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Cover image: Examples of some newly described species of gastropods from the Danian Brightseat Formation of Maryland. Top row: *Vitrinella* (*Vitrinellops*) *clarkmartinorum* n. sp., *Zikkuratia danica* n. sp., *Neverita* (*Neverita*) *potomacensis* n. sp., and *Mathilda* (*Fimbriatella*) *marylandensis* n. sp. Middle row: *Pseudocirsope feorra* n. sp., *Sigmesalia*? *gnoma* n. sp., and *Solariorbis laurelae* n. sp.. Bottom row: *Kapalmerella mortoni protomortoni* n. ssp., *Anticlimax*? *gardnerae* n. sp., *Mathilda* (*Fimbriatella*) *crebricosta* n. sp., and *Cyclostremiscus sohli* n. sp. Specimens are not shown to scale."

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GASTROPOD MOLLUSKS FROM THE BRIGHTSEAT FORMATION (PALEOCENE: DANIAN) OF MARYLAND

David L. Govoni[1], Kiera D. Crowley[2, 3*], Thor A. Hansen[4], and Warren D. Allmon[2]

[1]U. S. Geological Survey, Reston, Virginia 20192, USA; [2]Paleontological Research Institution, 1259 Trumansburg Road, Ithaca, New York 14850, USA; [3]School of Geosciences, University of Oklahoma, 100 E. Boyd Street, Norman, Oklahoma 73019, USA; [4]Geology Department, Western Washington University, Bellingham, Washington 98225, USA

ABSTRACT

The Brightseat Formation, exposed near the inner margin of the Salisbury Embayment in Maryland and Virginia, represents the earliest Paleocene sediments that crop out in this region of the northern Atlantic Coastal Plain. The formation is placed within the middle part of the Danian Stage, as defined by the presence of the *Chiasmolithus danicus* calcareous nannofossil Zone (NP3). Although a number of studies have investigated the microfauna of the Brightseat, no similarly thorough evaluation has been afforded to the macrofauna. This study provides the first extensive taxonomic treatment of the gastropods, collected largely from now-inaccessible Brightseat localities near the original type section in the lower Potomac River Valley, east of Washington, D. C.

The diverse gastropod fauna of the Brightseat Formation consists of 52 species or forms assigned to 41 genera distributed among 25 families. Twenty-five species or subspecies are described as new: *Kapalmerella mortoni protomortoni* n. ssp., "*Turritella*" *prehumerosa* n. sp., *Sigmesalia palmerae* n. sp., *Sigmesalia*? *gnoma* n. sp., *Neverita* (*Neverita*) *potomacensis* n. sp., *Pseudocirsope feorra* n. sp., *Pasitheola marylandensis* n. sp., *Anticlimax*? *gardnerae* n. sp., *Cyclostremiscus sohli* n. sp., *Solariorbis laurelae* n. sp., *Vitrinella* (*Vitrinellops*) *clarkmartinorum* n. sp., *Eulima brightseatensis* n. sp., *Calyptraea aldrichi* n. sp., *Lacinia pygmaea* n. sp., *Siphonalia potomacensis* n. sp., *Pseudoliva longicostata* n. sp., *Acrocoelum richardsi* n. sp., *Mathilda* (*Fimbriatella*) *crebricosta* n. sp., *Mathilda* (*F.*) *marylandensis* n. sp., *Mathilda* (*Mathilda*) *kauffmani* n. sp., *Acteon danicus* n. sp., *Zikkuratia danica* n. sp., *Scaphander* (*Priscaphander*) *potomacensis* n. sp., *Creonella obscuriplica* n. sp., and *Puposyrnola toulmini* n. sp. The author of all these new species is Govoni.

The Brightseat gastropods include a mixture of genera indicative of both northern mild-temperate and southern warm-temperate affinities, and we compare the assemblage to faunas of similar age from elsewhere in the Coastal Plain of North America, from West Greenland, and from northwestern Europe. In overall composition, the Brightseat fauna more strongly resembles the Danian to Selandian shelf faunas of the north-central and western margins of the North Atlantic Basin (West Greenland, Denmark, and Belgium), within the Danian Northern Mild-Temperate (NMT) Marine Zoogeographic Province, than it does contemporaneous faunas to the southwest in the Gulf Coastal Plain (in Texas, Mississippi, and Alabama), on the northern margin of the Southern Warm-Temperate (SWT) Province. This mixture of elements of differing biogeographic affinities suggests that the Brightseat gastropods flourished on a portion of the eastern North American continental shelf situated within a zone of overlapping northern and southern influence that marked the boundary between the two Danian North Atlantic marine zoogeographic provinces.

INTRODUCTION

The Brightseat Formation is a lower Paleocene (middle Danian) marine deposit lying between the Upper Cretaceous Severn Formation and the upper Paleocene Aquia Formation in the lower Potomac River Valley near Washington, D. C. (Bennett and Collins, 1952). Although the microfossils of the Brightseat are well known (Berggren, 1965a,b; Hazel, 1968; Loeblich and Tappan, 1957a,b; Self-Trail et al., 2022, 2023a,b), very few published studies have appeared on either the composition or significance of the diverse and relatively well-preserved molluscan macrofauna, which constitutes the richest lower Paleocene assemblage of its kind preserved in the Atlantic Coastal Plain. Previous studies that have focused on the mollusks (e.g., Kauffman and Beauchamp, 1969; Bretsky, 1974; Bretsky and Kauffmann, 1977) have been concerned primarily with Bivalvia. To date, no attempt has been made to describe systematically either the bivalve or the gastropod fauna, or to explore their potential value in biostratigraphic or biogeographic analysis, yet the Brightseat Formation occupies a key geographic and stratigraphic position for transatlantic correlation and comparison. The Brightseat fauna is the most northern and eastern lower Paleocene assemblage in North

*Corresponding author. Email: kdc62@cornell.edu

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America of sufficient diversity and adequate preservation to allow meaningful comparison with well-known European faunas. The Brightseat provides the best available intermediate link between the lower-latitude shelf assemblages of the Gulf Coastal Plain at the far-western extension of the North Atlantic Basin and those of somewhat higher latitudes in northwestern Europe at the far-eastern margin, as well as with the highly diverse fauna of West Greenland on the north-central margin.

STRUCTURAL AND STRATIGRAPHIC FRAMEWORK OF THE BRIGHTSEAT FORMATION

Regional Setting

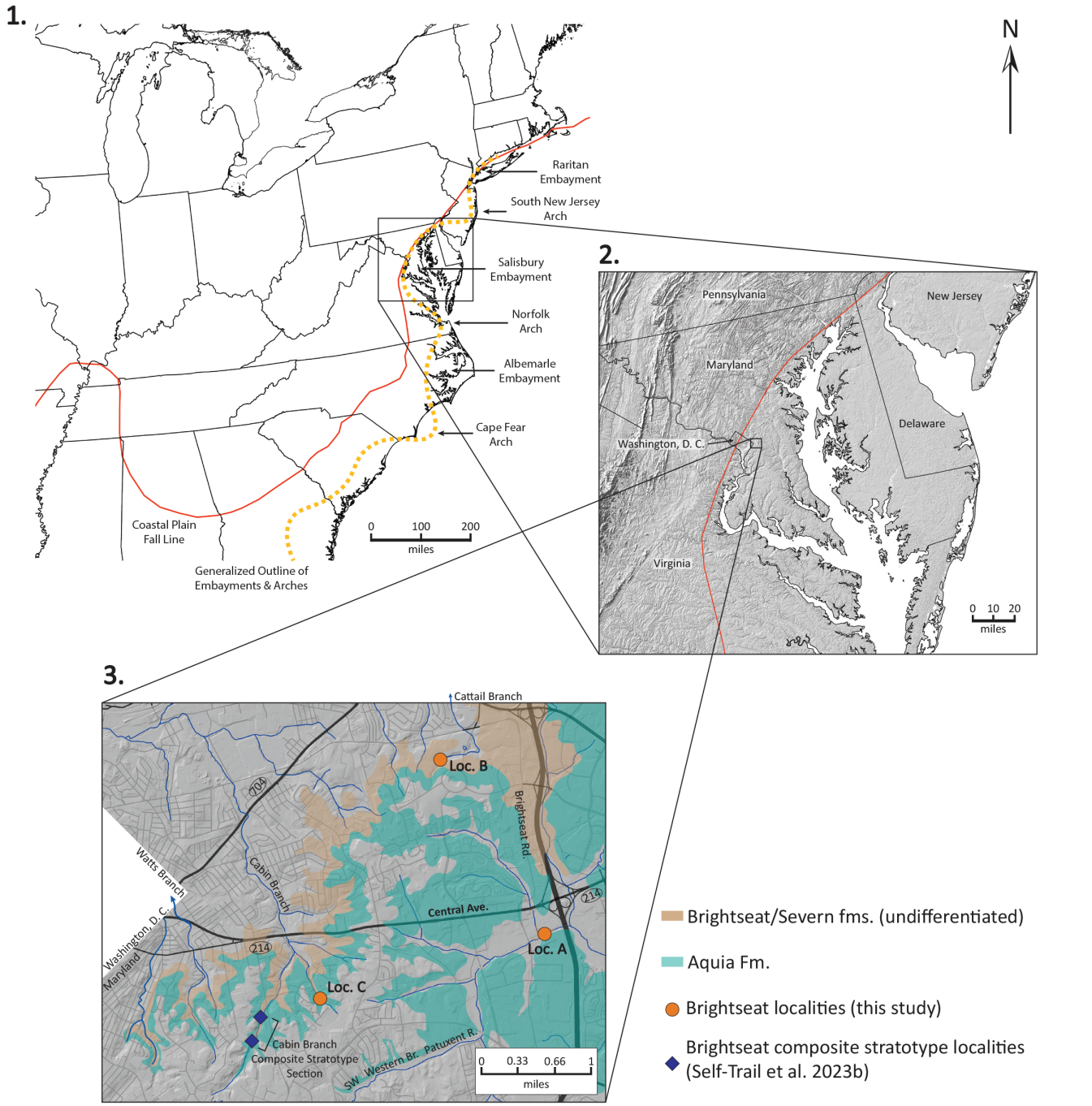
Sedimentary deposits of Paleocene age crop out near the inner (western) margin of the northern Atlantic Coastal Plain in a generally narrow and, to the south, increasingly discontinuous belt that extends from northern New Jersey, south of Raritan Bay, through northern Delaware and Maryland, south to the region between Petersburg and Richmond in Virginia (U. S. Geological Survey, 1967; Teifke 1973; Weed et al., 1974; Ward, 1992). In the Delaware-Maryland-Virginia region, these deposits are exposed a short distance east of the "Fall Line," which marks the inner margin of preserved onlap of Cretaceous- and Cenozoic-age sedimentary rocks of the Coastal Plain Province onto the Precambrian and early Paleozoic crystalline rocks of the Piedmont Province at the edge of the continental craton (Ward, 1992). The basement complex upon which the Cretaceous and Cenozoic units rest is downwarped in this region into a shallow, east-southeastward plunging, open-ended basin known as the Salisbury Embayment (Richards, 1948), which is bounded on the north and south by basement structural highs known respectively as the South New Jersey arch and Norfolk arch (Text-fig. 1.1). The position and extent of downwarping of the Salisbury Embayment is the result of a structurally dynamic margin experiencing sea-level change and episodic reactivation of block faults related to an old Triassic rift system (Hansen, 1978; Ward and Powars, 2004). The pinch-out of lower Paleocene (Danian) strata that broadly coincides with the southern flank of the embayment is thought to have resulted from postdepositional uplift and erosion during one such reactivation event.

Lithostratigraphy

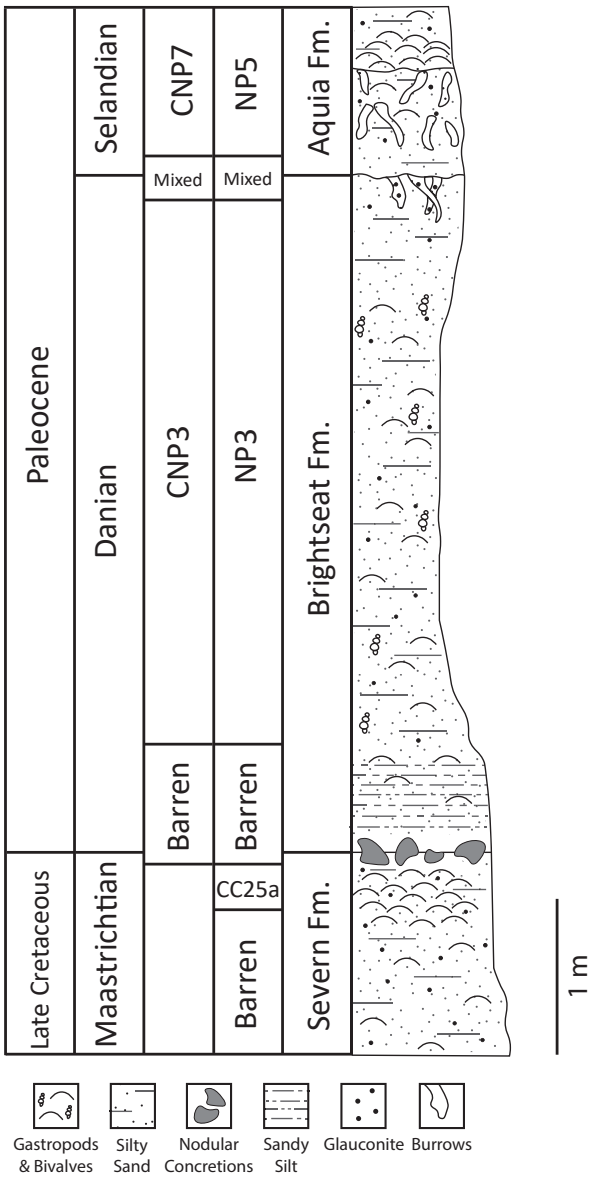
The Brightseat Formation is the lowest stratigraphic unit of the Pamunkey Group, which ranges from Paleocene to lower Eocene in age and also includes, in ascending order, the Aquia Formation, the Marlboro Clay, and the Nanjemoy Formation (Hazel, 1968; Gibson et al., 1980; Ward and Powars, 2004). Bennett and Collins (1952) first named the Brightseat Formation when they demonstrated the existence of surface outcrops of lower Cenozoic age older than the upper Paleocene Aquia Formation in four localities near the village of Brightseat in Prince George's County, Maryland, just east of Washington, D. C. They applied the name to beds of macrofossiliferous, dark-gray, micaceous, silty and clayey, fine quartz sand up to 2.4 m thick that occur in the lower Potomac River Valley at a few scattered outcrops ~ 1.6−4.8 km southwest of Brightseat. Thus defined, the Brightseat Formation is exposed, mainly in stream beds and river bluffs, along a narrow and highly discontinuous band that extends with a strike of approximately N 55° E from the type area to the region on both sides of the Severn River in the vicinity of Round Bay in Anne Arundel County (Glaser, 1968, 1973, 1976; Beauchamp, 1969; Minard et al., 1976; Owens et al., 1977; Minard, 1980). The outcrop thickness of the formation varies along strike from near-zero to a maximum of ~ 6 m.

Throughout these outcrops, the unit maintains a more or less uniform lithologic character, consisting for the most part of alternately fining and coarsening, unconsolidated, dark gray to olive or greenish gray, poorly sorted, micaceous, clayey and silty, fine to very fine quartz sand (Text-fig. 2). Coarse grains and granules of quartz are scattered throughout the unit and small quartz pebbles also occur, especially near the base. The unit is variably (up to ~ 25%) but usually very sparsely (< 5%) glauconitic. Fragments of lignitized wood are scattered throughout but are most abundant toward the base. Primary bedding structures have for the most part been obscured by intense bioturbation, although very fine and commonly somewhat inclined laminae are sometimes visible in intervals where burrowing was less intense. The average ratio of planktic to benthic foraminifers (10–20%) in the Brightseat indicates a likely depositional environment in middle neritic water depths of 120–140 m (Self-Trail et al. 2017, 2023b).

Southwest of Washington, D. C., on opposite sides of the Potomac River in Charles County, Maryland, near Glymont, and further southwest in Stafford County, Virginia, along Aquia Creek, ~ 5.5 m of mostly unfossiliferous, dark gray to blue-gray, slightly glauconitic, micaceous, silty, very fine-grained quartz sand occurs above beds of Cretaceous age and below the highly fossiliferous, coarser grained, and highly glauconitic quartz sands characteristic of much of the Aquia Formation. These sands were included by Clark and Martin (1901) in their "Zone 1," a lithologic unit estimated to be up to 18.3 m in thickness, which they regarded as being the basal unit of the Aquia Formation. The beds of Zone 1 are lithologically similar to, and occupy the same relative stratigraphic position as, the Brightseat Formation east and northeast of Washington, D. C., and, as noted by Hazel (1968: 100), are at least in part equivalent to the Brightseat Formation. The Brightseat Formation thus appears to extend into northeast-



Text-fig. 1. The Atlantic Coastal Plain and geographic context of the Brightseat localities in Prince George's County, Maryland, investigated during this study. (**1**) Major tectonic features of the Atlantic Coastal Plain with underlying basement architecture (dotted yellow line) and inner margin of Cretaceous and Cenozoic onlap (red "Fall Line") indicated. (**2**) Topographic map of the Chesapeake Bay region with the inner margin of the Salisbury Embayment approximated by the Fall Line (red). (**3**) Local map of Brightseat localities used in this report (orange dots; localities of Bennett and Collins, 1952) as well as the newly designated Brightseat composite stratotype section (blue diamonds; Self-Trail et al., 2023b) for reference. Due to heavy urban development, Localities A and B are no longer accessible. Generalized surface geology (as per Glaser, 2003) is shaded for the Severn-Brightseat (light brown) and Aquia (teal) formations to help contextualize regional availability, although the exposed outcrop for the Brightseat Formation is extremely limited. Maps developed using QGIS and USGS data (public domain) from Horton et al. (2017) and State of Maryland GIS data (public domain) from MD iMap Data Catalog (2010, 2018a, b, c). Topographic data derived from the Shuttle Radar Topography Mission (SRTM GL3)Global 90m (Farr and Kobrick, 2000).



Text-fig. 2. Generalized stratigraphic section for the Brightseat Formation in the area of the original type section and the recently established principal and supplementary reference sections in Prince George's County, Maryland. Zonation of Sissingh (1977) used for the Cretaceous and those of Martini (1971) and Agnini et al. (2014) used for the Paleocene. Modified from Self-Trail et al. (2023b).

ern Virginia, where it shifts to a somewhat more north-northeasterly strike as its outcrop belt continues to conform to the curving inner margin of the Salisbury Embayment.

East and northeast of Washington, D. C., the Brightseat Formation is often fossiliferous, but the preservation of molluscan shell material is generally poor; at most localities, molluscan fossils are limited to scattered unidentifiable molds and casts. At the type locality (Locality A) and in nearby outcrops (Localities B and C, and the newly designated composite stratotype section of Self-Trail et al., 2023b), however, molluscan fossils are generally well preserved both as abundant scattered shells and shell fragments and as discrete (although thin and discontinuous) shell beds. The current study relies solely on the better-preserved molluscan material obtained from three of these localities, two of which are no longer accessible (Text-fig. 1.3). The Brightseat Formation rests unconformably upon sediments of Cretaceous age; southwest of Washington, D. C., in Charles County, Maryland, and Stafford County, Virginia, the unit overlies fluvial/estuarine deposits of the Lower Cretaceous (Albian) Patapsco Formation. The contact here is marked by a sharp change in lithology across the distinctly undulatory, heavily burrowed erosional surface, and the Brightseat contains a basal pebbly quartz lag deposit (first noted by Berry, 1912). In the type area east of Washington, D. C., northeast to the Severn River outcrops, the formation rests upon the Upper Cretaceous (Maastrichtian) Severn Formation. The Severn is a marine unit composed of highly fossiliferous, massive, dark gray, micaceous, clayey and silty, fine to very fine grained quartz sand that resembles the overlying Brightseat material (Self-Trail et al., 2023a,b). The lithologic similarity of the Severn and the Brightseat serves to obscure the contact between the units, but careful scrutiny reveals that the boundary is abrupt and slightly undulatory and is marked by a complex zone of shell-filled burrow chambers below the contact and reworking of Cretaceous fossils upward into the Brightseat as well as by a concentration of coarser quartz and phosphate granules or small pebbles and lignite (Text-fig. 2). Occasional beds of exhumed and bored siderite concretions or small flattened clay clasts can occur at the base of the Brightseat. Even in the field, the greater proportion of basal clay and higher ratio of very fine to fine sand in the Brightseat compared to the Severn is distinguishable with a hand lens (Self-Trail et al., 2023b). In the immediate study area of Bennett and Collins' (1952) original type section and the newly designated primary and secondary reference sections (see Localities section, Locality C), the Cretaceous-Paleogene boundary disconformity has recently been calculated to represent a hiatus of ~ 5 Ma (Self-Trail et al., 2023b).

The contact between the Brightseat and the overlying Paleocene (Selandian–Thanetian) Aquia Formation can also be seen to be abrupt and disconformable, although in weathered outcrops, it can sometimes appear gradational. This deceptive appearance is the result of intense burrowing activity by marine organisms into the upper 0.6 m of the Brightseat that took place following the deposition of that unit, and the subsequent filling of these burrows with glauconitic quartz sand and phosphate pebbles derived from the basal Aquia. The importance of bioturbation in mixing upper

Brightseat and lower Aquia sediments (and their contained microfossils) was overlooked by some workers (e.g., Nogan, 1964; Drobnyk, 1965; Glaser, 1968), leading them to suggest that the Brightseat-Aquia contact represents neither a major break in sedimentation nor a major episode of erosion. Hazel (1969) presented both lithologic and faunal evidence for the existence of a disconformity involving a significant hiatus between the Brightseat and Aquia, and he calculated its absolute time duration to be ~ 3.6 Ma. A more recent estimate for the duration of this break, made on the basis of diagnostic NP3 and NP5 calcareous nannofossil occurrences in the Brightseat and Aquia, respectively, places the hiatus at only ~3 Ma (Self-Trail et al., 2023b).

Biostratigraphy

The earliest attempt to define the age of the Brightseat was made by Julia Gardner of the U. S. Geological Survey (USGS) in an unpublished preliminary study of macrofossils (primarily mollusks) recovered from the type section and given to R. R. Bennett and G. G. Collins in preparation for their 1952 publication on the unit (see Appendix). Gardner noted that several Brightseat forms, including certain bivalves and the ringiculid gastropod *Gilbertina texana* Gardner, 1935, are the same as, or very close to, forms characteristic of Midwayan (Paleocene) age sediments in the Gulf Coastal Plain. Based on these observations, Gardner (see Appendix) concluded that what was later called the Brightseat Formation "probably represents a northern phase of the Paleocene." Since Gardner's preliminary study, a number of analyses of various microfaunal and microfloral groups preserved in the formation have appeared that form the basis for more precisely defining the position of the unit within the Paleocene. Using planktic foraminifers, Loeblich and Tappan (1957a,b) demonstrated the Paleocene age of both the Brightseat and the Aquia. They placed the Brightseat in their *Globigerinoides daubjergensis-Globorotalia compressa* Zone, which they regarded as defining the lower Paleocene Danian Stage (s.l. = Danian Stage s.s. + Montian Stage s.s. of other workers). Page (1959) and Nogan (1964) both adopted Loeblich and Tappan's zonal and age assignment, and Page provided additional information concerning the regional and intercontinental correlation of the Brightseat. Berggren (1965a,b) showed that the lower part of the *Globigerinoides daubjergensis-Globorotalia compressa* Zone is equivalent to his *Globigerina* (= *Globoconusa*) *daubjergensis-Globorotalia* (= *Subbotina*) *trinidadensis* Zone, which he equated with the lower half of the Danian (s.l. = Danian s.s.). Berggren (1965b) and later Hazel (1969) each placed the Brightseat in the upper part of the *Globigerinoides daubjergensis-Globorotalia trinidadensis* Zone.

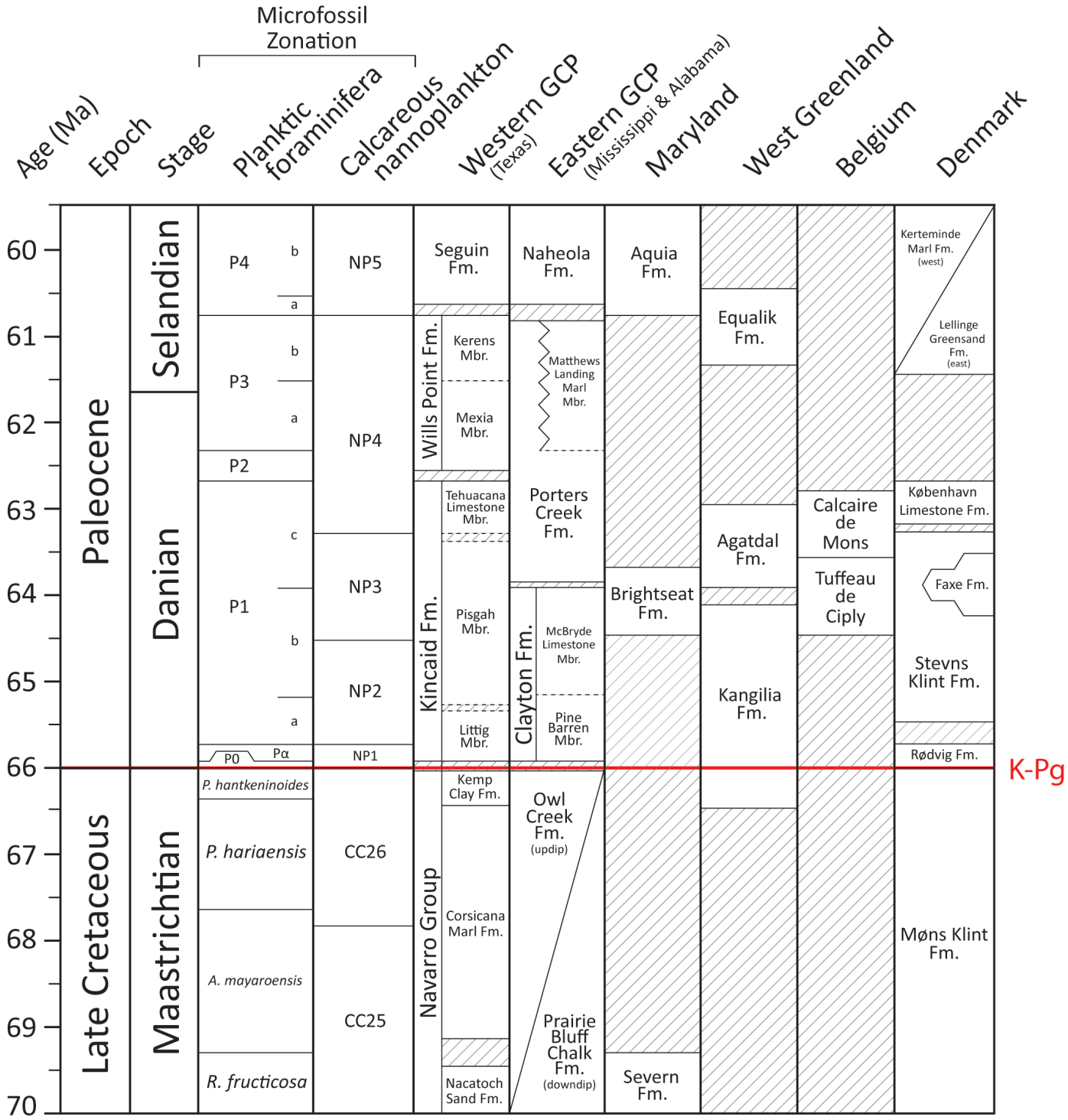
The calcareous nannofossil assemblage of the Brightseat is characteristic of the *Chiasmolithus danicus* NP3 Zone of Martini (1971) and the CNP3 Zone of Agnini et al. (2014), placing it within the middle Danian Stage (Hazel et al., 1984; Bybell and Gibson, 1991; Bybell et al., 2021; Self-Trail et al., 2022, 2023a,b). The lack of the upper NP3 species *Prinsius martinii* (Perch-Nielson, 1969) in the principal Brightseat reference section at Cabin Branch further constrains the age of the formation in the immediate study area to the lower-middle NP3 Zone and suggests a sedimentation duration of < 0.7 Ma, between 64.32 and 63.62 Ma (Self-Trail et al., 2023b).

Although planktic foraminiferal and calcareous nannofossils have together provided the most refined biostratigraphic information, analyses of other microfossil groups have also confirmed the Paleocene age of the Brightseat. Using ostracods, Hazel (1968)—and later Self-Trail et al. (2023b)—demonstrated a lower Paleocene age of the formation and suggested that it was correlative with the middle and upper parts of the Kincaid and Clayton formations in the Gulf Coastal Plain. Benson (1975) and Whitney (1976) each showed that the dinoflagellate and acritarch assemblage is indicative of a Paleocene age but were unable to place the unit more precisely within the epoch. May (1980) found an assemblage nearly identical to that reported earlier by Benson (1975) from Round Bay and noted that it showed strong similarity to a Danian age assemblage recovered from the subsurface in South Carolina. Brenner (1974: 67) identified an acritarch and pollen assemblage recovered from the lower part of the Brightseat in a core taken near Annapolis, Maryland, which he determined to be of the "Paleocene-Danian" age.

Correlation

The Brightseat Formation is correlative, in the eastern Gulf Coastal Plain, with the McBryde Limestone Member of the Clayton Formation (NP3, P1b) and the lower Porters Creek Formation (NP3/4, P1c) on the basis of shared calcareous nannoplankton [*Chiasmolithus danicus* (Brotzen, 1959)] and planktic foraminiferal [*Globorotalia compressa* (Plummer, 1927), *Globorotalia pseudobulloides* (Plummer, 1927), and *Globigerinoides daubjergensis* (Brönnimann, 1953)] zonal taxa (Loeblich and Tappan, 1957b; Mancini, 1984; Siesser, 1984) (Text-fig. 3). In the western Gulf Coastal Plain, it is correlative with the Pisgah and Tehuacana Limestone members of the Kincaid Formation (P1b/c) based on shared planktic foraminifers *Globigerinoides daubjergensis* and *Globorotalia pseudobulloides* (Loeblich and Tappan, 1957b; Brown and Loucks, 2009; Garvie, 2021).

Around the periphery of the North Atlantic Ocean Basin, in the central Nuussuaq area of West Greenland, the Brightseat is correlative with the upper Kangilia Formation (NP3) and Agatdal Formation (NP3, *Chiasmolithus danicus* coccolith assemblage; P1c, *Globigerinoides daubjergensis* and



Text-fig. 3. Generalized correlation chart showing selected Upper Cretaceous and Paleocene stratigraphic units preserved in the North American Coastal Plain and around the North Atlantic Ocean basin margin. Chronostratigraphy based on the time scale of Gradstein et al. (2020), calcareous nannofossil zonation based on Martini (1971) and Sissingh (1977), and planktonic foraminiferal zonation from Coccioni and Premoli Silva (2015) and Berggren and Miller (1988). Data on the lithostratigraphic and biostratigraphic correlation of the units are derived from: Berggren (1965a), Gaskell (1991), Schulte et al. (2006), and Brown and Loucks (2009) on the western Gulf Coastal Plain; (*continued on next page*)

Globorotalia compressa planktic foraminiferal assemblage) (Dam et al., 2009). Farther east along the basin margin into northwestern Europe, the Brightseat is correlative with the NP3/4 Tuffeau de Ciply and Calcaire de Mons formations of the Mons Basin of Belgium, which contain indicative upper P1 planktic foraminiferal assemblages with *Globorotalia compressa*, *Globorotalia pseudobulloides*, *Globigerinoides daubjergensis*, and *Globigerina triloculinoides* (Plummer, 1927) (Loeblich and Tappan, 1957b; Moorkens, 1982). In eastern Denmark, the Brightseat is coeval with the upper Stevns Klint Formation and the laterally equivalent Faxe Formation, which represent coccolith zone NP3 (Lauridsen et al., 2012).

MATERIALS AND METHODS

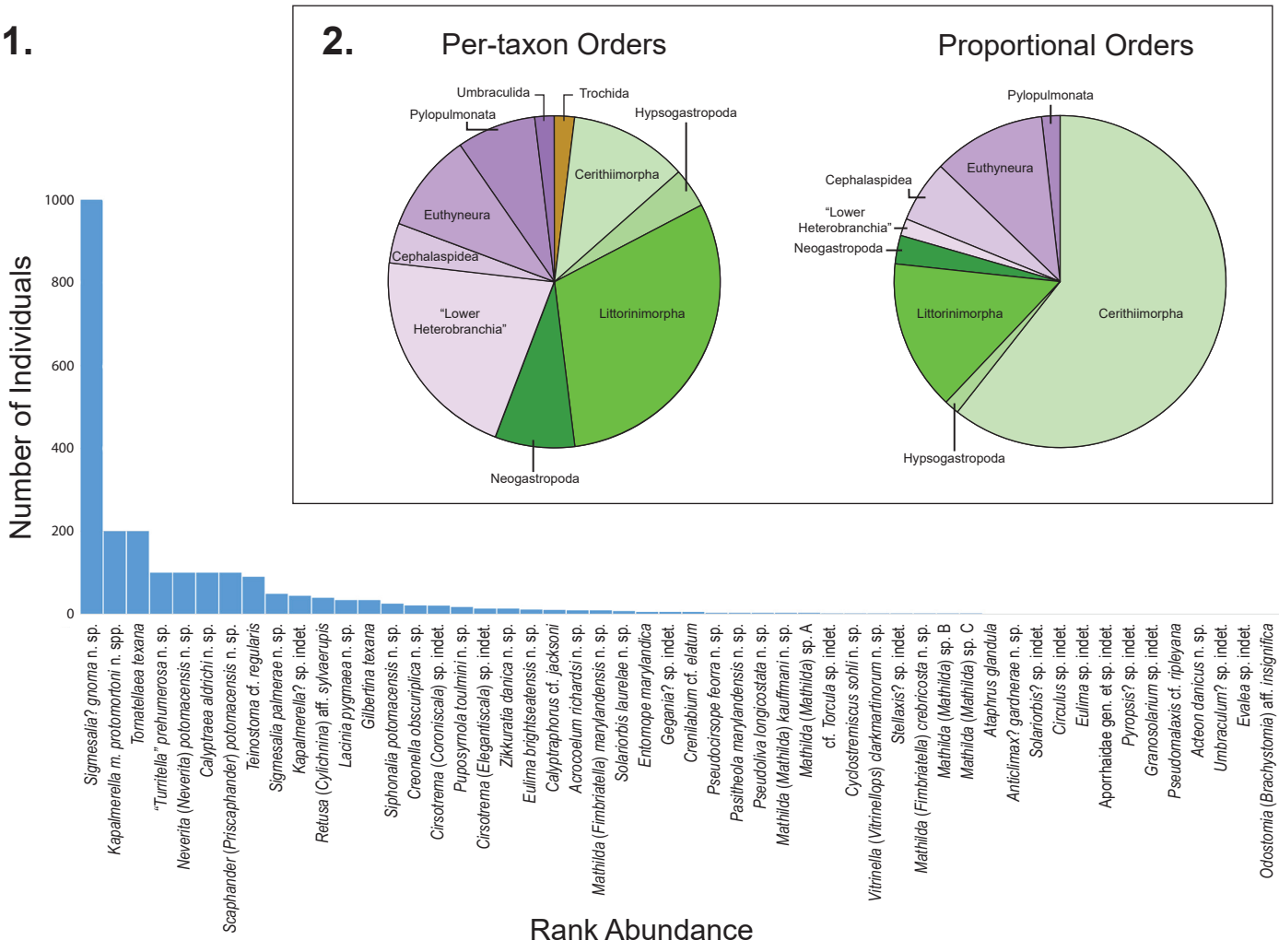
Material examined in this report was collected in the field in the 1970s and 1980s by the late Norman Sohl and Erle Kauffman, with the help of a number of their students from George Washington University as well as local amateur collectors. Sadly, the identity of most of these individuals has been lost to time. Govoni and L. Bybell were among the students involved and contributed some small portion of the usable molluscan material, however most of their fieldwork at the time was focused instead on the calcareous nannofossil biostratigraphy of the Brightseat and Aquia formations. At the point that Govoni began work on the gastropod fauna of the Brightseat, the material available was an amalgamation from numerous collectors over many years, housed in the National Museum of Natural History in Washington, D. C. (NMNH/USNM) in both "bulk sample" and "prepared" form, with prior collection and preparation effort unattributable to any individual worker.

Govoni prepared the bulk of the gastropod material for analysis through both wet and dry preparation. Bulk samples of Brightseat material were originally washed and sieved, however, given the fragile nature of the molluscan shells preserved in the Brightseat, the wet sieving technique was found to result in much breakage of larger shells while preferentially preserving "microgastropods" in the 1–10 mm range. Subsequent preparation techniques included the splitting of large blocks of matrix into smaller pieces and then careful separation of shells from the matrix using a needle and water. Small specimens were placed in a sputter coater and covered in platinum before imaging by an unnamed technician under scanning electron microscopy (SEM) at the USGS and NMNH in the 1980s. Govoni measured specimens using Helios dial calipers, a protractor, and a ruler, with the aid of a binocular microscope. This work—a systematic description of the Brightseat gastropod fauna and an explanation of its biogeographic significance—would become his 1983 Master's thesis (Govoni, 1983) at George Washington University, under the supervision of the late Anthony Coates and Norman Sohl.

Allmon used Govoni's (1983) thesis in his study of the Paleogene turritellid gastropods of the Gulf and Atlantic Coastal Plains (Allmon, 1988, 1996). A portion of the thesis manuscript, focused on the "archaeogastropod" and "mesogastropod" faunas, was revised in the 1990s by Hansen, and again in the 2000s by Allmon, but was never published. In 2021, Crowley took over the project when using the Brightseat turritellid taxa in her own research on the Coastal Plain turritellids spanning the Cretaceous-Paleogene boundary. Govoni's thesis specimens were rediscovered in the collections of the NMNH and accessioned. Approximately half of the specimens were reimaged: larger specimens were photographed using a Canon EOS 5D Mark II camera at the NMNH in 2022, and SEM stubs were coated in gold and imaged in the JEOL JCM-5000 NeoScope SEM at the Paleontological Research Institution (PRI) in 2024. At the same time, Govoni, Jean Self-Trail, and Laurel Bybell, with others of the USGS, refocused efforts on Atlantic Coastal Plain stratigraphy (including the Brightseat Formation) through the Atlantic Subsurface Stratigraphic Initiative (ASSI), during which new Brightseat outcrops were located to reference against the now-inaccessible original localities. The paper presented here builds on Govoni's thesis, with significant taxonomic, biostratigraphic, and biogeographic faunal revisions stemming from four decades of further scientific progress.

Measurements of selected specimens are provided in Table 4. Specimens for which measurements are given include primary types (all holotypes and selected paratypes), all figured specimens, and, where desirable and practical to illustrate intraspecific variability, additional better-preserved specimens. When possible, only the best preserved and most complete specimens were chosen for measurement. Because many taxa are represented by slightly to severely damaged specimens, however, it has sometimes been necessary to provide certain dimensions "as preserved." In these cases, no attempt was made to estimate true (original) dimensions and the nature and extent of the damage affecting particular measurements is noted. Linear measurements were made using vernier cali-

(*continued from previous page*) Siesser (1984), Mancini (1984), and Dockery (1996) on the eastern Gulf Coastal Plain; Self-Trail et al. (2023b) on the western Chesapeake Bay region of Maryland; Dam et al. (2009) on central Nuussauq, West Greenland; Schnetler (2001), Surlyk et al. (2006), Lauridsen et al. (2012), and Surlyk et al. (2013) on the eastern Danish Basin; and Moorkens (1982) on the Mons Basin of Belgium. Taxa not otherwise mentioned in the text are *Plummerita hantkeninoides* (Brönnimann, 1952), *Pseudoguembelina hariensis* Nederbragt, 1991, *Abathomphalus mayaroensis* (Bolli, 1951), and *Racemiguembelina fructicosa* (Egger, 1899).

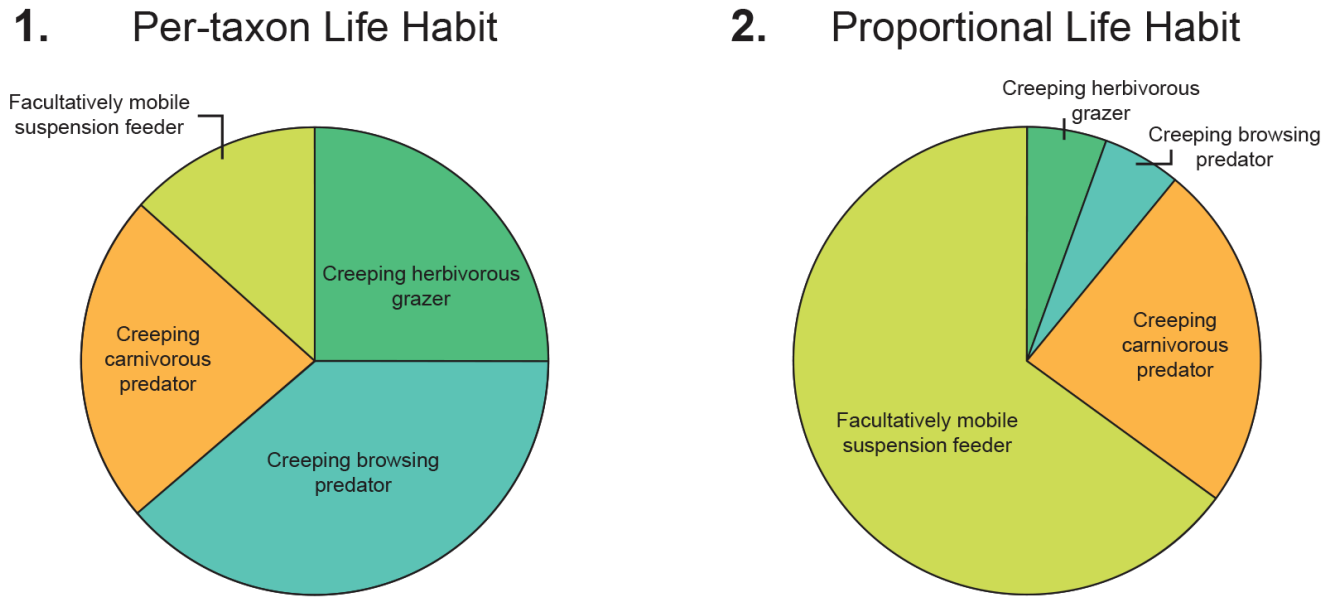


Text-fig. 4. Specimen abundance and taxonomic richness of gastropod taxa found in the Brightseat. (**1**) Rank abundance and individual counts for all recovered species. Taxa with > 100 individuals recorded to the nearest hundred. (**2**) Taxonomic distribution of the Brightseat gastropods depicting their per-taxon composition by order as well as the proportional abundance of taxonomic orders within the assemblage. Orders with summed abundance counts of < 1% of the total assemblage not shown in the pie chart.

pers for larger specimens and a microscope equipped with a calibrated eyepiece for small individuals. All linear measurements are given in millimeters. Angular measurements were taken from photographs of the measured specimens.

For ecological analysis, Brightseat gastropod taxa were classified by adult life mode using the same coding conventions for tiering, mobility, and feeding as described by Sessa et al. (2012), with additional references to the Paleobiology Database (PBDB; https://paleobiodb.org/#/) and the Neogene Marine Biota of Tropical America database (NMITA; https://nmita.rsmas.miami.edu/) (accessed July 2024) for genera not mentioned in that text (see Sessa et al., 2012: supplement pp. 8–21). Ecological composition was assessed in terms of both species richness ("per-taxon" life habit) as well as by proportional abundance among individuals in the assemblage as a whole ("proportional" life habit) (Text-fig. 5). Taxonomic composition was likewise assessed in terms of both species-level taxonomic richness per order ("per-taxon" orders) and proportional abundance by order among all individuals in the assemblage ("proportional" orders) (Text-fig. 4). Ecological comparisons between the Brightseat and other faunas were made using only proportional abundances (Text-fig. 6).

The generic and subgeneric composition of faunas on the margin of the North Atlantic Ocean basin was compiled using verified occurrences from monographic studies, direct ex-



Text-fig. 5. Ecological composition of gastropod taxa found in the Brightseat. (**1**) Per-taxon autecological richness by life habit (Table 3). (**2**) Proportional distribution of life habits within the assemblage.

amination of fossil material in comparable North American units, and comparison with published descriptions and figures for West Greenland and northwestern European faunas (Table 1). For older monographs especially, taxonomic assignments were verified against their currently understood assignments in PBDB and the World Register of Marine Species (WoRMS; https://www.marinespecies.org/) (accessed July 2024). In some cases, occurrence data derived from units of similar age and lithology in the same region have been merged in our analysis, including when there is insufficient information available to allow more precise subdivision of the published occurrence data (e.g., Calcaire de Mons merged with Tuffeau de Ciply in Belgium). To evaluate the extent to which local ecological conditions (e.g., depth, substrate and stability, turbulence, etc.) might have influenced the local occurrence or relative abundance of certain taxa—independent of regional factors controlling the development of provincial-level biogeographic systems (e.g., physical barriers to migration, availability of currents for long-range larval dispersal, latitudinal temperature gradients, etc.)—spatiotemporal faunas are broadly classified by lithology (carbonate-dominated or siliciclastic-dominated) and environment of deposition (primarily water depth).

