the history.

The earliest species known so far appear to be *Oniscidia antiqua* (Bayan, 1870) (= *Oniscia antiqua* Bayan, 1870) from the Eocene of Italy, a fragmentary *Oniscidia* species (Woodring, 1959: 202–203, pl. 25, figs 11, 17) from the Eocene Gatuncillo Formation in Panama, and *O. harpula* (Conrad, 1848) from the Oligocene of the Gulf Coastal Plain.

Oniscidia claibornensis n. sp.
Pl. 2, Figs 4–5

Description.—Shell medium-sized. Whorls 7.25; protoconch of 2.5 (3?) smooth rounded whorls (tip missing in single available specimen). Transition to teleoconch abrupt; teleoconch whorls beginning with fine crowded longitudinal lines that rapidly change to final adult sculpture. Sculpture of almost horizontal ramp, sharply carinated, with numerous foliated blade-like axials and spiral lines; intersections of axials and spiral lines forming weakly upturned, adaptural pointing spines; ramp with single medial, fine spiral. Body whorl with 8 spirals; suture impressed. Outer lip broken in single available specimen but showing weak rounded lirae corresponding to external spirals. Aperture elongate; columella excavated medially with thin callus deposit; canal long, bent to left, twisted, with notched end; siphonal fasciole prominent.

Remarks.—The single available specimen is probably a juvenile because it is lacking a columellar shield. It can be distinguished from *Oniscidia antiqua* by having nine spiral lines versus 12 for *O. antiqua*, and the canal of this species is straighter and the spire higher; this is a much more spinose and foliated species than the Italian representative. The later Oligocene species *O. harpula* is shorter in form, has a shorter canal, and is less spinose. The Panamanian species is taller, more robust, has much more numerous axial folds; its affinities appear to lie closest to *O. antiqua*.

Etymology.—The specific name *claibornensis* refers to the species' occurrence in the Claiborne Stage.

Type Material.—Holotype: TMM NPL46595, from locality 89-T-12.

Type Localitiy.—89-T-12: bluff along lower part of Nagel Creek, south of the Guadalupe River; northeastern flowing creek paralleling county road from Monthalia to Oak Forest; 1.9 mi (3.1 km) south of Oak Forest, Gonzales County, Texas. Eocene, Cook Mountain Formation.

Material Examined.—One specimen, the holotype (TMM NPL46595), 20.9 mm in height.

Family **VOLUTIDAE** Rafinesque, 1815

Genus ***CARICELLA*** Conrad, 1835 in 1832–1835

Type Species.—*Turbinella pyruloides* Conrad, 1832 in 1832–1835, by subsequent designation (Cossmann, 1899 in 1895–1925).

Description.—Shell medium to large, elongate pear-shaped; spire coleoconoid. Protoconch smooth, paucispiral with flattened nucleus. Whorls rounded, early ones often with spiral lines; body whorl large, usually rounded, smooth. Basal canal long, twisted, without siphonal fasciole, anteriorly feebly notched. Columella usually concave, with 4 oblique folds.

Remarks.—This is a diverse taxon in the Paleogene of the Gulf Coast with 30 species and subspecies described. In the U.S., the genus is restricted to the Claibornian and Vicksburg groups where it is one of the more common larger gastropods found. The closely similar genus *Scaphella* Swainson, 1832 in 1820–1833, is more elongate and has two to four columellar plications and an erect pointed nucleus. Another similar taxon is *Xancus* Röding, 1798, the general shape of which is very similar, with a multispiral mammilate protoconch, long

canal, siphonal fasciole, and three to five columellar plications, known from the Oligocene onward.

Caricella*? *turboides n. sp.
Pl. 2, Figs 8–9

Description.—Shell large, top-shaped, anteriorly elongated. Whorls 6; protoconch of 2 whorls, smooth, mammillate, overhanging first teleoconch whorl; transition to teleoconch gradual. First teleoconch whorl smooth; next 3 whorls with 5 or 6 spiral lines that gradually disappear; remaining whorls smooth. Collar slightly swollen; suture impressed; ramp concave, with weak rounded carina below whorl median. Body whorl with rounded periphery, conical below, with straight sides and weak basal carina merging into canal. Columella weakly concave with 6 columellar plaits; angle with shell axis decreasing toward base. Canal broken in available specimens, but growth lines at anterior end of columella indicate siphonal fasciole probably present.