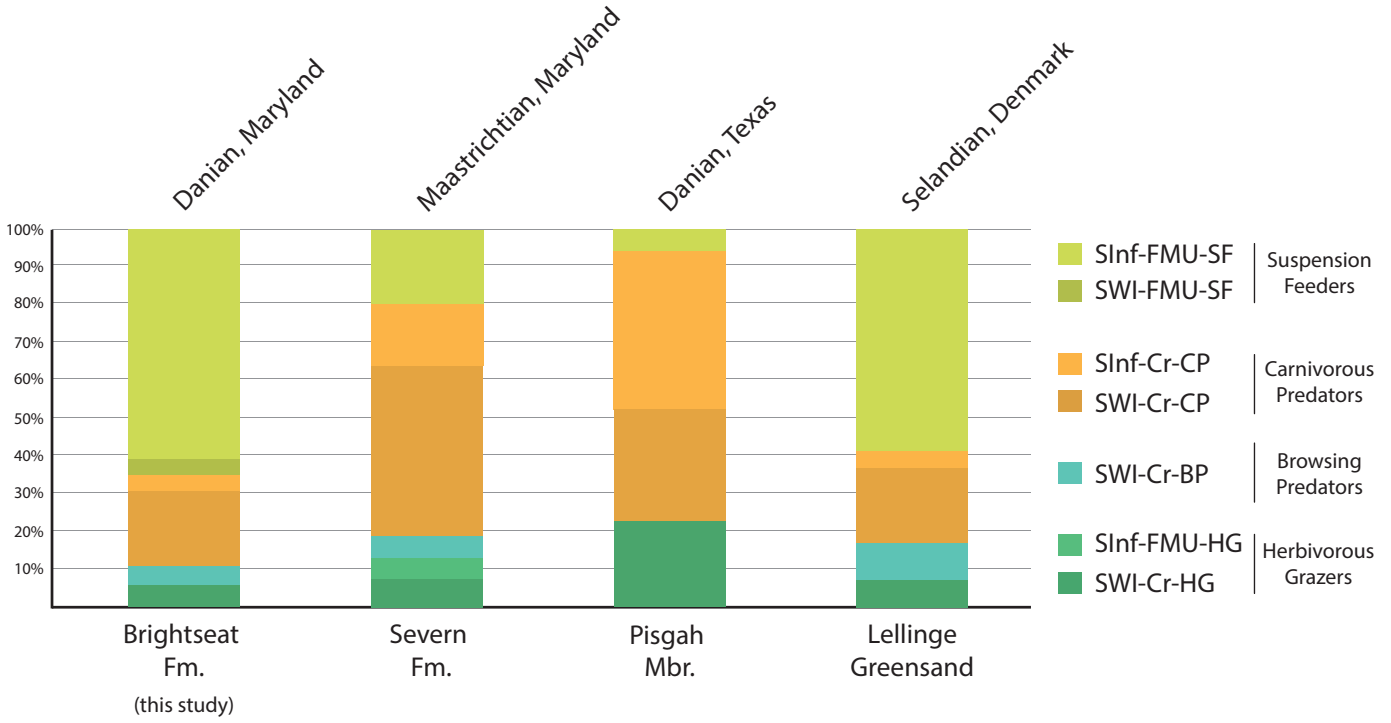
Localities

The following descriptions of sample collection localities in the Brightseat Formation are based primarily upon data provided by the late Erle Kauffman in the early 1980s. In most cases, bulk samples were collected by several people so that some sample intervals overlap; each sample is given a separate number (Table 2). Because the original collection localities are no longer accessible, it is impossible to precisely indicate where these samples were collected on the new composite Brightseat stratigraphic column (Self-Trail et al., 2023b; see Text-fig. 2). However, the relative spacing of the collection horizons is accurate and permits relative positioning on Brightseat outcrops in the local area. Localities are mapped in Text-fig. 1.3.

Locality A—[No longer exposed] South bluff of Southwest Branch, on the western branch of the Patuxent River, 0.19−0.29 km due west of Interstate Route 95 (Capital Beltway). Coordinates (38.887297°N, −76.84965°W). This was the original type locality ("Locality A") of Bennett and Collins (1952), now destroyed by urban development.

Locality B—[No longer exposed] Banks and stream bed of unnamed intermittent tributary to Cattail Branch, 0.43 km due south of Sheriff Road. Coordinates (38.910603°N, −76.866439°W). This was "Locality B" of Bennett and Collins (1952) and locality HL12 of Hazel (1968), now destroyed by urban development.

Locality C—Banks and stream bed along a 91.4 m stretch of an unnamed tributary to Cabin Branch, 0.93 km due south of Central Avenue. Coordinates (38.878789°N, −76.886536°W). This is "Cabin Creek" of Self-Trail et al. (2023a,b) and serves as the supplementary reference section for the new composite stratotype section for the Brightseat



Text-fig. 6. Proportional ecological composition of gastropod taxa found in the Brightseat, compared to other assemblages proximal in time and space. Life habit codes and assignment method as in Table 3; ecological guilds with < 1% proportional abundance not represented in the chart. Far left, ecological guild distribution within Brightseat gastropods. Second from left, ecological guild distribution within the Late Cretaceous Severn Formation gastropods of the *Haustator bilira* zone in Maryland, compiled from occurrences of Sohl and Koch (1987). Third from left, ecological guild distribution within the early Danian Pisgah Member gastropods of the Brazos River, Texas, compiled from Hansen et al. (1993, samples 22–32), which roughly equate to the age of the Brightseat. Fourth from left, ecological guild distribution within the Selandian Lellinge Greensand Formation gastropods, compiled from Schnetler (2001, composite of samples 1a/b through 4).

Formation. It has also been referred to as "Cappy Avenue" in prior literature (e.g., Self-Trail et al., 2022, 2023a).

GASTROPOD FAUNA AND PALEOECOLOGY

General Composition and Abundance

The gastropod fauna of the Brightseat Formation consists of 52 taxa assignable to 41 genera distributed among 25 families. Of these taxa, roughly one-half (25) are assigned to new species, one-third (16) are assigned only to genus or subgenus, and the remaining one-fifth (11) are assigned or compared to previously described species. One fragmental specimen could only be assigned to family. The rank distribution of species exhibits a fairly rapid decline; a few species occur in abundance, but most are known from only a handful of specimens and 13 taxa are known from only a single individual (Text-fig. 4.1, Table 3). Gastropods of the orders Cerithiimorpha, Littorinimorpha, and "Lower Heterobranchia" are the most taxonomically diverse, but in proportional abundance the assemblage is dominated by Cerithiimorpha (61%) with secondary contributions by Littorinimorpha (15%) and Euthyneura (11%) (Text-fig. 4.2). The most common taxon by a wide margin is *Sigmesalia*? *gnoma* n. sp., and indeed five of the top ten most abundant taxa are similarly members of the family Turritellidae.

The numerical dominance of the Turritellidae in the Brightseat is somewhat reminiscent of other turritelline-rich or turritelline-dominated assemblages (TDAs) in middle to lower shoreface and inner shelf soft-substrate deposits. Such assemblages in which turritellids are the dominant, or at least a significant, element of the molluscan macrofauna are well documented in mid-Cretaceous through Cenozoic shallow marine settings (Allmon and Knight, 1993; Allmon, 2007, 2011). TDAs in modern oceans are frequently indicative of relatively high primary productivity and nutrients (often at sites of oceanic upwelling) as well as relatively cooler water temperatures (Allmon, 2007, 2011). Although the abundant turritellids in the Brightseat are not as densely packed as the

individual shells in most TDAs, they might likewise reflect the cooler-water affinity of the fauna and sufficient productivity and oxygen to support a healthy population. The small size of the most abundant Brightseat turritellid, *Sigmesalia? gnoma* n. sp., is also unusual for the family. Interestingly, Schnetler (2001) reported that a similarly minute turritellid, *Turritella nana* von Koenen, 1885, of average length < 5.3 mm, from the Selandian–Thanetian Lellinge Greensand Formation of Copenhagen, Denmark, is the most abundant taxon in those collections and at times comprises > 60% of the assemblage. Very small (< 5 mm) turritellids have been reported by only a few other authors (e.g., Garrard, 1972, on several Recent species from deep waters off Australia), and their environmental significance in these two Paleocene formations on either side of the North Atlantic remains unclear.

Faunal ecology

Creeping predators and grazers are the most taxonomically diverse in the assemblage and cumulatively represent 86% of the species in the community (Text-fig. 5.1). However, in proportional abundance, the assemblage is dominated by facultatively mobile suspension feeders (i.e., turritellids and *Calyptraea aldrichi* n. sp.), which represent 65% of the individuals in the community, with secondary contribution by carnivorous predators (24%). Browsing predators and herbivorous grazers each represent ~ 5% of the community in abundance (Text-fig. 5.2).

The proportional dominance of suspension feeders and comparative paucity of predators in the Brightseat gastropods is unusual both for this region (Maryland) at adjacent time intervals as well as contemporaneous shelf deposits elsewhere in the U. S. Coastal Plain (Text-fig. 6). The abundance of gastropod ecological guilds in the underlying Severn Formation, as compiled from Maryland occurrence data from the uppermost Maastrichtian *Haustator bilira* Zone by Sohl and Koch (1987), reflects a Late Cretaceous fauna comprised of > 60% carnivorous predators with only 20% suspension feeding species and < 20% grazers and browsers. Likewise, the gastropod component of the Danian fauna analyzed by Hansen et al. (1993) from the Pisgah Member of the Kincaid Formation on the Brazos River, Texas, is comprised of 71% predators, 23% grazers, and only 5% suspension feeders. Compared to these sites, the Brightseat has 3–12 times as many suspension feeding gastropods. Even when the single most abundant taxon, *Sigmesalia? gnoma* n. sp., is removed from the analysis of the Brightseat, the proportion of suspension feeding species remains 15–25% higher than those of other Upper Cretaceous and Paleocene Coastal Plain faunas. Until bulk analysis of the bivalves of the Brightseat has been performed, it is unclear whether the composite molluscan fauna will share this same pattern, or if the phenomenon is isolated in the gastropods (in this case, predominantly the turritellids).

The Brightseat fauna does, however, mirror well the ecological composition of the gastropods of the slightly younger (~ 61–59 Ma) Lellinge Greensand Formation near Copenhagen, Denmark. Both contain ~ 60% suspension feeding species, 25% predators, and lesser percentages of browsers and grazers. Described by Schnetler (2001), this Selandian fauna, which includes large quantities of *Turritella nana*, was reconstructed as inhabiting a well-oxygenated transgressing sea shelf with moderate energy but limited transport (i.e., the abundance of *T. nana* is believed to be largely autochthonous, at least in the facies where it is most abundant). Previous studies (e.g., Andrews, 1971; Beauchamp, 1984) have investigated the community structure and paleoecological significance of turritellids within transgressive-regressive sea-level cycles in the Aquia Formation of Maryland, but this analysis has not been extended to the Brightseat. Thus, it is impossible to know if the similarities in ecological composition between the Brightseat and the Lellinge Greensand are a reflection of shared environmental factors and a homologous phase of sea-level rise, or something else entirely.

BIOGEOGRAPHIC IMPLICATIONS

Faunal Affinities

By virtue of its moderately high diversity and particularly its geographic position, the gastropod fauna of the Brightseat Formation is well suited for transatlantic faunal comparison. Its location at the northern and eastern end of the North American Atlantic Coastal Plain places it in an intermediate geographic position with respect to faunas of similar age in the Gulf Coastal Plain of North America, in West Greenland, and in northwestern Europe. Precise biogeographic analysis of the fauna is nevertheless hampered to a certain extent by the highly endemic character of the Brightseat taxa: 25 of the 52 species or forms are formally assigned to new species, and some additional proportion of the 22 compared and unnamed forms could also represent new species, although they are too poorly represented in the present collections to warrant the establishment of new species. This apparent endemism is exaggerated by the fact that many of these forms belong to rare, small, fragile, or poorly understood families (e.g., Vitrinellidae, Mathildidae, Eulimidae, and Pyramidellidae) that, for reasons of nonpreservation, collection failure, or confused nomenclature, might have been unrepresented or overlooked in other collections. Thus, the endemic nature of the Brightseat fauna is not necessarily due only to the effects of any unique isolating factors.

In overall generic and subgeneric composition, the Brightseat gastropod fauna shows a greater resemblance to deposits of similar age in the east and northeast (West Greenland, Belgium, Denmark) than it does deposits in the

Table 1. Occurrence of selected genera and subgenera of gastropods in deposits of Danian to lower Selandian age around the margin of the North Atlantic Ocean Basin. A "dot" denotes a confirmed occurrence; "?" denotes a questionable occurrence. Aporrhaids are omitted from consideration due to inability to assign the Brightseat specimen to a specific genus. When a particular subgenus is represented in the Brightseat fauna, occurrences in other units of the genus to which it belongs are not indicated unless the same subgenus is represented in those units. Thus, for example, the occurrence of *Tornatellaea* in the Danian of West Greenland and Denmark and the Selandian of Denmark is not indicated because the species preserved in those units belong to the subgenus *Ravniella*. Occurrence data derived and modified from: Foster et al. (2020), Gardner (1935), Garvie (2021), Glibert (1973), Hansen et al. (1993), von Koenen (1885), Kollmann and Peel (1983), Lauridsen and Schnetler (2014), Palmer and Brann (1966), Ravn (1902, 1933, 1939), Rosencrantz (1960, 1970), Schnetler (2001), Toulmin (1977), Villatte (1977), and Vincent (1930).

Age	**Early to Middle Danian**	**Late Danian**	**Early to Middle Danian**	**Late Danian to Early Selandian**	**Middle Danian**	**Early to Middle Danian**	**Middle Danian**	**Early to Middle Danian**	**Selandian**
Strata	**Kincaid Fm (Littig and Pisgah mbrs) [Texas]**	**Kincaid Fm (Tehuacana Limestone Mbr) [Texas]**	**Clayton Fm [Mississippi, Alabama, Georgia, Tennessee]**	**Porters Creek Fm and Matthews Landing Marl Mbr [Mississippi, Alabama, Georgia, Tennessee]**	**Brightseat Fm [Maryland]**	**Kangilia and Agatdal fms [West Greenland]**	**Calcaire de Mons and Tuffeau de Ciply fms [Belgium]**	**Stevns Klint and Faxe fms [Denmark]**	**Lellinge Greensand Fm [Denmark]**
Predominant Lithology	**Siliciclastic**	**Carbonate**	**Carbonate**	**Siliciclastic**	**Siliciclastic**	**Siliciclastic**	**Carbonate**	**Carbonate**	**Siliciclastic**
Depositional Environment	**Shallow shelf marine (~ 90 m)**	**Outer shelf marine (200+ m) to shallow shelf hardground**	**Very shallow to shallow shelf marine (20–90 m)**	**Very shallow to shallow shelf marine (20–90 m)**	**Middle shelf marine (120–140 m)**	**Very shallow to middle shelf marine**	**Very shallow to middle shelf marine**	**Middle shelf marine (80–150 m) and cold-water coral mound (200–400 m)**	**Middle to outer shelf marine**
References	**Gardner, 1935; Hansen et al., 1993**	**Kellough, 1959; Garvie, 2021**	**Palmer and Brann, 1966; Toulmin, 1977**	**Palmer and Brann, 1966; Toulmin, 1977; Foster et al., 2020**	**This study**	**Rosenkrantz, 1970; Kollman and Peel, 1983**	**Vincent, 1930; Glibert, 1973; Villatte, 1977**	**Rosenkrantz, 1960; Lauridsen and Schnetler 2014**	**von Koenen, 1985; Ravn, 1939; Schnetler, 2001**
Ataphrus					●	●			
Kapalmerella	●	●	●	●	●	?			
"*Turritella*"	●	●	●	●	●	●	●		●
Torcula					?				
Sigmesalia			?		●		●		
Cirsotrema (*Elegantiscala*)					●				
Cirsotrema (*Coroniscala*)					●		●		
Neverita (*Neverita*)				●	●				
Entomope					●	●	●		●
Pseudocirsope		?			●	●			●
Pasitheola					●				

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Table 1 (*continued from previous page*).

Teinostoma	●	●			●	●		●	●
Anticlimax					?		●		
Cyclostremiscus					●				
Solariorbis	●	●			●				
Circulus					●	●	●	?	?
Vitrinella (*Vitrinellops*)		?			●				
Eulima					●		●		
Calyptraea	●	●	●	?	●	●	●		●
Calyptraphorous	●	●	●	●	●		●		
Lacinia					●				
Siphonalia				●	●	●			●
Pyropsis					?				
Pseudoliva	●	●	●	●	●	●	●		●
Granosolarium				●	●				●
Pseudomalaxis					●	●		●	●
Stellaxis	?				?				
Acrocoelum		?			●	●		●	●
Mathilda (*Fimbriatella*)					●	●		●	●
Mathilda (*Mathilda*)		●			●	●	●	●	●
Gegania		●			?	●	●	●	
Acteon		●			●	●	●	●	●
Crenilabium					●	●			●
Tornatellaea	●	●	●	●	●		●		
Zikkuratia					●	?			
Gilbertina	●	●		●	●	●	●		●
Umbraculum					?				
Retusa (*Cylichnina*)	?	●		●	●				?
Scaphander (*Priscaphander*)					●				
Evalea					●				
Odostomia (*Brachystomia*)	?				●			?	?
Creonella	●	●			●	●			
Puposyrnola		●			●	●	●	●	
In common	**13**	**18**	**7**	**11**	**--**	**21**	**16**	**11**	**18**
Percent	**30%**	**42%**	**16%**	**26%**	**--**	**49%**	**37%**	**26%**	**42%**

Table 2. Bulk sample collection horizons for Brightseat material recovered by the late Erle Kauffman and his students. Some sample horizons overlap, but each is given its own sample number. See Text-fig. 1.3 for locality sites.

Sample	Locality	Stratigraphic Position
A-10	A	Shell band 11 ft. (3.4 m) above the base of the Brightseat Fm.
A-9	A	Shell bed 9 ft. (2.7 m) above the base of the Brightseat Fm.
A-8	A	Blocks from 6−8 ft. (1.8−2.4 m) above the base of the Brightseat Fm.
A-7	A	Blocks from 6 ft. (1.8 m) above the base of the Brightseat Fm.
A-6	A	Blocks from 4−6 ft. (1.2−1.8 m) above the base of the Brightseat Fm.
A-5	A	Blocks from 3−5 ft. (0.9−1.5 m) above the base of the Brightseat Fm.
A-4	A	Blocks from 2−4 ft. (0.6−1.2 m) above the base of the Brightseat Fm.
A-3	A	Blocks from 2−3 ft. (0.6−0.9 m) above the base of the Brightseat Fm.
A-2	A	Blocks from 2 ft. (0.6 m) above the base of the Brightseat Fm.
A-1	A	Blocks from 0−3 ft. (0−0.9 m) above the base of the Brightseat Fm.
B-2	B	Blocks from 0.5−1 ft. (0.2−0.3 m) below the top of the Brightseat Fm.
B-1	B	Blocks from 2.5−3 ft. (0.8−0.9 m) below the top of the Brightseat Fm.
C-1	C	Blocks from 7−8 ft. (2.1−2.4 m) below the top of the Brightseat Fm.

Table 3. Sample abundance and autecological life habit of gastropod taxa from the Brightseat. Taxa with > 100 individuals are recorded to the nearest hundred. Ecological codes used are those of Sessa et al. (2012) and abbreviated as follows: BP = browsing predators; CP = carnivorous predators; Cr = creeping; FMU = facultatively mobile unattached; HG = herbivorous grazing; SF = suspension feeding; SInf = semi-infaunal; SWI = sediment-water interface.

Order	Superfamily	Family	Species	Count	Life Habit
Trochida	Trochoidea	Ataphridae	*Ataphrus glandula* (Conrad, 1830)	1	SWI-Cr-HG
Cerithiimorpha	Cerithioidea	Turritellidae	*Kapalmerella mortoni protomortoni* n. ssp.	200+	SInf-FMU-SF
Cerithiimorpha	Cerithioidea	Turritellidae	*Kapalmerella*? sp.	44	SInf-FMU-SF
Cerithiimorpha	Cerithioidea	Turritellidae	"*Turritella*" *prehumerosa* n. sp.	100+	SInf-FMU-SF
Cerithiimorpha	Cerithioidea	Turritellidae	cf. *Torcula* sp. indet.	2	SInf-FMU-SF
Cerithiimorpha	Cerithioidea	Turritellidae	*Sigmesalia palmerae* n. sp.	49	SInf-FMU-SF
Cerithiimorpha	Cerithioidea	Turritellidae	*Sigmesalia*? *gnoma* n. sp.	1,000+	SInf-FMU-SF
Hypsogastropoda	Epitonioidea	Epitoniidae	*Cirsotrema* (*Elegantiscala*) sp. indet.	13	SWI-Cr-BP
Hypsogastropoda	Epitonioidea	Epitoniidae	*Cirsotrema* (*Coroniscala*) sp. indet.	20	SWI-Cr-BP
Littorinimorpha	Naticoidea	Naticidae	*Neverita* (*Neverita*) *potomacensis* n. sp.	100+	SInf-Cr-CP
Littorinimorpha	Truncatelloidea	Elachisinidae	*Entomope marylandica* (Clark and Martin, 1901)	5	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Elachisinidae	*Pseudocirsope feorra* n. sp.	3	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Iravadiidae	*Pasitheola marylandensis* n. sp.	3	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Teinostomatidae	*Teinostoma* cf. *regularis* Garvie, 2021	90	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Tornidae	*Anticlimax*? *gardnerae* n. sp.	1	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Tornidae	*Cyclostremiscus sohli* n. sp.	2	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Tornidae	*Solariorbis laurelae* n. sp.	7	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Tornidae	*Solariorbis*? sp. indet.	1	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Vitrinellidae	*Circulus* sp. indet.	1	SWI-Cr-HG
Littorinimorpha	Truncatelloidea	Vitrinellidae	*Vitrinella* (*Vitrinelllops*) *clarkmartinorum* n. sp.	2	SWI-Cr-HG
Littorinimorpha	Vanikoroidea	Eulimidae	*Eulima brightseatensis* n. sp.	11	SWI-Cr-BP
Littorinimorpha	Vanikoroidea	Eulimidae	*Eulima* sp. indet	1	SWI-Cr-BP
Littorinimorpha	Calyptraeoidea	Calyptraeidae	*Calyptraea aldrichi* n. sp.	100+	SWI-FMU-SF

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Table 3 (*continued from previous page*).

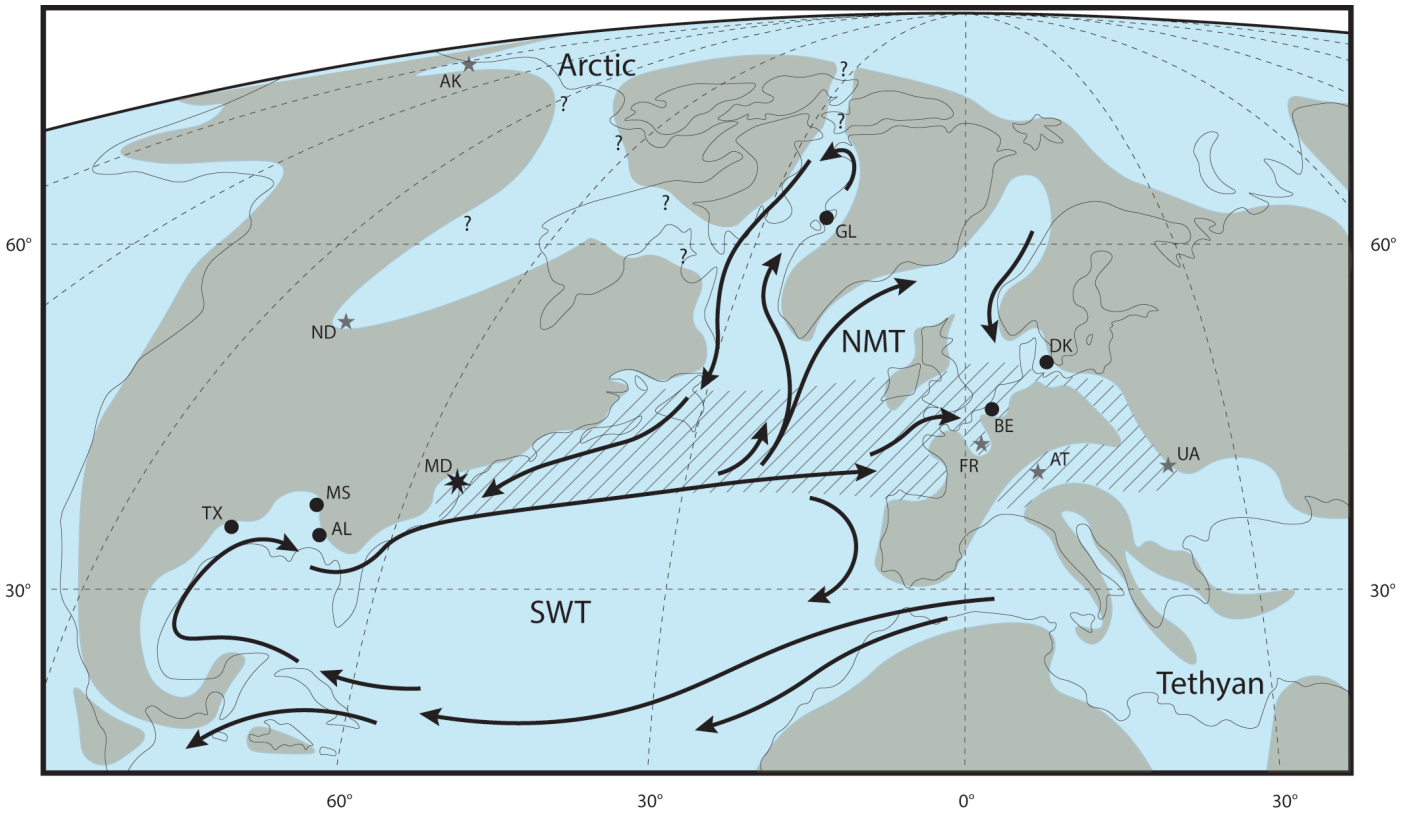
Order	Superfamily	Family	Species	Count	Life Habit
Littorinimorpha	Stromboidea	Aporrhaidae	Aporrhaidae gen. and sp. indet.	1	SWI-Cr-HG
Littorinimorpha	Stromboidea	Rostellariidae	*Calyptraphorus* cf. *jacksoni* Clark, 1896	10	SWI-Cr-HG
Neogastropoda	Buccinoidea	Buccinidae	*Lacinia pygmaea* n. sp.	34	SWI-Cr-CP
Neogastropoda	Buccinoidea	Buccinidae	*Siphonalia potomacensis* n. sp.	25	SWI-Cr-CP
Neogastropoda	Turbinelloidea	Turbinellidae	*Pyropsis*? sp. indet.	1	SWI-Cr-CP
Neogastropoda	Olivoidea	Pseudolividae	*Pseudoliva longicostata* n. sp.	3	SWI-Cr-CP
"Lower Heterobranchia"	Architectonicoidea	Architectonicidae	*Granosolarium* sp. indet.	1	SWI-Cr-BP
"Lower Heterobranchia"	Architectonicoidea	Architectonicidae	*Stellaxis*? sp. indet.	2	SWI-Cr-BP
"Lower Heterobranchia"	Architectonicoidea	Architectonicidae	*Pseudomalaxis* cf. *ripleyana* Wade, 1926	1	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Acrocoelum richardsi* n. sp.	9	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Fimbriatella*) *crebricosta* n. sp.	2	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Fimbriatella*) *marylandensis* n. sp.	9	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Mathilda*) *kauffmani* n. sp.	3	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Mathilda*) sp. A	3	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Mathilda*) sp. B	2	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Mathilda* (*Mathilda*) sp. C	2	SWI-Cr-BP
"Lower Heterobranchia"	Mathildoidea	Mathildidae	*Gegania*? sp. indet.	5	SWI-Cr-BP
Euthyneura	Acteonoidea	Acteonidae	*Acteon danicus* n. sp.	1	SWI-Cr-CP
Euthyneura	Acteonoidea	Acteonidae	*Crenilabium* cf. *elatum* (von Koenen, 1885)	5	SWI-Cr-CP
Euthyneura	Acteonoidea	Acteonidae	*Tornatellaea texana* Gardner, 1935	200+	SWI-Cr-CP
Euthyneura	Ringiculoidea	Cylichnidae	*Zikkuratia danica* n. sp.	13	SWI-Cr-CP
Euthyneura	Ringiculoidea	Ringiculidae	*Gilbertina texana* Gardner, 1935	34	SWI-Cr-CP
Umbraculida	Umbraculoidea	Umbraculidae	*Umbraculum*? sp. indet.	1	SWI-Cr-BP
Cephalaspidea	Bulloidea	Retusidae	*Retusa* (*Cylichnina*) aff. *sylvaerupis* (Harris, 1899)	39	SWI-Cr-CP
Cephalaspidea	Philinoidea	Scaphandridae	*Scaphander* (*Priscaphander*) *potomacensis* n. sp.	100+	SWI-Cr-CP
Pylopulmonata	Pyramidelloidea	Pyramidellidae	*Evalea* sp. indet.	1	SWI-Cr-BP
Pylopulmonata	Pyramidelloidea	Pyramidellidae	*Odostomia* (*Brachystomia*) aff. *insignifica* (Aldrich, 1897)	1	SWI-Cr-BP
Pylopulmonata	Pyramidelloidea	Pyramidellidae	*Creonella obscuriplica* n. sp.	21	SWI-Cr-BP
Pylopulmonata	Pyramidelloidea	Pyramidellidae	*Puposyrnola toulmini* n. sp.	17	SWI-Cr-BP

southwest (Texas, Mississippi, Alabama). It is most closely related to the Danian West Greenland fauna (49% genera/subgenera in common) and is also highly similar to the upper Danian Texas fauna and the Selandian Denmark fauna (each 42% in common). Of the 43 gastropod genera and subgenera in the Brightseat, 14 (32%) are widespread and found in both the Gulf and Atlantic regions, 4 (9%) are shared between the Brightseat and the Gulf region only, 12 (28%) are shared between the Brightseat and Atlantic region only, and 13 (30%) are unique to the Brightseat itself and not found in other roughly contemporaneous deposits analyzed here. The Brightseat material generally shows greater resemblance to faunas from similarly siliciclastic-dominated depositional environments (e.g., Agatdal Formation in Greenland and Lellinge Greensand in Denmark) but also shares relatively high affinity with the carbonate-dominated Tehuacana Limestone fauna of Texas. Analysis of regional patterns is to some extent impeded by preservational bias; in certain carbonate-dominated units, perhaps most profoundly in the Clayton Formation of the eastern Gulf and in the early Danian carbonate deposits of Denmark, aragonitic shells were selectively altered/destroyed in taphonomic processes that serve to reduce the diversity of forms preserved in those deposits. Thus, the faunal affinities described here are conservative estimates and partly reflect facies-controlled faunal relationships, not solely biogeographic provincial effects.

FAUNAL PROVINCES

The distribution of molluscan occurrences in early Paleocene time around the margin of the North Atlantic suggests the existence of two broadly overlapping, more or less latitudinally defined, amphiatlantic faunal realms (Text-fig. 7). Govoni (1983, 1991) summarized these realms as the Northern Mild-Temperate (NMT) Province and the Southern Warm-Temperate (SWT) Province. The NMT encompassed the Labrador Sea off western Greenland and the opening straits between eastern Greenland and Scandinavia, eastward into the North Sea Basin, and south to at least the Belgian Mons and northern Paris basins on the eastern Atlantic margin. The faunal similarity of Belgian and Danish faunas discussed herein with assemblages from Austria, Ukraine, and Poland suggests that the NMT (or its influence) reached eastward through the Polish Trough into the Russian Basin as well, at least until early Selandian time (Krach, 1963; Wozny, 1964; Moroz, 1972; Davies, 1975; Kollmann, 1979; Schnetler, 2001). On the western Atlantic margin, the NMT appears to have extended at least as far south as the Salisbury Embayment, given the strong faunal affinities of Brightseat taxa with other NMT faunas (West Greenland, Belgium, Denmark).

The second province, the SWT, was bounded to the south by the circumequatorial Tethyan Province and stretched westward to encompass the Gulf of Mexico (including Gulf Coastal Plain states: Texas, Mississippi, Alabama) and Caribbean regions. Paleontological evidence is scarce to fix the latitudinal boundary of the SWT on the eastern Atlantic



Text-fig. 7. Paleogeographic reconstruction of the North Atlantic Ocean Basin region during the middle to late Danian (interval of calcareous nannofossil zones NP3 and NP4), showing the distribution of land (light gray) and water masses (light blue), with modern shorelines outlined for reference. Danian to Selandian faunas analyzed in this text are denoted in black, with the Brightseat fauna marked as a seven-pointed star and all other faunas marked as dots: AL = Alabama; BE = Belgium; DK = Denmark; GL = West Greenland; MD = Maryland; MS = Mississippi; TX = Texas. Danian to Selandian faunas mentioned here but analyzed elsewhere by other authors are denoted with gray stars: AK = Ocean Point Formation, Alaska; AT = Austria; FR = Paris Basin, France; ND = Cannonball Formation, North Dakota; UA = Ukraine. Zoogeographic divisions of the marine molluscan shelf faunas are indicated: Arctic = Arctic Province; NMT = Northern Mild-Temperate Province; SWT = Southern Warm-Temperate Province; Tethyan = Tethyan Province. Arrows indicate inferred patterns of flow of the dominant surface currents. The transitional zone of overlapping influence between the NMT and SWT provinces is denoted by gray diagonal lines and occurs at ~ 40–45° latitude, impacting amphiatlantic faunas in MD, FR, and BE. Base map derived from the 65 Ma and 60 Ma paleogeographic reconstructions of Scotese (2014), with additional reference to Silfer (1990), Marincovich (1993), Schnetler (2001), Thomas et al. (2006), and Slattery et al. (2015).

margin, but it probably extended to the southwestern portion of the Iberian Peninsula. Faunas from the northwestern margin of South America (e.g., in Colombia and Trinidad) maintain strongest affinities with the SWT Gulf Coastal Plain taxa, but also have subtle yet Tethyan influence (Gardner, 1931, 1935; Rutsch, 1940, 1943; Etayo-Serna, 1979).

The borders of the NMT, SWT, and adjacent provinces (Tethyan, Arctic) were notably diffuse in this largely temperate world, and the literature cites many instances of molluscan assemblages sharing elements of multiple provincial sources. The thermophilic and cryophilic nature of some of these genera, combined with the implications of reported molluscan distributions on presumed surface ocean circulation and paleobiogeography of the early Paleocene, has produced several (not always complementary) models for the evolution of the paleoenvironment at this time. We do not aim to summarize all these arguments in depth here but merely note the placement of the Brightseat taxa within a broader North Atlantic Danian context. Indeed, drawing strict conclusions about the zoogeographical provincial extent and paleoceanography of the time is ineffective given the scarce and widely scattered extent of outcrops around the North Atlantic margin and the current state of chronological uncertainty surrounding the time of deposition and correlation of many of these faunas.

Biogeographic Position of the Brightseat Fauna

The gastropods of the Brightseat share elements in common with both the NMT and the SWT provinces, indicating that the assemblage flourished on a portion of the North Atlantic continental shelf that was situated within an intermediate zone of overlapping northern and southern influence. The appearance of more cryophilic taxa (*Pseudocirsope* Boettger, 1907, *Entomope* Cossmann, 1888, indet. Aporrhaidae) in the Brightseat demonstrate this northern influence, and neither of the two former genera are found in Danian–Selandian deposits south of the Salisbury embayment. Several taxa in the Brightseat are closely allied with lower Paleocene forms from Greenland and northwestern Europe: *Granosolarium* sp. indet. with western European and Ukrainian species; *Sigmesalia? gnoma* n. sp. with *Turritella nana* from the Selandian of Denmark and Poland; *Sigmesalia palmerae* n. sp. with a species complex widely distributed in the upper Danian–Selandian of Belgium, France, Germany, and Poland; *Mathilda* (*Mathilda*) *kauffmani* n. sp. with an unnamed form from the Danian of West Greenland; *Creonella obscuriplica* n. sp. with another West Greenland species; and a small *Crenilabium* Cossmann, 1889 that is very similar to a species from the Selandian of Denmark. Additionally, similarities exist with assemblages from the Arctic Province, namely the Prince Creek Formation of Alaska: *Mathilda* (*Fimbriatella*) *crebricosta* n. sp. appears allied with *Mathilda* (*F.*) *amundseni* Marincovich, 1993. Silfer (1990) described the neogastropod fauna of the Cannonball Formation in North and South Dakota and did not find any species in common with the Brightseat but remarked on the high degree of similarity of his assemblage with that of the Agatdal Formation of West Greenland, with which the Brightseat also shares great similarity. Although the oceanic connectivity in the Danian between West Greenland, Alaska, and the Dakotas is uncertain (see Silfer, 1990: 49, and Marincovich, 1993: 6), some degree of interchange was occurring and the Brightseat was influenced by it.

The northern influence is matched by the southern affinities of certain other Brightseat gastropods. Several taxa are conspecific or otherwise closely related to Gulf Coast species: *Tornatellaea texana* Gardner, 1935, *Gilbertina texana*, *Teinostoma* cf. *regularis* Garvie, 2021, *Odostomia* (*Brachystomia*) aff. *insignifica* (Aldrich, 1897), and *Retusa* (*Cylichnina*) aff. *sylvaerupis* (Harris, 1899). The turritellids *Kapalmerella mortoni protomortoni* n. ssp. and "*Turritella*" *prehumerosa* n. sp. are early members of species complexes that evolve and reach their greatest diversity and geographic distribution in the northern half of the SWT.

The mixture of faunal elements of differing biogeographical affinities in the Brightseat could mark its location on the Atlantic coast of North America at the northwestern edge of an early Paleocene anticyclonic warm-water gyre (Text-fig. 7). Analogous to the thermal ecological barrier at Cape Hatteras today, where the warm-water flow of the Gulf Stream turns away from the coast of North America, the Salisbury Embayment was positioned so that it lay north of SWT currents traversing eastward across the Atlantic and thus remained largely in the realm of influence of cooler-water NMT currents and fauna. However, the embayment was still close enough to the SWT gyre to receive and support some thermophilic taxa associated with more equatorial latitudes. Available experimental evidence does seem to support a clockwise surface current flow in the North Atlantic at this time (Barron and Peterson, 1991; Thomas et al., 2006), complementing the physical evidence (Bartlett, 1973; Berggren and Hollister, 1974, 1977). Concurrently, the northeastern margin of influence of this SWT gyre appears to have been positioned near the Mons Basin of Belgium, itself located within the southern reaches of the NMT yet likewise exhibiting thermophilic taxonomic components of the SWT that lend it a transitional provincial aspect. Although the latitudinal thermal contrast in the North Atlantic was, overall, considerably less pronounced at this time, and a temperate climate prevailed throughout the ocean basin (Thomas et al., 2006), enough latitudinal environmental contrast existed to perceive the existence of these two North Atlantic Ocean molluscan zoogeographic provinces (Govoni, 1991).

TAXON MEASUREMENTS AND SPECIMEN REPOSITORIES

The higher order (family and above) classification of the Gastropoda employed in the Systematic Paleontology section is that of Bouchet et al. (2017). The arrangement of subfamilial taxa is in agreement with WoRMS and MolluscaBase (https://www.molluscabase.org/index.php) (accessed January 2024), except in a few instances where subgenera now accepted at the generic rank were maintained to facilitate easier comparison with faunas described in older literature that do not reflect the latest taxonomic assignments. Methodological procedure for open nomenclatural assignments follows that outlined by Bengtson (1988).

All specimens examined in this study, including the type, figured, and measured specimens described and listed in the systematic descriptions, are reposited in the National Museum of Natural History (NMNH) of the Smithsonian Institution, Washington, D. C. The sample numbers given for each species refer to the localities and stratigraphic level from which individuals of the species were recovered (Table 2). Specimen repositories are abbreviated as follows: Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania (ANSP); Louisiana State University Museum of Zoology, Baton Rouge (LSUMZ); Non-vertebrate Paleontology Laboratory, University of Texas, Austin (NPL); Paleontological Research Institution, Ithaca, New York (PRI); Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM PAL).

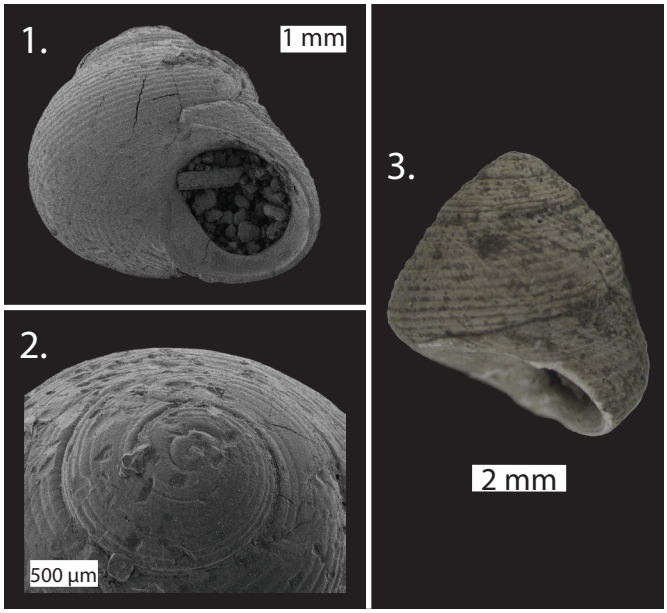
SYSTEMATIC PALEONTOLOGY

Phylum **MOLLUSCA** Cuvier, 1795a
Class **GASTROPODA** Cuvier, 1795b
Subclass **VETIGASTROPODA** Salvini-Plawen, 1980
Superfamily **TROCHOIDEA** Rafinesque, 1815
Family **ATAPHRIDAE** Cossmann, 1915
Genus ***ATAPHRUS*** Gabb, 1869

Type species.—*Ataphrus crassus* Gabb, 1869, by original designation.

Ataphrus glandula (Conrad, 1830)
Text-fig. 8, Table 4

Monodonta glandula Conrad, 1830: 214, 220, pl. 9, fig. 15; 1866: 11.
Monodonta glandula Conrad. H. C. Lea, 1849: 102.
Monodonta? *glandula* Conrad. Palmer and Brann, 1966: 778.
Gibbula glandula (Conrad). Clark, 1895: 5; 1896: 72, pl. 14, fig. 5.
Gibbula glandula (Conrad). Clark and Martin, 1901: 157, pl. 29, fig. 5.



Text-fig. 8. *Ataphrus glandula* (Conrad, 1830). (**1, 2**) USNM PAL 642415, sample A-1, apertural (**1**) and oblique apical (**2**) views, SEM. (**3**) Holotype, ANSP 30556, Aquia Formation of Prince George's County, Maryland, lateral view; light photograph courtesy of Alejandra Martinez-Melo.

Ataphrus glandula (Conrad). Govoni, 1983: 64–67, pl. 1, figs. 1, 2.

Type material.—Holotype ANSP 30556 from the Aquia Formation of Prince George's County, Maryland.

Other material examined.—Single complete figured specimen, USNM PAL 642415, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Aquia Formation, Piscataway and Paspotansa members (Selandian and Thanetian). Virginia: Aquia Formation, Piscataway and Paspotansa members (Selandian and Thanetian).

Diagnosis.—Shell small, thickened, anomphalous, turbiniform; aperture subcircular with thick nacre-covered columellar and outer lips; distinct tubercle on columellar lip and low tubercle-like swelling on anterior portion of outer lip; ornament of closely spaced spiral cords and grooves.

Description.—Shell small, moderately thick, turbiniform, anomphalous, low-spired, almost as wide as tall. Shell consisting of five rapidly expanding whorls including smooth, low, slightly emerged protoconch of approximately one and

Table 4. Measurements of specimens (in mm). Column abbreviations and definitions adapted from Sohl (1964a): AA, apical angle, subtended between two straight lines (lying in a plane through shell axis) that touch opposite sides of adjacent whorls near apex; H, total height of shell, measured parallel to teleoconch coiling axis; HA, height of aperture, measured parallel to teleoconch coiling axis; HB, height of last body whorl, measured parallel to teleoconch coiling axis; HS, height of spire, measured parallel to teleoconch coiling axis; L, long diameter, measured at base of conical or similarly shaped shells; MD, maximum diameter, measured normal to teleoconch coiling axis; NW, number of whorls, including or excluding whorls of protoconch as noted in text; PA, pleural angle, subtended between two straight lines (lying in a plane through shell axis) tangential to and on opposite sides of last two whorls; WA, width of aperture, measured normal to teleoconch coiling axis. Comments: 1, whorl number includes protoconch; 2, specimen incomplete; 3, whorl number exclusive of protoconch; 4, immature; 5, specimen damaged during SEM preparation (after measurements); 6, measurement of specimen as preserved (i.e., not extrapolated to complete/whole dimensions of unbroken shell). HT, holotype; PT, paratype.

Species	USNM PAL number	NW	H	MD	H:MD	HA	WA	HB	HS	HB:H	AA	PA	L	Comment	Type status
Ataphrus glandula (Conrad, 1830)	642415	5	4.7	4.6	1.02	2.3	2.5							1	non-type
Kapalmerella mortoni protomortoni Govoni n. ssp.	642439	6.5	39.9	14.9										2, 3	HT
	642440	8	13.1	4.8							24			2, 3	PT
	642441	9.5	6.8	2.3							19			2. 3	PT
Kapalmerella? sp.	642447	9	6.6	1.9							14			2	non-type
	642448	7+	8.5	3							12			2	non-type
"*Turritella*" *prehumerosa* Govoni n. sp.	642449	11	43.8	11.1										2, 3	HT
	642450	5	29.6	9.1										2, 3	PT
	642451	5	14.3	5.6										2, 3	PT
	642452	8	4.4	1.4								17		2, 3	PT
cf. *Torcula* sp. indet.	642453	2	5.5	3.5										2	non-type
	642454	4	7.1	3.2										2	non-type
Sigmesalia palmerae Govoni n. sp.	642455	8	15.1	6								20		2	HT
	642456	8	25.2	11.2										2	PT
	642457	7	13.2	5.6										2	non-type
	642458	4	17.4	8.5										2	non-type
	642459	5.5	5.9	2.7										2	non-type
	642460	6	10	4.8										2	PT
	642461	7	4.9	2.5										2	non-type
	642462	5.5	2.3	1.2							35			2	non-type
	642463	4.5	2	1.1							33.5			2, 5	PT
Sigmesalia? *gnoma* Govoni n. sp.	642442	6.5	4.3	1.5								16		3	HT
	642443	6.5	4.4	1.7										3	PT
	642444	6	4.6	1.9										3	non-type
	642445	6	3.4	1.3										3	non-type
	642446	7	4.7	1.7								21		3	PT

(*continued on next page*)

Table 4. (*continued from previous page*).

Species	USNM PAL no.	NW	H	MD	H:MD	HA	WA	HB	HS	HB:H	AA	PA	L	Comment	Type status
Cirsotrema (*Elegantiscala*) sp. indet.	642488		2.1											2	non-type
	642489	3+	5											2, 5	non-type
	642490	1.5	3.4	2.5										2	non-type
Cirsotrema (*Coroniscala*) sp. indet.	642491	5+	3.9	2.2										2	non-type
	642492	2.5	4.4	3.1										2	non-type
Neverita (*Neverita*) *potomacensis* Govoni n. sp.	642502		16.4	15.5	1.06									6	HT
	642503		14	12.7	1.1									6	non-type
	642504		16.1	12.3	1.31									6	non-type
	642505		19.7	16.6	1.19									6	PT
	642506		17.3	16	1.08									6	non-type
	642507		16.3	13.6	1.2									6	non-type
	642508		14.5	12.1	1.2									6	non-type
	642509		13	11.6	1.12									6	non-type
Entomope marylandica (Clark and Martin, 1901)	642418	1.67	4.4	2.8										2, 3	non-type
	642419	4.5	2.5	1.7										1, 2, 5	non-type
	642420	2.25	3.5	2.3										2, 3	non-type
Pseudocirsope feorra Govoni n. sp.	642416	5	2.5	2.4	1.04			2.2	0.3	0.88				1	HT
	642417	5	3.1	2.6	1.19			2.6	0.5	0.84				1	PT
Pasitheola marylandensis Govoni n. sp.	642496	5.25	2.65	1.25	2.12			2		0.75				1	HT
Teinostoma cf. *regularis* Garvie, 2021	642421		1.3	1.1	1.18									2, 4	non-type
	642422		1.4											2	non-type
	642423		1.4	3.1	0.45									2	non-type
	642424		1.3											2	non-type
	642425		1.5											2	non-type
	642426		1.5											2	non-type
	642427		1.4	3.1	0.45									2, 5	non-type
	642428		1.4											2	non-type
	642429		1.3											2	non-type
Anticlimax? *gardnerae* Govoni n. sp.	642435	4	1.3	2.4	0.54									1	HT
Cyclostremiscus sohli Govoni n. sp.	642434	3.5	1.6	2.1	0.76									1	HT
Solariorbis laurelae Govoni n. sp.	642431	4.5	1.6	2.9	0.55									1	HT
Solariorbis? sp. indet.	642432			2.1										2, 6	non-type

(*continued on next page*)

Table 4. (*continued from previous page*).

Species	USNM PAL no.	NW	H	MD	H:MD	HA	WA	HB	HS	HB:H	AA	PA	L	Comment	Type status
"*Circulus*" sp. indet.	642433		1.5	1.9										2, 6	non-type
Vitrinella (*Vitrinellops*) *clarkmartinorum* Govoni n. sp.	642430	4	1	1.8	0.56									1	HT
Eulima brightseatensis Govoni n. sp.	642493	4.75	4.55	1.9	2.4			3		0.66				3	HT
	642494	4.5	4	1.7	2.4			2.65		0.66				3	PT
Eulima sp. indet.	642495	4+	1.4	0.6	2.3			0.8		0.57				3, 4, 5	non-type
Calyptraea aldrichi Govoni n. sp.	642499		10.9										19	2	HT
	642500		2.2										4.1	1, 2	PT
	642501		1.4										2.8	1, 2	PT
Aporrhaidae gen. and sp. indet.	642497		6.3											2, 6	non-type
Calyptraphorus cf. *jacksoni* Clark, 1896	642498		35.5	20.5										2, 6	non-type
Lacinia pygmaea Govoni n. sp.	788756	5	15.4	13.6					1.8					3, 6	HT
	788757	5	20.4	16.4					1.6					3, 6	PT
	788758	5	19.6	16.8					2.6					3, 6	non-type
	788759	2.5	19.9	15.6										3, 6	PT
Siphonalia potomacensis Govoni n. sp.	788760	3.75	23.6	14.5	1.63									3	HT
	788761	2.5	15.7	10	1.57									3	PT
	788762	1+	17.5											3	PT
Pyropsis? sp. indet.	788764			26.1										2, 6	non-type
Pseudoliva longicostata Govoni n. sp.	788763	5	13.6	10.1	1.35				2.6					1, 6	HT
Granosolarium sp. indet.	642437	4	0.9	3										1, 2. 6	non-type
Pseudomalaxis cf. *ripleyana* Wade, 1926	642436	4	0.5	1.8	0.28									1	non-type
Stellaxis? sp. indet.	642438	2	1.1	3										2, 3, 6	non-type
Acrocoelum richardsi Govoni n. sp.	642480	5+	1.95	1.4+										1, 4	HT
	642481	4.5	1.25	0.7										1, 4	PT
	642482	5	1.3	0.7										1, 4	non-type
	642483	4+	1.6+	0.9										1, 4, 5	non-type
	642484	3	0.7	0.5										1, 4	non-type
Mathilda (*Fimbriatella*) *crebricosta* Govoni n. sp.	642473	5	5	2.8										2, 3, 5, 6	HT
Mathilda (*Fimbriatella*) *marylandensis* Govoni n. sp.	642474	5	4.7	2.4										2, 3	HT
	642475	2	4.2	2.6										2, 3	PT

(*continued on next page*)

Table 4. (*continued from previous page*).

Species	USNM PAL no.	NW	H	MD	H:MD	HA	WA	HB	HS	HB:H	AA	PA	L	Comment	Type status
Mathilda (*Fimbriatella*) *marylandensis* (continued)	642476	1.5	3.6	2.3										2, 3	non-type
	642477	2.5	2.4	1.6										2, 3	non-type
	642478	3.5	2.4	1.3										2, 3	PT
	642479	4	3.2	1.7										2, 3	PT
Mathilda (*Mathilda*) *kauffmani* Govoni n. sp.	642464	4	5	2.4										1	HT
	642465	3	3.7	2.3										5, 6	PT
Mathilda (*Mathilda*) sp. A	642466	3.75	3.6	1.5										2, 6	non-type
	642467	1.5	1.9	1.4										2, 6	non-type
	642468	2.5	1.4	0.8										2, 6	non-type
Mathilda (*Mathilda*) sp. B	642469	3	1.5	0.8										2, 6	non-type
	642470	2	2	1.3										2, 6	non-type
Mathilda (*Mathilda*) sp. C	642471	1.75	2.3	1.3										2, 6	non-type
	642472	1.25	1.7	1.3										2, 6	non-type
Gegania? sp. indet.	642485		3											2	non-type
	642486		1.5											2	non-type
	642487		1.8											2, 5	non-type
Acteon danicus Govoni n. sp.	788772	4	4.2	2.3	1.83			3.4	0.8					1, 5	HT
Crenilabium cf. *elatum* (von Koenen, 1885)	788775	3	2.4	1				1.6	0.8					3	non-type
	788776	2	1.9	0.9				1.5	0.4					3	non-type
	788777	3	2.6	1.1				1.7	0.9					3	non-type
Tornatellaea texana Gardner, 1935	788773	4.33	7.4	4	1.85									3	non-type
	788774	3.75	5.6	3.5	1.6									3	non-type
Zikkuratia danica Govoni n. sp.	788780		4.9	1.9	2.6			4.2	0.7					2	HT
	788781		5.3	2.1	2.5			4.7	0.6					2	PT
	788782		2.9	1.3	2.2			2.4	0.5					2	non-type
	788783		3.5					3	0.5					2	non-type
	788784		2.2	1.1	2			1.8	0.4					2	non-type
	788785		2.4						0.5					2, 5	non-type
	788786		3.3	1.3	2.5			2.7	0.6					2	PT
	788787		3.4	1.4	2.4			2.9	0.5					2	non-type
	788788		3.5	1.3	2.7			3	0.5					2	PT
Gilbertina texana Gardner, 1935	788778	4	3.1	2.8	1.1			2.9	0.2					1	non-type

(*continued on next page*)

Table 4. (*continued from previous page*).

Species	USNM PAL no.	NW	H	MD	H:MD	HA	WA	HB	HS	HB:H	AA	PA	L	Comment	Type status
Gilbertina texana (continued)	788779	4	2.8	2.7	1+			2.6	0.2					1, 5	non-type
Umbraculum? sp. indet	788800		1.7										6.5	6	non-type
Retusa (*Cylichnina*) aff. *sylvaeriphis* (Harris, 1899)	788794		6.7	3.1	2.16									6	non-type
	788795		6.2	2.7	2.3									6	non-type
	788796		6.6	2.8	2.36									6	non-type
	788797		4.9	2.2	2.23									6	non-type
	788798		1.5											6	non-type
	788799		5.5	2.6	2.12									6	non-type
Scaphander (*Privaphander*) *potomacensis* Govoni n. sp.	788789		7.9	4.3	1.84									6	HT
	788790		5.6	3.3	1.7									6	non-type
	788791		7.6	4.1	1.85									6	PT
	788792		0.9											6	non-type
	788793		6	3.2	1.88									6	non-type
Evalea sp. indet.	788765	2.25	4.9	2.9										2	non-type
Odostomia (*Brachystomia*) aff. *insignifica* (Aldrich, 1897)	788766	4.33	3.1	1.6										3, 5	non-type
Creonella obscuriplica Govoni n. sp.	788769	5.5	3.5	1.3										3	HT
	788770	5	3.7	1.5										3	PT
	788771	2.33	2.9	1.5										3	non-type
Putosymola toulmini Govoni n. sp.	788767	4.5	4	1.7										2, 3, 4	HT
	788768	3.5	2.1	1										2, 3, 4	PT

one-half whorls. Earlier whorls of teleoconch broadly convex like protoconch at first, becoming somewhat flattened and finally slightly concave posteriorly in last whorl so that maximum convexity is achieved in anterior half of whorls; last whorl anteriorly flattened. Suture relatively deeply impressed and accentuated in penultimate and last whorl by increasingly well-defined subsutural collar formed by two somewhat thickened and raised spiral cords. Primary sculpture of teleoconch consists of numerous spiral cords and grooves. Cords flattened, of uniform size, closely and evenly spaced on earlier whorls. On last whorls, cords becoming more rounded and consisting, from posterior to anterior, of two enlarged cords on subsutural collar, five or six thin and closely spaced cords and, extending to base, a number of somewhat larger cords separated by flat-floored grooves that become equal to cords in width. Intercord grooves filled by small secondary threads on latest portion of last whorl. Spiral ornament intersected by growth lines of varying strength that impart a vaguely beaded appearance to cords of latest whorls. Growth lines strongly prosocline, broadly convex abaperturally except for slight adapical reflection on subsutural collar. Aperture subcircular, flattened along columellar margin and slightly wider than high. Outer lip rapidly thickening and turning outward anteriorly where it curves and merges into broad, thick, forward-facing columellar lip. Interior of lips exhibiting nacreous shell layer; thin nacreous callus also developed on parietal apertural surface. Prominent laterally elongated and inclined tubercle developed on columella slightly above base. Second low, tubercle-like swelling of inner lip margin developed at the point of maximum curvature along arc between columellar and outer lip.

Remarks.—The genus *Ataphrus* has heretofore been recognized in North

America predominantly in Cretaceous age deposits where it is represented by five species: *Ataphrus crassus*, of uncertain but most probably Late Cretaceous age in the Great Valley Series (Maastrichtian) of California (Gabb, 1869: 171), *Ataphrus compactus* (Gabb, 1864) from the Chico Formation (Campanian) of California (Stewart, 1927: 316), *Ataphrus kerri* Gabb, 1876, from the Snow Hill Member of the Black Creek Formation (Campanian) of North Carolina (Stephenson, 1923: 353), *Ataphrus griffini* Dockery, 1993, from the Coffee Sand (Campanian) of Mississippi (Dockery, 1993: 45), and a new but unnamed form from the Providence Sand (Maastrichtian) of Georgia (figured by Sohl and Smith, 1980, pl. 3, fig. 1). In the Paleogene, the genus extends into the upper Paleocene (Selandian–Thanetian) Aquia Formation of Maryland and Virginia: examination of *Monodonta glandula* (erroneously assigned by Clark [1895: 5; 1896: 72] to the phaneromphalous genus *Gibbula* Risso, 1826) from the Aquia Formation suggests that the species is actually a large *Ataphrus* and that the specimen from the Brightseat is referrable to it. In addition to *Ataphrus glandula*, a second unnamed lower Paleocene species of *Ataphrus* is known from the middle Danian Agatdal Formation of West Greenland (Kollmann and Peel, 1983), and a third from the middle Danian Faxe Formation of Denmark (Lauridsen and Schnetler, 2014).

Ataphrus glandula most closely resembles *Ataphrus compactus*, as figured by Stewart (1927, pl. 29, fig. 5), in general outline. All five Cretaceous ataphrids are, however, broader relative to height than *Ataphrus glandula*, and none possesses as high or inflated penultimate whorl. *Ataphrus glandula* differs from the Cretaceous species both in the details of number, shape, and position of the small turbercles and tubercle-like swellings on the columellar and outer lips, and in the appearance of the small secondary spiral threads in the final volution of the shell. The Danian West Greenland *Ataphrus* differs from *Ataphrus glandula* in having a lower and less inflated penultimate whorl, lack of the secondary spiral threads and secondary tubercle, lack of the subsutural collar, reduction in prominence of the columellar tubercle, and in the angulation of the outline of its final whorl. The Danian *Ataphrus* from Denmark is very rare and lacks detailed figured material; however, the presence of a deep umbilicus in that species sets it apart from all other members of the genus known from the northern margin of the Atlantic Basin during this time period.

The secondary tubercle inside the inner margin of the outer lip as well as the secondary spiral threads are best developed in the Aquia representatives of the species. In addition, the Aquia specimens possess, but the Brightseat example lacks, the faint irregularities of the inner shell surface immediately to the rear of the inner margin of the outer lip reported in *Ataphrus kerri* and seen in the unnamed Cretaceous species from the Providence Sand. The larger size of Aquia specimens relative to both the Brightseat and Cretaceous ataphrids suggests, however, that the presence or absence of these characters might be ontogenetically controlled in *Ataphrus glandula* and that the Brightseat specimen is immature.

Subclass **CAENOGASTROPODA** Cox, 1960
Subcohort **CERITHIIMORPHA** Bouchet et al., 2017
Superfamily **CERITHIOIDEA** Fleming, 1822
Family **TURRITELLIDAE** Lovén, 1847

Remarks.—As in many other fossil assemblages from the Cenozoic deposits of North America, Turritellidae of the Brightseat forms a taxonomically diverse and numerically significant component of the gastropod fauna (see, e.g., Allmon, 1996; Friend et al., 2023). The systematic subfamilial study of turritellids has historically been hampered by competing supraspecific classification schemes that place a different emphasis on morphological characteristics including whorl profile, ontogeny of spiral sculpture, details of the aperture, form of the protoconch, and shape of the growth line trace (Allmon, 1996; Friend et al., 2023, and references therein). Because of this, and a general practice by many workers to unite geographically widespread and chronologically/stratigraphically well-separated taxa into a single wastebasket genus—"*Turritella*" Lamarck, 1799—the group is rarely useful as a true indicator of close evolutionary relationships (i.e., monophyletic clades) within the family (Allmon, 1996; Harzhauser and Landau, 2019; Friend et al., 2023). Yet with careful attention to morphology within a temporally and geographically constrained region, generic memberships can be assigned to groups of taxa with consistent and unique features so that important details of their evolutionary history can be conveyed at higher resolution (Friend et al., 2023; Anderson and Allmon, 2023). In this paper, we use terminology for shell morphology from Allmon (1996) and Friend et al. (2023) and pay special attention to details of apical spiral-sculpture ontogeny and growth-line trace in describing species.

Subfamily **TURRITELLINAE** Woodward, 1851
Genus ***KAPALMERELLA*** Allmon, 2005

Type species.—*Turritella mortoni* Conrad, 1830, by original designation.

Diagnosis.—Small to large turritellid with round to basally carinate adult whorl profile, the "*hybrida-imbricataria*" type lateral growth-line sinus, and apical sculpture formula of $C_1B_1A_2$.

Remarks.—Allmon (1996) named the genus *Palmerella* (replaced by *Kapalmerella* Allmon, 2005 because *Palmerella* was

preoccupied), and included in it species belonging to what he referred to as the "*Turritella mortoni* group" from the Paleocene and Eocene of the U. S. Gulf and Atlantic Coastal Plains: *K. alabamiensis* (Whitfield, 1865); *K. alveata* (Conrad in Wailes, 1854); *K. apita* (de Gregorio, 1890); *K. arenicola* (Conrad, 1865); *K. chirena* (Stenzel and Turner, 1940); *K. clevelandia* (Harris, 1894b); *K. creola* (Palmer in Harris and Palmer, 1947); *K. dumblei* (Harris, 1895); *K. dutexata* (Harris, 1894a); *K. femina* (Stenzel in Renick and Stenzel, 1931); *K. hilli* (Gardner, 1935); *K. levicunea* (Harris, 1896); *K. lisbonensis* (Bowles, 1939); *K. mortoni* (Conrad, 1830) [including the subspecies *K. m. mediavia* (Bowles, 1939); *K. m. postmortoni* (Harris, 1894a); and *K. m. premortoni* (Govoni, 1983) (herein *K. m. protomortoni* n. ssp.; see below)]; *K. pleboides* (Vaughan, 1895); *K. potomacensis* (Clark and Martin, 1901); and *K. stenzeli* (Allmon, 1996). Based upon consideration of the characteristics listed above, two Brightseat turritellids, described below, are assigned to *Kapalmerella*.

Kapalmerella mortoni protomortoni Govoni n. ssp.
Text-figs. 9, 10; Table 4

Haustator premortoni Govoni, 1983: 104–107, pl. 5, figs. 1–5 (unpublished).

Palmerella mortoni ssp. Allmon, 1996: 64, pl. 1, figs. 1–3 [citing and quoting description by Govoni, 1983, as unpublished; ICZN, 1985: Art. 11(d)].

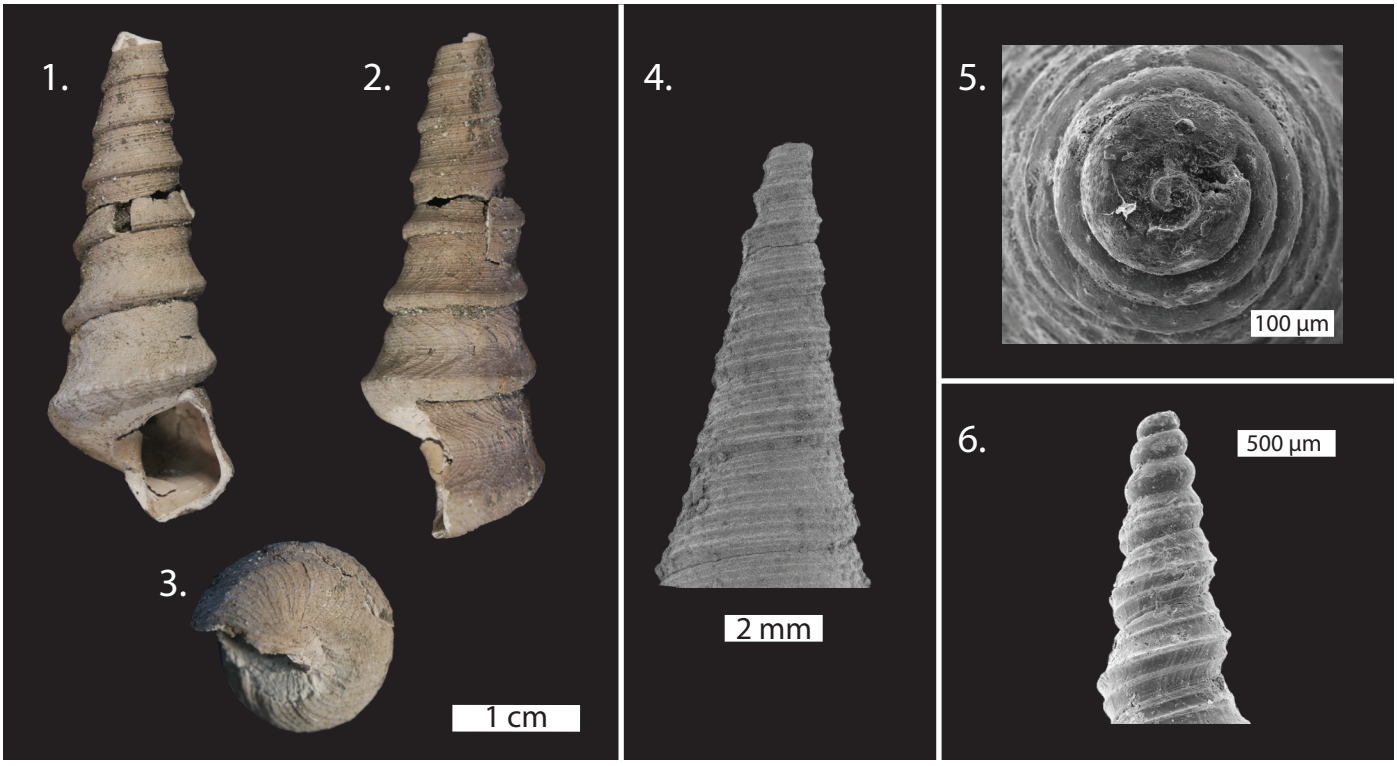
ZooBank LSID.—urn:lsid:zoobank.org:act:F2FEF42E-56A9-425C-8AB1-71445D1ADD79.

Type material.—Holotype USNM PAL 642439 from Locality A (sample A-5); paratypes USNM PAL 642440 and 642441 from Locality A (sample A-6).

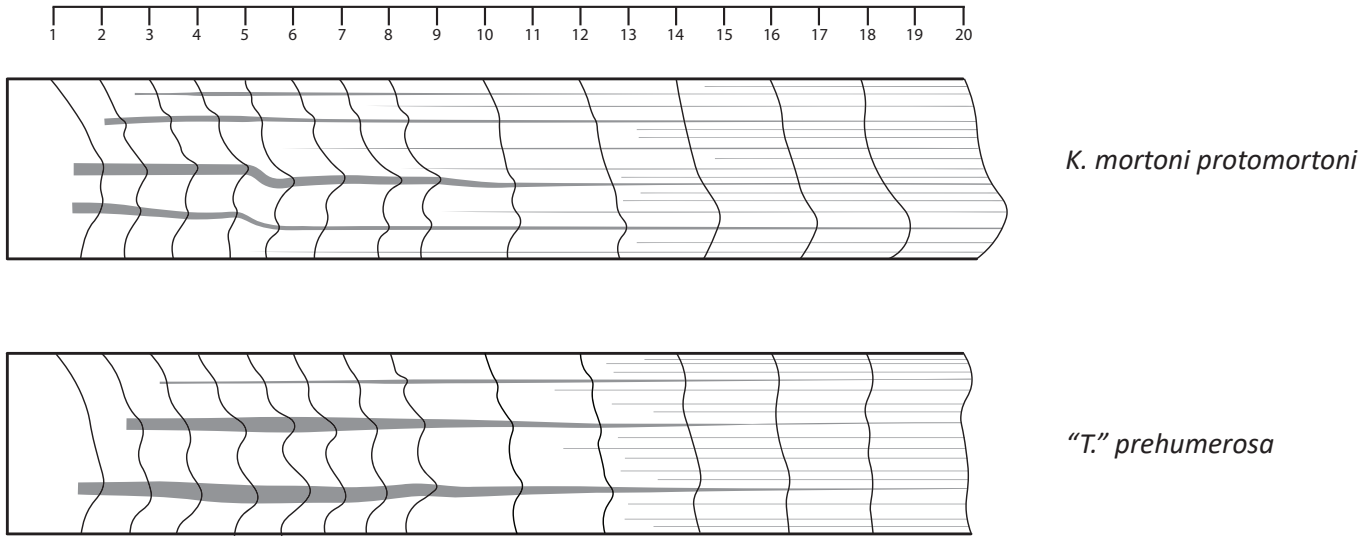
Other material examined.—More than 75 single- and multi-whorl fragments, with a considerable proportion consisting mainly of the earlier apical whorls, from Locality A (samples A-1, A-2, A-3, A-6, A-7, A-8); Locality B (sample B-1); and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).



Text-fig. 9. *Kapalmerella mortoni protomortoni* Govoni n. ssp. (**1–3**) Holotype, USNM PAL 642439, sample A-5, light photographs, in apertural (**1**), lateral (**2**), and basal (**3**) views. (**4**) Paratype, USNM PAL 642440, sample A-6, SEM, detail of early teleoconch whorls. (**5, 6**) Paratype, USNM PAL 642441, sample A-6, SEM, protoconch in apical (**5**) and lateral (**6**) views.



Text-fig. 10. Marwick diagrams depicting the ontogenetic development of spiral cords in *Kapalmerella mortoni protomortoni* Govoni n. ssp. and "*Turritella*" *prehumerosa* Govoni n. sp. (herein). Marwick diagrams schematically illustrate the strength and order of appearance of spiral cords on the teleoconch through ontogeny, and are named after a similar technique used by Marwick (1971). Numbers at the top represent whorl numbers exclusive of the protoconch, with the youngest whorls of the teleoconch beginning on the left. Horizontal lines indicate spiral ornament and are shaded according to their prominence; the thick spirals in early ontogeny of both species reflect, from bottom to top of the whorl, the primary spirals C, B, and A, which are used to assign the apical ontogenetic formula for the species. Vertical lines show the shape of the lateral whorl profile at indicated whorls. All whorl outlines are standardized to the same height. See Allmon (1996: 25, 26) and Friend et al. (2023: 7, 8) for more information on these schematic diagrams.

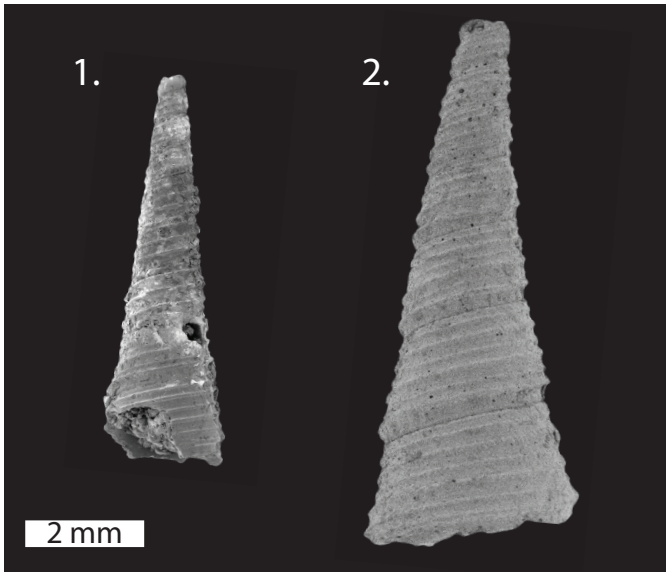
Etymology.—The subspecific epithet *protomortoni* refers to the presence of this species in sediments immediately preceding the appearance of *Kapalmerella mortoni mortoni* (Conrad, 1830), with which it shares great morphological affinity, in the overlying Aquia Formation. This species, before its formal description herein, has previously been mentioned in the literature with the epithet "*premortoni*" (e.g., Govoni, 1983; Allmon, 1996); however, that name is preoccupied by *Turritella premortoni* Moret, 1938, from the upper Danian or lower Selandian of Tamdakht, Morocco.

Diagnosis.—Medium-sized, tapering turritellid; apical sculpture formula $C_1B_1A_2$; mature whorls with medial constriction and rounded basal carina; sculpture of mature whorls consisting of numerous fine, subequal spiral threads and prominent, deeply sinuous growth lines.

Description.—Shell medium-sized, tapering turriculate. Suture narrowly impressed. Protoconch erect, homeostrophic, turbinate, of approximately three smooth, rounded, rapidly expanding volutions; first volution minute, initially somewhat depressed; protoconch merging into teleoconch without perceptible break. Whorls of teleoconch wider than high; total number of whorls unknown but can reach > 20. Primary spiral threads B and C can appear on earliest juvenile whorl simultaneously (C_1B_1) or, more frequently, C can appear just slightly ahead of B (C_1B_2); within a single volution, primary spiral thread A appearing just slightly posterior of midpoint between B and posterior suture, whereas at the same time, B shifting slightly anteriorly of midwhorl and strengthening rapidly relative to C, forming a sharp, raised cord, and yielding a sculptural pattern that dominates remaining juvenile whorls. First fine secondary thread appearing no later than fourth to fifth teleoconch whorl between primary spiral A and posterior suture; additional secondary threads added progressively starting at sixth to seventh whorl, first between primaries A and B, then between B and C; three or four additional threads or weak cords do not appear in interspace until later adolescent to mature whorls. Starting on earlier adolescent whorls, many spirals, particularly stronger ones, can become finely but distinctly beaded where intersected by growth lines; beading persisting throughout mature whorls but can become subdued, or late in ontogeny, beads can merge and be incorporated into strong, elongate, wavy wrinkles as growth lines strengthen and become raised and crinkled. Whorl profile convex and submedially carinate in juvenile whorls; with addition and strengthening of secondary spirals in conjunction with relative weakening of primaries A and B, sides of adolescent whorls initially flattening then quickly becoming shallowly concave medially above low, sharp, carinate basal

angulation that overhangs succeeding whorl; basal angulation formed by relative strengthening of primary C and sometimes the secondary spiral below; on mature whorls, basal carination becoming rounded and increasing in prominence, with whorl sides becoming somewhat more constricted medially, and posterior third of whorl can become broadly convex or develop very low secondary carination at position of primary spiral A. Mature whorls covered by numerous fine spiral threads that tend to be of subequal strength on posterior third of whorl, of similar but more obviously alternating strength medially, and strongest on and below the basal carina; on latest whorls, spirals appearing wavy and disrupted by intersection of strongly wrinkled growth lines; flattened whorl base covered by numerous relatively coarse, subequal spiral threads. Growth lines sinuous, indistinct at first, becoming increasingly prominent on mature whorls; on upper surface of mature whorls above basal carina, growth lines forming a deep, nearly symmetrical antispiral lateral sinus with gently curved and acutely inclined limbs, with vertex immediately above midwhorl and corresponding to point of maximum constriction of whorl side; lines recurving to form prospiral sinus of similar width and depth centered upon basal carina, then continuing in broad antispiral arc across whorl base to columella. Aperture incompletely known, possibly subquadrate; parietal region calloused.

Remarks.—*Kapalmerella mortoni protomortoni* n. ssp. is one of the most abundant species of gastropod in the Brightseat Formation and is represented in collections by several incomplete mature and numerous immature individuals and fragments. In its general form as well as details of protoconch and adult whorl profile and sculpture, *K. m. protomortoni* n. ssp. closely resembles *K. m. mortoni* from the overlying Aquia Formation, but it differs from the Aquia form in its considerably smaller size and more narrow and rounded anterior (basal) carina. The Brightseat form is also similar to *Kapalmerella hilli* from the Kincaid Formation (Danian) of Texas. Allmon (1996) discussed the possible evolutionary relationships among these and other forms, including *K. m. mediavia* from the Clayton Formation of the Gulf Coast and the Black Mingo Formation of South Carolina, and *K. m. postmortoni* from the Nanafalia and Tuscahoma formations (among others) on the Gulf Coast, and tentatively concluded that all of these forms were part of a single, variable and geographically widespread early Paleocene species that evolved, in toto, into another variable and widespread species in the late Paleocene, and he recognized the forms (other than *K. hilli*) as geographic/chronologic subspecies of *K. mortoni*. We retain that judgment here. Allmon suggested that a larger sample size of the forms from the Brightseat, Clayton, Kincaid, and Black Mingo formations might help further resolve the issue.



Text-fig. 11. *Kapalmerella*? sp. indet. (**1**) USNM PAL 642447, sample A-1, SEM, lateral view. (**2**) USNM PAL 642448, sample A-6, SEM, lateral view.

Kapalmerella? sp. indet.
Text-fig. 11, Table 4

Haustator? sp. Form A. Govoni, 1983: 110–112, pl. 5, figs. 9, 10.

Material examined.—Figured specimens USNM PAL 642447 and 642448 from Locality A (samples A-1 and A-6, respectively), as well as 42 incomplete multiwhorl specimens from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-10) and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, slender, gently tapering. Protoconch incompletely known, but containing at least two smooth, well-rounded volutions. Whorls of teleoconch wider than high; total number of whorls unknown, but reaching at least ten. Primary spiral thread C appearing slightly ahead of B with formula $C_1B_2A_3d$; spiral A following quickly on the succeeding volution and from its inception forming a thin but distinct cord that can equal or very nearly equal spirals B and C in strength. The first fine secondary thread appearing a short distance below the posterior suture and above spiral A by approximately the sixth volution; two additional secondaries appearing more or less simultaneously two or three

volutions later in the interspaces between spirals A, B, and C, and quickly approaching them in strength. On the most mature whorls preserved, an additional extremely fine thread is added in each of the interspaces between the earlier spirals. Primary spirals (especially A) and larger secondaries of the most mature volutions are distinctly beaded where they are crossed by growth lines. Whorl profile very slightly convex on juvenile whorls, quickly flattening and acquiring a trapezoidal outline on later adolescent to mature whorls. A small increase in the relative strength of spiral C on later whorls results in the development of a weak but noticeable basal angulation a short distance above the anterior suture that overhangs the succeeding whorl. Lateral growth line traces difficult to distinguish; lateral antispiral sinus deep, its limbs asymmetrical, with vertex located at a point slightly more than one-third of total whorl height below the posterior suture.

Remarks.—Distributed throughout the samples under study is a small number of specimens of a slender and very gently tapering turritellid that appears to differ enough from co-occurring forms in certain essential characters to be regarded as a distinct and possibly new species. However, the material at hand is not sufficiently complete to allow definitive taxonomic assignment or proper comparison with other taxa.

All of the available specimens lack complete final whorls so it is uncertain whether they represent mature or submature individuals of a relatively small species, or are simply the broken tips of a larger form. This form is more slender and gently tapering than *Kapalmerella mortoni protomortoni* n. ssp., and in fact much more closely resembles equivalent-sized specimens of "*Turritella*" *prehumerosa* n. sp. in this respect. The early ontogenetic development of its spiral sculpture and whorl profile are quite distinctive but clearly approach *K. m. protomortoni* n. ssp. more closely than "*T.*" *prehumerosa* n. sp. when details of these characters are considered. Although the relative strengths and positions of the upper three primaries differ from those observed in *K. m. protomortoni* n. ssp., the addition of the secondary spirals in this form is quite similar. The shape of the growth line trace is not diagnostic, because both *K. m. protomortoni* n. ssp. and "*T.*" *prehumerosa* n. sp. exhibit very similar traces at equivalent whorl sizes. Therefore, this form is tentatively placed in *Kapalmerella* largely on the basis of the earlier development of its primary and secondary spiral sculpture that most nearly resembles that of *K. m. protomortoni* n. ssp.

Genus ***"TURRITELLA"*** Lamarck, 1799

Remarks.—One turritellid in the Brightseat appears to belong to the "*Turritella humerosa* group" of Allmon (1996), which overlaps in part Bowles' (1939: 270) "*Turritella humerosa* Subgroup." These Paleogene Coastal Plain species are characterized by moderate to pronounced adapical carination, an apical sculpture formula of $C_1B_2A_3$, a *hybrida-imbricataria*-type lateral sinus on the growth line, a moderately shallow basal sinus, and a protoconch possibly varying from 1–1.5 to 3–4 whorls with a small P1. The group includes *Turritella aldrichi* Bowles, 1939; *Turritella biboraensis* Gardner, 1945; *Turritella claytonensis* Bowles, 1939; *Turritella eurynome* Whitfield, 1865; *Turritella gardnerae* Leblanc, 1942; *Turritella humerosa* Conrad, 1835; *Turritella multilira* Whitfield, 1865; *Turritella praecincta* Conrad, 1864; and *Turritella toulmini* Allmon, 1996. Because protoconchs and early teleoconch whorls are not known for all of these species, Allmon (1996) cautioned that their similarities could be convergent and that they might not all be closely related.

Govoni (1983) placed the Brightseat form in the genus *Torquesia* Douvillé, 1929. Douvillé erected this genus to contain Eurasian Cretaceous species with lateral growth line traces intermediate between those of Guillaume's (1924) *Turritella imbricataria* and *Turritella hybrida* groups and bearing prominent adapical carinae and beaded sculpture on the spiral ribs. The use of *Torquesia* was extended by Rutsch (1943: 163 ff.) to include species from the Paleogene of Trinidad. Allmon (1996), however, argued that the definition of *Torquesia*, and its distinction from other turritellid genera such as *Haustator*, were ambiguous. For example, the apical ontogeny is unknown for both the type species of *Torquesia* from the Cretaceous and for any of the less-sculptured forms assigned by Marwick (1957) to the genus. We therefore follow the approach of recent works of assigning turritellids that cannot be confidently assigned to a genus to "*Turritella*" s. l. (e.g., Allmon, 1996; DeVries, 2007; Anderson and Allmon, 2023; Friend et al., 2023). In doing so, we explicitly acknowledge that we do not believe that these are closely related to *Turritella* s. s. (i.e., *sensu* Marwick, 1957), which would be biogeographically implausible for the Americas, because the type species of *Turritella* s. s. is restricted to the tropical Indo-Pacific.

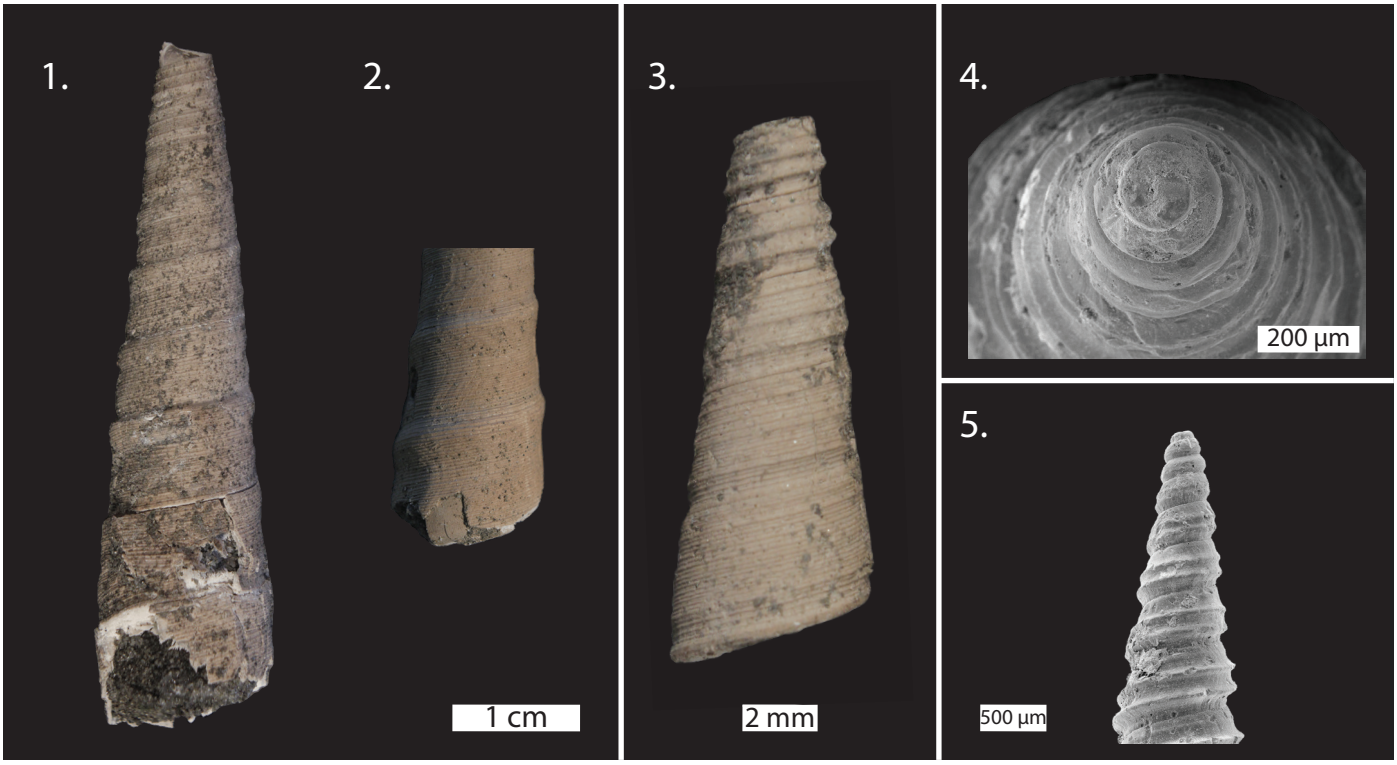
"*Turritella*" *prehumerosa* Govoni n. sp.
Text-figs. 10, 12; Table 4

Torquesia prehumerosa Govoni, 1983: 114–118, pl. 5, figs. 11–15 (unpublished).

"*Turritella*" sp. Allmon, 1996: 88, 90, pl. 13, fig. 5 [citing and quoting description by Govoni, 1983, as unpublished; ICZN, 1985: Art. 11(d)].

ZooBank LSID.—urn:lsid:zoobank.org:act:D7ED6AE5-E8FD-41D9-827A-DA56F178F9ED.

Type material.—Holotype USNM PAL 642449 from Locality A (sample A-3); paratypes USNM PAL 642450 and 642451



Text-fig. 12. "*Turritella*" *prehumerosa* Govoni n. sp. (**1**) holotype, USNM PAL 642449, sample A-3, light photograph, lateral view. (**2**) Paratype, USNM PAL 642450, sample A-5, light photograph, detail of sculpture. (**3**) Paratype, USNM PAL 642451, sample A-5, light photograph, dorsal view of early teleoconch whorls. (**4, 5**) Paratype, USNM PAL 642452, sample A-1, SEM, protoconch in oblique apical (**4**) and lateral (**5**) views.

from Locality A (sample A-5) and 642452 from Locality A (sample A-1).

Other material examined.—More than 25 single- and multiwhorl fragments consisting largely of portions of the earlier apical whorls; from Locality A (samples A-1, A-2, A-3, A-6, A-7, A-8); Locality B (sample B-1); and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—The specific epithet *prehumerosa* refers to the presence of this species in sediments immediately preceding the appearance of *Turritella humerosa,* with which it shares great morphological affinity, in the overlying Aquia Formation.

Diagnosis.—Medium-sized, slender, gently tapering turritellid; primary spirals appearing in order $C_1B_2a_3d$; mature whorls flat-sided with broad, low, rounded posterior subsutural collar and bearing numerous fine, subequal spiral threads.

Description.—Shell medium-sized, long, slender, gently tapering turriculate. Suture narrowly but distinctly impressed in earlier whorls, becoming indistinct adpressed to nearly flush on mature whorls. Protoconch erect, homeostrophic, turbinate, of approximately two smooth, rounded, rapidly expanding volutions; first volution minute, initially depressed. Whorls of teleoconch wider than high; total number of whorls unknown. Apical sculpture formula $C_1B_2A_3$, with spirals B and C quickly developing into strong, sharp-edged cords (C remaining slightly stronger than B) that dominate sculpture of juvenile and earliest adolescent whorls; spiral A initially forming low but distinct, rounded thread midway between B and posterior suture, but increasing rapidly in strength relative to concurrently weakening cords B and C until, by approximately tenth to twelfth whorl, it forms strong thread equal to B and C; spiral D appearing very early (probably prior to B) and forming distinct although increasingly obscured spiral equal in strength to A. Over same interval, whorl sides becoming very slightly convex above gentle angulation formed by primary spiral C by approximately eighth or ninth teleoconch whorl, fine secondary threads developing, first between spiral A and posterior suture and then in other interspaces below. With continuing addition and strengthening of threads in ad-

olescent whorls, sides becoming more or less flattened except for very slight inflection between anterior suture and remnant of anterior angulation, and posterior swelling on all but most mature whorls forming broad, low, rounded, although usually readily apparent subsutural collar. Numerous fine, subequal spiral threads, numbering ~ 40 in largest preserved whorls, covering entire whorl surface including subsutural collar. Last whorl lacking obvious subsutural collar and exhibiting moderately strong, spiral thread-covered carina at basal whorl angulation that apparently extends back from aperture onto penultimate whorl just above anterior suture; whorl base covered by numerous spiral threads. Growth lines indistinct, sinuous; acutely prosocline on upper third of whorl and steeply opisthocline below, forming moderately deep spiral lateral sinus with vertex above midwhorl; slope increasing on anterior third of whorl until, on lower fifth, increasing very rapidly so that lines intersect suture at nearly right angle; recurved slightly on base angulation to form very shallow spiral arc on base. Aperture incompletely known; parietal region calloused.

Remarks.—"*Turritella*" *prehumerosa* n. sp. from the Brightseat closely resembles "*Turritella*" *humerosa* of the overlying Aquia Formation. Both species show a similar apical sculpture formula and form of the adapical carina, i.e., rounded and including more than a single spiral rib. Mature individuals of "*Turritella*" *prehumerosa* n. sp. are, however, readily separable from those of "*Turritella humerosa*," which attains much greater adult size and is slightly less gently tapering than the Brightseat form. In addition, the subsutural collar of the Aquia species is stronger and more persistent on later whorls, its spiral sculpture is somewhat coarser and more variable in strength, and its growth lines tend to be more strongly etched.