Remarks.—The six columellar plications and probable existence of a siphonal fasciole make questionable a confident assignment to *Caricella s.s.* However, the close relationship to the Lower Eocene *C. podagrina* Dall 1890 in 1890–1903, makes that species the likely ancestor of *C.*? *turboides* n. sp., but the former species is a true *Caricella* with four columella plications and is further distinguished with having by a shorter spire and its body whorl smoothly merging into the canal. More distantly related is *C. praetenuis* (Conrad, 1833b: 45), a species that in his description Conrad described with "columella 5 to 6-plated," although Palmer (1937: 395) only noted four or five; this species is more ovate and has a shorter spire than *C.*? *turboides* n. sp. The wide flattened shoulder area of *C. subangulata* Conrad in Wailes, 1854, from the Moodys Branch Formation is similar to that of *C.*? *turboides* n. sp., but its spire is lower, the body whorl more rounded, and it only has four columellar folds. There is some similarity to the Recent *Xancus* (*Xancus*) *pyrum* (Linnaeus, 1758), a species with three, sometimes five columella folds, and a doubly carinate body whorl. The turbinellid taxon *Psilocochlis* Dall, 1904, which Wenz (1943 in 1938–1944: 1302), regarded as a subgenus of *Xancus*, is known from the Claibornian of Georgia, but is in a very different line and, except for the columellar folds, would likely be placed near *Lacinia* Conrad, 1853.

Etymology.—The specific name *turboides* (Latin, child's top) refers to the similarity to a top.

Type Material.—Holotype: TMM NPL46594, from locality 113-T-20.

Type Locality.—Locality 113-T-20, Rock flat, west of Percilla, Houston County, Texas. Eocene, Weches Formation.

Material Examined.—Two specimens, the holotype (TMM NPL46594, 84.6 mm in height) and one fragmentary specimen (TMM NPL10422, from locality 197-T-4).

Clade **HETEROBRANCHIA** Haszprunar, 1985
Informal Group **OPISTHOBRANCHIA**
Milne-Edwards, 1848
Superfamily **PHILINOIDEA** Gray, 1850
Family **CYLICHNIDAE** H. & A. Adams, 1854
in 1853–1858

Genus ***SCAPHANDER*** Montfort, 1810 in 1808–1810

Type Species.—*Scaphander lignarius* Linnaeus, 1758, by original designation. Recent, North Sea.

Description.—Shell usually very small, solid, cylindrical to ovate. Apex depressed, umbilicate, or closed. Body whorl usually spirally striate. Aperture approximating shell height, constricted above, expanded below, with outer lip retracted abaperturally. Columella short, usually with weak fold; callus reflected over last whorl.

Subgenus ***MIRASCAPHA*** Stewart, 1927

Type Species.—*Cylichna costatus* Gabb, 1864, by original designation. Martinez Eocene, California.

Description.—Distinguished from *Scaphander s.s.* by more cylindrical body whorl and heavier columellar callus deposit.

Remarks.—Stewart (1927) also included *Scaphander ligniticus* Aldrich, 1897, and *S. cinctus* (Deshayes, 1858) in his subgenus. I have not seen the Deshayes species, but under his description, Stewart noted the species' extreme fragility, which could make the assignment doubtful. I do not think that this is a well-characterized subgenus because the characters defining *Scaphander* (*Mirascapha*) overlap considerably with those of *Cylichnopsis* Cossmann, 1904 in 1895–1925, making a reliable assignment to one or the other problematic. *Cylichnopsis*, a genus also in the Scaphandridae, which most authors treat as a subgenus of *Cylichna* Lovén, 1846 (Cossmann, 1904 in 1895–1925: 118–119; Zilch, 1959: 23–24; Palmer & Brann, 1966 in 1965–1966: 619), can be characterized as follows (following Zilch): shell usually very small to small, robust (solid); elongate-cylindrical, seldom ovate, apex truncated; whorls conically involute, apical umbilical area covered with callus; body whorl usually finely spirally striate,

seldom smooth; aperture the length of the shell, constricted above, expanded below; columella with callus deposit, below reflected, usually with one weak fold. One could examine the respective genotypes for guidance, but in this case the discernible differences come down to the size and shape of the two taxa. Therefore, if there is utility in keeping both subgenera in use, one should restrict *Cylichnopsis* to those species that are small or very small, cylindrical in outline, and have a columellar fold or swelling, whereas *Mirascapha* can be used for medium-sized to large species with a more rounded or ovate outline and no columellar fold.