The fine axial sculpture of "*Turritella*" *prehumerosa* n. sp. is similar to that of "*Turritella*" *biboraensis* from the Kincaid Formation of Texas, but the Brightseat species is somewhat smaller and possesses a much weaker subsutural collar than the Kincaid form. In size, profile of the mature whorls, and relative weakness of the subsutural collar, "*Turritella*" *prehumerosa* n. sp. approaches some individuals of "*Turritella*" *aldrichi*, a morphologically variable species widely distributed in late Danian through Selandian age deposits in Alabama, Georgia, and Louisiana (Allmon, 1996). *Turritella aldrichi* possesses a more elongate and gently tapering spire than *Turritella prehumerosa* n. sp. and differs in relative strength of the primary spirals on its earliest teleoconch whorls. The Brightseat species differs from "*Turritella*" *toulmini* in having a relatively straight whorl profile below the carina. "*Turritella*" *prehumerosa* n. sp. appears quite closely related to "*Turritella*" *calax* Garvie, 2021, from the Tehuacana Limestone of Texas, and is distinguishable only in the early teleoconch whorls: *Turritella calax* is bilirate (C_1B_2) until approximately whorls eight through ten, when spiral cord A becomes visible, whereas the A cord in "*Turritella*" *prehumerosa* n. sp. is visible, although faint, by whorl three.

Genus ***TORCULA*** Gray, 1847

Type species.—*Turbo exoletus* Linnaeus, 1758, by original designation.

Remarks.—The genus *Torcula* is based on the Recent species *Torcula exoleta* (Linnaeus, 1758) from the western Atlantic and is recognizable back to at least the Miocene (Woodring, 1957; Friend et al., 2023). Allmon (1996) suggested that his "*Turritella rina* group" of species from the Paleocene and Eocene of the U. S. Gulf and Atlantic Coastal Plain, which he placed in the genus *Haustator* Montfort, 1810, might have been ancestral to *Torcula*.

cf. *Torcula* sp. indet.
Text-fig. 13, Table 4

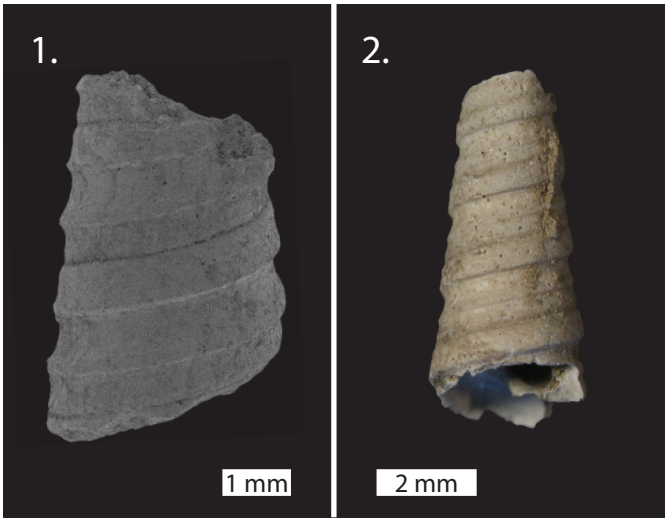
cf. *Torcula* sp. indet. Govoni, 1983: 118–120, pl. 6, fig. 1.

Material examined.—Two incomplete measured specimens, USNM PAL 642453 and 642454, from Locality A (sample A-8).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Remarks.—Two incomplete, medium-sized specimens of a turritellid, consisting respectively of approximately four earlier and two slightly later postjuvenile whorls, possess characters of shape and ornament that are apparently unique with respect to other Paleogene Gulf and Atlantic Coastal Plain forms. The shell appears to have been rather slender and gently tapering. The suture is narrowly and weakly impressed. Two primary spiral carinae form moderately strong angulations that serve to subdivide the whorl into three regions, with the central region slightly larger than the others above and below. A third very weak angulation of the whorl formed by a slight accentuation of a secondary spiral occurs in the anterior region a short distance above the suture. The posterior region is nearly flat in profile and has the appearance of overhanging the other two, both of which are concave. All three regions possess several low, closely and evenly spaced secondary spiral threads. The growth lines are indistinct and sinuous. The trace of the growth line is strongly prosocline posteriorly, forming a moderately deep antispiral lateral sinus with a gentle inflection of the slope occurring at the primary



Text-fig. 13. cf. *Torcula* sp. indet. (**1**) USNM PAL 642453, sample A-8, SEM, lateral view. (**2**) USNM PAL 642454, sample A-8, light photograph, lateral view.

whorl angulation; the shape of the line on the whorl base is unknown.

The whorl profile and the nature and extent of the spiral ornament is strongly reminiscent of that typical of the genus *Torcula*, a predominantly later-Paleogene and Neogene group of tropical to subtropical affinities in the Americas (Merriam, 1941; Allison and Adegoke, 1969). Such a strongly and symmetrically bicarinate profile is not totally restricted to *Torcula*, however, and without additional material yielding knowledge of the protoconch and sculpture of the early apical whorls, the exact taxonomic position of this form cannot be reliably determined.

In the Atlantic Coastal Plain, *Turritella vaughani* Bowles, 1939 from the middle Eocene McBean Formation in South Carolina most nearly approaches the Brightseat form in shape but possesses more widely spaced peripheral carinae and totally lacks secondary spiral sculpture.

Subfamily **PAREORINAE** Finlay and Marwick, 1937
Genus ***SIGMESALIA*** Finlay and Marwick, 1937

Type species.—*Turritella sulcata* Lamarck, 1804, by monotypy.

Remarks.—The genus *Sigmesalia* was originally erected by Finlay and Marwick (1937: 43) and included in their newly proposed family Pareoridae. The genus was considered to include several Paleogene forms from the Northern Hemisphere formerly placed in the turritellid genus *Mesalia* Gray, 1847 but separated from typical members of that genus by features of the aperture, including a much more strongly sigmoid outer lip and a very short, broad anterior canal. Later Marwick (1957: 163), agreeing with Eames (1952: 31), considered it desirable to return *Sigmesalia* to the Turritellidae, uniting it with *Mesalia* and several other genera in the subfamily Pareorinae, but noted that both apical and apertural differences are significant enough to justify retention of generic rank for it rather than the subgeneric status within *Mesalia* favored by Eames.

Although the aperture of the new Brightseat form *Sigmesalia palmerae* n. sp. is imperfectly known, it appears to more closely approach that of *Sigmesalia* than that of *Mesalia*. The Brightseat form *Sigmesalia*? *gnoma* n. sp. is placed with some uncertainty but seems to most closely match the features diagnostic of *Sigmesalia* as opposed to other turritellid genera. It possesses a multiwhorl protoconch with a small P1, unusually small size of seemingly adult individuals, a teardrop shaped aperture (although with no noticeable anterior canal), and a more deeply sinuous growth line that is diagnostic of *Sigmesalia* rather than *Mesalia* (Marwick, 1957).

Sigmesalia palmerae Govoni n. sp.
Text-fig. 14, Table 4

Sigmesalia palmerae Govoni, 1983: 121–124, pl. 6, figs. 2–5 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:882E9E93-7EBA-4A91-BB9C-C37669BE2F28.

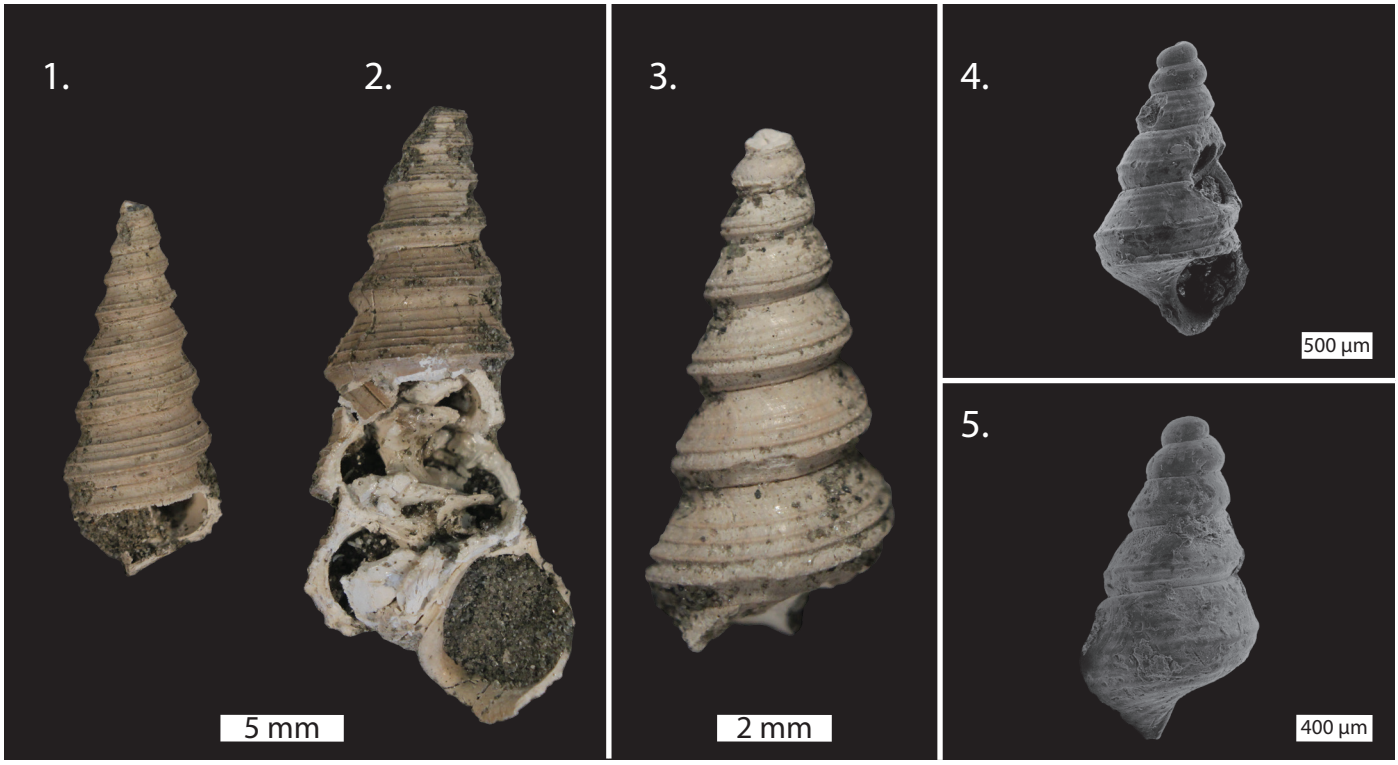
Type material.—Holotype USNM PAL 642455 from Locality A (sample A-5); paratypes USNM PAL 642456 and 642460 from Locality A (samples A-5 and A-7, respectively) and USNM PAL 642463 from Locality C (sample C-1).

Other material examined.—Measured specimens USNM PAL 642457, 642458, 642459, 642461, and 642462, plus additional single and multiwhorl fragments of 40 individuals from Locality A (samples A-1, A-7, A-8, A-10) and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of Dr. Katherine Van Winkle Palmer (1895–1982), second director of the Paleontological Research Institution, in recognition of her many important contributions to the study of North American Cenozoic Mollusca.



Text-fig. 14. *Sigmesalia palmerae* Govoni n. sp. (**1**) Holotype, USNM PAL 642455, sample A-5, light photograph, apertural view. (**2**) Paratype, USNM PAL 642456, sample A-5, light photograph, apertural view. (**3**) Paratype, USNM PAL 642460, sample A-7, light micrograph, dorsal view. (**4**) USNM PAL 642462, sample C-1, SEM, apertural view. (**5**) Paratype, USNM PAL 642463, sample C-1, SEM, dorsal view.

Diagnosis.—Medium-sized, turriculate shell of flattened-angular profile bearing carinate, anteriorly situated peripheral angulation; spiral sculpture variable, including two strong, close-set primary cords, four to six weaker secondary cords, and many extremely fine, low, closely spaced threads filling interspaces; aperture subcircular with anteriorly produced and reflected outer lip, with short, broad, moderately deep, canal-like inner anterior margin.

Description.—Shell of medium size, sturdy, turriculate, rapidly tapering, with moderately broad pleural angle. Protoconch erect, homeostrophic, smooth, rounded, turbinate, of between one and one and one-half volutions, with a minute, low, mammilate apex; merging without perceptible break into teleoconch. Suture distinct, impressed. Total number of teleoconch whorls unknown; eight volutions preserved in largest but incomplete specimen. Juvenile whorls of teleoconch quickly becoming flattened-angular in profile as carination formed by rapidly strengthening spiral cord developing between middle and anterior thirds of whorl; a second cord quickly arising anterior to the first and rapidly increasing in prominence so that after fourth or fifth volution, it usually slightly exceeds first in strength and replaces it at angulation; two primary cords remaining closely spaced throughout later whorls but shifting relative positions somewhat so that peripheral angulation occurs at approximate anterior quarter-line; later whorl profiles somewhat variable, ranging from very slightly convex to concave posteriorly and flat to concave anterior of whorl angulation. Secondary spiral elements also arising early on apical whorls but exhibiting more variability in number and relative strength; most whorls possessing fine cords immediately adjacent to both posterior and anterior sutures; two to three fine cords of equal or unequal and alternating strength are situated at nearly equal intervals between posterior primary and subsutural cords; an additional fine cord can be placed just below anterior primary cord at angulation. Interspaces between primary and secondary cords usually filled with extremely low, flattened, closely spaced threads, normally five to ten in number, that can be almost imperceptible or lacking in posterior interspaces of later whorls. Growth lines very fine, forming broad opisthocyrt arc of moderate depths on upper whorl surface, recurving slightly below to form extremely shallow prosocyrt arcs on basal whorl surface. Whorl base of immature shell flattened, sloping, with several closely spaced, low spiral ribbons. Aperture incompletely known, apparently subcircular; outer lip anteri-

orly produced and reflected, forming a short and very broad, moderately deep, canal-like inner anterior margin below, with low swelling just inside margin above.

Remarks.—Many species assigned to *Sigmesalia* and *Mesalia* exhibit very strong superficial resemblance. In poorly preserved specimens, which frequently lack complete final whorls with well-preserved apertures, it is difficult to determine the true extent to which *Sigmesalia*, included by earlier workers within *Mesalia*, could actually be distributed within the Paleogene of North America (but see Squires and Saul, 2007). In comparing *Sigmesalia palmerae* n. sp. to the North American *Mesalia* s. l., we note that Bowles (1939: 323) has pointed out that two distinct morphological groups of *Mesalia* can be recognized in the Paleocene and Eocene deposits of the Atlantic and Gulf Coastal Plains. The first and best-represented group includes those forms characterized by rounded whorls usually bearing numerous spiral cords on the adult whorls. The second group, to which *Sigmesalia palmerae* n. sp. belongs, is characterized by a strong medial to anteriorly offset carination of the whorls with more or less flattened whorl sides above and below.

The Brightseat species is the only carinate form to be found in the Atlantic Coastal Plain. The carinate group is represented in the Gulf Coastal Plain by only two described species, *Mesalia hardemanensis* (Gabb, 1860) from the Danian age Clayton and lower Porters Creek formations of the Eastern Gulf Embayment and *Mesalia sayi* Bowles, 1939, from the "lower Eocene" of Nuevo Leon, Mexico. A small fragment identified as *Mesalia*? sp. indet. and figured by Harris (1896, pl. 12, fig. 3) from undifferentiated lower Paleocene deposits in Alabama might also be referrable to the carinate group. *Sigmesalia palmerae* n. sp. is easily separated from these forms on the basis of both the number and placement of the primary and secondary spiral cords and by the persistence and more anterior position of the peripheral angulation. The carinate group is represented in western North America by a single large species, *Mesalia martinezensis* (Gabb, 1869), from the Paleocene of California. This form, which appears to bear a moderately strong similarity to the smaller *Sigmesalia palmerae* n. sp., was tentatively regarded as a *Sigmesalia* by Finlay and Marwick (1937: 41). A few poorly preserved specimens from the lower Paleocene Soldado beds in Trinidad, tentatively compared with *Mesalia martinezensis* by Rutsch (1943: 161, 162), could also be referrable to *Sigmesalia*. Outside of the Americas, *Sigmesalia instabilis* (Briart and Cornet, 1873) s. l., distributed widely in late Danian and Selandian(?) age deposits in Belgium, France, Germany, and Poland, also appears to be closely related to the Brightseat form.

Sigmesalia? *gnoma* Govoni n. sp.
Text-fig. 15, Table 4

Haustator? gnoma Govoni, 1983: 107–110, pl. 5, figs. 6–8 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:4C625734-6957-4885-B913-221BDB9C5889.

Type material.—Holotype USNM PAL 642442 from Locality A (sample A-1); paratypes USNM PAL 642443 and 642446 from Locality A (samples A-1 and A-8, respectively).

Other material examined.—Measured specimens USNM PAL 642444 and 642445 from Locality A (sample A-1); plus hundreds of additional individuals from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-10) and Locality B (samples B-1, B-2).

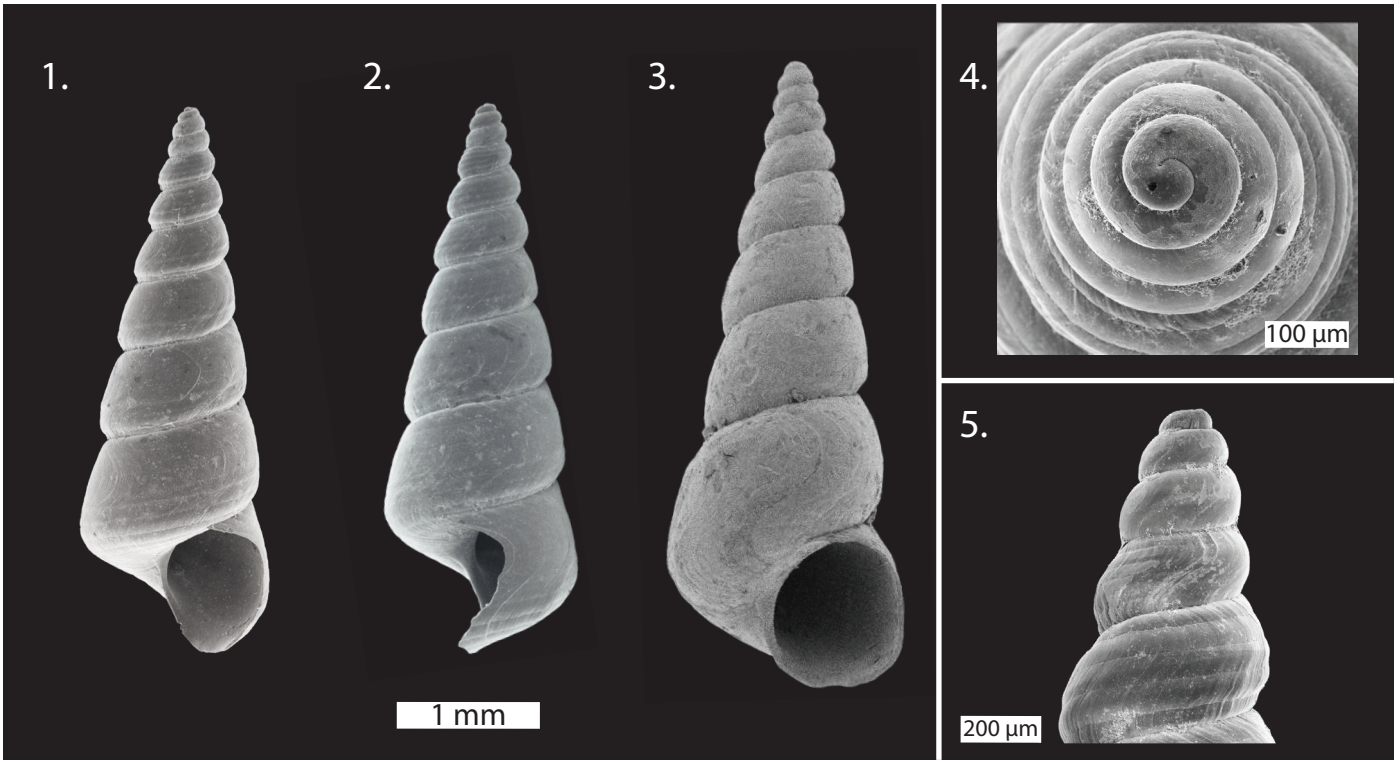
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—The specific epithet is derived from the New Latin *gnoma*, meaning "small," referencing its diminutive size.

Diagnosis.—Very small, short turritellid of few whorls with profile ranging from rounded to slightly flattened and broadly angulate anteriorly; spiral sculpture weak and sparse, usually consisting of two to three low primary cords on the upper whorl surface of mature whorls; two strongest located anteriorly at and below peripheral angulation; third very weak cord, if present, located on otherwise smooth whorl surface posterior of angulation.

Description.—Shell very small, short, tapering turriculate. Suture distinctly impressed. Protoconch erect, homeostrophic, turbinate, of roughly three and one-half smooth, rounded, rapidly expanding volutions; first half-volution minute and flush to very slightly immersed; protoconch merges into teleoconch almost without perceptible break. Whorls of teleoconch wider than high; usually numbering six or seven but occasionally reaching eight volutions. Whorl profile rounded to slightly flattened, commonly with a low, rounded but more or less distinct carinate anterior angulation, that can increase or decrease in prominence during ontogeny. Spiral sculpture generally weak and variable in number, strength, order of appearance, and persistence. Primary spiral elements consisting of two or three low, narrow to slightly broader cords that appear on earliest juvenile whorl more or less simultaneously or in order $C_1B_2A_2$, with primary spiral B and (when present) spiral A appearing within half a volution of

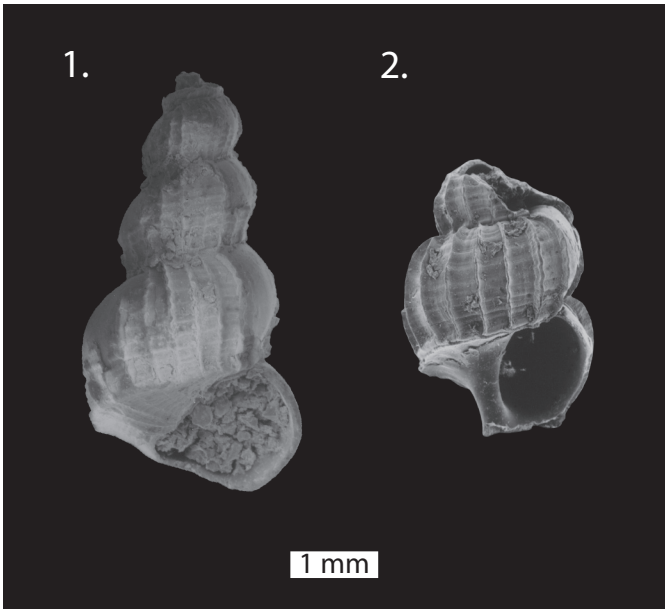


Text-fig. 15. *Sigmesalia*? *gnoma* Govoni n. sp., SEM. (**1, 2, 4, 5**) Holotype, USNM PAL 642442, sample A-1, in apertural (**1**), lateral (**2**), enlarged apical (**4**), and enlarged lateral (**5**) views. (**3**) Paratype, USNM PAL 642446, sample A-8, apertural view.

C; spiral C is usually strongest at first, although B can sometimes be equal or slightly stronger; stronger primary (C or B) initially forming peripheral carination and can persist or be succeeded by other at angulation; spiral A, when present, usually very faint and not persisting for more than two volutions; thin secondary thread can appear on mature whorls between two anterior primaries; whorl surface posterior of angulation usually smooth in mature whorls but occasionally with one or two faint secondary threads. Another thin cord (spiral D), that can sometimes be partially visible in earlier whorls at anterior suture, can be seen on last whorl of many shells to be first of several closely spaced, low spirals that cover whorl base. Growth lines obscure to moderately distinct, sinuous, on upper whorl surface more or less straight and acutely prosocline and acutely opisthocline below, forming broad, deep, antispiral lateral sinus with vertex immediately above midwhorl; slope increasing very rapidly on lower fourth of whorl below peripheral angulation, then recurving to form sinus of similar width and depth centered upon curved whorl base. Aperture occasionally preserved more or less intact, ovate to subcircular; outer lip thin, with trace of peristome sinuous and with deep sinus above, projecting rather sharply outward and slightly downward below; inner lip thin, curved; parietal wall flattened, very lightly calloused.

Remarks.—This remarkable little species is the most abundant gastropod in the Brightseat Formation and is represented in collections by more than 1,000 individuals. Despite its unusually small size, the overall combination of conch form, ornament, nature of the protoconch, and apertural shape clearly place it in the Turritellidae.

The size range exhibited by *Sigmesalia*? *gnoma* n. sp. might at first suggest that the shells are merely juvenile representatives of a larger form. However, the general uniformity of size and maximum whorl number, the total lack of substantially larger individuals (particularly when compared to the preserved range of whole and fragmental material of co-occurring turritellids), and the general condition of the final whorls, which show no sign of having been broken away from larger shells, all tend to confirm the contention that the specimens are, for the most part, mature individuals. *Sigmesalia*? *gnoma* n. sp. does not appear to be closely allied to other known North American turritellids. *Haustator furoni* Adegoke, 1977, from the upper Paleocene (Thanetian) Ewekoro Formation of Nigeria also possesses relatively few whorls with very subdued spirals, but is considerably larger than *Sigmesalia*? *gnoma* n. sp. and exhibits the pattern of early spiral ontogeny characteristic of *Haustator* ($C_1B_2A_3$).



Text-fig. 16. *Cirsotrema* (*Elegantiscala*) sp. indet., SEM, apertural views. (**1**) USNM PAL 642489, sample A-6. (**2**) USNM PAL 642490, sample A-8.

Subcohort **HYPSOGASTROPODA**
Bouchet et al., 2017
Superfamily **EPITONIOIDEA** Berry, 1910
Family **EPITONIIDAE** Berry, 1910
Genus ***CIRSOTREMA*** Mörch, 1852

Type species.—*Scalaria varicosa* Lamarck, 1822, by monotypy.

Subgenus ***ELEGANTISCALA*** de Boury, 1910

Type species.—*Scalaria elegantissima* Deshayes, 1861, by original designation.

Cirsotrema (*Elegantiscala*) sp. indet.
Text-fig. 16, Table 4

Cirsotrema (Elegantiscala) sp. Form A. Govoni, 1983: 142–144, pl. 8, figs. 1–3.

Material examined.—Three incomplete figured specimens, USNM PAL 642488, 642489, and 642490, plus ten additional single and multiwhorl fragments from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-9) and Locality B (sample B-2).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Mature shells small to medium-sized. Ornament of numerous nearly vertical to posteriorly forward-arching, thin, relatively closely spaced, moderately raised axial costae of regularly rounded profile with single or occasionally multiple sets of gently wavy lamellae. Low-rounded but distinct spiral threads separated on early whorls by spaces equal to thread width that become filled with secondary threads later in ontogeny and that strengthen rapidly to equal the primaries. Spirals crossing intercostal spaces up the abapertural side of the axial lamellae, developing wavy shape of axials. Basal whorl angulation defined by strong cord separating upper surface from flat to gently concave base; axial and spiral sculpture, reduced in strength, continuing across basal surface. Narrow umbilical aperture present in largest specimens, but most anomphalous. Complete aperture unknown, but more or less subcircular.

Remarks.—A number of single and multiwhorl fragments of this strongly and complexly sculptured *Cirsotrema* are present in the collections. The subgenus *Elegantiscala* is very poorly represented in the Paleogene of the North American Coastal Province. In addition to the Brightseat form, only two other species, both from the Eocene of the Gulf Coastal Plain, have been attributed to the subgenus (and placed within the genus *Epitonium* Röding, 1798). The first, "*Epitonium*" (*Elegantiscala*) *kingae* Palmer, 1937, from middle Eocene deposits in Louisiana, is a very small species that is more gently tapering and that possesses fewer spirals than the Brightseat shells. The second, "*Epitonium*" (*Elegantiscala*) *aldrichi* (de Boury, 1912), described as coming simply from the Eocene of Alabama, is based upon a single specimen, now apparently lost. On the basis of the original description and figure (reprinted by Palmer, 1937: 95, 96, pl. 10, fig. 9), it appears that this form also differs substantially from the Paleocene shells, being considerably larger and possessing fewer large primary and many more and finer secondary spiral threads.

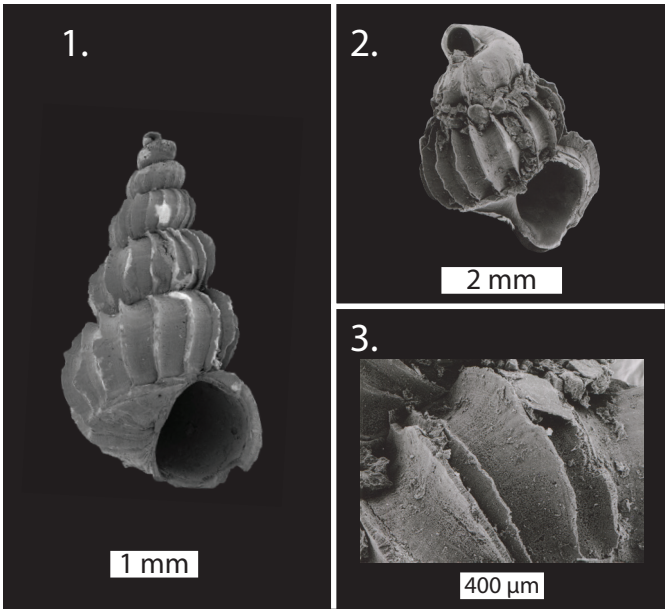
The Brightseat *Elegantiscala* very likely represents a new species, but the incomplete nature of the available specimens makes specific designation undesirable.

Subgenus ***CORONISCALA*** de Boury, 1909

Type species.—*Scalaria coronalis* Deshayes, 1861, by original designation.

Cirsotrema (*Coroniscala*) sp. indet.
Text-fig. 17, Table 4

Cirsotrema (Coroniscala) sp. Form B. Govoni, 1983: 144, 145, pl. 8, figs. 4–6.



Text-fig. 17. *Cirsotrema* (*Coroniscala*) sp. indet., SEM. (**1**) USNM PAL 642491, sample A-1, apertural view. (**2, 3**) USNM PAL 642492, sample A-1, in oblique apertural (**2**) and surface detail (**3**) views.

Material examined.—Two incomplete figured specimens, USNM PAL 642491 and 642492, plus 18 additional single and multiwhorl fragments from Locality A (samples A-1, A-2, A-6, A-9) and Locality B (samples B-1, B-2).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Aquia Formation? (Selandian–Thanetian).

Description.—Shell small to medium-sized. Axial costae strongly and consistently arcuate; single vertical to slightly forward-leaning, nonwavy broad blades curving sharply inward above to form a narrowly rounded to angulate posterior shoulder. Sculpture of a number of more or less evenly spaced, shallow grooves that cut across the intercostal spaces and climb the abapertural side of the axial blades; moderately to strongly developed basal carina; spirals can be extremely weak and occasionally absent. Axial and probably spiral sculpture continuing across basal surface. Narrow umbilical aperture present in one specimen, but most anomphalous. Aperture circular.

Remarks.—A number of incomplete specimens of an apparently small to medium-sized epitoniid are present in the Brightseat samples that appear, on the basis of general form and sculpture, to be more closely allied to several Coastal Plain taxa placed by earlier workers in *Coroniscala* than to the co-occurring *Cirsotrema*, *Cirsotrema* (*Elegantiscala*) sp. indet. In *Coroniscala*, the axial costae are more strongly and consistently arcuate than in *Elegantiscala*, and the blades are broader and somewhat sturdier than the lamellae of *Elegantiscala*. The basal surface of *Coroniscala* appears to be slightly more strongly inclined than in *Elegantiscala*.

Several *Coroniscala* are described from the Eocene of the Gulf Coastal Plain that bear a general resemblance, particularly in the structure and shape of the axial blades, to the Brightseat species. These Eocene species are easily distinguished from the Paleocene form by their more strongly developed spiral ornament that more closely approaches that seen in *Elegantiscala*.

A single broken specimen of *Cirsotrema* (USNM PAL 207089) illustrated and discussed by Clark and Martin (1901: 154, pl. 28, fig. 12) under the name *Scala carinata* Lea, 1833 from the overlying Aquia Formation might belong to the Brightseat species.

Superfamily **NATICOIDEA** Guilding, 1834
Family **NATICIDAE** Guilding, 1834
Subfamily **POLINICINAE** Gray, 1847
Genus ***NEVERITA*** Risso, 1826

Type species.—*Neverita josephinia* Risso, 1826, by monotypy.

Subgenus ***NEVERITA*** s. s.

Diagnosis.—Globose to ovate naticid with umbilical callus entirely covering umbilicus and not divided into two lobes by transverse groove (after Marincovich, 1977: 301).

Neverita (*Neverita*) *potomacensis* Govoni n. sp.
Text-fig. 18, Table 4

Neverita (*Neverita*) *potomacensis* Govoni, 1983: 159–161, pl. 10, figs. 1–12 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:3C4C1581-CAAC-44BF-B25A-42D52E8C30AE.

Type material.—Holotype USNM PAL 642502 from Locality A (sample A-1); Paratype USNM PAL 642505 from Locality A (sample A-1).

Other material examined.—Measured specimens USNM PAL 642503, 642504, 642506, 642507, 642508, and 642509, plus numerous individuals and fragments from Locality A (samples A-1, A-2, A-3, A-5, A-6, A-8, A-10) and Locality B (sample B-2).

Text-fig. 18. *Neverita* (*Neverita*) *potomacensis* Govoni n. sp., sample A-1, light photographs. (**1–4**) Holotype, USNM PAL 642502, in apertural (**1**), lateral (**2**), dorsal (**3**), and apical (**4**) views. (**5–8**) Paratype, USNM PAL 642505, in apertural (**5**), lateral (**6**), dorsal (**7**), and apical (**8**) views.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named for the valley of the Potomac River and its tributaries, the region in which it was discovered.

Diagnosis.—Medium-sized, elongately ovate to subglobose shell with broad, thick, protrusive parietal callus merging into similarly strong umbilical callus that partially fills and completely covers umbilicus.

Description.—Shell of medium size, moderately sturdy, elongately ovate to subglobose. Sutures impressed above, usually becoming adpressed below. Protoconch of three smooth, round-topped volutions with distinctly impressed sutures, elevated only slightly above teleoconch whorls and sometimes separated from them by impressed line. Teleoconch usually not exceeding approximately four rapidly expanding volutions; spire very low to slightly elevated; whorls somewhat flattened adjacent to posterior suture, becoming gently convex to slightly flattened below; last whorl moderately inflated, broadly rounded on sides, drawn out anteriorly. Shell surface glazed, lacking ornamentation except for distinct prosocline growth lines that are flexed slightly abaperturally where outer lip overrides parietal callus. Aperture highly oblique, subovate, subangulate posteriorly, well rounded anteriorly, often flattened on inner side; outer lip gently rounded to somewhat flattened posteriorly, becoming more strongly rounded below; inner lip strongly calloused. Parietal callus broad, massive, posteriorly forming thick outward-facing lobe that extends beyond apertural angle, remaining thick or thinning somewhat before merging with broad umbilical callus, and continuing below umbilicus as thickened rim on columellar lip that thins rapidly and disappears as columellar lip merges with outer lip. Umbilical callus developing early and usually completely obscuring umbilicus throughout all or most of ontogeny of teleoconch; callus can form flattened or distinctly rounded plug that can be separated from parietal callus above or, more frequently, from columellar lip rim below by shallow, distinct or indistinct groove situated normal or slightly inclined to axis of coiling; callus can occasionally be incompletely developed or more frequently can thin away from aperture and, by subsequent chipping or breakage, reveal narrow slit-like umbilical aperture. Umbilicus lacking fissure.

Remarks.—This form is remarkable for its possession of a massive and protrusive parietal callus and especially the extent to which the similarly strong umbilical callus into which it merges obscures and nearly completely plugs the umbilicus. The extent and consistency with which the umbilical callus covers the umbilicus would appear to place the Brightseat form within the limits of *Neverita* s. s. as rather broadly defined by Marincovich (1977: 300), who regarded the degree of umbilical closure to be of primary importance in subdividing the often otherwise difficult to distinguish Polinicinae. The Brightseat *Neverita* is separated from members of the subgenus *Glossaulax* Pilsbry, 1929, by the lack of a consistently developed transverse groove dividing the umbilical callus into anterior and posterior lobes.

Neverita (*Neverita*) *potomacensis* n. sp. can be distinguished from similarly shaped poliniciform shells in the lower Cenozoic of the Atlantic and Gulf Coastal Plains by the disposition and strength of its parietal and umbilical callus and the consistency with which the umbilicus is obscured by the callus. A specimen figured by Harris (1896, pl. 12, fig. 17) as *Natica onusta* Whitfield, 1865, apparently from the lower Selandian Matthews Landing Marl Member of the Porters Creek Formation in Alabama, seems to closely resemble *Neverita* (*Neverita*) *potomacensis* n. sp. although the parietal callus does not appear from the drawing to be greatly thickened or protrusive as in many of the Brightseat specimens. It is doubtful that this Alabama specimen actually represents Whitfield's species. Whitfield's original description (copied by Harris, 1896: 118) as well as a figure of the holotype provided by Gardner (1945, pl. 14, fig. 14) under the name *Neverita onusta* indicate that the latter is much more compressed vertically, the shell being wider than high, with flattened whorl sides above, and with an umbilical callus even more massive and much more rounded and button-like than either the form figured by Harris (1896) or the Brightseat species. A number of unnamed *Polinices* Montfort, 1810 variously distributed in the late Thanetian Nanafalia and Tuscahoma formations and in the lower Ypresian Hatchetigbee Formation in Alabama, earlier placed within Whitfield's *Neverita onusta* (see Palmer and Brann, 1966: 848; Toulmin, 1977: 233), approach some members of *Neverita* (*Neverita*) *potomacensis* n. sp. in general shape and strength of the callus, but typically retain a narrow umbilical opening.

"**RISSOIFORM CLADE"** Bouchet et al., 2017
Superfamily **TRUNCATELLOIDEA** Gray, 1840
Family **ELACHISINIDAE** Ponder, 1985
Genus ***ENTOMOPE*** Cossmann, 1888

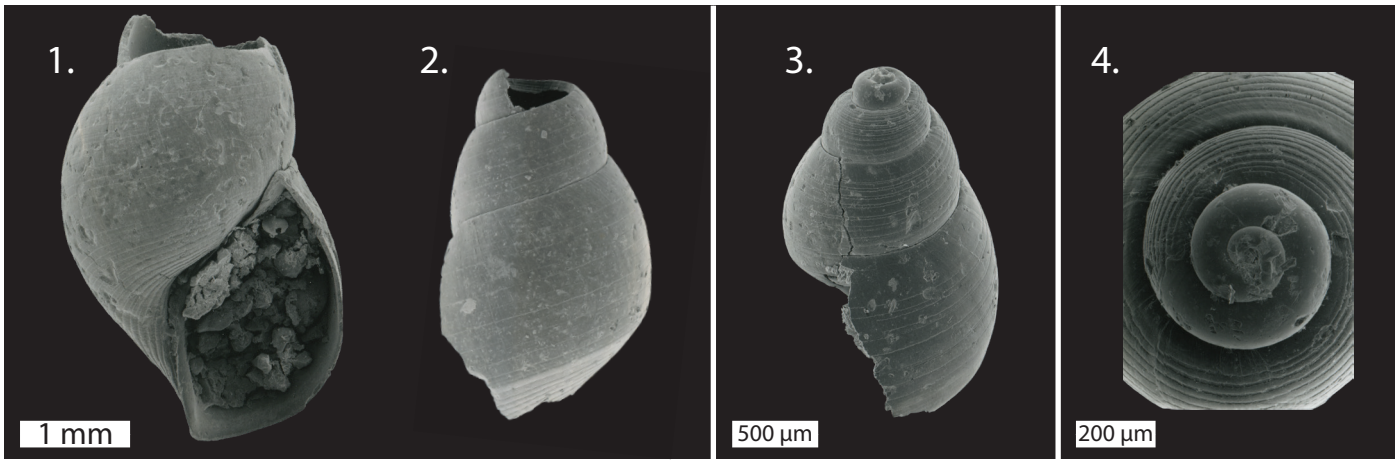
Type species.—*Litiopa klipsteini* Cossmann, 1882, by original designation.

Entomope marylandica (Clark and Martin, 1901)
Text-fig. 19, Table 4

Litiopa marylandica Clark and Martin, 1901: 152, pl. 28, fig. 6–6a.
Litiopa marylandica Clark and Martin. Palmer and Brann, 1966: 741.
Medoriopsis (*Entomope*) *marylandica* Govoni, 1983: 70–73, pl. 1, figs. 7–11 (unpublished).

Type material.—Holotype USNM PAL 207084 from the Aquia Formation of King George's County, Virginia.

Other material examined.—Three incomplete figured specimens, USNM PAL 642418, 642419, and 642420, plus two additional incomplete specimens, from Locality A (samples A-1, A-9).



Text-fig. 19. *Entomope marylandica* (Clark and Martin, 1901), SEM. (**1**) USNM PAL 642418, sample A-1, apertural view. (2) USNM PAL 642420, sample A-9, lateral view. (**3, 4**) USNM PAL 642419, sample A-1, in oblique lateral (**3**) and apical (**4**) views.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Virginia: Aquia Formation (Selandian).

Diagnosis.—Small, ovate-conic shell with deep pseudoumbilicate slit; sculpture of numerous fine, evenly spaced spirals that extend from earliest teleoconch whorls to the basal surface of adult whorls; smooth, bluntly turbinate protoconch of roughly two volutions.

Description.—Shell small, thin, glossy, ovate-conical; protoconch homestrophic, bluntly turbinate, of two to three smooth, rounded, rapidly expanding volutions, the first of which is immersed; upper (intersutural) teleoconch whorl surfaces initially with very fine spiral striae; later whorls smooth with very fine spiral striae or very low spiral ribbons; underside of whorls below basal angulation with numerous closely and evenly spaced spiral ribbons; aperture large, auriform; peristome thin, continuous; outer lip sharply angulated posteriorly, truncated and slightly emarginate anteriorly; columellar lip narrow, straight, anteriorly produced, reflected; pseudoumbilicus reduced to moderately deep, elongate slit.

Remarks.—*Entomope marylandica* was originally attributed to the genus *Litiopa* Rang, 1829, on the basis of a single specimen, the holotype USNM PAL 207084, from the Selandian–Thanetian age Aquia Formation in Virginia. The holotype is a worn and broken specimen of six whorls that is apparently lacking a final volution. None of the available Brightseat specimens are as complete as the holotype, but all are better preserved. The Brightseat specimens all closely resemble the holotype in size, shape, and form of the protoconch, but exhibit a range of variability in the form and strength of the spiral sculpture on the whorl sides not apparent in the Aquia representative. The spirals can consist of very fine striae or very low, evenly-spaced ribbons that can be either broad with broad interspaces or narrow with narrow interspaces.

The Brightseat and Aquia material is placed in the genus *Entomope* from the Eocene of the Paris Basin on the basis of overall size, shape, protoconch form, and particularly apertural form, which conforms quite closely to that of the type species of *Entomope*. Clark and Martin (1901: 152) might have originally misassigned the Aquia holotype to *Litiopa* because of the relatively strong superficial resemblance that it bears to the Holocene genotype, *Litiopa melanostoma* Rang, 1829, or similar forms. It is also possible that they erroneously interpreted the significance of the shape of the columella and basal margin of the aperture that, due to breakage of the holotype, does indeed appear to approach the rather blunt, truncated form typical of *Litiopa*.

Despite the superficial resemblance between the two genera, the Brightseat and Aquia specimens, as well as other members of the genus *Entomope*, can be readily distinguished from *Litiopa* on the basis of protoconch form. The protoconch of *Entomope* is characteristically bluntly turbinate, consisting of a few rounded, highly polished volutions that lack sculpture. In contrast, the protoconch of *Litiopa* has been shown to be more erect and conical, and to be highly sculptured (Lebour, 1945; Robertson, 1971).

The genus *Entomope* is well represented in the upper Paleocene and Eocene of Europe and is particularly abundant in the middle Eocene of the Paris Basin. From the lower Paleocene, Kollmann and Peel (1983) reported two species of *Entomope* from the middle Danian Agatdal Formation in West Greenland; the Brightseat species most closely resembles their *Entomope* sp. 1 in general shape, but is differentiated by possessing more prominent basal sculpture and a broader aperture. Schnetler (2001) described a species from the Selandian of Denmark, *Entomope kirstineae* Schnetler, 2001, which he also stated appears closely related to the West Greenland form; it differs from the Brightseat species in its considerably more prominent psuedoumbilical slit, but otherwise closely resembles *Entomope marylandica* in shape and ornament. In continental North America, the genus does not appear to be represented in the Paleogene of the Gulf Coast, although Dockery (1993) described a Late Cretaceous species, *Entomope ponderi* Dockery, 1993, from the Coffee Sand (Campanian) of Mississippi. In the Atlantic Coastal Plain, in addition to *Entomope marylandica*, *Litiopa palaeosargassina* Maury, 1910, from the Miocene Oak Grove Sands of Florida, which closely resembles the Paleocene species, also belongs to *Entomope*.

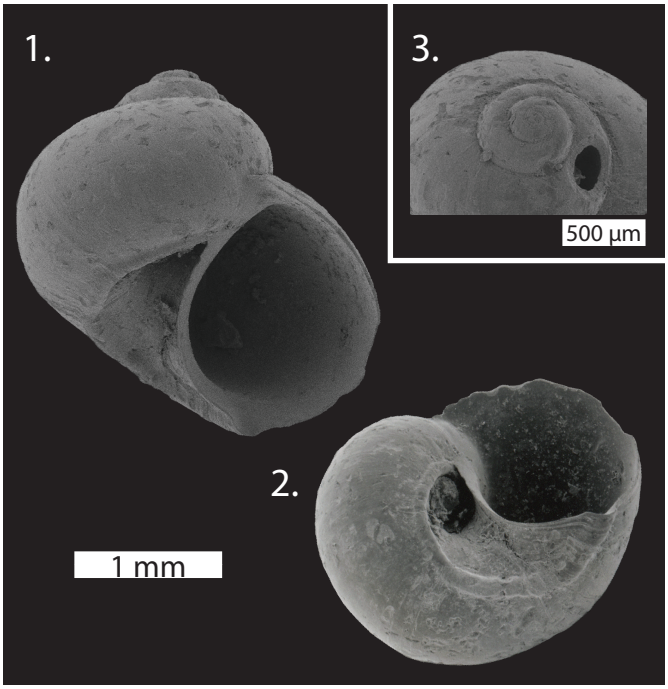
Genus ***PSEUDOCIRSOPE*** Boettger, 1907

Type species.—*Lacuna* (*Pseudocirsope*) *galeodina* Boetgger, 1907, by monotypy.

Remarks.—WoRMS elevates *Pseudocirsope* to genus level from being a subgenus of *Lacuna*. Representatives of *Lacuna* W. Turton, 1827 s. s. have previously been reported from deposits older than Oligocene in age in the Gulf or Atlantic Coastal Plains only by Garvie (2021: 70) who figured a species identified as *Lacuna* sp. indet. from the Danian Tehuacana Limestone of Texas.

Pseudocirsope feorra Govoni n. sp.
Text-fig. 20, Table 4

Lacuna (*Pseudocirsope*) *feorra* Govoni, 1983: 68–70, pl. 1, figs. 3–6 (unpublished).



Text-fig. 20. *Pseudocirsope feorra* Govoni n. sp., holotype, USNM PAL 642416, sample A-2, SEM, in apertural (**1**), oblique basal (**2**), and apical (**3**) views.

ZooBank LSID.—urn:lsid:zoobank.org:act:F613CA7E-A2DF-42AB-A731-C6DB5B8942C3.

Type material.—Holotype USNM PAL 642416 from Locality A (sample A-2); paratype USNM PAL 642417 from Locality A (sample A-1).

Other material examined.—None.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—The specific epithet is derived from the Anglo-Saxon *feor*, meaning "remote in space and time," referring to the species' substantial temporal and geographic separation from other members of the genus.

Diagnosis.—Very small, rounded turbiniform *Pseudocirsope* with a wide, deep, well-exposed umbilicus separated from the basal whorl surface by a distinct, raised, well-rounded, and thickened spiral cord that forms a very short, distinct, downward-produced, shallowly excavated, beak-like extension at intersection with peristome at base of columella.

Description.—Shell very small, rounded turbiniform, phaneromphalous, low-spired. Protoconch minute, homeostrophic, worn but apparently slightly depressed, probably of little more than one volution. Whorls approximately five in number, sutures impressed; whorl sides convexly rounded, somewhat flattened near posterior suture, becoming more uniformly and broadly rounded below; last whorl greatly inflated, well rounded except for very low, more or less indistinct, narrowly rounded subsutural collar, and strong, raised, well-thickened and rounded spiral cord separating basal whorl surface from umbilicus. Umbilicus well exposed, broad, deep, circular in outline within, with broadly convex walls. Shell surface appearing glazed; spiral sculpture inconsistently developed, consisting of a few extremely indistinct, fine, shallow striae on the posterior third of last whorl; axial sculpture limited to distinct, closely-spaced prosocline growth lines. Aperture very large, broadly ovate, very broadly angulate posteriorly; peristome thin, continuous; outer lip broadly arched; inner lip concave, parietal portion consisting of narrow band of callus adhering to parietal wall; columellar portion, corresponding to margin of umbilical wall, broad, very slightly reflected above, and becoming forward-projecting below; transition from outer lip to base of columellar lip curved, interrupted only by a small but distinct, very short, slightly downward-produced, shallowly excavated, beak-like extension of the peristome formed at distal margin of circumbilical cord.

Remarks.—This species differs from *Lacuna* s. s. by its well-rounded turbiniform shape and possession of a much broader umbilicus bounded by a strong, rounded circumbilical cord that terminates at the base of the columellar lip in a characteristic short, shallowly excavated, beak-like extension of the peristome.

Pseudocirsope does not appear to have been recognized in the continental North American Cenozoic prior to the identification of *Pseudocirsope feorra* n. sp. in the Brightseat. It is well represented by several species in middle Eocene through Pliocene deposits in Europe. In the lower Paleocene of Europe, it is represented by a single species, *Lacuna* (*Pseudocirsope*) *ovalis* von Koenen, 1885, from Selandian age deposits in Denmark, which appears to somewhat resemble the Brightseat form. Rosencrantz (1970) reported the occurrence of *Pseudocirsope* in the lower Paleocene (middle Danian) Agatdal Formation in West Greenland. *Pseudocirsope feorra* n. sp. also superficially resembles some members of the Neogene subgenus *Eulithidium* Pilsbry, 1898, of the phasianellid genus *Tricolia* Risso, 1826. These shells are similar in size and shape to those of *Pseudocirsope* but are characterized by a much narrower umbilical groove bounded by a sharp-edged ridge that lacks the distal projection typical of *Pseudocirsope*.

Family **IRAVADIIDAE** Thiele, 1928
Genus **PASITHEOLA** Cossmann, 1896

Type species.—*Pasithea claibornensis* I. Lea, 1833, by subsequent designation (Cossmann, 1896).

Pasitheola marylandensis Govoni n. sp.
Text-fig. 21, Table 4

Pasitheola marylandensis Govoni, 1983: 151–153, pl. 9, figs. 2, 3 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:05E7DEA8-3472-4BE9-8B46-B83ABE2DE171.

Type material.—Holotype USNM PAL 642496 from Locality A (sample A-1).

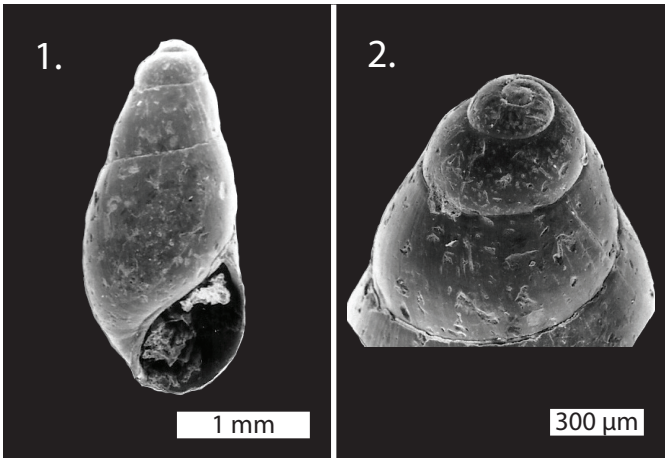
Other material examined.—Two additional fragmental individuals from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named after the state of Maryland, in which it was discovered.

Diagnosis.—Shell very small, smooth, low-spired, blunt-tipped, elongate-ovate; protoconch relatively large, bluntly turbinate; teleoconch whorls lengthening rapidly relative to width with last volution equal to three-quarters of total shell height; aperture lacriform, acutely angled posteriorly; outer lip thickened within, particularly toward posterior margin, and bearing anteriorly expanding and strongly prosocline external rim-like band.



Text-fig. 21. *Pasitheola marylandensis* Govoni n. sp., holotype, USNM PAL 642496, sample A-1, SEM, in apertural (**1**) and oblique apical (**2**) views.

Description.—Shell very small, low-spired, rather blunt-tipped, elongate-ovate, anomphalous; last whorl three-quarters of total shell height. Protoconch relatively large compared to total shell, bluntly turbinate, of three smooth, glazed, very rapidly expanding volutions tilted very slightly to teleoconch coiling axis; first volution minute, flattened, rising very slightly above subsequent volutions; whorls separated by impressed sutures; transition to teleoconch abrupt, marked by impressed line, slight roughening of subsequent shell surface, and rapid relative increase in intrasutural whorl height that causes suture to appear to dip and then rise across boundary. Teleoconch of approximately two and one-quarter glazed, rapidly lengthening volutions; whorl sides very gently convex over most of length, flattening very slightly just below narrow, adpressed suture to give impression of very narrow, nearly imperceptible subsutural band. Spiral sculpture absent; axial sculpture confined to numerous fine, very gently prosocline growth lines. Just behind aperture, outer whorl surface exhibiting abrupt break in deposition; renewed shell formation directed slightly outwardly so apertural margin appears to rise above level of earlier surface and develop anteriorly expanding and strongly prosocline rim-like band. Aperture lacrifom, incurved, and acutely angled posteriorly forming narrow notch within, widest opposite columella; outer lip gently curved and forward-directed posteriorly and medially, becoming more strongly curved and slightly patulous below and extending slightly below base of columella; lip narrow at margin, somewhat thickened well behind margin below but becoming more strongly thickened just behind posterior margin adjacent to angulation; columellar lip of moderate length, narrow, concave, outward-facing and slightly reflected below, well calloused; parietal wall moderately broad, very gently convex, rather distinctly calloused, particularly posteriorly and toward columella.

Remarks.—The appearance of *Pasitheola marylandensis* n. sp. in the Brightseat Formation marks the earliest known occurrence of the genus, which is represented by several species in the Eocene of the Paris Basin and by two or three species, including the genotype *Pasithea claibornensis*, from the middle Eocene deposits of the Gulf Coastal Plain. Of the North American species, the Brightseat form is nearest the genotype but is relatively more elongate and narrower than that species and does not exhibit its characteristic partial closure of the aperture at the posterior angulation. The Maryland species

bears a strong resemblance to one or more of the Paris Basin forms, particularly *Pasitheola macera* Cossmann, 1899.

The systematic position of *Pasitheola* has long been uncertain. The various possible relationships of the genus were discussed in detail by Palmer (1937: 68, 69) and by Gougerot and Le Renard (1977: 48, 49). The genus has variously been placed in the marine family Eulimidae (= Melanellidae) by Conrad (1866) and Palmer (1937) and in the predominantly nonmarine Melaniidae (= Thiaridae) by Cossmann (1909, as a section of *Balanocochlis* Fischer, 1885), Wenz (1939, as a subgenus of *Anculosa* Say, 1821), and by Gougerot and Le Renard [1977, as the genus *Pasitheola,* fide Cossmann and Pissaro (1910–1913)]. More recently, it has been placed in Iravadiidae (e.g., Le Renard, 1995).

Family **TEINOSTOMATIDAE**
H. and A. Adams, 1853
Genus ***TEINOSTOMA*** H. and A. Adams, 1853

Type species.—*Teinostoma politum* A. Adams, in H. and A. Adams, 1853, by subsequent designation (Cossmann, 1888).

Remarks.—This genus was formerly placed in the family Vitrinellidae.

Teinostoma cf. *regularis* Garvie, 2021
Text-fig. 22, Table 4

Teinostoma aff. *barryi* Leblanc. Govoni, 1983: 73–76, pl. 2, figs. 1–6. Not *Teinostoma barryi* Leblanc, 1942.
Teinostoma regularis Garvie, 2021: 83, pl. 9, figs. 20, 21.

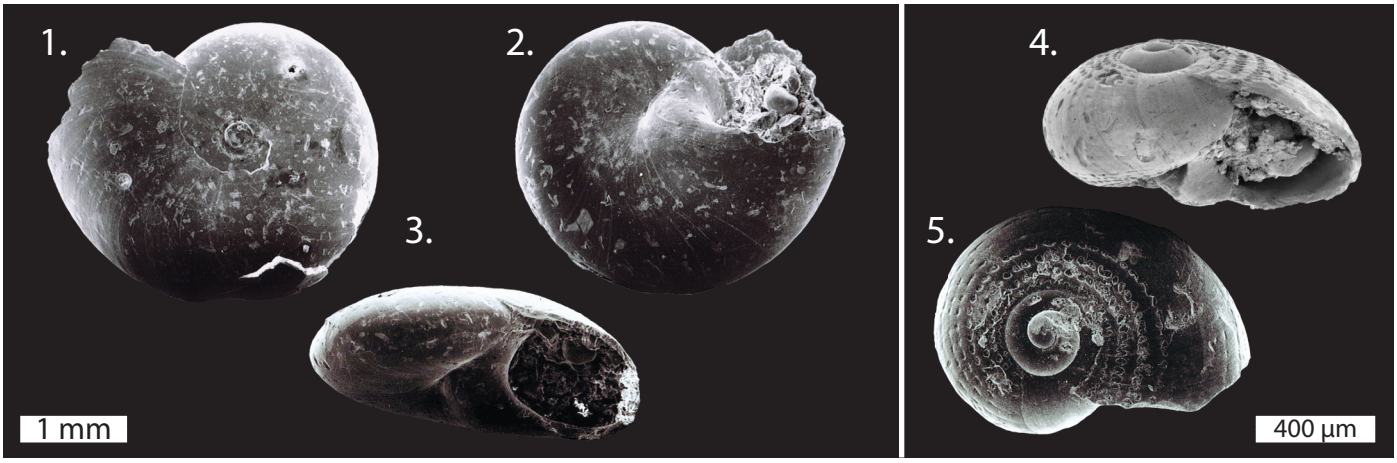
Type material.—Holotype NPL 93584 from the Danian Tehuacana Limestone Member of the Kincaid Formation in Falls County, Texas.

Other material examined.—Measured individuals USNM PAL 642421, 642422, 642423, 642424, 642425, 642426, 642427, 642428, and 642429, plus additional adult and juvenile shells and fragmentary material representing ~ 90 individuals, from Locality A (samples A-1, A-2, A-7, A-9), Locality B (samples B-1, B-2), and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell very small, glazed, sturdy, sublenticular, anomphalous, with more or less flush to very slightly sunken spire. Protoconch of approximately three nearly smooth, globose, convexly rounded volutions, separated by impressed sutures, with very low spire that rises slightly above first teleoconch whorl to approximate level of enveloping final whorl of teleoconch; junction between protoconch and teleoconch sharp, marked by flattening of upper whorl surface and impressed axial line separating unornamented protoconch from strongly ornamented teleoconch. Teleoconch of roughly two rapidly laterally expanding, posteriorly flattened, and peripherally submedially rounded volutions; first teleoconch volution enveloping and partially obscuring part of protoconch; last whorl similarly overlapping penultimate whorl obscuring much of posterior surface; base of final volution broadly flattened convex. Sutures more or less distinct, adpressed.



Text-fig. 22. *Teinostoma* cf. *regularis* Garvie, 2021, SEM. (**1–3**) USNM PAL 642423, sample A-1, in apical (**1**), basal (**2**), and apertural (**3**) views. (**4, 5**) USNM PAL 642421, sample A-1, in oblique apertural (**4**) and apical (**5**) views.

Strength and distribution of spiral sculpture variable, consisting in earlier part of penultimate whorl of a number of closely spaced rows of distinctly punctate grooves that can become quite strong, particularly on apical surface and marginal to and within umbilical depression; strong spirals of earlier portion of penultimate whorl rarely visible except on immature shells or occasionally nearest posterior suture of mature specimens due to extent of overlap of final volution; spirals becoming slightly more numerous and closely spaced but rapidly weakening and losing punctate appearance in later portion of penultimate whorl; spirals usually totally lacking on last whorl except for a few extremely obscure lines that can continue on apical surface nearest suture or on base. Axial sculpture limited to extremely numerous fine growth lines that slope in moderately deep prosocline arc across upper whorl surface, straightening and inclining slightly abaperturally across periphery, and recurving in relatively gentle opisthocline arc across base. Umbilicus of immature shell initially narrowly open behind strong, funicle-like ridge within broad, inward-sloping depression of shell base; funicular wad rapidly thickening and becoming expanded and reflected to form smooth-surfaced, convexly curved callus plug; plug extending a short distance onto base beyond limit of umbilical depression that it usually fills except for shallow groove or sometimes a minute opening behind upper margin of columellar lip. Aperture oblique, subcircular in immature shell and becoming slightly expanded laterally in mature shell, narrowly and obliquely grooved at posterior margin of inner lip; outer lip very narrow at margin, arched forward above; inner lip concave; parietal lip narrow, thinly coated with callus that continues downward into strongly callus-reinforced, reflected columellar lip.

Remarks.—Despite the availability of several relatively well-preserved specimens, the precise taxonomic relationship of this form is uncertain. As with other teinostomatid and vitrinellid genera, taxonomic evaluation using only conchological criteria is difficult owing to both intraspecific variation of characters such as general outline, extent of umbilical closure, and development of spiral sculpture, and to superficial convergence of unrelated forms arising from the relative simplicity of shell architecture. This latter problem is particularly acute in the more or less smooth-shelled species of *Teinostoma*.

The early ontogenetic development of the Brightseat shells is very interesting. The strongly punctate grooves visible on the apical and basal whorl surfaces, and the shallow "open" umbilical depression, out of which projects the strong funicle-like ridge that terminates in a broad, facet-like umbilical wad behind the lower portion of the inner lip, are seen only in the earlier portion of the penultimate (first teleoconch) whorl. These features strongly resemble those seen in mature individuals of the genus *Solariorbis* Conrad, 1865, including those of the genotype, *Solariorbis depressus* (I. Lea, 1833). These *Solariorbis*-like features are quickly suppressed (and hidden) in the latter part of the penultimate and final whorls in favor of a generally smooth, strongly overlapping, anomphalous shell form unmistakably of the *Teinostoma* type. The sequential expression during ontogeny of these rather distinctly different shapes and ornamental patterns, rarely visible in the mature shells, suggests the possibility that a somewhat closer phylogenetic link could exist between the two genera than might be apparent from comparison of mature individuals alone.

Comparison of the Brightseat shells with those from elsewhere in the Paleogene of the Atlantic and Gulf Coastal Plains indicates that they most closely resemble *Teinostoma regularis*, from the Danian Tehuacana Limestone in Texas. It is also similar, although less so, to *Teinostoma harryi* from the lower Eocene Sabinetown Formation of Louisiana and to *Teinostoma harrisi* Palmer, 1937, from the lower Eocene (Ypresian) Nanjemoy Formation in Virginia. *Teinostoma eoa* Gardner, 1935, from the uppermost Danian to lower Selandian Wills Point Formation in Texas, is based on a single, probably immature specimen that is much thinner than the Brightseat shells.

Family **TORNIDAE** Sacco, 1896
Genus ***ANTICLIMAX*** Pilsbry and McGinty, 1946

Type species.—*Teinostoma* (*Climacia*) *calliglyptum* Dall, 1903, by monotypy.

Anticlimax? *gardnerae* Govoni n. sp.
Text-fig. 23, Table 4

Anticlimax? *gardnerae* Govoni, 1983: 89–92, pl. 3, figs. 10–12 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:04C13D1B-3646-4592-AAFD-01A78BBF4119.

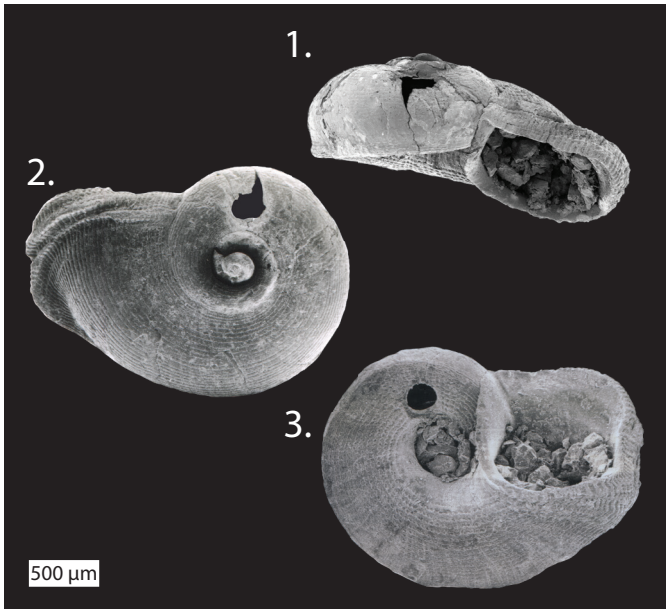
Type material.—Holotype USNM PAL 642435 from Locality A (sample A-6).

Other material examined.—None.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. Julia Gardner of the United States National Museum of



Text-fig. 23. *Anticlimax*? *gardnerae* Govoni n. sp., holotype, USNM PAL 642435, sample A-6, SEM, in apertural (**1**), apical (**2**), and basal (**3**) views.

Natural History of the Smithsonian Institution, for her important contributions to the study of the Cenozoic Mollusca of the Gulf and Atlantic Coastal Plains.

Diagnosis.—Very small, phaneromphalous shell with highly depressed dome-shaped spire and flattened base separated by distinct peripheral carina; sculpture of numerous fine, low, closely spaced spiral threads with punctate interspaces and very low collabral axial threads; aperture oblique, quadrate, with strongly thickened and reflected outer lip.

Description.—Shell very small, sturdy, phaneromphalous, with depressed dome-shaped spire and flattened base. Rapidly expanding whorls total four in number, including two and one-half smooth, rounded volutions of protoconch that rise slightly above subsequent whorls. Suture rather adpressed; later whorls very narrowly overlapping earlier whorls. Posterior surface of teleoconch flattened to very slightly concave near suture, becoming broadly rounded and somewhat inflated abaxially onto periphery; in last whorl, side flattening slightly below midline of periphery and sloping very gently inward to meet narrow but distinct, outward-facing basal peripheral carina at angulation between upper surface and base; basal surface sloping inward toward broad, deep, open umbilicus. Spiral ornament distinct, beginning abruptly at start of teleoconch, consisting of numerous low, closely spaced threads; threads fine and most closely spaced on upper whorl surface, obscure on periphery, becoming more distinct again on basal carina, and continuing onto anterior surface, where they become more distinct again on basal carina, and continuing onto anterior surface, where they become broader and more widely spaced toward umbilicus; umbilical wall initially smooth except for very fine lines of growth, with a few additional irregularly developed threads appearing on the wall well within umbilicus. Axial sculpture consisting of very low, closely spaced collabral threads sloping in gently prosocline arc across upper whorl surface and describing slightly sinuous curve on basal surface; axials widening somewhat at intersection with spirals to impart finely punctate appearance to shell surface; axials and punctae very weak and obscure on upper surface, strongest on base; group of axials on base thickening very slightly at more or less regular intervals to form extremely obscure, radiating waves. Aperture very large and highly oblique, subcircular within but quadrate at margin; peristome continuous, moderately thick, posteriorly, medially, and adaxially flattened, and gently rounded anteriorly, sharply notched and internally grooved at inner posterior margin, broadly emarginate at upper peripheral angulation, more narrowly emarginate at intersection with basal carina, weakly serrated by intersecting spiral threads; outer lip posterior of intersection with basal carina much thickened behind margin and irregularly wrinkled and reflected externally; inner lip not as thick as outer lip, extending forward and very gently reflected above, becoming slightly thicker and more reflected below along the periphery of umbilical wall as it curves to meet outer lip.

Remarks.—This unique little species does not appear to be closely related to other known Paleogene forms of the Gulf and Atlantic Coastal Plains, and its precise taxonomic position is uncertain. It lacks the compact, lens-like subdiscoidal shape and the smooth, thick callous pad covering the umbilical region that is characteristic of *Teinostoma*. Like the Brightseat form, representatives of *Circulus* Jeffreys, 1865, are openly umbilicate, but tend typically to be thinner-shelled and more nearly discoidal or lenticular in shape, with distinctly impressed sutures, a thin ovate peristome, and fewer, stronger spiral threads that are more irregular in size and distribution. Some members of the strongly phaneromphalous genus *Cyclostremiscus* Pilsbry and Olsson, 1945, exhibit a similarly flattened base and a more or less inflated but depressed upper surface separated from the base by a strong peripheral carina that, at least in gross aspect, resembles the Brightseat form. However, the cyclostremiscids also tend to possess several additional strong spiral keel-forming carinae on the last whorl and the aperture is not thickened behind the margin. In its possession of numerous fine spiral threads with punctate interspaces, the Brightseat shell also bears a certain resemblance

to *Solariorbis*, but it lacks the usually strong umbilical cord or ridge and marginal callus lobe characteristic of that genus.

Genus ***CYCLOSTREMISCUS*** Pilsbry and Olsson, 1945

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

Cyclostremiscus sohli Govoni n. sp.
Text-fig. 24, Table 4

Cyclostremiscus sohli Govoni, 1983: 86–89, pl. 3, figs. 7–9 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:B63F1947-A4BA-4C27-88E1-884A81808E9F.

Type material.—Holotype USNM PAL 642434 from Locality A (sample A-1).

Other material examined.—One additional specimen from Locality A (sample A-6).

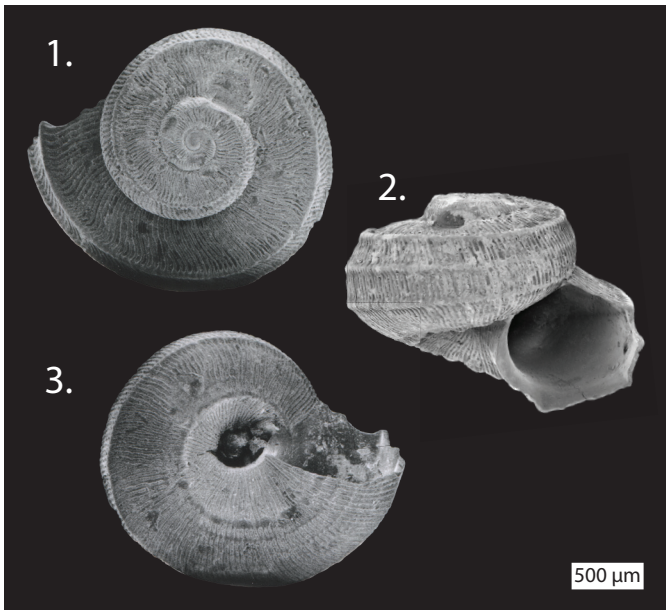
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. Norman F. Sohl of the United States Geological Survey, for his important contributions to the study of fossil gastropods in the Gulf and Atlantic Coastal Plains.

Diagnosis.—Very small, low-spired, posteriorly flattened, phaneromphalous shell with four distinct primary spiral carinae and strong axial ornament of evenly and closely spaced collabral riblets.

Description.—Shell very small, sturdy, posteriorly flattened, low spired, phaneromphalous, consisting of three and one-half rapidly expanding whorls. Protoconch of approximately one-half of a volution, smooth, rounded, distinct but immersed slightly below rim of following whorl. Suture impressed. Approximately first half volution of teleoconch convexly rounded, bearing only axial riblets, then developing rapidly strengthening carina at whorl shoulder that bounds broad, flattened sutural ramp of approximately one-third whorl width. Posterior ramp initially tilting inward toward shell axis, then flattening and finally tilting increasingly away from axis as it approaches aperture. Below shoulder carina, middle third of whorl initially convexly rounded, becoming subdivided by appearance of second primary carina on penultimate whorl slightly before final volution that divides it into subequal to equal regions: an upper, flattened to slightly concave, slightly posteriorly inclined portion, and lower, flattened to slightly concave portion, the outline of which initially parallels shell axis but becomes increasingly anteriorly inclined. A third strong carina, apparently covered by partial overlap of final whorl, becoming visible in the final third of the penultimate whorl and forming lower boundary to middle third of whorl. Below this carina, basal third of final whorl turning sharply inward toward umbilicus from which it is separated by a strong, raised, beaded circumbilical carina that develops distinct nodes as it nears aperture. In addition to primary carinae, additional spiral elements developing in basal region of whorl including a low but distinct and continuous cord developing just before the circumbilical carina and four less-distinct to very indistinct cords added consecutively on last quarter of whorl. Umbilicus deep, funnel-shaped. Axial ornament consisting of distinct, closely and evenly spaced, occasionally bifurcating, rounded collabral riblets that curve adaperturally across spiral carinae and extend completely into umbilicus. Peristome not thickened at margin; aperture large, circular within, at margin remaining uniformly curved on inner side of peristome but becoming flattened between notches formed by intersection of four primary carinae and outer side of peristome; fifth poorly developed notch forming where outer lip meets parietal wall. Parietal portion of aperture equal in width to distance between third and fourth



Text-fig. 24. *Cyclostremiscus sohli* Govoni n. sp., holotype, USNM PAL 642434, sample A-1, SEM, in apical (**1**), apertural (**2**), and basal (**3**) views.

(circumbilical) carinae and covered by thin callus. Inner lip, corresponding below parietal wall to margin of umbilical wall, somewhat reflected. Shell smooth within except for shallow groove extending inward beneath the posterior (shoulder) carina.

Remarks.—The generic name *Cyclostremiscus* was first applied to a number of modern western American tropical species of small umbilicate shells typified by depressed or discoidal shape, the possession of several keel-forming spiral carinae and axial riblets or striae, and thin, continuous, externally unthickened apertures (Pilsbry and Olsson, 1945: 266). In North America, Gardner (1948: 189) recognized the genus in the Neogene deposits of the middle Atlantic Coastal Plain and Pilsbry (1953: 424–430) in the Neogene of Florida. Palmer and Brann (1966: 618, 619) extended its range into the middle and early Eocene of the Gulf Coastal Plain by reassigning species previously attributed to the genera *Skenea* Fleming, 1825, *Circulus*, and *Adeorbis* Wood, 1848. None of these forms closely resemble *Cyclostremiscus sohli* n. sp., and the assignment of one of them, *Cyclostremiscus dalli* (Bush, 1897), to the genus is in fact highly questionable. Many members of the genus *Circulus* bear a strong superficial resemblance to the cyclostremiscids in both size and general shape (particularly the development of keel-forming carinae on low-spired or discoidal shells). This similarity might be seen, for example, in *Circulus montensis* (Rutot in Cossmann, 1915) as figured by Glibert (1973, pl. 4, fig. 4) from the late Danian Calcaire de Mons of Belgium. The most striking difference between the Brightseat *Cyclostremiscus* and the Belgian *Circulus* is the development in the latter genus of numerous spiral cords rather than strong axial riblets between the primary carinae. Without detailed knowledge of living representatives, the exact relationship between these two genera is uncertain, but the possession of extensive or well-developed intercarinal axial ornament in conjunction with or at the expense of spiral ornament in *Cyclostremiscus* might be the most useful characteristic upon which to separate fossil representatives of the two genera.

Genus ***SOLARIORBIS*** Conrad, 1865

Type species.—*Delphinula depressa* I. Lea, 1833, by subsequent designation (Dall, 1892).

Solariorbis laurelae Govoni n. sp.
Text-fig. 25, Table 4

Solariorbis laurelae Govoni, 1983: 79–81, pl. 2, figs. 11–14 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:43227B85-AA3B-4CFA-8395-97F61627059A.

Type material.—Holotype USNM PAL 642431 from Locality A (sample A-2).

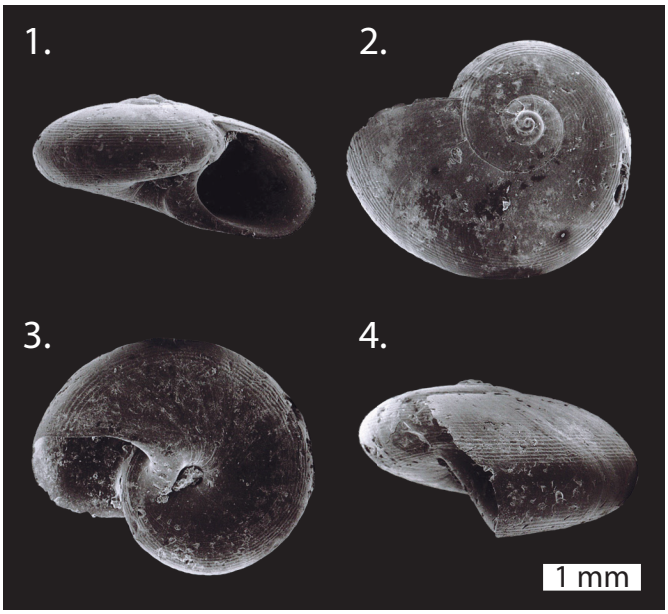
Other material examined.—Six fragmental individuals from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of Laurel M. Bybell of the United States Geological Survey, not only for her important contributions to the study of the micropaleontology and biostratigraphy of the Paleogene deposits of the Gulf and Atlantic Coastal Plains, but especially for her help and support that contributed so decisively to the completion of this study.

Diagnosis.—Very small, narrowly phaneromphalous, sublenticular shell with very depressed spire, rounded at periphery; umbilical walls thickened, convex; spiral sculpture of very fine, shallow, closely spaced striae on posterior surface and outer half of base; inner portion of base covered by smooth, slightly thickened layer of columellar callus extending outward from umbilicus; aperture large, oblique, subcircular; outer lip very narrow; columellar lip forming thick, outward facing, crescent-shaped facet at margin.



Text-fig. 25. *Solariorbis laurelae* Govoni n. sp., holotype, USNM PAL 642431, sample A-2, SEM, in apertural (**1**), apical (**2**), basal (**3**), and lateral (**4**) views.

Description.—Shell very small, relatively sturdy, very narrowly phaneromphalous, highly depressed, sublenticular. Whorls roughly four and one-half in number including protoconch of roughly two and one-half smooth, low convex volutions that are very slightly elevated above teleoconch. Sutures narrowly but distinctly impressed on protoconch, becoming more nearly adpressed in teleoconch. Whorls of teleoconch rapidly expanding; posterior surface more or less flattened near suture, very broadly and gently rounded abaxially; periphery rounded; anterior surface broad, flattened, sloping very gently to deep, narrow umbilicus; umbilical walls thickened, convex, appearing loosely coiled or disjunct within. Shell surface glossy or with nacreous luster. Spiral sculpture consisting of very fine, shallow, closely spaced striae; striae evenly distributed across posterior surface, although extremely weak on central third and perceptively stronger toward periphery; spirals weakening again across periphery and can disappear completely on later portion of last whorl; striae appearing again on slightly more than outer half of shell base, strongest nearest periphery but weakening rapidly toward axis; smooth, slightly thickened columellar callus extending outward from umbilicus to cover slightly less than half of base. Growth lines sinuous, of very fine, narrow grooves of somewhat irregular strength and spacing; lines sloping in gentle but increasingly inclined prosocline arc on upper whorl surface, straightening and cutting almost vertically across periphery, curving very gently inward away from aperture across outer half of base, and finally straightening before proceeding into umbilicus; whorl base marked at more or less regular intervals by very obscure, radiating collabral waves of slightly thickened shell. Intersection of growth lines and spiral striae imparting extremely vaguely cancellate appearance to posterior surface of shell. Aperture large, oblique, subcircular except for rather broad and weakly grooved posterior angulation at intersection of outer lip and parietal wall; outer lip very narrow at margin, arched forward above; columellar lip concave, thickened, and reflected at margin of umbilical wall and inner portion of shell base to form rather broad, well-calloused, outward-facing, convexly rounded, crescent-shaped facet; parietal wall narrow, gently convex, lightly calloused within.

Remarks.—*Solariorbis laurelae* n. sp. is represented by a single complete and several badly broken specimens. In general form and particularly in the distribution and relative strength of its spiral elements, *Solariorbis laurelae* n. sp. is rather similar to the type species, *Solariorbis depressus* from the middle Eocene of Alabama and South Carolina. However, the Brightseat form is smaller and lacks the spirally "punctate" appearance typical of the genotype. The Brightseat species is close to *Solariorbis proius* Gardner, 1935 from the upper part of the lower Paleocene (Danian) Kincaid Formation in Texas, but can be separated from it by the latter species' possession of much fewer, usually weaker and less persistent spiral striae on the posterior shell surface, its subtrigonal aperture, and by its somewhat more compressed form. *Solariorbis planulatus* Garvie, 2021, from the Danian Tehuacana Limestone of Texas, is similar in size and shape, but differs from *Solariorbis laurelae* n. sp. in its small to closed umbilicus and punctate lirae. *Solariorbis subangulatus smithii* (Aldrich, 1921) from the late Thanetian Tuscahoma Formation in Alabama also appears to be very close to *Solariorbis laurelae* n. sp. but is much larger and possesses a smooth, raised, collar-like area adjacent to the posterior suture. All of these forms are similar, although larger in size, than the Late Cretaceous species *Solariorbis clara* (Sohl, 1960) from the Campanian Coffee Sand of Mississippi (Dockery, 1993).

Solariorbis? sp. indet.
Text-fig. 26, Table 4

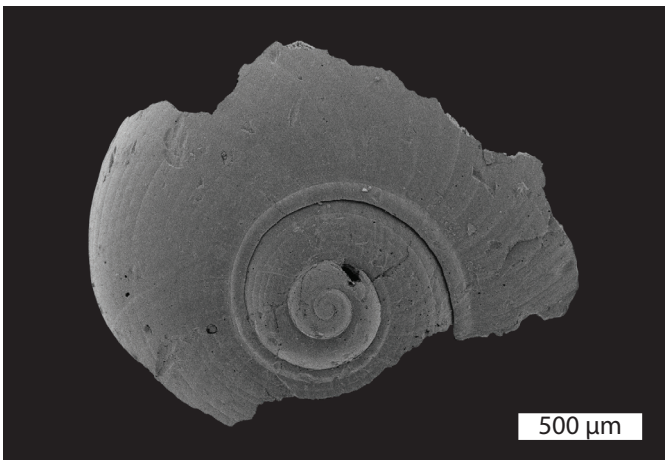
Solariorbis sp. Form A. Govoni, 1983: 82, 83, pl. 3, figs. 1, 2.

Material examined.—Single figured specimen, USNM PAL 642432, from Locality B (sample B-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell fragment small. Protoconch round, of roughly three volutions, and elevated above the subsequent whorls. Spire depressed. Posterior surface of teleoconch whorls broadly rounded abaxially; last preserved whorl very bluntly rounded at periphery; whorl surface possessing very



Text-fig. 26. *Solariorbis*? sp. indet., USNM PAL 642432, sample B-1, SEM, apical view.

narrow, ramp-like spiral collar that slopes steeply away from suture into shallow depression before becoming convexly rounded over remaining surface. Spiral ornament consisting of many very fine, evenly spaced, shallow striae developed over entire preserved teleoconch whorl surface; spirals strongest nearest suture; intersection of spirals and relatively strong growth lines imparting vaguely beaded appearance to adaxial portions of whorl surfaces.

Remarks.—A single fragment consisting of a smooth, rounded protoconch of roughly three volutions plus the posterior portions of two teleoconch whorls resembles *Solariorbis* in size, shape, and ornament. The spire is considerably less depressed than in *Solariorbis laurelae* n. sp., and the protoconch is much more clearly elevated above the subsequent whorls. The spirals are strongest nearest the suture and are considerably less numerous and more widely spaced than in *Solariorbis laurelae* n. sp. The relative strength and disposition of the spiral sculpture, and particularly the development of the subsutural spiral collar and depression, very closely resembles those seen in *Teinostoma* (= *Solariorbis*) *regularis* Aldrich, 1921 from the middle Eocene (Bartonian) Gosport Sand in Alabama. Palmer (1937: 51) regarded Aldrich's species as a synonym of *Solariorbis depressus*. *Solariorbis subangulatus smithii* from the late Thanetian Tuscahoma Formation in Alabama also possesses a similar raised subsutural collar but is apparently much larger, is more depressed posteriorly, and lacks spirals on the whorl periphery.

Family **VITRINELLIDAE** K. J. Bush, 1897
Genus ***CIRCULUS*** Jeffreys, 1865

Type species.—*Delphinula duminyi* Requien, 1848, by monotypy.

Diagnosis.—"Shell small, circular, not nacreous, of few more or less convex whorls usually more or less grooved and carinated; aperture nearly circular, oblique, somewhat angulated below; peritreme simple, more or less continuous, in the adult modified on the body-whorl into a very thin glaze which is absent in the young; umbilicus wide, the reverse of the spire" (Bush, 1897: 111, for *Circulus* s. s.).

Remarks.—Several workers (e.g., Bush, 1897: 110, 111; Woodring, 1928: 438, 439; Gardner, 1947: 599) have noted and discussed the confusion that has arisen as a result of attempts to classify the numerous small, depressed or low-spired vitrinellid (and related) taxa bearing strong and usually extensive spiral ornament and a broad deep umbilicus using only conchological criteria. The resulting proliferation of generic names (e.g., *Adeorbis*; *Cyclostrema* Marryat, 1819; *Tornus* Turton and Kingston, 1830) of overlapping and frequently shifting specific content bears testimony to the inadequacy of the purely conchological approach to the subdivision of this group of shells. Unfortunately, even with a thorough revision of the modern groups based upon anatomical criteria, completely consistent and satisfactory division of the many superficially convergent fossil taxa will probably remain impossible. In view of these difficulties, the approach taken here to the classification of the single broken specimen of subdiscoidal, strongly phaneromphalous, and spirally ornamented vitrinellid described below is simply to apply the name "*Circulus*" in the more or less informal sense envisioned by both Woodring (1928) and Gardner (1947). In so doing, the essential structural qualities of the shell and the specimen's obviously unique taxonomic position relative to the co-occurring vitrinellid form are emphasized.

"*Circulus*" sp. indet.
Text-fig. 27, Table 4

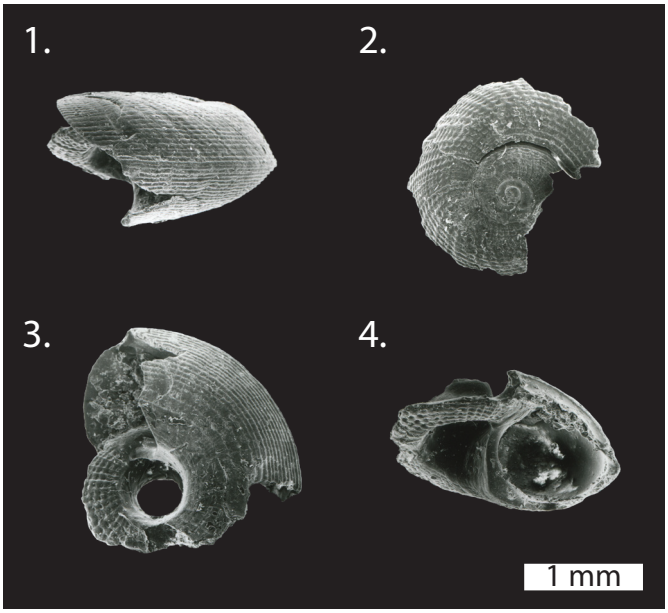
"*Circulus*" sp. Form A. Govoni, 1983: 84–86, pl. 3, figs. 3–6.

Material examined.—Single incomplete specimen, USNM PAL 642433, from Locality A (sample A-2).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell very small, inflated subdiscoidal, of approximately four volutions including smooth, posteriorly flattened, and depressed protoconch of two whorls. Teleoconch posteriorly depressed, whorls adaxially flattened both above and below but slope rather steeply abaxially to strong although noncarinate submedial peripheral angulation; last whorl much inflated. Umbilical periphery more or less sharply angulate and slightly reinforced within; umbilicus moderately broad, deep; on last whorl, umbilical wall weakly thickened, nearly flat sided, very gently sloping within and unornamented except for fine growth lines. Spiral sculpture strong, consisting of numerous closely spaced threads separated by narrower grooves; threads broadest approaching umbilicus on basal shell surface. Axial sculpture of numerous closely spaced growth lines sloping in strongly prosocline arc across upper whorl surface and recurving at peripheral angulation to form gentler prosocyrt arc across base to umbilicus; many axials strengthening substantially away from periphery and aperture forming closely spaced collabral riblets on apical and basal shell surface; intersection of riblets with spirals imparting strongly punctate to somewhat reticulate appearance to adaxial whorl surfaces. Subcircular aperture quite large and



Text-fig. 27. "*Circulus*" sp. indet., USNM PAL 642433, two pieces of the same specimen, sample A-2, SEM, in lateral (**1**), apical (**2**), basal (**3**), and oblique apertural (**4**) views.

oblique; outer lip angled and internally grooved at inner posterior margin, broadly curved, thin, and obscurely serrate posteriorly due to intersection of spirals, angled and narrowly emarginate at intersection with peripheral angulation, shape unknown anteriorly; above, inner lip short, concave, calloused over parietal wall; below the inner lip corresponding to margin of umbilical wall and appearing straight in apertural view but strongly concave in profile, slightly reflected above and broadening below to form narrow, slightly reflected, forward-facing, calloused shelf or facet at margin of circumbilical angulation before curving to meet outer lip.

Remarks.—The single specimen available is badly damaged. Nevertheless, it is readily separable from the co-occurring Brightseat vitrinellid and from other Paleogene Coastal Plain forms, including those currently attributed to *Circulus*, on the basis of both outline and the nature and distribution of the spiral and axial sculpture. In general outline, the Brightseat specimen approaches *Circulus ottonius* Harris and Palmer, 1947, from the upper Eocene Moodys Branch Formation in Mississippi. That species is, however, substantially larger, with a somewhat less depressed spire and more strongly rounded whorls compared to the Paleocene shell. In addition, the Eocene form bears a basal carination, the umbilicus is slightly broader, the umbilical walls more rounded, and the weaker and stronger spiral elements are distributed with respect to each other in a manner quite unlike that displayed in the Brightseat shell. The strongly punctate appearance of the apical and basal spirals of the Brightseat form is reminiscent of many members of the genus *Solariorbis*, although the general shape, size of the umbilicus, and lack of strong reinforcement of the umbilical wall with the callus to form a distinct ridge and terminal lobe preclude assignment to that genus.

The Brightseat "*Circulus*" is very likely new, but the lack of sufficient and adequately preserved material prevents adequate comparison with existing taxa and renders the erection of a new taxon inadvisable.

Genus ***VITRINELLA*** C. B. Adams, 1850

Type species.—*Vitrinella helicoidea* C. B. Adams, 1850, by subsequent designation (Bush, 1897).

Subgenus ***VITRINELLOPS*** Pilsbry and Olsson, 1952

Type species.—*Vitrinella zonitoides* Pilsbry and Olsson, 1952, by original designation.

Vitrinella (*Vitrinellops*) *clarkmartinorum* Govoni n. sp.
Text-fig. 28, Table 4

Vitrinella (*Vitrinellops*) *clarkmartini* Govoni, 1983: 77–79, pl. 2, figs. 7–10 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:F5DC32DA-1D42-46C4-BBA5-727BCFAB9A36.

Type material.—Holotype USNM PAL 642430 from Locality A (sample A-1).