Scaphander* (*Mirascapha*) *smithvillensis n. sp.
Pl. 2, Figs 10–13

Description.—Shell medium-sized, solid, elongate-conic, medially straight. Aperture approximating shell length, moderately expanded basally. Apex constricted to blunt point; apical umbilical area covered by thick callus, with inner edge delimited by spiral ridge. Columellar callus thick, without folds, not umbilicated. Sculpture of evenly spaced spiral ribbons that are duplex due to medial fine impressed lines; interspaces half width of ribbons, showing lattice pattern due to fine lamellar growth lines.

Remarks.—The Lower Eocene species *Scaphander ligniticus* is smaller, more ovate and thin-shelled, and lacks the thick labial callus extending the length of the aperture. Closer is *S. richsoni* Palmer in Richards & Palmer, 1953, from the Inglis Member, Moodys Branch Formation of Florida; it is shorter, more ovate, and the outer lip is basally extended more prominently. Palmer (in Richards & Palmer, 1953: 40–41) mentioned microscopic longitudinal lines in the interspaces between the spiral ribs, a feature also seen in *S.* (*Mirascapha*) *smithvillensis* (Pl. 3, Fig. 31). Interestingly, all of the species examined by Bullis (1956) in his paper on Gulf of Mexico *Scaphander* have either punctuations or fine longitudinal lines between the spiral lines, indicating this might be an important diagnostic feature for the genus. Stephenson (1941: 391) already remarked on the similarity of several Texas Cretaceous taxa that he placed in his genus *Ellipsoscapha* to *Mirascapha*, all of them also showing punctate grooves within the spiral lines.

Etymology.—The specific name *smithvillensis* refers to the location near the town of Smithville from which the specimens were found.

Type Material.—Holotype: TMM NPL32660. Paratype: TMM NPL38015, both from locality 11-T-2.

Type Locality.—Locality 11-T-2: bluff on right bank of Colorado River at Smithville, *ca.* 625 ft (190.5 m) downstream from the new bridge on Highway 71, Bastrop County, Texas. Eocene, Weches Formation, Viesca Member.

Material Examined.—Two specimens, the holotype (TMM NPL32660), 25.5 mm in height, and a paratype (TMM NPL38015), 22.0 mm in height.

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PLATES

PLATE 1

Figure

1–3. *Barbatia* (*Cucullaearca*) *kickapooensis* n. sp., holotype (TMM NPL6885), a left valve, locality 113-T-16, Weches Formation, Tyrus Member. Length 76.5 mm. 165
1. Exterior view.
2. Interior view.
3. Umbonal lateral view.

4–5. *Cochlodesma unda* n. sp., holotype (TMM NPL3788), a double valve, locality 245-T-3, Cook Mountain Formation. Length 37.5 mm. 166
4. Exterior view.
5. Umbonal lateral view.