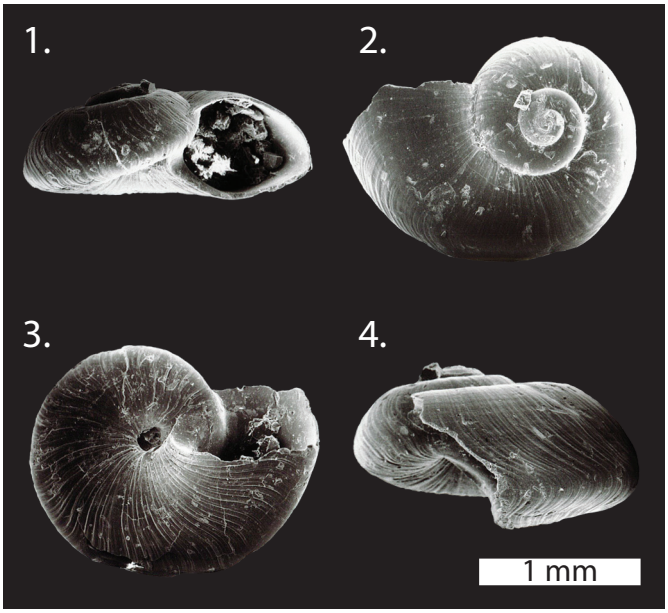
Other material examined.—Single extremely small fragment from Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. William B. Clark, former State Geologist of Maryland, and the late Dr. George C. Martin, formerly of the United States Geological Survey, in recognition of their very important early contributions to the stratigraphy and paleontology of the Paleogene deposits in Maryland and Virginia.

Diagnosis.—Very small, thin, phaneromphalous, subdiscoidal vitrinellid with very low, depressed spire, narrowly rounded basal peripheral angulation, and flattened base; umbilical walls convex, lacking marginal spiral ridge; spiral sculpture barely developed on posterior surface; growth lines distinct, sinu-



Text-fig. 28. *Vitrinella* (*Vitrinellops*) *clarkmartinorum* Govoni n. sp., holotype, USNM PAL 642430, sample A-1, SEM, in apertural (**1**), apical (**2**), basal (**3**), and lateral (**4**) views.

ous; aperture very large, oblique, angular ovate, arched forward above, sharply incurved to form narrow sinus at basal periphery.

Description.—Shell very small, thin, phaneromphalous, rapidly expanding, subdiscoidal, with very low, depressed spire and flattened base. Whorls roughly four in number including two smooth, dull, flattened-convex volutions of protoconch. Sutures distinctly impressed, situated in well-marked depression. Whorls of teleoconch narrowly arched posteriorly; rather wide, broadly rounded, and gently sloping abaxially in last whorl to basal peripheral angulation; basal angulation rounded but becoming increasingly narrow toward aperture; anterior surface of shell very broad, low flattened-convex, sloping gently inward to deep, narrow umbilicus; umbilical walls convex, somewhat thickened but without distinct marginal spiral cord or thread, appearing loosely coiled or disjunct within. Shell surface glossy; spiral sculpture lacking except for a number of extremely obscure, shallow striae on upper surface of last whorl. Growth lines sinuous, closely spaced and distinct, particularly on base; lines sloping in increasingly inclined prosocline arc on upper whorl surface, recurving sharply across basal angulation to form moderately deep narrow sinus, curving gently outward again toward aperture in broad, very shallow arc into umbilicus. Aperture very large, oblique, angular ovate; peristome thin, apparently arching forward above, curving sharply inward to form narrow sinus at basal periphery, nearly straight across base; outer lip posteriorly arched, curving broadly outward medially, sharply incurving across basal angulation, basally flattened; columellar lip extended and strongly inclined, thickened at margin of umbilical wall to form narrow, weakly concave, posteriorly truncated crescent-shaped, slightly reflected, lightly calloused facet; parietal wall narrow, convex, very lightly calloused.

Remarks.—This little *Vitrinella* is assigned to the subgenus *Vitrinellops* owing to the convexity of the umbilical walls and the lack of a distinct spirally emergent marginal umbilical cord or thread like that of *Vitrinella* s. s.

Vitrinella is not well represented in the earlier Paleogene deposits of the Gulf and Atlantic Coastal Plains and none of the forms currently assigned to the genus appear closely related to *Vitrinella* (*Vitrinellops*) *clarkmartinorum* n. sp.

Superfamily **VANIKOROIDEA** Gray, 1840
Family **EULIMIDAE** Philippi, 1853

Remarks.—The nomenclature applied in the subfamilial division of this family is in a state of considerable confusion. Apparently owing to their mode of life (commonly that of ectoparasites on echinoderms), the eulimids generally possess rather small, structurally uncomplicated shells that, particularly in fossil forms, tend to make taxonomic differentiation difficult. Further complications in attempting to satisfactorily subdivide the family have arisen due to the differing degrees of importance attached by various workers to simple shell characters, such as profile and thickness, shape of the aperture and outer lip, curvature of the spire, and coloration, which were later shown to be subject to wide variation within a single species or to be similarly developed by several distinct taxa (see, e.g., Dall, 1915: 80–82; Palmer, 1947: 223, 224; Gougerot, 1969: 117–119). The overemphasis in classification placed upon such simple shell characters of questionable diagnostic value has led to the introduction of a plethora of wholly or partially overlapping generic and subgeneric names for the eulimids. As a result, the specific content and usage of these taxa remains confused and inconsistent.

The Eulimidae is represented in the Brightseat Formation by only a few complete shells and shell fragments. The specimens appear to be separable into two distinct forms. However, considering the state of eulimid taxonomy as indicated above, as well as the paucity of material and the distinct possibility that one or both of the Brightseat taxa might be represented by only immature or at best submature individuals, it does not seem useful to attempt to place the material at hand in a specific generic or subgeneric category of unclear status. Therefore, the Brightseat forms will be regarded as belonging simply to the genus *Eulima* Risso, 1826 s. l. as defined below.

Genus ***EULIMA*** Risso, 1826

Type species.—*Turbo subulatus* Donovan, 1803, by subsequent designation (Herrmannsen, 1847).

Diagnosis.—Small, more or less subulate, anomphalous shell with straight to curved spire; protoconch blunt, homeostrophic but initially somewhat deviated; whorl sides flat to very gently convex; sutures slightly impressed to closely adpressed or flush, often indistinct; shell surface smooth, glazed; aperture ovate to auriform, acutely angled posteriorly, well-rounded and sometimes rather patulous anteriorly; peristome often continuous; outer lip straight, adaperturally arched, or sinuous in profile, generally sharp at margin but thickened behind.

Eulima brightseatensis Govoni n. sp.
Text-fig. 29, Table 4

Eulima brightseatensis Govoni, 1983: 147–149, pl. 8, figs. 7–11 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:5798BF98-2338-4D47-97FA-806C29032561.

Type material.—Holotype USNM PAL 642493 from Locality A (sample A-2); paratype USNM PAL 642494 from Locality A (sample A-1).

Other material examined.—Nine individuals from Locality A (samples A-1, A-2) and Locality B (samples B-1, B-2).

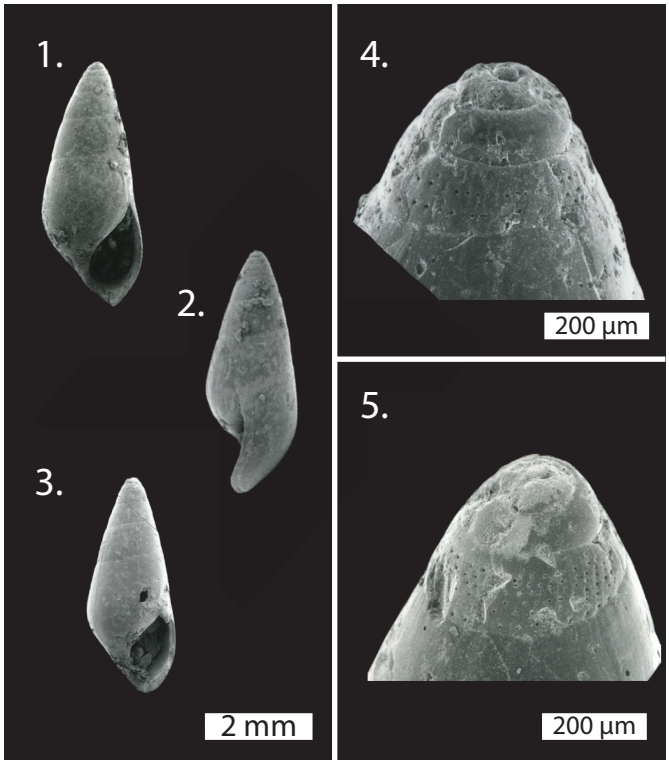
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named for the sediments of the Brightseat Formation, in which it was discovered.

Diagnosis.—Very small, paucigyrate, elongate-lacriform eulimid with relatively low spire and very high, relatively broad last whorl; first teleoconch whorl with several rows of extremely fine, shallow, regularly spaced punctae; aperture auriform, with gently sinuous and anteriorly produced, sharply rounded, forward-twisted, and patulous outer lip.

Description.—Shell very small, relatively sturdy, elongate lacriform; spire acutely tapering, very slightly curved. Protoconch relatively low, blunt, of two and one-half to three smooth, somewhat bulbous volutions; first volution deviated. Transition from protoconch to teleoconch distinguished by sudden appearance of fine spiral punctae on earliest teleoconch whorl and transition from clearly impressed suture of protoconch to rather indistinct, very nearly flush suture of teleoconch. Teleoconch of at least four and three-quarters smooth, glazed volutions; whorls of spire wider than high, but becoming proportionately more elongate below, very nearly flat-sided; last whorl approximately two-thirds of total shell height, broadly rounded medially, gently sloping below. Whorls of teleoconch lacking spiral sculpture except for two to six rows of extremely fine, shallow, regularly spaced punctae that appear abruptly at onset of teleoconch whorl deposition but disappear as abruptly within single volution, and narrow, ill-defined but continuous subsutural band formed by nearly imperceptible puckering of posterior whorl surface. Axial sculpture confined to very fine, extremely gently opisthocyrt growth lines that can sometimes be rather distinctly incised. Aperture auriform, acutely angled posteriorly, widest opposite columella, rounded and somewhat patulous below; outer lip narrow at margin, thickened within; lip profile gently sinuous, broadly incurved above, curved outward and becoming somewhat forward-twisted below, produced below shell base, rather sharply rounded at anterior extremity, and shallowly emarginate where it joins inner lip; columellar lip short, slightly curved above, narrow, slightly thickened, slightly re-



Text-fig. 29. *Eulima brightseatensis* Govoni n. sp., SEM. (**1, 2, 4**) Holotype, USNM PAL 642493, sample A-2, in apertural (**1**), lateral (**2**), and protoconch (**4**) views. (**3, 5**) Paratype, USNM PAL 642494, sample A-1, in apertural (**3**) and protoconch (**5**) views.

flected; callus very thin, frequently chipped away on lower half of parietal wall, but perceptibly thicker and well fused above and on columella.

Remarks.—This form is rather paucigyrate compared to many similar eulimids. However, the relative uniformity in maximum shell size as well as the more or less complete preservation of the final whorls in the available material suggest that the shells represent at least submature individuals. The sinuous profile of the outer lip is nearest that considered diagnostic for the subgenus *Polygyreulima* Sacco, 1892, by Gougerot (1969: 119).

Small, narrow, acutely tapering, anomphalids of the type placed variously within *Melanella* Bowdich, 1822 and *Eulima* are relatively well represented in the Upper Cretaceous and upper Paleogene deposits of the Atlantic and particularly the Gulf Coastal Plain, where the greatest diversity within the group is reached in middle Eocene time. In the Paleocene-age deposits, however, the only other eulimid previously reported is a single unnamed specimen, *Balcis* sp. indet., from the late Paleocene (Selandian) Naheola Formation in Alabama (Toulmin, 1977).

Eulima brightseatensis n. sp. can be distinguished from the other Paleogene species by its paucigyrate shell characterized by a relatively low spire and very high, relatively broad final whorl, and by its anteriorly sharply rounded and produced aperture.

Eulima sp. indet.
Text-fig. 30, Table 4

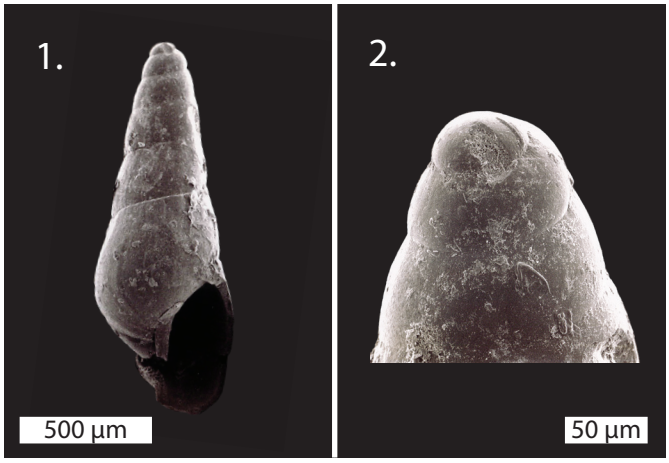
Eulima sp. Form A. Govoni, 1983: 149–151, pl. 9, fig. 1.

Material examined.—Single figured specimen, USNM PAL 642495 from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell very small, moderately slender, acutely tapering, turriculate; whorl surface glazed. Apex narrow but blunt-tipped; protoconch not clearly separable from teleoconch, of roughly two smooth, gently rounded volutions, the first of which is minute and slightly deviated. Teleoconch of slightly more than four volutions; last whorl accounting for nearly three-fifths of total shell height; volutions separated by very narrow and slightly impressed but distinct sutures. Whorls of spire nearly flat-sided; last whorl nearly flat-sided above and very broadly rounded below an indistinct, medially situated angulation. Sculpture absent except for gently sinuous growth lines. Aperture incompletely known, apparently subovate, acutely angled posteriorly, and rounded anteriorly; as seen by growth lines on last whorl, outer lip broadly sinuous, gently incurved above with maximum inflection just below posterior suture, sloping gently forward below, and recurving in broad, shallow arc across basal angulation; columellar lip rather straight, narrow, recurved; parietal wall not calloused.



Text-fig. 30. *Eulima* sp. indet., USNM PAL 642495, sample A-1, SEM, in apertural (**1**) and protoconch (**4**) views.

Remarks.—This form is represented by only a single, very small, probably immature individual. The broad, rather shallow, but distinct sinuosity of the outer lip is like that considered diagnostic for members of the subgenus *Polygyreulima* by Gougerot (1969: 119).

This form is easily separable from the co-occurring form *Eulima brightseatensis* n. sp. on the basis of its much smaller relative size, more acutely tapering and relatively higher-spired shape, more distinct and impressed sutures, and by the overall shape of its aperture and outer lip profile. Satisfactory comparison of this form with other upper Paleogene eulimids is not possible owing to the apparent immaturity of the only available specimen and so is not attempted here.

Superorder **LATROGASTROPODA** Bouchet et al., 2017
Superfamily **CALYPTRAEOIDEA** Lamarck, 1809
Family **CALYPTRAEIDAE** Lamarck, 1809
Genus ***CALYPTRAEA*** Lamarck, 1799

Type species.—*Patella chinensis* Linnaeus, 1758, by monotypy.

Calyptraea aldrichi Govoni n. sp.
Text-fig. 31, Table 4

Calyptraea aldrichi Govoni, 1983: 156–158, pl. 9, figs. 8–11 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:91E25822-E09B-4F42-87C3-595E3117B58D.

Type material.—Holotype USNM PAL 642499 from Locality A (sample A-5); paratypes USNM PAL 642500 from Locality A (sample A-1) and 642501 from Locality B (sample B-2).

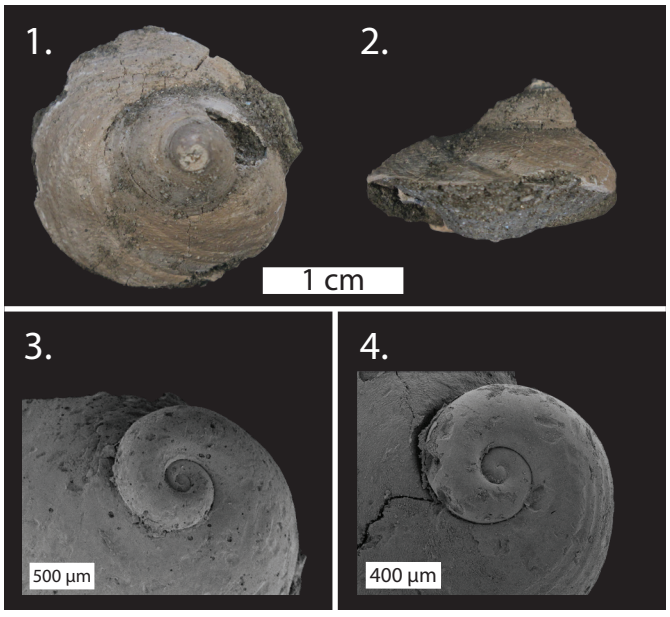
Other material examined.—Forty-four individuals plus numerous apical fragments from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-10), Locality B (sample B-2), and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Truman H. Aldrich, in recognition of his many important contributions to the study of North American Cenozoic Mollusca.

Diagnosis.—Medium-sized, cyrtoconoid shell bearing fine, closely spaced, acutely opisthocline axial threads that can form collabrally arranged rows of short, low ridges or nodes where they intersect irregularly spaced, acutely prosocline growth lines.



Text-fig. 31. *Calyptraea aldrichi* Govoni n. sp. (**1, 2**) Holotype, USNM PAL 642499, sample A-5, light photographs, in apical (**1**) and lateral (**2**) views. (**3**) Paratype, USNM PAL 642500, sample A-1, SEM, apical view. (**4**) Paratype, USNM PAL 642501, sample B-2, SEM, apical view.

Description.—Shell of medium size, asymmetrically cyrtoconoid, with broad subcircular basal outline. Sutures impressed, poorly defined. Protoconch homeostrophic, subplanispirally coiled, of approximately two and one-half rounded volutions, smooth or with few fine, low, evenly spaced spiral threads on last half volution; first one and one-half volutions minute and immersed. Protoconch can merge without perceptible break into teleoconch or be defined by slight thickening at growth line. Teleoconch of approximately two and one-half very rapidly expanding, convexly curved volutions; first one and one-half volutions acutely inclined, forming high, caplike spire; last whorl more rapidly expanding laterally and progressively less acutely inclined than those of spire; final half volution abruptly slowing its downward expansion causing it to partially override preceding whorl. Very earliest portion of teleoconch whorl surfaces usually worn smooth; irregularly but closely spaced, acutely prosocline growth lines quickly becoming apparent and growing in prominence, lending coarse, wrinkled appearance to surface of last whorl. Numerous fine, closely spaced, acutely opisthocline axial threads cutting across growth lines, sometimes forming collabrally arranged, *en echelon* rows of short, low ridges or nodes of slightly greater relief than surrounding shell surface. Apertural characteristics of mature shell unknown.

Remarks.—Although only a single mature individual of *Calyptraea aldrichi* n. sp. is known, numerous apices, all presumably referable to the new species, are distributed throughout the Brightseat Formation. The Brightseat form is the only species described from the Paleocene of the Gulf or Atlantic Coastal Plains, although apices of unnamed calyptraeids have been reported from Paleocene deposits in Texas (Gardner, 1935: 300), Alabama (Harris, 1896: 116), and Mexico (Gardner, 1945: 163). Garvie (2021) recorded the presence of *Calyptraea aperta* (Solander in Brander, 1766) from the Danian Tehuacana Limestone of Texas, which is a variable, long-ranging, and widely distributed species reported from a number of upper Paleocene through Miocene age units in the Gulf and Atlantic Coastal Plains of North America and, questionably, the lower Paleocene of Trinidad. The Brightseat species most nearly approaches in size and shape some individuals of *Calyptraea aperta*, however, the latter species typically possesses much coarser sculpture, including various combinations of coarsely rugose or frilled growth lines, numerous wavy or irregular riblets, and hooked nodes or spines, than does the more delicately sculptured *Calyptraea aldrichi* n. sp.

Two additional species of *Calyptraea* are reported from Eocene age Coastal Plain sediments. *Calyptraea alta* (Conrad, 1854) from the upper Eocene of Mississippi and Louisiana is a moderately high conical form bearing coarse radiating ribs that differ in strength, number, and orientation from the finer axial sculpture of *Calyptraea aldrichi* n. sp. *Calyptraea glandaria* Dockery, 1977, from the upper Eocene of Mississippi is easily separated from the Brightseat form by its thickness and very high conical profile.

Superfamily **STROMBOIDEA** Rafinesque, 1815
Family **APORRHAIDAE** Gray, 1850

Aporrhaidae gen. and sp. indet.
Text-fig. 32, Table 4

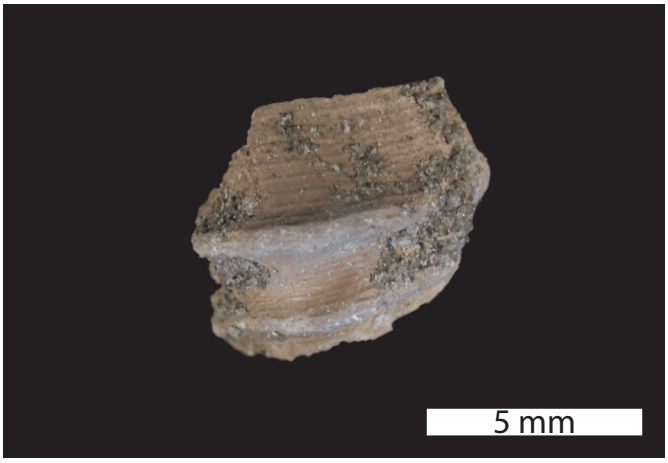
Aporrhaid gastropod gen. and sp. indet. Govoni, 1983: 154, pl. 9, fig. 4.

Material examined.—Single figured specimen, USNM PAL 642497, from Locality A (sample A-8).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Remarks.—A single fragment of a portion of the last whorl of an aporrhaid gastropod bearing two strong, raised, relatively close-set carinae and numerous fine spiral threads that cover the entire whorl surface including the carinae, is present in the collections under study. The presence of two such thick carinae on an otherwise finely sculpted shell is reminiscent of the keel of a number of fossil and modern aporrhaids (see, for example, *Aporrhais potomacensis* Clark and Martin, 1901: 146, from the upper Aquia Formation in Maryland). The specimen is too incomplete to allow either generic assignment or comparison with related fossil forms.



Text-fig. 32. Aporrhaidae gen. and sp. indet., USNM PAL 642497, sample A-8, light photograph, detail of sculpture.

Family **ROSTELLARIIDAE** Gabb, 1868
Genus ***CALYPTRAPHORUS*** Conrad, 1857

Type species.—*Rostellaria velata* Conrad, 1833, by subsequent designation (Cossmann, 1904).

Calyptraphorus cf. *jacksoni* Clark, 1896
Text-fig. 33, Table 4

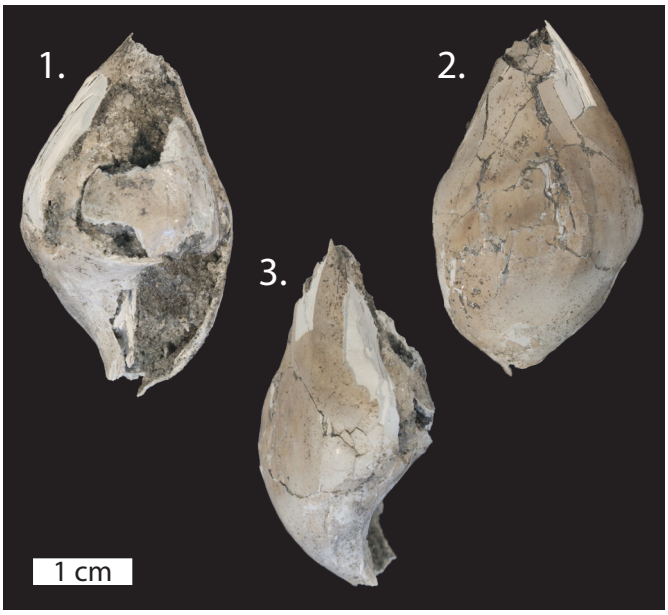
Calyptraphorus cf. *C. jacksoni.* Govoni, 1983: 155, pl. 9, figs. 5–7.

Material examined.—Figured specimen USNM PAL 642498 from Locality A (sample A-1), plus nine fragmental specimens from Locality A (samples A-3, A-6).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Remarks.—Very poorly preserved material, including two broken or possibly submature adults and several fragments



Text-fig. 33. *Calyptraphorus* cf. *jacksoni* Clark, 1896, USNM PAL 642498, sample A-1, light photographs, in apertural (**1**), dorsal (**2**), and lateral (**3**) views.

of thickly enamel-coated shells with flattened, rapidly flaring, blunt-tipped apices suggesting a relatively broad, robust form of *Calyptraphorus*. Although somewhat smaller in size, the Brightseat shells most nearly approach *Calyptraphorus jacksoni* (see Clark and Martin, 1901: 145) from the upper Paleocene (Selandian) Aquia Formation in general outline. Surface ornament of the whorls beneath the enamel covering is unknown in *Calyptraphorus jacksoni*. The Brightseat form possesses numerous low, rounded, closely spaced spiral threads and faint axial riblets on the early spiral whorls that are somewhat reminiscent of early ornament in *Calyptraphorus velusus* Garvie, 2021, from the Danian Tehuacana Limestone of Texas.

Order **NEOGASTROPODA** Wenz, 1938a
Superfamily **BUCCINOIDEA** Rafinesque, 1815
Family **BUCCINIDAE** Rafinesque, 1815
Genus ***LACINIA*** Conrad, 1853

Type species.—*Lacinia alveata* Conrad, 1853, by original designation.

Lacinia pygmaea Govoni n. sp.
Text-fig. 34, Table 4

Lacinia pygmaea Govoni, 1983: 162–164, pl. 11, figs. 1–8 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:E35F5F6B-414F-4C88-96FA-0B729950DFF4.

Type material.—Holotype USNM PAL 788756 from Locality A (sample A-6); paratypes USNM PAL 788757 from Locality B (sample B-1) and 788759 from Locality A (sample A-5).

Other material examined.—Measured specimen USNM PAL 788758 plus 30 individuals from Locality A (samples A-1, A-3, A-4, A-5, A-6, A-8) and Locality B (sample B-1).

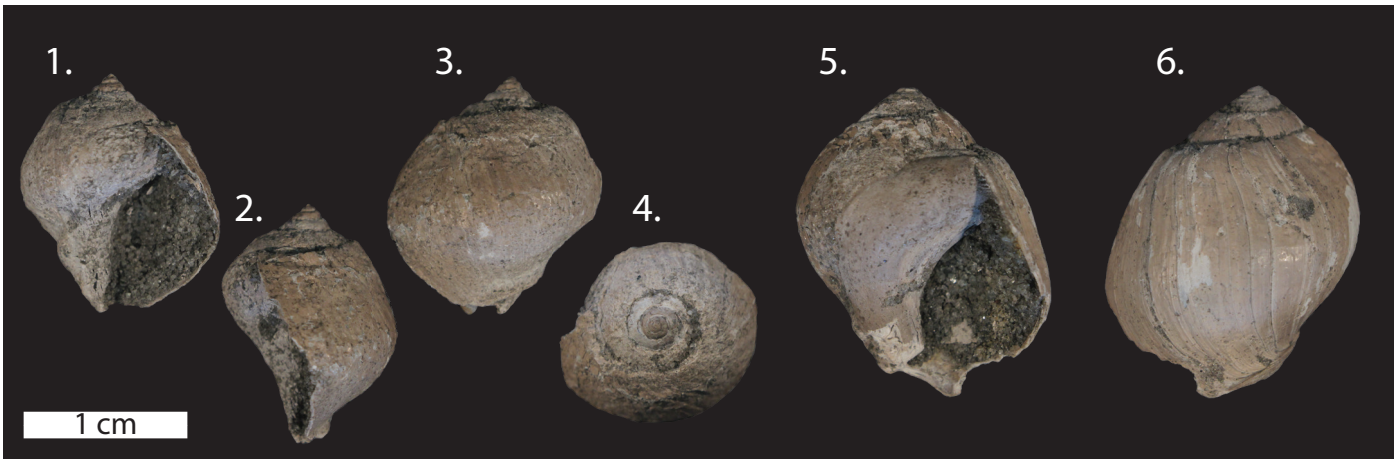
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named from the Latin *pygmaeus*, referring to its small size relative to other members of the genus.

Diagnosis.—Medium-sized globose shell with low spire and greatly inflated last whorl bearing obscure subsutural and medial peripheral angulations and strong siphonal fasciole; aperture curved-lacriform, posteriorly and anteriorly notched; inner lip strongly calloused.

Description.—Globose shell of medium size, although relatively small for genus; spire low, conical to slightly coeloconoid. Protoconch unknown, probably minute. Suture indistinctly impressed. Teleoconch of five volutions; whorls of spire gently rounded to nearly flat medially, very narrowly shelved posteriorly above indistinct peripheral shoulder angulation; last whorl greatly inflated, angulated first by narrow, rounded, slightly raised posterior subsutural shoulder and second by very broad, gently rounded, medially situated swelling; whorl flattened between angulations, rounded below; base of whorl terminating with sharp, thin, raised ridge forming posterior margin of shallow but distinct siphonal fasciole. Shells generally lacking ornament except for gently sinuous lines of growth that can become quite prominent on last whorl,



Text-fig. 34. *Lacinia pygmaea* Govoni n. sp., light photographs. (**1–4**) Holotype, USNM PAL 788756, sample A-6, in apertural (**1**), lateral (**2**), dorsal (**3**), and apical (**4**) views. (**5, 6**) Paratype, USNM PAL 788757, sample A-1, in apertural (**5**) and dorsal (**6**) views.

forming vague undulations of shell surface between each line marking temporary cessation of growth; one shell exhibiting several extremely faint, evenly spaced striae on medial portion of last whorl. Aperture broad, curved-lacriform, widest at medial whorl angulation; outer lip thin, gently sinuous at margin, gently angled at posterior and particularly at medial whorl angulations, narrowly notched posteriorly at intersection with parietal callus, terminating anteriorly in moderately wide and deep siphonal notch; inner lip covered by broad thick callus.

Remarks.—*Lacinia pygmaea* n. sp. is the oldest known representative of the predominantly Eocene genus. In the Gulf Coastal Plain, the genus has been reported from the middle Eocene (Lutetian) age sediments of Texas, but is most abundant in the middle Eocene (Bartonian) Gosport Sand of Alabama, where it is represented by two species, *Lacinia alveata* and *Lacinia claibornensis* Palmer, 1937. The most common and typical Eocene form, *Lacinia alveata*, is considerably larger than *Lacinia pygmaea* n. sp., with mature shells reportedly attaining a height of > 11 cm (Palmer, 1937: 302). In addition to its smaller size, the new Paleocene species also lacks the apical nodes and strong anterior spiral sculpture typical of *Lacinia alveata,* and its posterior and medial whorl angulations are much weaker and obscure than those of the Eocene species. *Lacinia claibornensis* is also larger than *Lacinia pygmaea* n. sp. and possesses a much more elongate spire bearing strong nodes in addition to well-defined and extensively developed spiral cords. Despite these differences, however, its low-spired globose form, the shape of the aperture, the size and strength of the siphonal fasciole and notch, and the shape and extent of the thick callus clearly establish the Brightseat form as a small representative of the genus *Lacinia.*

Genus ***SIPHONALIA*** A. Adams, 1863

Type species.—*Buccinum cassidariaeforme* Reeve, 1846, by subsequent designation (Cossmann, 1889).

Siphonalia potomacensis Govoni n. sp.
Text-fig. 35, Table 4

?Strepsidura subscalarina Heilprin. Clark and Martin, 1901: 136, pl. 22, fig. 6. Not *Strepsidura subscalarina* Heilprin, 1881: 372 [= *Strepsidura heilprini* (de Gregorio, 1890)].
Strepsidura? sp. indet. Palmer and Brann, 1966: 924.
Siphonalia potomacensis Govoni, 1983: 164–168, pl. 11, figs. 9–13 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:EF2EF61C-60DD-46A7-BA02-BE027B96FF78.

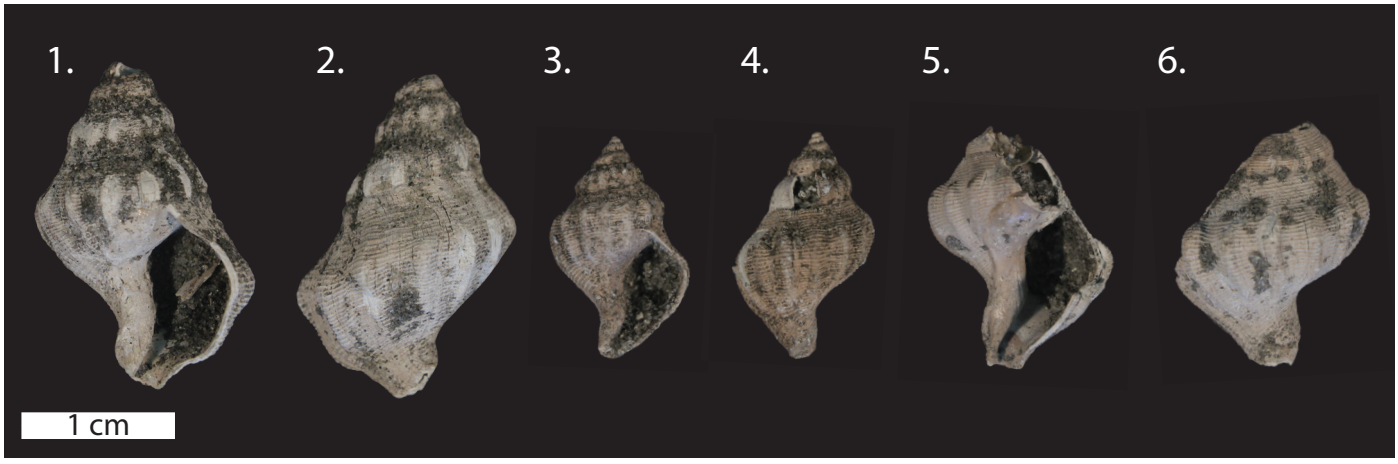
Type material.—Holotype USNM PAL 788760 from Locality A (sample A-6); paratypes USNM PAL 788761 from Locality A (sample A-1) and 788762 from Locality A (sample A-8).

Other material examined.—Twenty-two individuals from Locality A (samples A-1, A-3, A-5, A-6, A-8).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Virginia: Aquia Formation (Selandian).

Etymology.—This species is named for the valley of the Potomac River and its tributaries, the region in which it was discovered.



Text-fig. 35. *Siphonalia potomacensis* Govoni n. sp., light photographs. (**1, 2**) Holotype, USNM PAL 788760, sample A-6, in apertural (**1**) and dorsal (**2**) views. (**3, 4**) Paratype, USNM PAL 788761, sample B-1, in apertural (**3**) and dorsal (**4**) views. (**5, 6**) Paratype, USNM PAL 788762, sample A-3, in apertural (**5**) and dorsal (**6**) views.

Diagnosis.—Medium-sized, axially elongate shell of rhomboid-fusiform outline with broad, strongly inclined subsutural ramps above narrowly rounded shoulder situated slightly below midwhorl; last volution bearing ~ 14 collabral costae; columella twisted strongly to left, lacking folds.

Description.—Shell of medium size, rhomboid-fusiform in outline; spire steeply conical, approximately one-quarter of total shell height. Protoconch erect, homeostrophic, tilted slightly to coiling axis, of approximately three smooth volutions, rounded to slightly flattened posteriorly, separated by distinctly impressed suture; first volution minute, initially depressed to slightly immersed; junction with ornamented teleoconch apparently abrupt. Suture narrow, ill-defined, barely impressed to more or less adpressed. Teleoconch of approximately four volutions; whorls strongly shouldered slightly below midwhorl; subsutural ramp rather broad, flat and strongly abaxially inclined above, generally becoming more inclined and gently concave below, on last whorl sometimes approaching vertical just below suture before curving gently outward to shoulder; whorl profile narrowly rounded and slightly protrusive across shoulder angulation, becoming on last whorl very broadly rounded to flattened and sloping adaxially slightly less steeply than ramp before curving sharply inward to meet columellar pillar; pillar of moderate length, twisted rather strongly to left at approximate midneck and reflected slightly dorsally at tip, reinforced by moderately sturdy fasciole. Axial sculpture very distinct, consisting of fine growth lines and very gently sinuous collabral costae. Costae fairly evenly and closely spaced throughout, numbering ~ 14 on last whorl of mature shells; costae can appear node-like on lower half of volutions of spire; on last whorl, costae form barely curved, round-topped ridges that are broadest and most elevated at shoulder; below shoulder, costae narrow and lower but remaining quite distinct, weakening suddenly only where whorl contracts to meet pillar; on pillar, axials can continue as obscure wrinkles; above shoulder, costae curving very gently adaperturally and can extend across ramp as obscure ridges or wrinkles to posterior suture where, on final whorl of mature shells, they can strengthen somewhat to form broad, low subsutural nodes. Growth lines gently sinuous, forming simple sigmoidal curve with points of inflection centered above on raised portion of axial costae at shoulder and below at point of shell contraction between main body of whorl and neck. Spiral sculpture of fine, closely spaced threads developed over entire exterior shell surface; spirals tending to be most widely spaced and weakest on ramp and coarsest on columellar pillar above siphonal fasciole upon which they can irregularly continue; very fine secondary threads can appear in interspaces between primaries over region of shell below shoulder occupied by axial costae; threads often finely beaded where intersected by growth lines. Aperture broadly pyriform; narrowly but obscurely channeled posteriorly, drawn out anteriorly into rather strongly leftward inclining and gently curved siphonal canal of moderate depth, breadth, and length; outer lip relatively thin at margin, drawn forward slightly below posterior margin, rather flattened above, very broadly rounded-angulate at shoulder, somewhat flattened to very gently curving below to meet outer margin of siphonal canal; inner surface of canal and perhaps also outer margin of lip above slightly glazed, inner margin of lip above sometimes with numerous shallow grooves extending from near margin a short distance into interior; inner lip well calloused, flattened to very gently convexly curved on parietal wall, and similarly straight to slightly curved and slightly right-sloping on upper half of columellar pillar; columellar margin below bending narrowly rounded or sometimes slightly raised and ridge-like. Callus thin to moderately thick, loosely adherent, extending across parietal surface in broad arc extending outward well beyond posterior margin of outer lip, then straightening and extending downward onto columella below. Columella lacking folds, although overridden portion of thickened fasciolar ridge can sometimes extend as obscure, oblique, fold-like ridge within.

Remarks.—Although restricted today to the western Pacific Ocean, the genus *Siphonalia* was widely distributed during the Paleogene throughout both the Indo-Pacific and Atlantic regions. On the eastern Atlantic margin, the genus has been reported from the Paleocene of Denmark, Belgium, and Nigeria, and is particularly well represented in the Eocene of the Paris Basin. On the western Atlantic margin, the genus has long been recognized throughout the Eocene (particularly middle and upper) deposits of the Gulf Coastal Plain. The genus has been reported in the Paleocene deposits of West Greenland but not in those of either the Gulf or Atlantic Coastal Plains. This apparent gap in the otherwise wide distribution of the genus in eastern North America is, in fact, an illusion created by misidentification that has persisted in the literature to the present day.

Siphonalia potomacensis n. sp. is closely allied with certain Gulf and Atlantic Coastal Plains forms of Paleocene and early Eocene age traditionally, although erroneously, placed in the volutacean genus *Strepsidura* Swainson, 1840. In the Gulf Coastal Plain, these "*Strepsidura*" include *Strepsidura contorea* Aldrich, 1895, from the uppermost lower Porters Creek Formation (upper Danian) and earliest Selandian age Matthews Landing Marl Member of the Porters Creek in Alabama, and *Strepsidura heilprini* (as *Strepsidura subscalarina* = *Strepsidura heilprini*) from the upper Paleocene (Selandian–Thanetian) Aquia Formation in Virginia. Like other typical *Siphonalia,* these species all possess axially costate, fusiform shells with leftward-twisted columellas that generally lack

well-defined folds (except for *Strepsidura contorea*, which bears a single fold within that does not reach the aperture). In contrast, species of *Strepsidura,* although bearing a similarly bent or twisted columella, are characteristically rounded-pyriform and possess at least one, and usually two, strong columellar folds.

Siphonalia potomacensis n. sp. is easily distinguished from the other Coastal Plain taxa attributable to the genus on the basis of its characteristically and rather strongly elongate rhomboid-fusiform outline and broad, strongly inclined and very weakly costate subsutural ramp. Only one other form, a shell from the overlying Aquia Formation in Virginia (USNM PAL 207044), illustrated by Clark and Martin (1901, pl. 22, fig. 6) as a morphological variant of *Strepsidura subscalarina* (= *Strepsidura heilprini*), closely approaches the Brightseat species. The Aquia shell bears a somewhat less twisted columellar pillar, its subsutural ramp is more noticeably concave, and its axial costae are narrower and more strongly developed on the posterior ramp. Despite these differences, the Aquia form appears close enough to the Brightseat specimens to warrant at least tentative inclusion in the new species.

Superfamily **TURBINELLOIDEA** Swainson, 1835
Family **TURBINELLIDAE** Swainson, 1835
Subfamily **VASINAE** H. and A. Adams, 1853
Genus ***PYROPSIS*** Conrad, 1860

Type species.—*Tudicla* (*Pyropsis*) *perlata* Conrad, 1860, by monotypy.

Pyropsis? sp. indet.
Text-fig. 36, Table 4

Pyropsis? sp. indet. Govoni, 1983: 171–173, pl. 12, figs. 4, 5.

Material examined.—Single figured specimen, USNM PAL 788764 from Locality A (sample A-5).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell of medium to large size; flat spired. Protoconch of between two and three low-rounded volutions, flattened above and slightly inclined to the teleoconch whorls; first volution of protoconch slightly immersed; ornament smooth initially, with several relatively strong spiral threads appearing on last volution. Posterior whorl surface of teleoconch flat, very gently sloping, and possessing a narrowly impressed suture. Shoulder angulation badly worn but apparently sharp, with narrow, raised, posterior-facing carina

Text-fig. 36. *Pyropsis*? sp. indet., light photographs, USNM PAL 788764, sample A-5, in apical (**1**), lateral (**2**), and enlarged apical, (**3**) views.

lacking nodes or spines on preserved whorls. Whorl sides below shoulder angulation very short, appearing flat-sided and, at first, slightly inward sloping toward suture below. Preserved remnant of parietal surface slopes strongly inward, suggesting substantial anterior construction of the original shell. Growth lines of variable strength, arching across the upper whorl face in an adaperturally inclined opisthocyrt arc, causing the surface to appear somewhat wrinkled. Spiral sculpture of extremely fine, low, close-set threads of alternating strength present on earlier portion of the whorl surface but disappearing later.

Remarks.—A single worn and badly broken specimen consisting of the upper portion of the earlier apical whorls of a nearly flat-spired shell is here tentatively assigned to the predominantly Cretaceous genus *Pyropsis*. The specimen on hand appears to have been of medium to perhaps large size, and the preserved portion consists of the protoconch and approximately one and one-half volutions of the teleoconch. The Brightseat form is too incomplete to allow certain taxonomic determination. However, among Cretaceous and Cenozoic gastropods characterized by very low or flat-spired and anteriorly constricted or pyriform shells, the Brightseat form appears to resemble most closely the earlier growth stages of members of the genus *Pyropsis*, particularly in the form of the protoconch. The protoconch of the Paleocene specimen is particularly close to that of the genotype, *Pyropsis perlata* Conrad, 1860, which Sohl (1964b: 236) described as "raised

above plane of teleoconch volution and generally resting at a slight angle … of 1½ or 2 broadly round-topped whorls that are spirally striate on the last one-third whorl," as well as to related forms from the Upper Cretaceous of the Gulf Coastal Plain. The Paleocene specimen also displays growth lines and spiral ornament on the upper whorl surface of the teleoconch very similar to that found on the early volutions of *Pyropsis perlata* and related species. The Brightseat specimen shares the thick shell and smooth ramp of *Pyropsis levis* Dockery, 2023, from the Coffee Sand of Mississippi.

Other Cretaceous and Cenozoic taxa with which the Brightseat shell can be compared include the vasid genus *Tudicla* Röding, 1798, which is closely related to *Pyropsis*, the Paleogene buccinacean *Heligmotoma* Mayer-Eymar, 1895, and some representatives of *Busycon* Röding, 1798 s. l. The protoconch of *Tudicla* characteristically consists of a few smooth volutions raised well above the teleoconch. In *Heligmotoma*, the protoconch is also smooth, but is paucispiral and quite large and bulbous. Additionally, the shoulder angulation of the teleoconch tends to be more rounded than that seen in the Brightseat specimen and the growth line develops a distinct abaperturally curved sinus where it crosses a subsutural groove on the upper whorl surface. In *Busycon*, the protoconch is also more distinctly erect than *Pyropsis* and consists typically of an initial smooth and rounded phase followed by a sculptured phase in which axial rather than spiral ornament tends to develop first (Smith, 1945: 14). In addition, the shoulder carina of *Busycon* is more or less strongly noded from the onset of teleoconch development.

Superfamily **OLIVOIDEA** Latreille, 1825
Family **PSEUDOLIVIDAE** de Gregorio, 1880
Genus ***PSEUDOLIVA*** Swainson, 1840

Type species.—*Buccinum plumbeum* Dillwyn, 1817, by original designation.

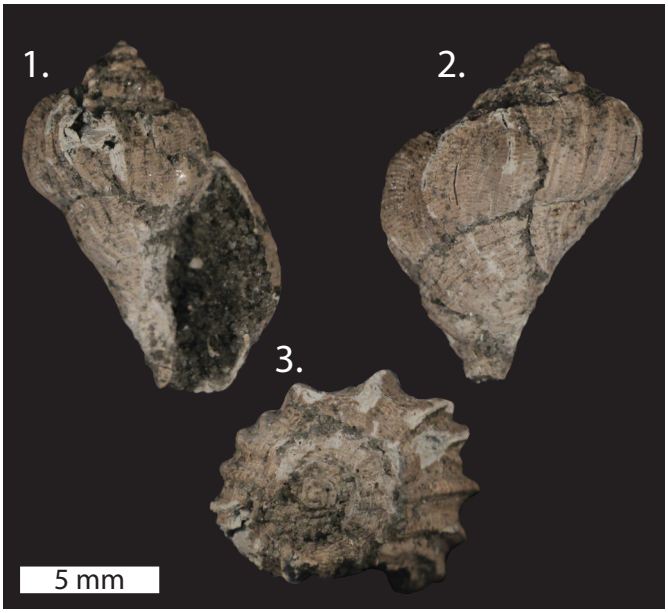
Pseudoliva longicostata Govoni n. sp.
Text-fig. 37, Table 4

Pseudoliva longicostata Govoni, 1983: 169–171, pl. 12, figs. 1–3 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:5FBC7D11-3BB8-4DE3-8032-4D57D2D01E7B.

Type material.—Holotype USNM PAL 788763 from Locality A (sample A-6).

Other material examined.—Two worn, broken individuals from Locality A (samples A-1, A-3).



Text-fig. 37. *Pseudoliva longicostata* Govoni n. sp., holotype, USNM PAL 788763, sample A-6, light photographs, in apertural (**1**), dorsal (**2**), and apical (**3**) views.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.— This species is named from the Latin *longus*, "long," and *costa*, "ribs," referring to its prominent axial ribs on the shell.

Diagnosis.—Medium-sized, subfusiform, anomphalous shell possessing numerous sigmoid collabral transverse ribs that are strong, raised, and narrow-topped above spiral sulcus. Ribs extending below sulcus where they become broader, lower, rounded, and less distinct. Spiral sculpture of numerous low, rounded to flattened spiral threads above and below sulcus.

Description.—Shell of medium size, anomphalous, subfusiform, of five rapidly expanding whorls. Spire low, somewhat less than one-fifth of total shell height. Protoconch of approximately two and one-quarter rounded, apparently smooth whorls. Suture slightly impressed, bounded by broad, low indistinct subsutural collar of thickened and merged spiral threads on latter half of last whorl. Teleoconch whorls shouldered; whorl outline initially flattened and angular due to development of broad, flat, obliquely sloping ramp above shoulder, which becomes less distinct on last whorl as it

increases in obliquity and merges with more rounded subcarinal portion of whorl below. Last whorl somewhat protracted anteriorly, ending in short, broad, deep siphonal canal. Axial sculpture strong, consisting of collabral ribs and spiral threads. On final whorl, ribs numbering ~ 15 and irregularly but generally closely spaced. Above spiral, sulcus ribs very distinct, raised, and narrow-topped, broadening and rising only slightly at shoulder. Most ribs extending below sulcus as broader, lower, rounded structures that turn sharply and disappear as they merge with moderately wide siphonal fasciole. Overall rib outline sigmoid, being prosocyrt below shoulder but turning in broad arc at shoulder to become opisthocyrt above. Spiral sulcus rather broad and shallow in immature shell, becoming deeper and very narrow in mature shell and meeting apertural callus approximately two-thirds of whorl height above base. Spiral sculpture of teleoconch consisting of numerous low-rounded or flattened, ribbon-like spiral threads that are coarser below sulcus. Aperture incompletely known, apparently narrow, elongate, lacriform in outline. Outer lip broadly convex, meeting parietal wall at acute angle above; broadly siphonate anteriorly. Columella straight-sided, relatively thick, with outward-facing, slightly concave surface bearing remnants of moderately thick callus.

Remarks.—The available specimens of *Pseudoliva longicostata* n. sp. are all rather poorly preserved. In the best-preserved specimen (the holotype), the aperture is badly damaged and the columella appears slanted due to postdepositional distortion. Despite the condition of the material, the new species is easily separated from the other Paleogene ribbed forms. It differs from *Pseudoliva unicarinata* Aldrich, 1886, from the lower Selandian Matthews Landing Marl Member of the Porters Creek Formation of Alabama in being somewhat less tumid and more anteriorly elongate, possessing more numerous, longer, and better-defined axial ribs that extend below the sulcus, that are not sharply pointed at the shoulder, and that do not turn as sharply adaperturally above the shoulder. Additionally, *Pseudoliva longicostata* n. sp. lacks the well-developed shoulder carina that links the shoulder tuberculations in *Pseudoliva unicarinata*.

Pseudoliva tuberculifera Conrad, 1860, from the upper Paleocene (late Thanetian) Tuscahoma Formation of Alabama and lower Eocene (Ypresian) Nanjemoy Formation of Maryland and Virginia is more inflated than *Pseudoliva longicostata* n. sp. and develops fewer and more compressed shoulder tubercles on the final whorl.

Pseudoliva longicostata n. sp. is much smaller than, and lacks the wide, deep sutural channel typical of *Pseudoliva scalina* Heilprin, 1881, from the lower Ypresian Hatchetigbee Formation of Alabama.

Subclass **HETEROBRANCHIA** Burmeister, 1837
Superfamily **ARCHITECTONICOIDEA** Gray, 1850
Family **ARCHITECTONICIDAE** Gray, 1850
Genus ***GRANOSOLARIUM*** Sacco, 1892

Type species.—*Solarium millegranum* Lamarck, 1822, by original designation.

Granosolarium sp. indet.
Text-fig. 38, Table 4

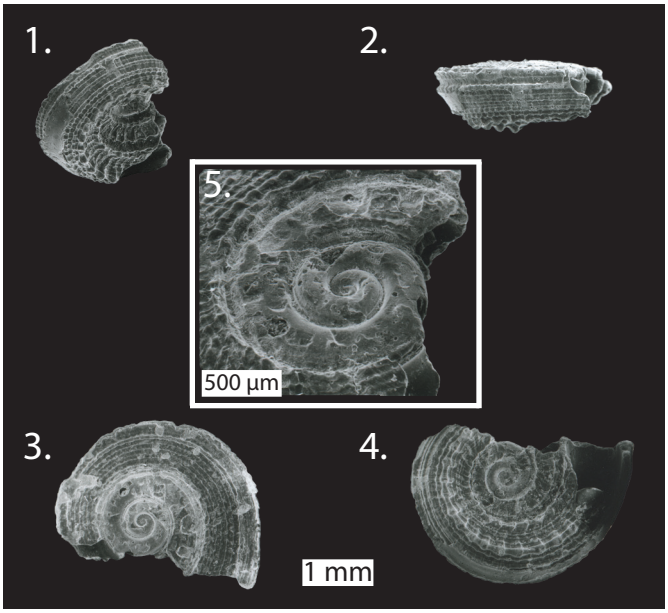
Architectonica (*Granosolarium*) sp. Form A. Govoni, 1983: 95, 96, pl. 4, figs. 6–10.

Material examined.—Single incomplete figured specimen, USNM PAL 642437, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, strongly peripherally bicarinate, broadly umbilicate, discoidal; spire much depressed or flat. Beaded spiral threads and cords on teleoconch. Broad umbilicus, lacking strong peripheral process but bearing strong angulation and nodose carina on umbilical wall.



Text-fig. 38. *Granosolarium* sp. indet., USNM PAL 642437, sample A-1, SEM, in oblique basal (**1**), lateral (**2**), apical (**3**), basal (**4**), and protoconch (**5**) views.

Remarks.—A single small fragment of a peripherally bicarinate shell with beaded spiral threads and cords appears to be related to several similarly shaped architectonicids from Paleocene age deposits of the Gulf Coastal Plain. The Brightseat specimen is distinguished from all the other forms by the number, strength, and disposition of the spirals, its strongly bicarinate periphery, and the development of a strong angulation bearing a nodose carina on the umbilical wall. Despite the apparently unique character of the shell, its incomplete state of preservation does not permit assignment of a specific name.

In general profile, ornament, and particularly the broad umbilicus, the Brightseat specimen approaches *Architectonica morozi* Amitrov, 1978, from lower Paleocene age deposits in Ukraine. Amitrov (1978: 471–473) united *Architectonica morozi* along with several other depressed or flat-spired, broadly umbilicate forms from the Paleocene of Europe within the subgenus *Granosolarium*. The Brightseat form is clearly allied to this group.

The Brightseat *Granosolarium* resembles the Campanian species *Granosolarium coffea* (Sohl, 1964a), from the Coffee Sand of Mississippi, in its bicarinate periphery and noded spiral sculpture. When compared to SEM images of *Granosolarium coffea* figured by Dockery (1993: 161), the Brightseat specimen is seen to differ from the Cretaceous species in possessing more uniformly strong spiral ornament above the suture and in lacking nodose ornament on its upper whorl face.

Genus ***STELLAXIS*** Dall, 1892

Type species.—*Solarium alveatum* Conrad, 1833, by original designation.

Stellaxis? sp. indet.
Text-fig. 39, Table 4

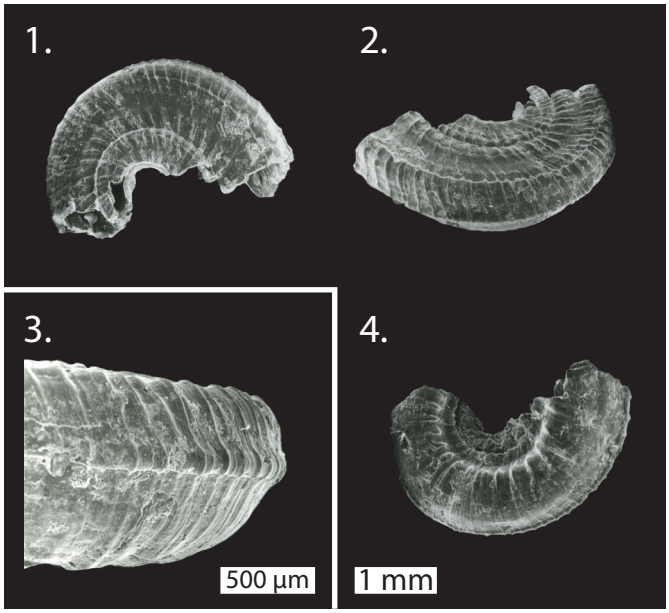
Architectonica (*Stellaxis*) sp. Form B. Govoni, 1983: 96, 97, pl. 4, figs. 6–10.

Material examined.—Incomplete figured specimen USNM PAL 642438 from Locality A (sample A-2), plus one additional small fragment from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, discoidal; spire flat; posterior whorl surface very slightly concave. Sculpture dominated adaxially by two spiral threads adjacent to the suture, which combine to form broad, low ridge; single strong, narrow, posteriorly directed cord situated at inner edge of rounded shoulder angulation. Axial ribs narrow; regularly spaced across whorl surface, forming distinctly raised ridges where they cross spirals. Outer whorl surface short, broadly rounded at shoulder; ornamented with indistinct low spiral threads and sharp axial ribs, which are continuations of ridges formed on marginal carina on surface above; bounded anteriorly by strong, peripheral carina with thin, sharp riblets developed at intersection with axials. Anterior surface broad, gently rounded to nearly flat, with few indistinct, widely spaced grooves and much-subdued axial ribs, becoming strongly rugose adjacent to umbilicus, forming sharply toothed marginal carina.



Text-fig. 39. *Stellaxis*? sp. indet., USNM PAL 642438, sample A-2, SEM, in apical (**1**), oblique lateral (**2**), enlarged lateral (**3**), and basal (**4**) views.

Remarks.—Two fragments of a small, discoidal architectonicid appear to represent a new species but are insufficiently complete to permit assignment of a specific name. The sculpture is sparse compared to the *Granosolarium* form and the umbilicus is not as wide, although it possesses a strong angulation of the wall that bears a nodose carina.

The incomplete nature of the available material makes it difficult to establish the precise taxonomic position of this form. The apparently flat-spired discoidal form of the shell is reminiscent of some other Paleocene representatives of *Granosolarium*. However, other characteristics—particularly the relative paucity of spiral ornament, the development of a single strong peripheral carina below the rather bluntly rounded posterior shoulder, and the more narrow umbilicus, which is separated from the anterior whorl surface by a strongly rugose carina and that bears within a strong, carinate

angulation of the wall—correspond more closely to those considered diagnostic for some early representatives of the genus *Stellaxis*, as defined by Amitrov (1978: 472).

Genus ***PSEUDOMALAXIS*** Fischer, 1885

Type species.—*Bifrontia zanclaea* Philippi, 1844, by monotypy.

Pseudomalaxis cf. *ripleyana* Wade, 1926
Text-fig. 40, Table 4

Pseudomalaxis cf. *P. ripleyana* Govoni, 1983: 93–95, pl. 4, figs. 1–5 (unpublished).

Type material.—Holotype USNM PAL 73098 from the Ripley Formation (Maastrichtian) of McNairy County, Tennessee.

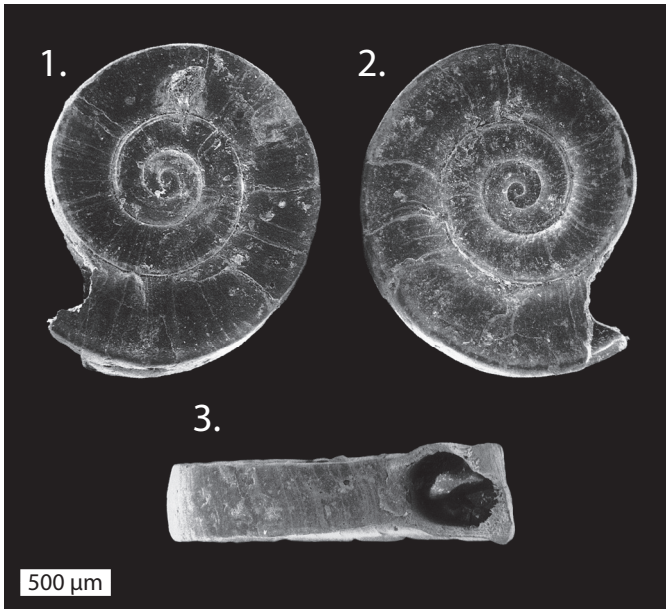
Other material examined.—Single figured specimen, USNM PAL 642436, from Locality A (sample A-2).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Tennessee: Ripley Formation (Maastrichtian).

Diagnosis.—Very small, discoidal, broadly umbilicate shell with gently convex whorl surfaces; outer whorl surface separated from upper and umbilical surfaces by smooth raised carinae; sculpture lacking except for fine growth lines.

Description.—Shell very small, discoidal, with very wide, gently inward-sloping umbilicus. Shell of two protoconch and two teleoconch whorls. Sutures impressed. Upper surface of first protoconch whorl smooth, low-rounded, slightly immersed, becoming more sharply inflated adaperturally; final third of second protoconch whorl bearing relatively sharp, medially situated, raised spiral ridge that ends abruptly at onset of teleoconch. Basal surface of protoconch initially convexly rounded, becoming flattened and inward sloping, merging gently into teleoconch as axis of maximum inflation shifts outward and joins umbilical carina of teleoconch. Upper surface of teleoconch whorls slightly convex with axis of maximum inflation offset slightly adaxially. Outer edge of upper surface bounded by smooth, raised, posteriorly directed spiral carina separating it from outer whorl surface. Outer whorl surface at aperture nearly flat and slanting slightly outward away from shell axis, separated from umbilical whorl surface by anteriorly directed, smooth, raised spiral carina. Umbilical whorl surface slightly convex, inward sloping. Teleoconch whorls lacking sculpture except for very fine, gently prosocline growth lines. Aperture subquadrate in outline, situated in plane of coiling.



Text-fig. 40. *Pseudomalaxis* cf. *ripleyana* Wade, 1926, USNM PAL 642436, sample A-2, SEM, in apical (**1**), basal (**2**), and apertural (**3**) views.

Remarks.—Flat, discoidal pseudomalaxids bearing only smooth spiral carinae at the upper and lower peripheral whorl angulations are relatively rare in the Cretaceous and Paleogene sediments of the Atlantic and Gulf Coastal Plains. In the Paleogene, only two such species have been recorded: *Pseudomalaxis rotella* (I. Lea, 1833), from the middle Eocene (Bartonian) Gosport Sand of Alabama, and *Pseudomalaxis plummerae* Palmer, 1937, from the middle Eocene (Lutetian) Stone City beds of Texas. In the Upper Cretaceous, *Pseudomalaxis ripleyana* has been reported only from the type locality of the upper Campanian to lower Maastrichtian age Ripley Formation of Tennessee.

The single well-preserved juvenile shell recovered from near the base of the Brightseat Formation does not appear to be readily separable from the Upper Cretaceous species by either size or overall form and appearance. The possibility of reworking of the shell from the underlying Cretaceous deposits is discounted due to its excellent state of preservation. However, because only the single immature shell has been found in the Brightseat deposits, it seems unwise to assign it to a geographically remote Cretaceous age species without more complete comparative material. The Brightseat specimen resembles *Pseudomalaxis rotella*, but is considerably smaller and possesses more rounded whorl surfaces. *Pseudomalaxis*

plummerae is also similar but is a smaller species and possesses a deviated aperture.

Superfamily **MATHILDOIDEA** Dall, 1889
Family **MATHILDIDAE** Dall, 1889
Genus ***ACROCOELUM*** Cossmann, 1888

Type species.—*Mathilda bouryi* Cossmann, 1888, by original designation.

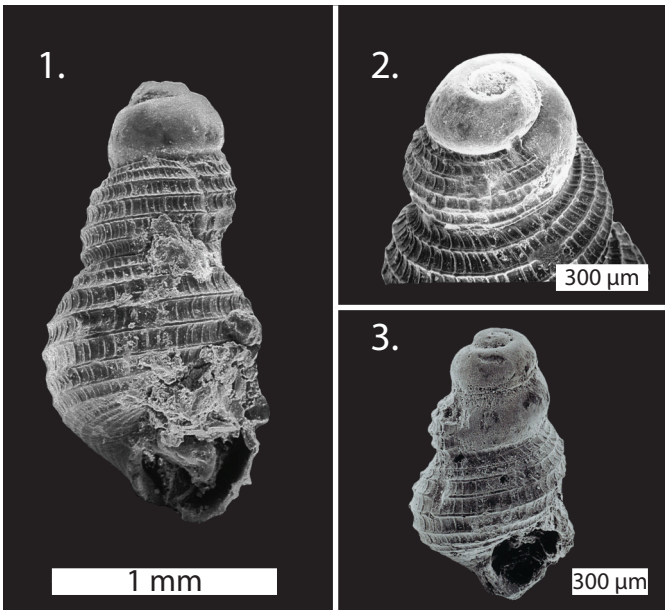
Acrocoelum richardsi Govoni n. sp.
Text-fig. 41, Table 4

Acrocoelum richardsi Govoni, 1983: 137–139, pl. 7, figs. 6–8 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:6537B26A-7CFE-4022-B1EE-BF844AC1496F.

Type material.—Holotype USNM PAL 642480 from Locality A (sample A-1); paratype USNM PAL 642481 from Locality A (sample A-1).

Other material examined.—Three measured individuals, USNM PAL 642482, 6422483, and 642484, plus fragments of four shells from Locality A (samples A-1 and A-2) and Locality C (sample C-1).



Text-fig. 41. *Acrocoelum richardsi* Govoni n. sp., SEM. (**1, 2**) Holotype, USNM PAL 642480, sample A-1, in apertural (**1**) and protoconch (**2**) views. (**3**) Paratype, USNM PAL 642481, sample A-1, oblique apertural view.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. Horace G. Richards, formerly of the Academy of Natural Sciences of Philadelphia, in recognition of his many valuable contributions to the stratigraphy and paleontology of the sediments of the Atlantic Coastal Plain.

Diagnosis.—Very small, turriculate shell with smooth, well-rounded protoconch that is initially blunted, deviated, and slightly immersed to flush above; teleoconch whorls round-sided, possessing five evenly and widely spaced flat-topped spiral ribbons and fine, closely spaced, raised axial threads.

Description.—Shell very small, turriculate, anomphalous. Protoconch smooth, well rounded, of approximately two and one-half volutions; first one and one-half volutions low, somewhat deviated; apex very slightly immersed to flush; last volution well expanded. Teleoconch of two and one-half to three volutions, last whorl almost two-thirds of total shell height. Suture narrowly impressed. Whorls of teleoconch rounded, possessing five evenly spaced, narrow, flat-topped spiral ribbons; posterior ribbon usually weakest; other ribbons of subequal strength. Interspaces much wider than ribbons. Axial sculpture consisting of fine, relatively closely and evenly spaced raised threads that are lower than spirals. Threads trending vertically on anterior and medial portions of whorl but curving adaperturally above. Many axials cross all or some of the spirals (particularly the posterior three) and form extremely fine, easily overlooked granular nodes on spirals. Base of last whorl inclined, nearly straight, bearing strong ribbon above that is normally obscured immediately below suture in preceding whorls, plus seven or eight increasingly crowded and less-distinct threads below. Axial threads present on base but rapidly becoming more crowded and obscure until they disappear as distinct elements below. Aperture subovate; outer lip thin, curved, angulated where intersected by spiral cords, extending slightly below inner lip; inner lip curved, slightly thickened, can be lightly calloused above and very slightly reflected below.

Remarks.—*Acrocoelum richardsi* n. sp. is represented by several complete individuals, all of which appear to be immature or submature, as well as whorl fragments. In addition to the Brightseat form, only three other members of the genus have been reported from the sediments of the Gulf and Atlantic Coastal Plains. *Acrocoelum*? *cereum* Sohl, 1960, from the Upper Cretaceous (Campanian to lower Maastrichtian) Coffee Sand and Ripley formations of Mississippi, is con-

siderably smaller and possesses five sharp-topped spirals, and six on the penultimate whorl of larger specimens. The specimens of *Acrocoelum*? *cereum* figured by Dockery (1993: 151) are comparable to the Brightseat shells in size, yet show the smaller protoconch and more faint axial ornament of the Cretaceous species when compared to *Acrocoelum richardsi* n. sp. *Acrocoelum cancellatum* (H. C. Lea, 1841), from the middle Eocene (Bartonian) Gosport Sand of Alabama, is of similar size and, like *Acrocoelum richardsi* n. sp., possesses five spiral elements on the penultimate and earlier teleoconch whorls. Its spirals, however, are wider than the interspaces and the axial elements are somewhat less numerous and stronger, lending a much more distinctly cancellate appearance to the ornament. Garvie (2021) described the subspecies *Acrocoelum cancellatum palaeocenica* Garvie, 2021 from the Danian Tehuacana Limestone of Texas, which differs in its wider anterior spiral lines and the possession of overlapping axial striae across the entire teleoconch.

In his discussion of the genus *Acrocoelum*, Sohl (1960: 133) placed some doubt on the assignment of the Cretaceous form to the genus. He specifically noted that the first volution of the protoconch of *Acrocoelum*? *cereum* was flush or very nearly so with respect to the succeeding whorl rather than distinctly immersed as in the type species, *Mathilda bouryi*. *Acrocoelum richardsi* n. sp. exhibits a similar deviation from the more typical protoconch form, with the first whorl ranging from very slightly immersed to flush. However, it is felt that such differences fall within the range of expected variation, and that the Brightseat form is close enough to *Acrocoelum* s. s. in overall shape, ornament, and protoconch characteristics to be confidently placed within the genus.

Several unnamed forms of *Acrocoelum* have been reported from Danian deposits in West Greenland and Denmark (Kollmann and Peel, 1983; Lauridsen and Schnetler, 2014). Additionally, von Koenen (1885) described two species, *Mathildia gracilis* von Koenen, 1885 and *Mathildia*? *obtusa* von Koenen, 1885, which Schnetler (2001) reported under the genus *Acrocoelum* from the Selandian Lellinge Greensand of Denmark. The available figures and descriptions of these Greenland and European forms are not sufficient for comparison with the Brightseat species.

Genus ***MATHILDA*** Semper, 1865

Type species.—*Turbo quadricarinatus* Brocchi, 1814, by subsequent designation (de Boury, 1883).

Subgenus ***FIMBRIATELLA*** Sacco, 1895

Type species.—*Cerithium fimbriatum* Michelotti, 1847, by original designation.

Diagnosis.—Small to medium-sized turriculate shell with body whorl approximately one-third length of total shell height; heterostrophic protoconch; whorl sides arched, usually with carinate peripheral angulation, basally bicarinate; base flattened; ornament of strong, often tuberculate spiral cords and finer axial threads; aperture rounded-quadrate, indistinctly "beaked" below; columella thick, vertical; umbilical fissure lacking (after Wenz, 1939: 662).

Remarks.—*Fimbriatella*, a common Paleocene to Pliocene subgenus, is poorly represented in the lower Cenozoic Coastal Plain sediments of North America. Only a single Eocene mathildid, *Mathilda* (*F.*) *singularis* Aldrich, 1907, from the lower Eocene of Alabama, is assignable to the genus. From the Paleocene, only the two new species described below, *Mathilda* (*F.*) *crebricosta* n. sp. and *Mathilda* (*F.*) *marylandensis* n. sp., are known. Neither Paleocene form seems to bear a close resemblance to the Eocene species. *Mathilda* (*F.*) *marylandensis* n. sp. does, however, bear a strong resemblance to a Late Cretaceous species, *Mathilda ripleyana* Wade, 1926, from Tennessee. The relationship between these two species is unclear and might be only superficial if, as has been argued by Sohl (1960: 129), the Cretaceous form represents a *Fimbriatella*-like member of *Mathilda* s. s.

Mathilda (*Fimbriatella*) *crebricosta* Govoni n. sp.
Text-fig. 42, Table 4

Mathilda (*Fimbriatella*) *crebricosta* Govoni, 1983: 132–134, pl. 7, fig. 3 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:406E2DCD-FC4F-41F2-8B2D-BBB7022BA8B0.

Type material.—Holotype USNM PAL 642473 from Locality A (sample A-2).

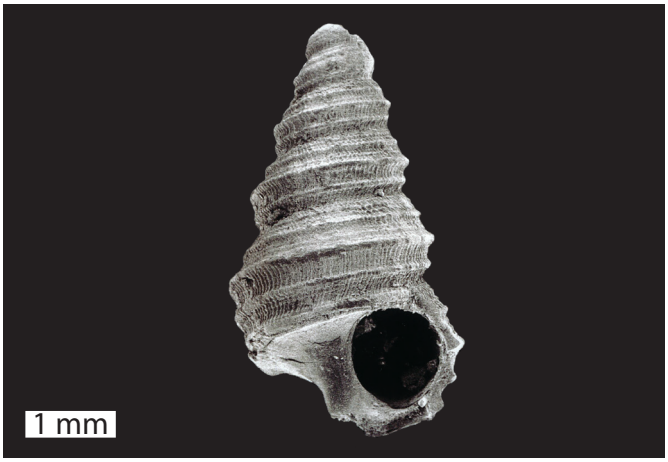
Other material examined.—Single broken individual from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named from the Latin *creber*, "thick," and *costa*, "ribs," referring to its thick spiral ribs.

Diagnosis.—Small, turriculate shell; teleoconch whorls flattened-angular, bearing three strong anteriorly offset spiral cords; middle cord forming carination at peripheral whorl angulation; axial sculpture of very numerous and closely spaced



Text-fig. 42. *Mathilda* (*Fimbriatella*) *crebricosta* Govoni n. sp., holotype, USNM PAL 642473, sample A-2, SEM, apertural view.

threads; granular nodes developed at intersection of spirals and axials.

Description.—Small, moderately thick, turriculate shell. Protoconch incompletely known but apparently heterostrophic and erect. Teleoconch incomplete, of at least five and three-quarters whorls. Suture very slightly imbricate. Upper whorl profile flattened-angular; whorl sides both above and below whorl angulation nearly flat. Base of whorl flat, sloping. Spiral ornament on upper whorl surface strongest, dominated by three strong, rounded, raised cords; cords evenly spaced with respect to each other but group offset anteriorly; posterior cord lowest, weakest of three; middle cord strongest, highest, forming distinct carination at peripheral whorl angulation somewhat anterior of midwhorl; anterior cord of intermediate strength. A fourth moderately strong, bifid cord developed at whorl base, just below level of the suture, normally hidden from view. Secondary spiral elements consisting of two or three very low, thin, generally indistinct threads developed in interspaces between the primary cords and between cords and sutures. Axial sculpture consisting of very numerous and closely spaced, thin, raised threads trending in distinctly opisthocyrt arc across whorl surface. Axials crossing all spiral elements forming fine, often sharp granular nodes. Whorl base with ornament like that developed on upper whorl surface. Aperture incompletely known, smooth, subcircular within; outer lip thick, gently curved above and medially, possibly somewhat forward flaring within at base, with distinctly flattened anterior outer wall that probably extends laterally and somewhat downward to meet base of columellar lip. Columella short, thick, somewhat inclined, with basally reflected lip. Umbilical fissure lacking.

Remarks.—The overall shape, ornament, and possession of an erect heterostrophic protoconch clearly place this form within the genus *Mathilda* s. l. Although the aperture is incompletely known, other preserved features including the apparent basal flattening of the outer lip, the basal reflection of the columellar lip (best seen in the paratype), the thick columella, and the possession of a basal bifold cord forming an angulation separating the flattened upper and lower whorl surfaces conform well with those considered diagnostic for the subgenus *Fimbriatella*.

On the basis of the details of its sculpture, particularly the number and placement of the primary spiral elements and the very numerous fine axial threads, *Mathilda* (*Fimbriatella*) *crebricosta* n. sp. is easily separated from all other known members of the genus or allied forms reported from the Cretaceous and Paleogene sediments of the Atlantic and Gulf Coastal Plain. Therefore, despite the fact that it is represented by only two incomplete individuals, the number and quality of diagnostic features preserved are sufficient to justify erection of the new species.

Mathilda (*Fimbriatella*) *crebricosta* n. sp. shares a similar apical angle, overall shape, and ornament of three prominent lateral spiral cords with basal bifid cord as does *Mathilda* (*F.*) *amundseni* from the late Danian Prince Creek Formation of northern Alaska. An unnamed species from the Danian of West Greenland, *Mathilda* sp. 5 of Kollmann and Peel (1983), also possesses these features. Given the fragmental nature of the material available for all three taxa, precise analysis of the extent of their similarity is not currently possible.

Mathilda (*Fimbriatella*) *marylandensis* Govoni n. sp.
Text-fig. 43, Table 4

Mathilda (*Fimbriatella*) *marylandensis* Govoni, 1983: 134–137, pl. 7, figs. 4, 5 (unpublished).

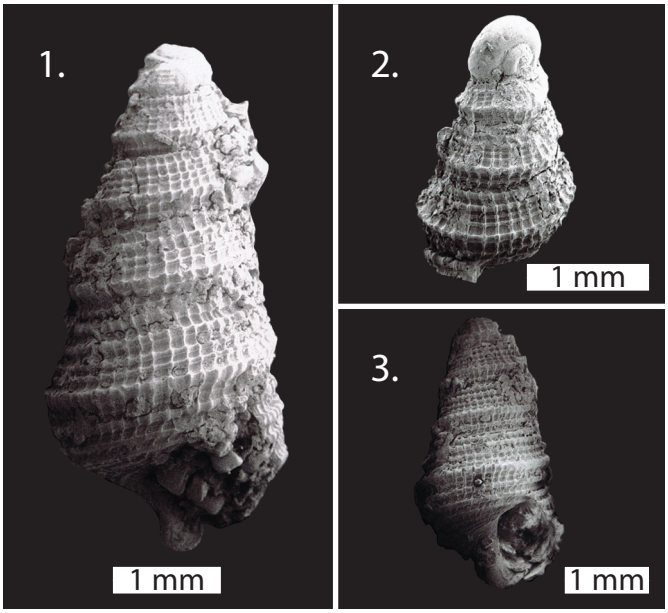
ZooBank LSID.—urn:lsid:zoobank.org:act:4FD0C405-CF8C-4952-BB71-DC56319B3EC5.

Type material.—Holotype USNM PAL 642474 from Locality A (sample A-1); paratypes USNM PAL 642475 from Locality A (sample A-1), 642478 from Locality A (sample A-2), and 642479 from Locality A (sample A-6).

Other material examined.—Five additional incomplete specimens from Locality A (samples A-1, A-9).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).



Text-fig. 43. *Mathilda* (*Fimbriatella*) *marylandensis* Govoni n. sp., SEM. (**1**) Holotype, USNM PAL 642474, sample A-1, apertural view. (**2**) Paratype, USNM PAL 642478, sample A-2, detail of protoconch. (**3**) Paratype, USNM PAL 642479, sample A-6, apertural view.

Etymology.—This species is named after the state of Maryland, in which it was discovered.

Diagnosis.—Small to medium-sized, turriculate, peripherally carinate shell with strong, distinctly noded spiral cords and threads and thin axial threads; aperture rounded-quadrate with short, straight, thick columella bearing reflected lip forming inclined, somewhat twisted canal.

Description.—Small to medium-sized, sturdy, turriculate shell. Protoconch erect, heterostrophic, of approximately two and one-half smooth, rounded whorls set nearly normal to axis of teleoconch. Teleoconch of at least five whorls. Sutures narrow, impressed. Upper whorl profile flattened-angular; side above peripheral whorl angulation broad, highly inclined; side below angulation appears short, flat, and inward sloping on spire whorls but is seen to be relatively broad and gently rounded in final whorl. Whorl base flattened, separated from upper surface by low spiral cord at basal angulation. Sculpture of upper whorl surface dominated by strong spiral cords and threads; on spire whorls, strongest cord forming distinct carination at peripheral angulation; two weaker cords placed posteriorly; first cord placed immediately below the suture forming subsutural collar; second cord placed a short distance below first; one or both posterior cords can grow in strength to equal peripheral carina on mature whorls; two prominent threads situated between lower posterior cord and peripheral carina below single finer thread placed below peripheral carina, midway between it and third weak cord immediately above anterior suture. On final whorl, a second weak spiral cord can be seen midway between first cord below the peripheral carina and low cord at basal angulation; additional threads can be added in one or more interspaces between earlier spirals. Axial sculpture of numerous, relatively closely and evenly spaced, thin axial threads that cross upper whorl surface with several weak flattened cords and threads; spirals weakly noded where crossed by fine axial threads. Aperture rounded-quadrate; outer lip notched at intersection with parietal wall, arched below, somewhat angulated at intersection with peripheral carination, posteriorly flattened, anteriorly arched and becoming distinctly flattened and inclined below; columella short, straight, thick, with lip reflected below, forming shallow, inclined, somewhat twisted canal at intersection with base of outer lip; parietal wall flattened, inclined, apparently with light coating of callus within. Umbilical fissure lacking.

Remarks.—*Mathilda* (*Fimbriatella*) *marylandensis* n. sp. is the most commonly preserved mathildid in the Brightseat Formation, although it still represents only a minor element of the total gastropod fauna. It differs significantly from *Mathilda* (*F.*) *singularis* from the lower Eocene (Ypresian) Bashi Formation of Alabama, in the number and placement of spiral cords and in its more numerous and narrow axial threads.

Based on outline and on details of ornamentation, the Brightseat form appears to be much more closely allied to a Late Cretaceous (late Campanian) species, *Mathilda ripleyana* from the lower Ripley Formation in Tennessee. The two species are close, although not identical, in number and relative strength of spiral elements, particularly on the earlier whorls. The two forms can, however, be separated on the basis of apertural characters that clearly place the Paleocene species within the genus *Fimbriatella*, but which appear to suggest for the Cretaceous form a closer affinity for *Mathilda* s. s. (Sohl, 1960: 129).

Mathilda (*Fimbriatella*) *marylandensis* n. sp. appears closely related to *Fimbriatella* sp. 1 of Kollmann and Peel (1983). The forms resemble each other in early apical morphology: both exhibit a noded appearance at the intersection of spiral cords and axial threads that grows less pronounced on later whorls, and both possess a prominent spiral cord on the adapical portion of the whorl at the peripheral angulation that is stronger than the other spirals of the juvenile shell. Both species could be closely related to *F. carinata* Ravn, 1939, which is known from the Selandian of Denmark.

Subgenus ***MATHILDA*** Semper, 1865 s. s.

Diagnosis.—"Medium-sized turriculate to turreted shells with heterostrophic protoconch; whorl sides usually rounded and basally subcarinate; base broadly arched and may or may not possess umbilical chink; ornament of strong spiral cords and fine axial threads" (Sohl, 1960: 129).

Remarks.—The range and geographic distribution of *Mathilda* s. s. within the lower Cenozoic sediments of the Gulf and Atlantic Coastal Plains is imperfectly understood. Prior to recognition of the genus in the Brightseat Formation, the genus was represented in the Paleocene by a single species, *Mathilda* (*Mathilda*) *leona* Aldrich, 1907, from the upper Paleocene of Alabama. Garvie (2021) reported the form *Mathilda* (*Mathilda*) aff. *claibornensis* Aldrich, 1887, from the middle Danian of Texas, noting the slight difference in apical angle and spiral-lirae prominence of the Paleocene specimens compared to their namesake form in the Eocene Gosport Sand of Alabama. In the Gulf Coastal Plain, several species are reported from the Eocene, including *Mathilda* (*Mathilda*) *leana* Aldrich, 1897, and *Mathilda* (*Mathilda*?) *elongatoides* Aldrich, 1907, from the lower Eocene of Alabama, *Mathilda* (*Mathilda*) *retisculpta* (Meyer and Aldrich, 1886) and *Mathilda* (*Mathilda*?) *claibornensis* from the middle Eocene of Mississippi and Alabama, respectively, and *Mathilda* (*Mathilda*) *regularis* (Meyer, 1886) from the upper Eocene of Mississippi. Only one species, *Mathilda* (*Mathilda*) *retisculpta* var. *aldrichi* Palmer, 1937, from the middle Eocene of South Carolina, is known from the Atlantic Coastal Plain.

Mathilda s. s. is represented in the Brightseat by a small number of broken and immature shells. Most of the specimens lack protoconchs and in most cases the aperture is broken away or incompletely preserved. However, other features of the shells, particularly gross aspects of shape and ornament, do serve to confirm their placement within *Mathilda* s. s.

Individual species within the genus *Mathilda* tend to show rather limited variability in size and shape. More significantly, they also appear to exhibit remarkably stable patterns of ornamentation, particularly with respect to number, relative size, and position of the spiral elements. In the Brightseat Formation, four distinct forms of *Mathilda* s. s. can be recognized, primarily on the basis of details of ornament. These include a new species, *Mathilda* (*Mathilda*) *kauffmani* n. sp., and three additional taxa that are probably also new, but which consist of insufficient material to justify specific designations.

Mathilda (*Mathilda*) *kauffmani* Govoni n. sp.
Text-fig. 44, Table 4

Mathilda (*Mathilda*) *kauffmani* Govoni, 1983: 126, 127, pl. 6, figs. 6–8 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:FCC4F76C-F74C-41F3-AE56-2A08CBB5C9C7.

Type material.—Holotype USNM PAL 642464 from Locality B (sample B-1); paratype USNM PAL 642465 from Locality A (sample A-2).

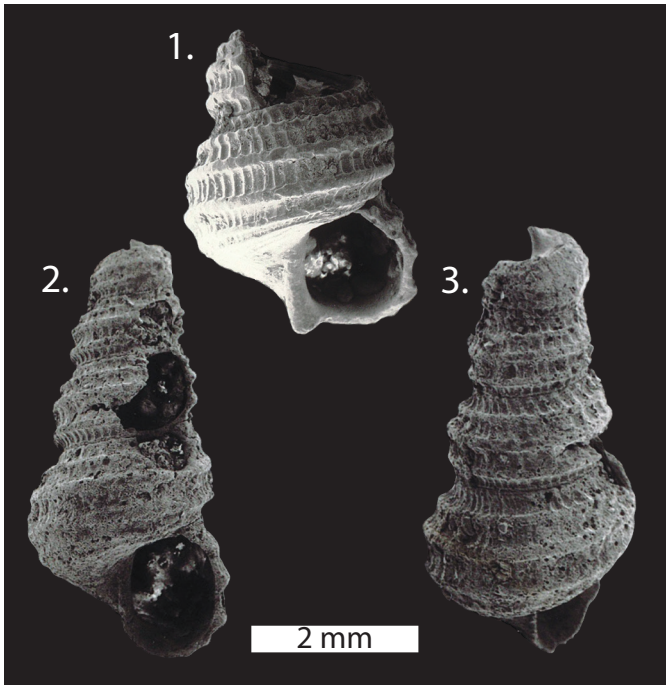
Other material examined.—Fragment consisting of damaged protoconch and approximately two and one-third volutions of teleoconch, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. Erle G. Kauffman, for his many valuable contributions to molluscan paleontology and biostratigraphy.

Diagnosis.—Small, turriculate shell; teleoconch whorls rounded, bearing three strong, more or less evenly spaced spiral ribbons and cords plus two weaker cords, one situated against each suture.



Text-fig. 44. *Mathilda* (*Mathilda*) *kauffmani* Govoni n. sp., SEM. (**1**) Paratype, USNM PAL 642465, sample A-2, apertural view. (**2, 3**) Holotype, USNM PAL 642464, sample B-1, in apertural (**2**) and oblique lateral (**3**) views.

Description.—Shell small, turriculate. Protoconch erect, heterostrophic, of roughly two smooth, rounded whorls set nearly normal to axis of teleoconch coiling. Suture impressed. Whorl sides rounded above; base flattened and sloping. Spiral ornament of upper whorl surface very strong, dominated by two thick, raised ribbons of approximately equal strength; first ribbon situated at midwhorl; second ribbon slightly more than midway between midwhorl ribbon and another, still weaker, cord that forms posterior subsutural collar; moderately strong ribbon at basal whorl margin partially concealed by subsequent whorl. Five or six additional, very faint, low, rounded spiral threads can appear in interspace between two strongest spirals in latest whorl, separated by narrow, shallow grooves. Axial sculpture of numerous, relatively evenly spaced threads; axials well defined, although lower and narrower than spiral elements; threads tending in opisthocyrt arc across upper whorl surface. Low rounded nodes forming on spirals where crossed by axials; nodes best developed on upper three spirals. Base of whorl possessing thin, nodose cord below basal ribbon, followed by several low, closely spaced ribbons below; numerous close-set axial threads filling interspaces. Aperture subovate; outer lip broadly rounded medially, becoming more sharply rounded anteriorly and forming broad angle at intersection with parietal wall; columellar lip of moderate height, slightly curved, slightly reflected; parietal wall flat, relatively narrow, sloping, with light coating of callous. Umbilical fissure lacking.

Remarks.—*Mathilda* (*Mathilda*) *kauffmani* n. sp. does not appear to be closely related to other known Paleogene species from the Gulf and Atlantic Coastal Plains. Of the North American species, only *Mathilda* (*Mathilda*?) *elongatoides* from the lower Eocene (Ypresian) Bashi Formation of Alabama approaches *Mathilda* (*Mathilda*) *kauffmani* n. sp. in number and placement of the spiral ornament. The Eocene form is, however, clearly separated from *Mathilda* (*Mathilda*) *kauffmani* n. sp. by its numerous, much smaller, very narrow, flat-sided whorls. *Mathilda* (*Mathilda*) *kauffmani* n. sp. appears close in both shape and ornament to an unnamed *Mathilda* from the middle Danian Agatdal Formation of West Greenland (*Mathilda* sp. 5 of Kollmann and Peel, 1983).

Mathilda (*Mathilda*) sp. A
Text-fig. 45, Table 4

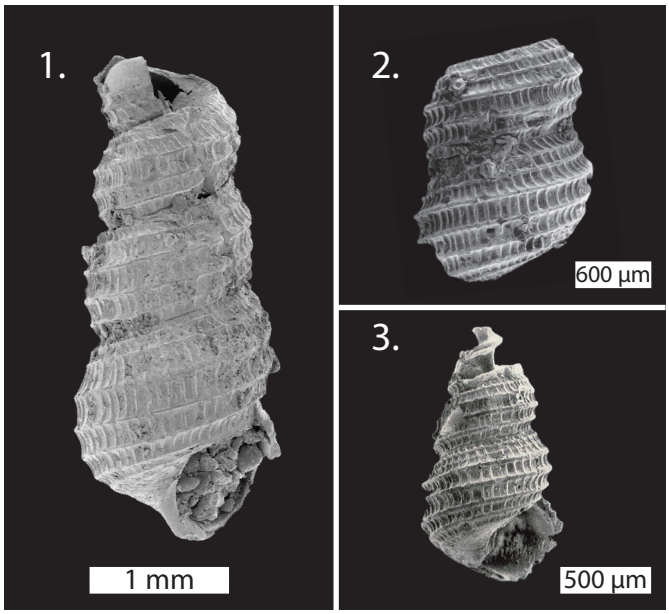
Mathilda (*Mathilda*) sp. Form A. Govoni, 1983: 128, 129, pl. 6, figs. 9–11.

Material examined.—Three incomplete figured specimens: USNM PAL 642466 from Locality B (sample B-2), and 642467 and 642468 from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, moderately slender, multiwhorled, turriculate. Suture narrow, impressed. Whorl sides somewhat flattened posteriorly, becoming rounded medially and anteriorly. Base of whorl nearly flat, sloping. Spiral ornament of upper whorl surface dominated by three raised, rounded to narrow-topped, evenly spaced, anteriorly situated cords: first cord placed slightly posterior of midwhorl; fourth strong cord developed at basal margin wholly or partially concealed by subsequent whorl; above upper cord, first one and then second small, but very distinct, spiral threads appear on flattened whorl surface; threads equidistantly situated with respect to each other, posterior suture, and first cord below. Axial sculpture consists of numerous evenly spaced threads equal in width to, but lower than, spiral threads; axials trending across upper whorl surface in opisthocyrt arc. Very low, indistinct nodes forming where axials cross spiral threads but less frequently form at intersections with spiral cords. Whorl base possessing three or more thinner, closely spaced spiral ribbons and numerous axial threads. Aperture incomplete, apparently ovate; outer lip thin, curved above, possibly somewhat flattened anteriorly; columellar lip curved, slightly reflected; parietal wall flat, probably lightly calloused. Umbilical fissure lacking.