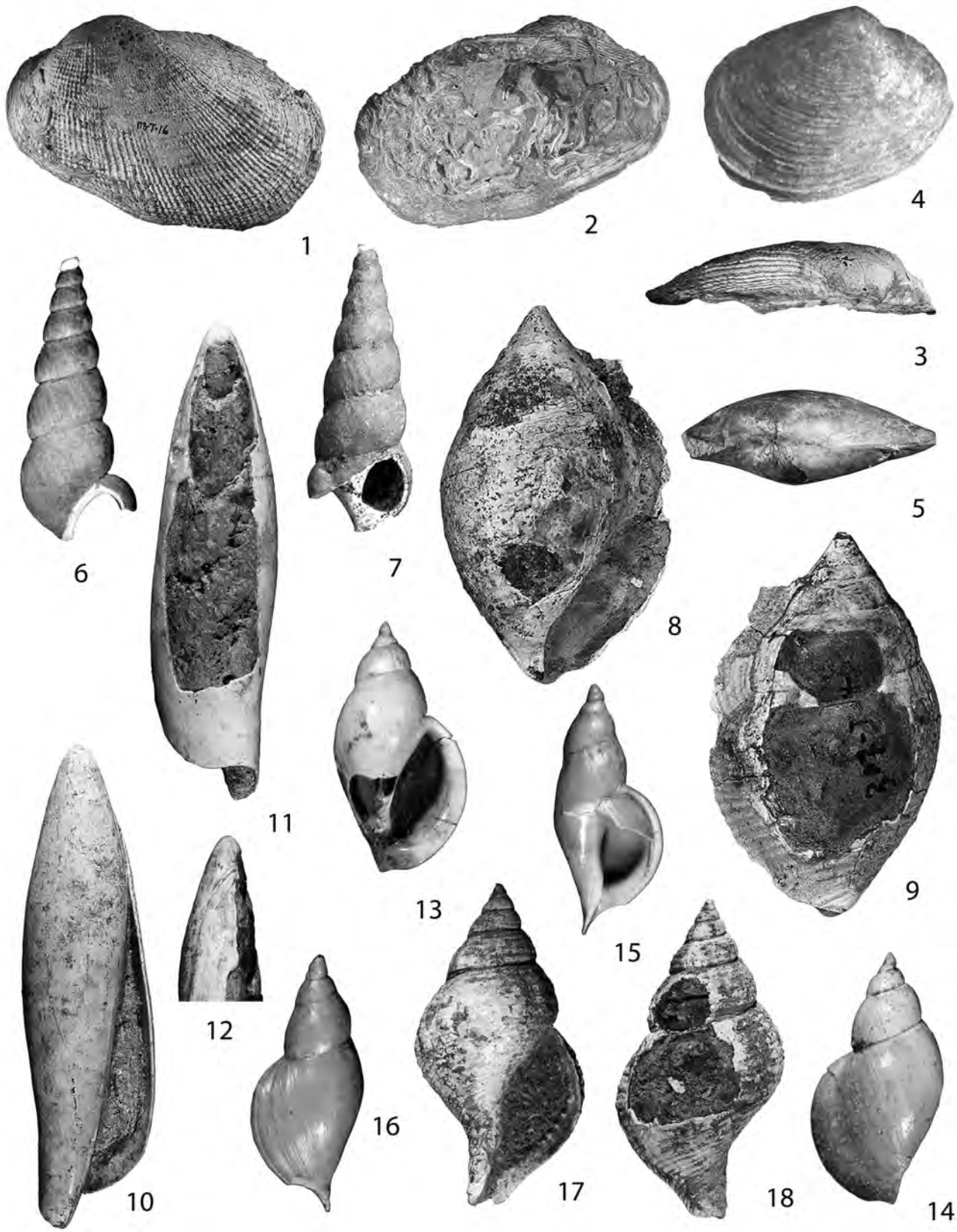
6–7. *Pachychilus fulvus* n. sp., holotype (TMM NPL45554), locality 11-T-2, Weches Formation. Length 21.3 mm. 166
6. Apertural view.
7. Dorsal view.

8–9. *Platyoptera cherokeensis* n. sp., holotype (TMM NPL6769), locality 37-T-4, Weches/Reklaw? Formation. Height 37.2 mm. 167
8. Apertural view.
9. Dorsal view.

10–12. *Paraseraphs texanopsis* n. sp., holotype (TMM NPL7075), locality 113-T-202, Weches Formation. Length 53.3 mm. 169
10. Apertural view.
11. Dorsal view.
12. Magnified view showing posterior channel. Height of field of view 16.4 mm.

13–16. *Volutostrombus eocenica* n. gen., n. sp. 168
13–14. Holotype (TMM NPL46617), locality 145-T-52, Cook Mountain Formation, lower Landrum Member. Length 10.8 mm.
13. Apertural view.
14. Dorsal view.
15–16. Paratype (TMM NPL38016), locality 113-T-9, Cook Mountain Formation, Landrum Member. Length 7.7 mm.
13. Apertural view.
14. Dorsal view.

17–18. *Cyrtochetus* (*Cyrtochetus*) *augustulus* n. sp., holotype (TMM NPL7101), locality 113-T-203, Weches Formation. Length 27.9 mm. 170
17. Apertural view.
18. Dorsal view.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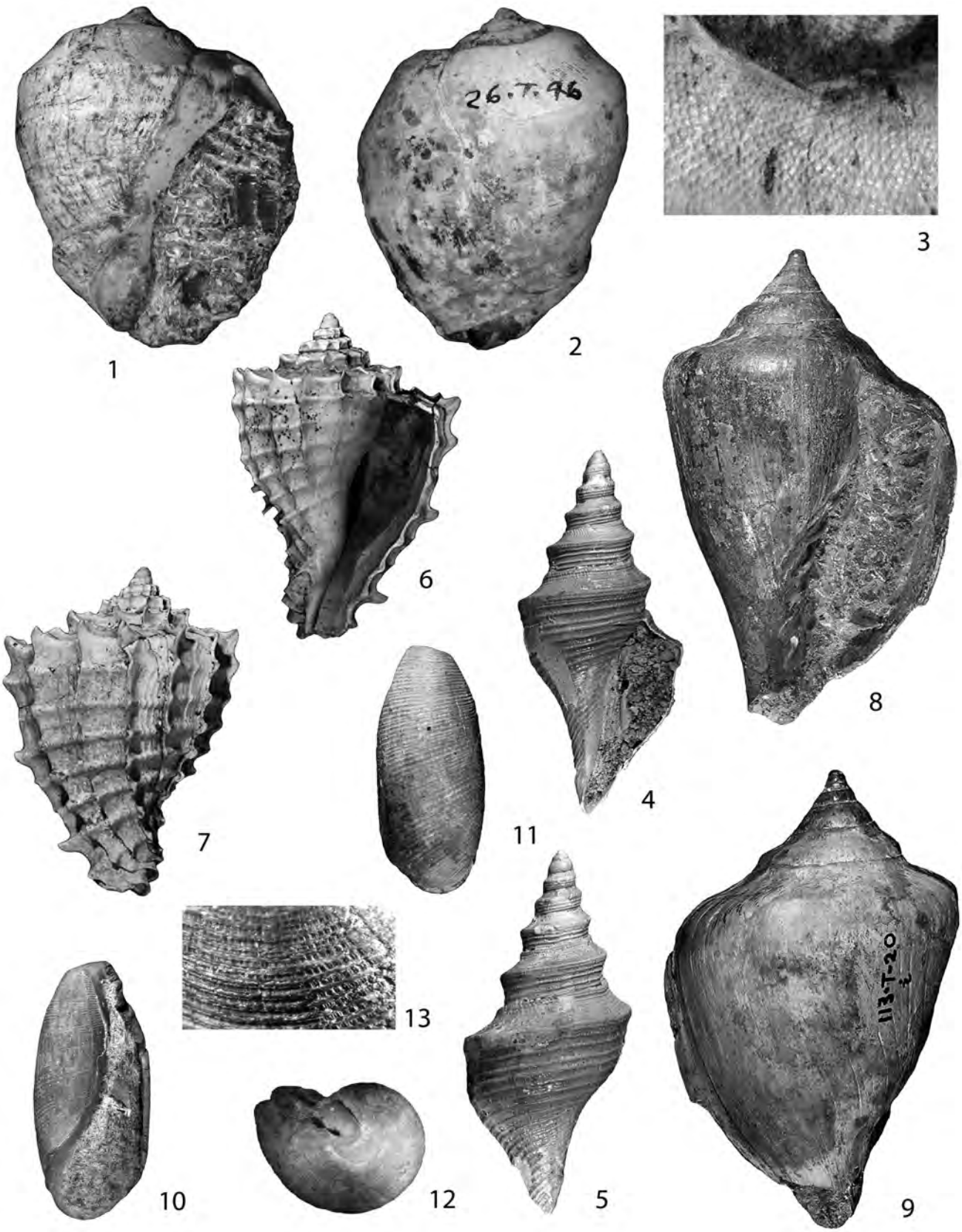
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Plate 2

Figure

1–3. *Lacinia alveata serpens* n. ssp., holotype (TMM NPL7101), locality 26-T-4, Yegua Formation. Height 40.7 mm. 170
1. Apertural view.
2. Dorsal view.
3. Magnified portion of spire showing surface pattern. Height of field of view 6 mm.

4–5. *Surculites venustus* n. sp., holotype (TMM NPL46616) from locality 89-T-12, Cook Mountain Formation, Wheelock Member? Height 27.4 mm. 171
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9. Dorsal view.

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11. Dorsal view.
12. Apical view.
13. Magnified view of the surface showing the lattice pattern. Height of field of view 3.5 mm.

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Note: Text pages are in regular font; plate pages are in **bold font**; text pages with definitions or principal discussions are in *italics.*

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