Text-fig. 45. *Mathilda* (*Mathilda*) sp. A, SEM. (**1**) USNM PAL 642466, sample B-2, apertural view. (**2**) USNM PAL 642467, sample A-1, lateral view. (**3**) USNM PAL 642468, sample A-1, apertural view.

Remarks.—*Mathilda* (*Mathilda*) sp. A does not appear to be closely related to any known Paleogene mathildid from either the Gulf or Atlantic Coastal Plains and probably represents a new species. The material at hand is insufficient to justify specific designation.

Mathilda (*Mathilda*) sp. B
Text-fig. 46, Table 4

Mathilda (*Mathilda*) sp. Form B. Govoni, 1983: 129, 130, pl. 6, figs. 12, 13.

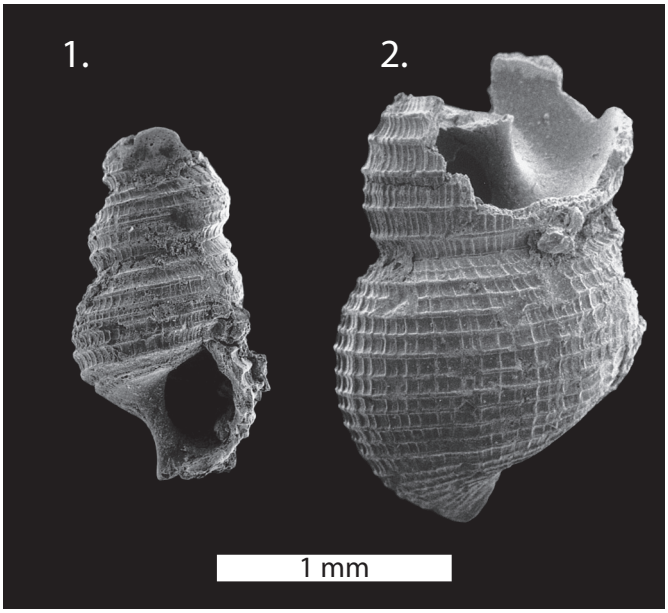
Material examined.—Two incomplete figured specimens, USNM PAL 642469 and 642470 from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, turriculate. Suture narrow, impressed. Whorl sides and base rounded. Spiral ornament of upper surface of earlier teleoconch whorls distinct but relatively fine; upper half of whorl with two fine cords, evenly spaced with respect to each other, posterior suture, and midwhorl spirals below; group of three still finer, closely spaced cords developed at midwhorl; third fine cord placed on lower portion of whorl midway between group above and anterior suture; fourth cord, equal in strength to one immediately above, situated at basal margin, partially concealed by subsequent whorl. Axial sculpture of fine, evenly and relatively closely spaced threads trending in broad opisthocyrt arc across upper whorl surface. Low, fine narrow granules or small nodes formed on spirals where crossed by axial elements. Three fine, evenly spaced cords with numerous, close-set, very fine axial threads filling interspaces developed on basal whorl surface. Character of ornament changing very rapidly in final whorl; > 20 evenly spaced, subequal, fine spiral cords and axial threads, more widely spaced than in earlier whorls, forming distinctly cancellate pattern with subquadrate interspaces. Aperture incomplete, apparently rounded-quadrate; outer lip broadly rounded medially, flattened anteriorly, and forming acute angle with parietal wall; columellar lip of moderate height, straight to slightly curved, slightly reflected; parietal wall flattened, sloping, lightly calloused. Umbilical fissure lacking.

Remarks.—*Mathilda* (*Mathilda*) sp. B appears to be a unique form without close affinities to other known Gulf and Atlantic Coastal Plain representatives of the genus. The available material is, however, insufficient to justify specific designation.



Text-fig. 46. *Mathilda* (*Mathilda*) sp. B, SEM. (**1**) USNM PAL 642469, sample A-1, apertural view. (**2**) USNM PAL 642470, sample A-1, dorsal view.

Mathilda (*Mathilda*) sp. C
Text-fig. 47, Table 4

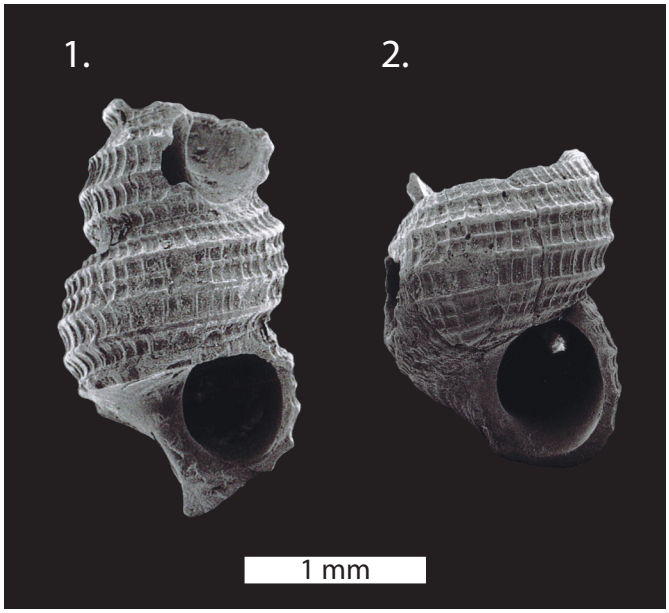
Mathilda (*Mathilda*) sp. Form C. Govoni, 1983: 130, 131, pl. 7, figs. 1, 2.

Material examined.—Two incomplete figured specimens, USNM PAL 642471 and 642472, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, turriculate. Suture narrow, impressed. Upper whorl sides initially somewhat flattened posteriorly and medially, becoming more rounded on later whorls; whorl base flattened and sloping. Sculpture subcancellate. Spiral sculpture dominated by three strong cords; first cord placed approximately midway between posterior suture; second cord located at midwhorl; third cord placed somewhat closer to anterior suture than to midwhorl cord; fourth equally strong cord present at basal whorl angulation but almost entirely concealed by subsequent whorl. Two weaker cords, one placed midway between upper and midwhorl primary cords, present on earlier whorls; these cords strengthening rapidly below



Text-fig. 47. *Mathilda* (*Mathilda*) sp. C, sample A-1, SEM, apertural views. (**1**) USNM PAL 642471. (**2**) USNM PAL 642472.

and joined by weak cords in middle of interspaces formed by midwhorl and lower primary cords and anterior suture; two fine threads appearing on last whorl in space between posterior suture and cord below. Axial sculpture of generally evenly spaced axial threads; many threads quite coarse, approaching and occasionally exceeding secondary spiral cords in strength; axials trending across upper whorl surface nearly straight anteriorly, curving gently toward aperture above. Very low, indistinct nodes formed at intersection of axial and spiral elements. Basal whorl surface possessing several low, closely spaced spiral cords and ribbons and closely spaced axial threads. Aperture incompletely known, apparently subovate; outer lip rounded above, possibly flattening somewhat anteriorly; columellar lip curved; parietal surface curved, with light coating of callus. Umbilical fissure lacking.

Remarks.—*Mathilda* (*Mathilda*) sp. C does not appear close to any known Paleogene representatives of the genus from either the Gulf or Atlantic Coastal Plains. The available material is, however, insufficient to justify specific designation.

Genus ***GEGANIA*** Jeffreys, 1884

Type species.—*Gegania pinguis* Jeffreys, 1884, by monotypy.

Gegania? sp. indet.
Text-fig. 48, Table 4

Tuba? sp. indet. Govoni, 1983: 140, 141, pl. 7, figs. 9–11.

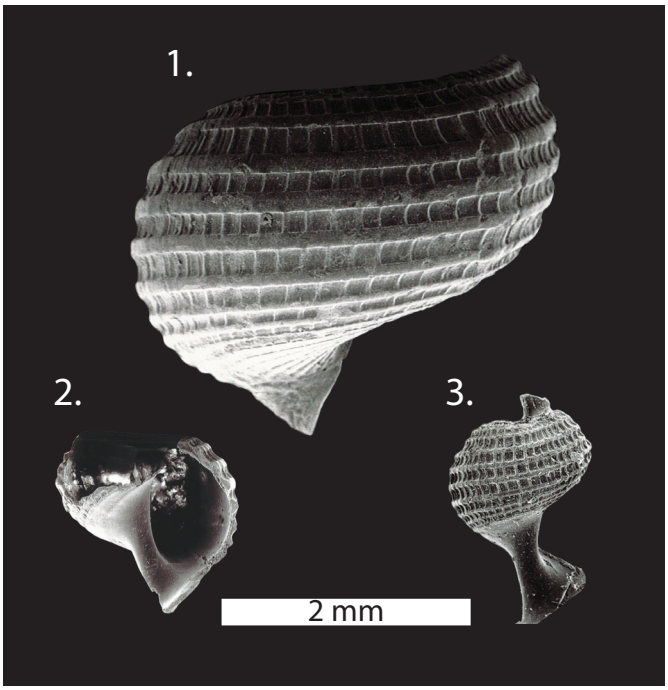
Material examined.—Three figured specimens, USNM PAL 642485, 642486, and 642487, plus two additional fragments from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Suture weakly incised. Sculpture on exposed portion of whorls consisting of six well-defined spiral cords, increasing anteriorly in strength and especially width; cords separated by wider, shallower interspaces, becoming more flattened and ribbon-like on more mature whorls. Axial sculpture of generally thin, sharp, evenly, relatively widely spaced threads developed within interspaces; axial elements cutting across only smaller posterior cords, giving vaguely thickened or nodose appearance. Basal whorl surface somewhat flattened and possessing same, although more closely spaced, sculpture as above.

Remarks.—Five small fragments from near the base of the Brightseat Formation are tentatively assigned to the genus



Text-fig. 48. *Gegania*? sp. indet., sample A-1, SEM. (**1**) USNM PAL 642485, detail of sculpture. (**2**) USNM PAL 642486, apertural view. (**3**) USNM PAL 642487, lateral view.

Gegania. The fragments are well rounded in outline and appear to exhibit a rapid expansion in whorl diameter, suggesting the globose, rapidly tapering turriculate shell form typical of *Tuba* I. Lea, 1833 (Wenz, 1939: 663, for *Gegania* = *Tuba*). The sculpture of this form appears to be somewhat atypical for *Gegania*. As in all other Paleogene members of the genus reported from the Atlantic and Gulf Coastal Plains, typical members of *Gegania* generally tend to be characterized by more closely spaced spiral cords that are often of more variable or alternating strength and distinctly nodose due to intersection of the axial elements.

Although incompletely known, the apertural characteristics seem to accord well with those described for typical *Gegania* (see Wenz, 1939: 663; Sohl, 1960: 134; as *Tuba*). The aperture appears to have been subovate, the columella relatively straight, and the thin calloused inner lip reflected back over and wholly or partially obscuring a narrow umbilical cleft.

Due to the lack of adequately preserved material, particularly a well-preserved protoconch, and the somewhat atypical sculpture exhibited by the specimens, it is impossible to assign them to the genus *Gegania* with complete confidence.

Infraclass **EUTHYNEURA** Spengel, 1881
Cohort **ACTEONIMORPHA** Bouchet et al., 2017
Superfamily **ACTEONOIDEA** d'Orbigny, 1843
Family **ACTEONIDAE** d'Orbigny, 1843
Genus ***ACTEON*** Montfort, 1810

Type species.—*Bulla tornatilis* Linnaeus, 1758, by original designation.

Acteon danicus Govoni n. sp.
Text-fig. 49, Table 4

Acteon danicus Govoni, 1983: 182–184, pl. 13, figs. 6, 7 (unpublished).

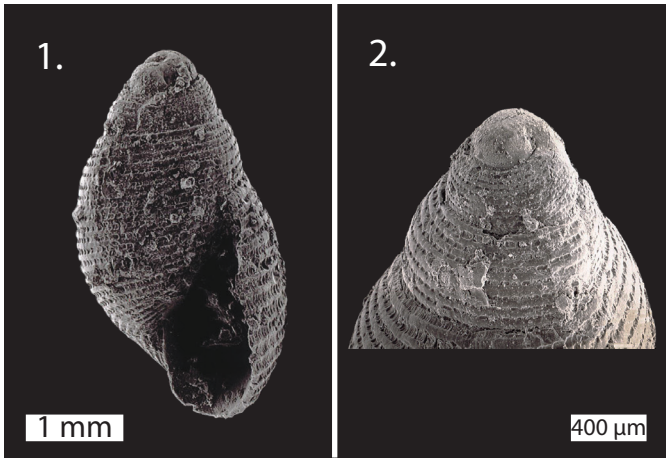
ZooBank LSID.—urn:lsid:zoobank.org:act:449D1D8A-1938-45F6-928A-FB0C7B9DA2F0.

Type material.—Holotype USNM PAL 788772 from Locality B (sample B-1).

Other material examined.—None.

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).



Text-fig. 49. *Acteon danicus* Govoni n. sp., holotype, USNM PAL 788772, sample B-1, SEM, in oblique apertural (**1**) and protoconch (**2**) views.

Etymology.—This species is named after the Danian stage, in which it was found.

Diagnosis.—Small lacriform shell with spire approximately one-fifth of total shell height; sculpture of numerous alternating ribbons and flat-bottomed furrows crossed within by thin collabral threads; spiral ribbons numbering eight or nine on earliest teleoconch whorls.

Description.—Shell small, lacriform, with spire approximately one-fifth of total shell height. Suture initially weakly channeled, becoming weakly impressed below. Protoconch heterostrophic, submerged, with approximately one smooth, bluntly rounded volution forming tip of apex, separated from teleoconch by sharp line marking thickening of succeeding whorls. Teleoconch of three very gently rounded whorls. Sculpture beginning abruptly at onset of teleoconch development. Spiral sculpture of numerous alternating ribbons and flat-bottomed furrows covering entire shell surface; ribbons of more or less uniform width, numbering nine on first whorl, eight on second (penultimate) whorl, and 23 on last whorl; furrows also of uniform width, approximately one-half that of ribbons. Axial sculpture of evenly spaced, fine collabral threads trending across whorl surface in broadly sinuous lines. Aperture elongate, posteriorly narrow, moderately broad, and rounded anteriorly; outer lip sturdy, broadly arcuate medially, becoming more acutely rounded and extending below base of shell anteriorly; columellar lip slightly reflected, calloused; parietal wall broad, lightly calloused. Columella bearing single broad, low but distinct plication that merges with columellar lip at posterior margin.

Remarks.—The genus *Acteon* is widespread and relatively diverse in the Late Cretaceous and middle and upper Eocene deposits of the Gulf and Atlantic Coastal Plains. A single species has been reported from lower Eocene sediments in Alabama and a few poorly preserved specimens, questionably assigned to *Acteon* sp. indet., have been reported from undifferentiated Paleocene sediments in Arkansas (Harris, 1894b: 45, pl. 3, fig. 1). Garvie (2021) described *Acteon pseudotypica* Garvie, 2021 and *Acteon pseudotypica fossa* Garvie, 2021 from the Danian Tehuacana Limestone of Texas, but those forms are larger in size and less well preserved in apical features and thus difficult to compare with the available Brightseat specimen.

The only available specimen of the Brightseat *Acteon*, the holotype, is relatively small and paucispiral compared to other members of the genus and very likely represents an immature individual. However, it exhibits certain differences in profile and sculpture that, when coupled with its stratigraphic position relatively far removed both geographically and temporally from other North American members of the genus, suggest that erection of a new taxon is of some utility. The Brightseat form is of a relatively slenderer profile compared to both the Cretaceous and Eocene representatives of the genus. In general size and extent of distribution of its sculptural elements, *Acteon danicus* n. sp. most nearly resembles members of the widely distributed Eocene group of *Acteon pomilius* Conrad, 1833, particularly *Acteon pomilius multannulatus* Aldrich, 1908, from the lower Eocene (Ypresian) Bashi Formation in Alabama. However, *Acteon danicus* n. sp. can be separated from these and related forms on the basis of the number of spiral ribbons developed on the earliest teleoconch whorls that, as Palmer (1937: 498) noted, appears to remain essentially constant within species of the genus and therefore is of diagnostic significance. *Acteon danicus* n. sp. possesses eight or nine spiral ribbons on its two apical whorls compared to only four in *Acteon pomilius* and its subspecies.

Several unnamed forms of *Acteon* have been reported in Danian- and Selandian-aged deposits of West Greenland and Denmark (Kollman & Peel, 1983; Lauridsen & Schnetler, 2014), but we consider comparison of the immature Brightseat specimen with sketches of these larger foreign taxa inadvisable with the present material.

Genus ***CRENILABIUM*** Cossmann, 1889

Type species.—*Actaeon aciculatum* Cossmann, 1889, by monotypy.

Crenilabium cf. *elatum* (von Koenen, 1885)
Text-fig. 50, Table 4

Crenilabium cf. *C. elatum* (von Koenen). Govoni, 1983: 186–188, pl. 14, figs. 1–4.

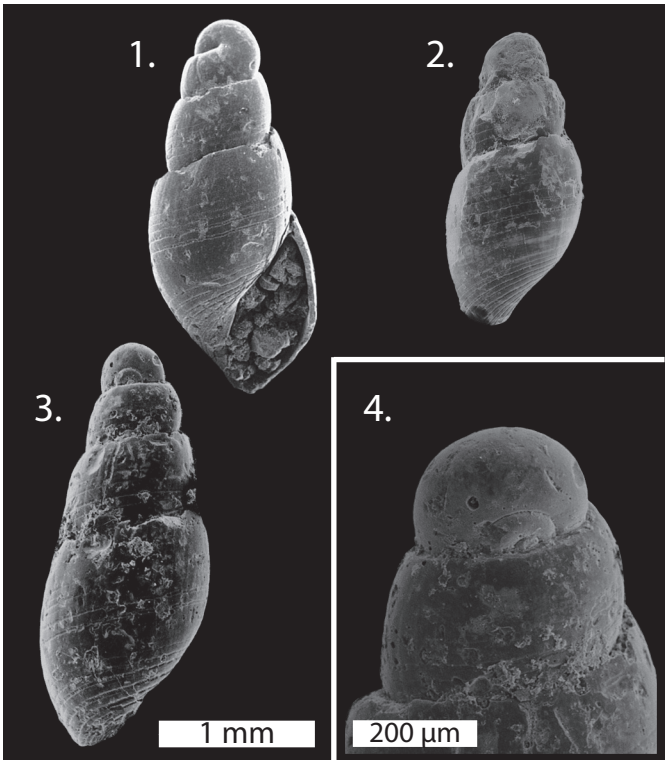
Material examined.—Three measured individuals, USNM PAL 788775, 788776, and 788777, plus five damaged juveniles from Locality A (samples A-1, A-7, A-9).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Diagnosis.—Very small, narrow, elongate-lacriform shell; relatively high spire; lacking or possessing only weakly developed columellar fold; ornament of approximately nine spirals, which are spaced further apart at midwhorl than nearer sutures.

Description.—Very small, glossy, elongately lacriform shells. Spire one-third of total shell height; protoconch smooth, rounded, partially erect, heterostrophic, deviated. Teleoconch



Text-fig. 50. *Crenilabium* cf. *elatum* (von Koenen, 1885), SEM. (**1**) USNM PAL 788775, sample A-1, apertural view. (**2**) USNM PAL 788776, sample A-1, dorsal view. (**3, 4**) USNM PAL 788777, sample A-9, in dorsal (**3**) and protoconch (**4**) views.

whorls gently flattened-convex; sutures narrowly but distinctly channeled. Spiral sculpture of narrow, evenly spaced grooves that, as viewed on last whorl, are lacking or very faint on posterior one-quarter of whorl, present and increasing in strength downward on next quarter below, absent or very faint on next quarter, and distinct again on basal quarter. Aperture moderately large, elongate-ovate. Outer lip thin, curved, forming acute angle with parietal wall above, sharply rounded and extending below base of shell. Columellar lip narrow, barely overturned; columella slightly curved, very faintly swollen above.

Remarks.—Five very small, damaged specimens of this acteonid were found in the Brightseat samples. Judging from the relatively large size of the protoconch compared to the rest of the shell, and the small number of teleoconch volutions preserved (three in the two largest specimens), the shells all appear to be juveniles. The basic form of the shell, particularly the relatively narrow, elongate-lacriform shape and relatively high spire, although typical of *Crenilabium*, is not commonly developed in other Acteonidae, which tend generally to be lower spired and rather tumid. Nevertheless, the Brightseat specimens are also somewhat reminiscent of some members of *Tenuiactaeon* Aldrich, 1921 and Actaeonidae Gabb, 1873. However, each of these dominantly Paleogene taxa possess a relatively strong columellar fold that is totally lacking or only very weakly developed in *Crenilabium*. The Late Cretaceous genus *Nonacteonina* Stephenson, 1941 is similarly shaped and also lacks a columellar fold, but its spiral striae are uniformly punctate and its protoconch is low and not deviated.

The Brightseat *Crenilabium* is nearly identical in size and shape and exhibits a similar pattern of distribution of its spiral sculptural elements, when compared to specimens of equivalent ontogenetic development of *Crenilabium elatum* from Selandian age deposits of Denmark, Germany, Austria, and Ukraine (compare Ravn, 1939, pl. 4, fig. 16a,b). The Brightseat shells also exhibit a very strong resemblance to *Crenilabium cossmanni* (Aldrich, 1910), reported from the upper Thanetian Tuscahoma Formation and lower Ypresian Hatchetigbee Formation in Alabama. However, the Alabama species appears to be relatively smaller, slightly more rapidly expanding, and to possess more uniformly distributed spirals on its early whorls than the Brightseat shells.

Genus ***TORNATELLAEA*** Conrad, 1860

Type species.—*Tornatellaea bella* Conrad, 1860, by monotypy.

Tornatellaea texana Gardner, 1935
Text-fig. 51, Table 4

Tornatellaea texana Gardner, 1935: 202, pl. 20, fig. 5.
Tornatellaea texana Gardner. Palmer and Brann, 1966: 954.
Tornatellaea (Tornatellaea) texana Gardner. Govoni, 1983: 184–186, pl. 13, figs. 8–10.

Type material.—USNM PAL 370981 from the Wills Point Formation (Selandian) of Bastrop County, Texas.

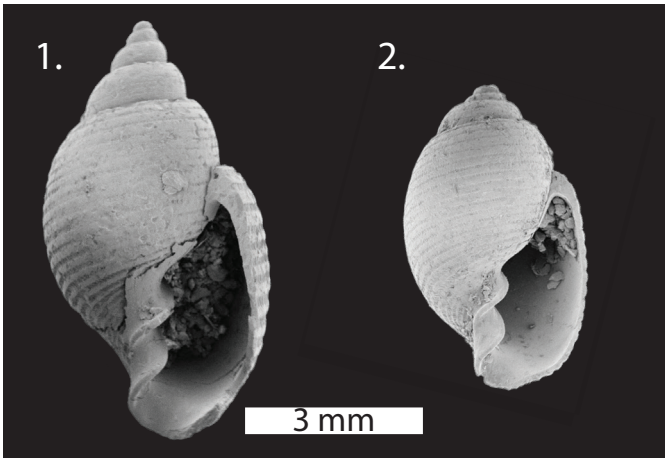
Other material examined.—Measured specimens USNM PAL 788773 and 788774 from Locality A (sample A-2), plus numerous additional complete and incomplete individuals from Locality A (samples A-1, A-2, A-5, A-6, A-7, A-8, A-9) and Locality B (sample B-2).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Texas: Kincaid Formation (Danian), Wills Point Formation (Danian–Selandian).

Diagnosis.—Moderately small subglobose tornatellaeid with variable but generally moderately high spire and final whorl width exceeding one-half of total shell height; in addition to spiral sculpture typical of genus, bearing fine axial riblets restricted to anterior portions of earliest teleoconch whorls; outer lip lacking interior spiral ridges and marginal crenulations; columella bearing two folds; parietal fold lacking.

Description.—Shell small; trigonal-ovate in outline. Protoconch partially immersed. Fine axial riblets developed on anterior portion of earliest teleoconch whorls; spiral ornament of 6−12 sulci on teleoconch, leaving widely, irregularly spaced grooves. Whorl sides relatively flattened medially. Collumella



Text-fig. 51. *Tornatellaea texana* Gardner, 1935, sample A-2, SEM, apertural views. (**1**) USNM PAL 788773. (2) USNM PAL 788774.

calloused, biplicate. Outer lip convex, lacking interior spiral ridges. Aperture angulated posteriorly.

Remarks.—This relatively small *Tornatellaea* is one of the most abundant species of gastropod found in the Brightseat Formation. The Maryland specimens are tentatively regarded as being conspecific with *Tornatellaea texana* from the upper (?) part of the Danian Kincaid Formation and lower (?) part of the late Danian to Selandian Wills Point Formation of Texas. The small amount of Texas material available for study exhibits an overall similarity to the Maryland specimens in size and shape, in the tendency to develop fine axial riblets on the anterior portion of the earliest teleoconch whorls, and in the lack of interior spiral ridges and marginal crenulations on the outer lip. However, the Brightseat shells do appear to possess generally less inflated (more medially flattened) whorl sides as well as somewhat coarser and more widely and irregularly spaced spiral grooves. Also, when compared to the illustration of the holotype of *Tornatellaea texana* (see Gardner, 1935: pl. 20, fig. 5), the two spiral columellar folds of mature individuals from Maryland appear much thicker and less obliquely inclined. Direct examination of the holotype suggests, however, that it is not quite mature and that the strength and obliquity of its folds compare more closely with that of individuals from Maryland preserved at a similar level of ontogenetic development. It would appear, therefore, that despite the observed differences, the Texas material falls within the total range of variability exhibited by the much larger Brightseat populations.

Tornatellaea linifera Garvie, 2021, from the Danian Tehuacana Limestone of Texas, appears similar in overall shape to the Brightseat specimens, but the Maryland shells have considerably thicker columellar folds than Garvie's species, and the lack of early apical preservation in the Texas specimens makes comparison with the early ontogenetic form of the Brightseat tornatellaeid difficult.

Cohort **RINGIPLEURA** Bouchet et al., 2017
Superfamily **RINGICULOIDEA** Philippi, 1853
Family **CYLICHNIDAE** A. Adams, 1850
Genus ***ZIKKURATIA*** Sohl, 1963

Type species.—*Zikkuratia tabanneensis* Sohl, 1963, by monotypy.

Zikkuratia danica Govoni n. sp.
Text-fig. 52, Table 4

Acteocina? sp. indet. Gardner, 1935: 204, pl. 20, fig. 3.
Acteocina? sp. indet. Palmer and Brann, 1966: 479.
Zikkuratia danica Govoni, 1983: 192–194, pl. 14, figs. 8–11 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:841D2437-32F6-474C-A0A1-6037EC6B510E.

Type material.—Holotype USNM PAL 788780 from Locality A (sample A-1); paratypes USNM PAL 788781 from Locality A (sample A-1), 788786 from Locality A (sample A-2), and 788788 from Locality A (sample A-9).

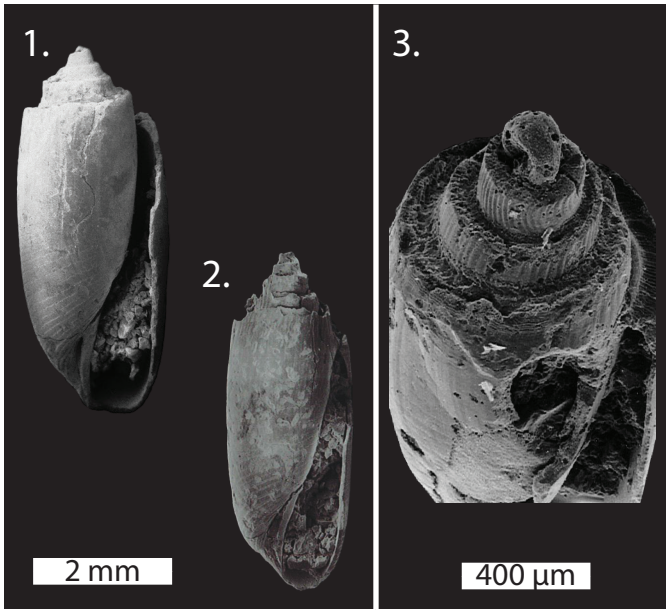
Other material examined.—Five measured specimens, USNM PAL 788782, 788783, 788784, 788785, and 788787, plus fragmental material comprising four additional specimens from Locality A (samples A-1, A-7, A-9) and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Texas: Wills Point Formation (Danian–Selandian).

Etymology.—This species is named after the Danian stage, in which it was found.

Diagnosis.—Shell very small, subcylindrical; spire turreted, usually comprising less than approximately one-fifth of total height; protoconch erect heterostrophic; whorls of te-



Text-fig. 52. *Zikkuratia danica* Govoni n. sp., sample A-1, SEM. (**1**) Paratype, USNM PAL 788781, apertural view. (**2**) Holotype, USNM PAL 788780, apertural view. (**3**) USNM PAL 788785, oblique protoconch view.

leoconch posteriorly flattened to form shelf; shelf bordered on outer edge by delicate raised shoulder rim; sculpture of closely spaced wavy spiral threads on surface of shoulder rim, closely spaced collabral riblets on posterior portion of earlier whorls, and very thin incised spiral grooves on anterior one-half to two-thirds of whorls; columella smooth, bearing no fold.

Description.—Shells very small, subcylindrical, anomphalous, with turreted spires of usually less than one-fifth but ranging to one-third of total height. Erect heterostrophic protoconch of approximately one and one-half smooth, rounded whorls oriented normal to axis of teleoconch coiling. Sutures impressed. Teleoconch of up to four volutions. Whorls rounded anteriorly, very broadly rounded medially, with distinctly flattened posterior shelf above. Shelf bordered on adaxial margin of later whorls by thin raised curtain of shell material. Outer edge of shelf bordered on later whorls by very delicate raised shoulder rim that, when well preserved, combines with inner raised curtain to give shelf appearance of forming deep straight-sided canal. Adaxial shoulder curtain possessing well-developed growth lines that are acutely adaperturally inclined. Shoulder rim possessing distinct, closely spaced, wavy spiral threads. Earlier whorls of teleoconch possessing easily worn, thin, closely spaced collabral riblets that extend anteriorly from shoulder rim to approximate level of following shelf or slightly below; these sculptural elements gradually lose prominence and finally disappear on penultimate whorl of mature shell. Very thin, incised spiral grooves, closely spaced below but becoming more widely spaced above, developed on anterior one-half to two-thirds of shell. Aperture narrow, notched above, broadening anteriorly, extending below base of columella where base of outer lip is narrowly rounded; outer lip thin, entire; columellar lip smooth, short, broadly curved, reflected slightly to form narrow pseudumbilical slit. Columella smooth, ranging from slightly concave to convex.

Remarks.—Prior to the discovery of *Zikkuratia danica* n. sp., the genus was known only from the Upper Cretaceous (upper Campanian to lower Maastrichtian) Ripley Formation of Mississippi and Georgia, where it is reported to be relatively rare (Sohl, 1964b: 304). There is no doubt that the Brightseat form belongs in this genus. *Zikkuratia danica* n. sp. differs, however, from the Cretaceous genotype, *Z. tabanneensis*, by its slightly larger size and narrower profile, the more limited extent of development of both the posterior axial riblets and anterior spiral grooves, the apparent failure of the axial riblets to extend across the shoulder onto the posterior shelf, and by its narrower and more anteriorly produced aperture. *Zikkuratia danica* n. sp. is easily distinguished from North American Paleogene members of the genus *Acteocina* Gray, 1847, which it superficially resembles, by its very erect heterostrophic protoconch, relatively high turreted spire, and most significantly, by the lack of a fold high on the columella that is characteristic of *Acteocina* (Zilch, 1959: 23).

An additional North American Paleogene occurrence of the genus *Zikkuratia* includes a juvenile specimen identified by Gardner (1935: 204, pl. 20, fig. 3) as *Acteocina*? sp. indet. from the lower Wills Point Formation (Mexia Member?) of lower Paleocene (Danian) age in Texas. The shell, which lacks the delicate posterior adaxial shell curtain and outer raised shoulder rim as well as the spiral grooves of *Z. danica* n. sp., nevertheless appears to be very close to the Brightseat species in overall appearance and dimensions and is probably referrable to it.

A small, turreted, posteriorly flat-shelved acteocinid lacking a columellar fold, reported from the middle Danian Agatdal Formation of West Greenland as cf. *Acteocina* (Kollmann and Peel, 1983) is probably also referrable to the genus *Zikkuratia*.

Family **RINGICULIDAE** Philippi, 1853
Genus ***GILBERTINA*** Morlet, 1888

Type species.—*Gilbertina inopinata* Morlet, 1888, by monotypy.

Gilbertina texana Gardner, 1935
Text-fig. 53, Table 4

Gilbertina texana Gardner, 1935: 212, pl. 20, figs. 8, 9.
Gilbertina texana Gardner. Palmer and Brann, 1966: 701.
Gilbertina texana Gardner. Govoni, 1983: 188–191, pl. 14, figs. 5–7.

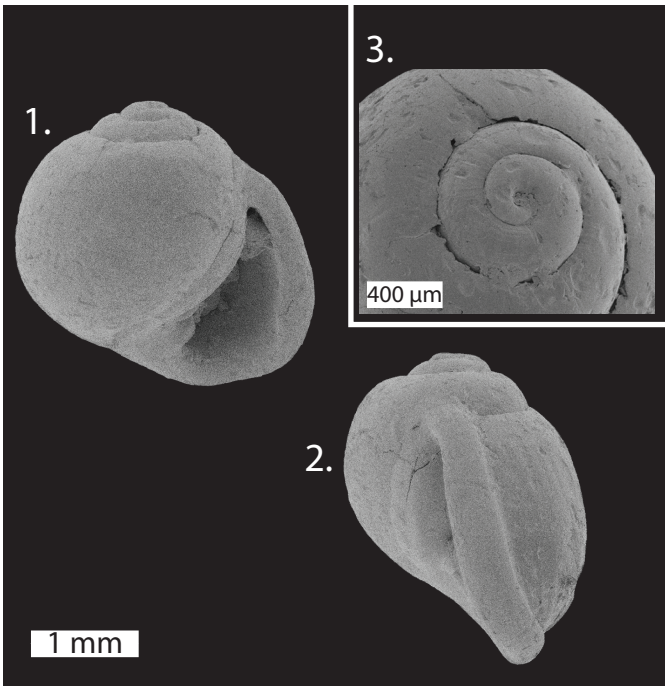
Type material.—USNM PAL 370983 from the Kincaid Formation (Danian) of Bastrop County, Texas.

Other material examined.—Two measured specimens, USNM PAL 788778 and 788779, plus 32 additional complete and fragmental individuals from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-9).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian); Texas: Kincaid Formation (Danian), Wills Point Formation (Danian–Selandian).

Diagnosis.—Very small, inflated, naticiform shell; spire depressed; penultimate whorl of teleoconch bearing fine, pitted, incised spiral grooves most extensively developed in first half to three-quarters turn of whorl; last whorl essentially smooth; aperture pyriform; parietal lip thickly calloused, bearing well-



Text-fig. 53. *Gilbertina texana* Gardner, 1935, USNM PAL 788778, sample A-1, SEM, in apertural (**1**), lateral (**2**), and apical (**3**) views.

defined longitudinally oriented ridge or bulge; columellar lip short, thick, bearing two prominent folds; outer lip very thick, bearing prominent single or double-tipped tubercle opposite columellar folds.

Description.—The following description is modified after Gardner (1935: 212). Shell very small, relatively thick, inflated, naticiform, anomphalous, almost as wide as tall. Spire depressed. Protoconch of one and one-half to two smooth, rounded, partly immersed whorls. Teleoconch of two to two and one-half rapidly expanding whorls. Last whorl highly inflated, sharply rounded posteriorly, slightly flattened medially, broadly rounded anteriorly. Sutures somewhat grooved above, merely abutting below. First (penultimate) whorl of teleoconch possesses fine, fairly closely but irregularly spaced, incised spiral grooves filled at close and regular intervals by low axial threads that impart to grooves appearance of being composed of linearly arranged, shallow punctae. Spiral grooves beginning abruptly at margin between protoconch and teleoconch; on posterior whorl surface, spiral grooves can continue for between one-quarter and three-quarters of a volution then all stop abruptly, or can continue on to end of penultimate whorl as gradually weakening grooves; on anterior whorl surface, spiral grooves fewer in number, somewhat wider and more deeply incised, often extending to end of penultimate whorl. Last whorl consistently smooth except for faint growth lines and few extremely faint, fine, closely spaced spiral striae extending short distance below suture on posterior portion of whorl. Aperture relatively broad, pyriform, somewhat obtusely angulated, feebly emarginate anteriorly. Aperture highly reinforced; broad, thick, flattened band of callus of somewhat variable width along outer margin of outer lip reflected back upon preceding portion of wall and extending above suture where it merges with parietal callus. Parietal callus thick, bearing single, long, longitudinally oriented, slightly outward-pointing, usually well-defined ridge or bulge of callus. Columellar lip short, straight, broad, heavily enameled, continuous above and below with parietal and outer lips. Columellar lip bearing two thick, very prominent folds that project subhorizontally into aperture. Upper fold, located at top of columellar lip, usually thinner than lower, centrally placed fold. Inner margin of outer lip much thickened, bearing prominent, singly or occasionally double-tipped tubercle opposite columellar folds.

Remarks.—Gardner (1935: 212, 213) reported the rare occurrence of an apparently smooth-shelled *Gilbertina* in the lower Paleocene (late Danian) upper Kincaid Formation and lower Wills Point Formation (Mexia Member?) in Texas that she named *Gilbertina texana*. Comparison of the Brightseat material with the holotype of *Gilbertina texana* reveals very clearly that the Brightseat shells are indistinguishable in any significant detail of size or morphology. Although not reported by Gardner in her original description, the Texas specimens of *Gilbertina texana* are not entirely smooth; they possess the same incised spiral grooves on the penultimate whorl seen in the Brightseat material. This ornamentation is very well preserved in Gardner's holotype (USNM PAL 370983) in which it exhibits the characteristic development of shallow pits between the closely spaced axial threads that cross the grooves.

As noted by Gardner (1935: 213), *Gilbertina texana* is very close to *Gilbertina estellensis* (Aldrich, 1921) from the lower Porters Creek Formation (Danian) in Alabama. Gardner stated that the spire of *Gilbertina estellensis* was more depressed and the total shell height was relatively greater than in *Gilbertina texana*. More significantly, the two species can be readily separated on the basis of ornamentation. In all the material examined, the final whorl of *Gilbertina texana* is virtually smooth, being consistently devoid of pitted spiral grooves like those of the penultimate whorl. In contrast, *Gilbertina estellensis* possesses fine pitted spiral grooves over the entire teleoconch surface.

Ringicula (= *Gilbertina*) *dubia* Stanton, 1920, from the Cannonball Formation (Danian) in North Dakota is virtually identical to *Gilbertina texana* in general form and dimensions. Careful examination of the worn holotype as well as of additional material reveals, however, that it too possesses very fine

spiral grooves on the entire teleoconch surface and is thus also separable from Gardner's species.

Gilbertina is rather widely distributed in both the lower and particularly the upper Paleocene and Eocene. Most of these species display spiral striation on all of the teleoconch whorls. Only *Gilbertina nuda* Traub, 1981, from the upper (lower Thanetian) part of the Danian to Thanetian age Oichinger Schichten in Austria bears a smooth final volution. The Austrian species is closely related to *Gilbertina texana* but is more produced anteriorly and the anterior margin of its outer lip is more strongly and narrowly emarginate than that of the North American form.

Cohort **TECTIPLEURA**
Order **UMBRACULIDA** Odhner, 1939
Superfamily **UMBRACULOIDEA** Dall, 1889 (1827)
Family **UMBRACULIDAE** Dall, 1889 (1827)
Genus ***UMBRACULUM*** Schumacher, 1817

Type species.—*Umbella chinensis* Martini, 1769 (= *Umbraculum chinense* Schumacher, 1817) by monotypy.

Umbraculum? sp. indet.
Text-fig. 54, Table 4

Umbraculum? sp. indet. Govoni, 1983: 202, 203, pl. 15, figs. 8–10.

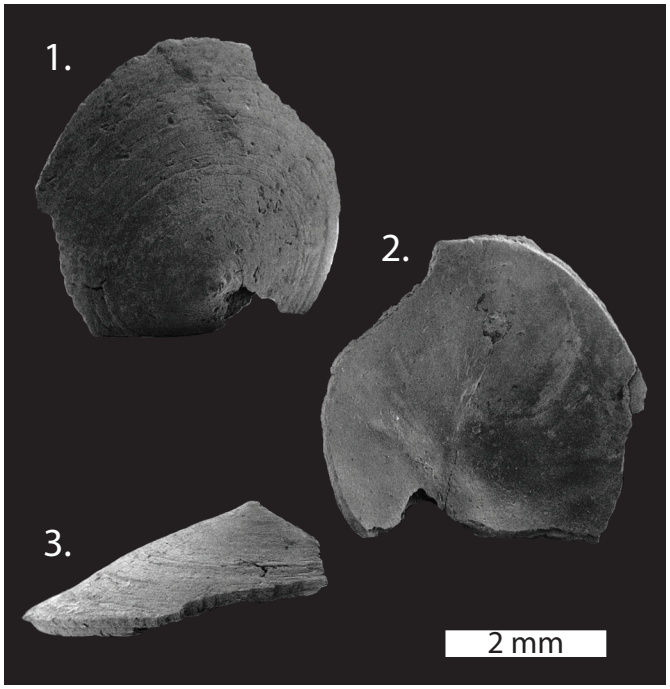
Material examined.—Single complete figured specimen, USNM PAL 788800, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Flattened patelliform shell of indeterminate original size. Profile suggesting presence of highly flattened margin that merges into gently rising, broadly convex region surrounding more rapidly rising apex. Apex well defined, slightly raised, with apparently sharp and somewhat curved tip. Outer surface displaying prominent, irregularly spaced, concentric growth lines that indicate subovate shell with subcentral apex. Inner shell surface irregular; area below apex slightly excavated; many low, thin ridges radiating with slight curve away from apex; broad, ovate, darker-colored, scar-like depression, most deeply impressed toward apex, curving acutely away from apex in direction opposite that of ridges. Inner shell surface coated with thin layer of nacre except on scar-like depression.

Remarks.—Although very incomplete, this specimen exhibits enough superficial similarity in terms of its low, suboval, flattened patelliform shape, lack of external radial sculpture, and possession of internal radial ridges to suggest that placement in the genus *Umbraculum* is reasonable. Of particular interest is the large curved, scar-like depression within the Brightseat specimen that could be equivalent to one of the radiating depressions reported by Harris (1899: 10) in *Umbraculum sylvaerupis* (Harris, 1899) from the lower Eocene (lower Ypresian) Hatchetigbee Formation of Alabama. More complete material with well-preserved musculature must be obtained before certain taxonomic placement is possible.



Text-fig. 54. *Umbraculum*? sp. indet., USNM PAL 788800, sample A-1, SEM, in apical (**1**), apertural (**2**), and lateral (**3**) views.

Order **CEPHALASPIDEA** P. Fischer, 1883
Superfamily **BULLOIDEA** Gray, 1827
Family **RETUSIDAE** Thiele, 1925
Genus ***RETUSA*** Brown, 1827

Type species.—*Bulla obtusa* Montagu, 1803, by original designation.

Subgenus ***CYLICHNINA*** Monterosato, 1884

Type species.—*Cylichnina laevisculpta* Granata-Grillo, 1877, by original designation.

Remarks.—Classification of small, involute subcylindrical to cylindrical fossil shells of the *Cylichna*-type is very difficult.

Proper superspecific division of the cephalaspid snails that bear such shells rests largely upon recognition of anatomical differences that indicate that this relatively simple shell form has arisen in groups assignable to more than one family. The problem of classification, particularly of fossil material, is significantly compounded because, as Lemche (1948) extensively documented for several modern taxa, populations can exhibit a considerable amount of environmentally controlled intraspecific and corresponding interspecific overlap in the characters, such as general shape, presence or absence of columellar folds, spire elevation, and width of apical perforation, that have generally been used to delineate generic or even higher taxonomic groups. It is not surprising, therefore, that attempts to apply purely conchological criteria to the classification of fossil (and modern) shells of these groups have resulted in the introduction of a number of generic and subgeneric names of at best questionable value.

Lemche (1948: 34) specifically noted the difficulty in distinguishing between certain members of the genera *Cylichna* Lovén, 1846, and *Retusa* without reference to soft parts. He demonstrated that some modern *Retusa* possess cylindriform shells with a sunken rather than elevated spire, a shape typical of *Cylichna*. For convenience, the Brightseat form discussed below, which also possesses a sunken spire, is referred to this group of *Retusa*. The shells characteristically possess a deep, narrow apical perforation that consistently remains open in adult specimens. In *Cylichna*, this perforation is usually plugged by a layer of callus at the base of the apical pit.

Lemche (1948) quite correctly raised an objection to the subgeneric division of *Retusa* given the then-current state of taxonomic confusion between it and *Cylichna*. This objection retains its general validity today, but the Brightseat form is nevertheless referred to the subgenus *Cylichnina*, because *Cylichnina* is used widely and with general consistency in the pertinent literature (see, e.g., Stewart, 1927: 439 and Palmer, 1937: 479) for small, involute, cylindriform shells with a truncated apex and single oblique columellar fold like that of *Cylichna*, but with a consistently perforate apex (here considered diagnostic of *Retusa*). Retaining the name *Cylichnina* serves to emphasize the obviously close relationship between the Brightseat form and certain of these earlier-described species.

Retusa (*Cylichnina*) aff. *sylvaerupis* (Harris, 1899)
Text-fig. 55, Table 4

Retusa (*Cylichnina*) aff. *R.* (*C.*) *sylvaerupis* (Harris). Govoni, 1983: 200, 201, pl. 15, figs. 4–7.

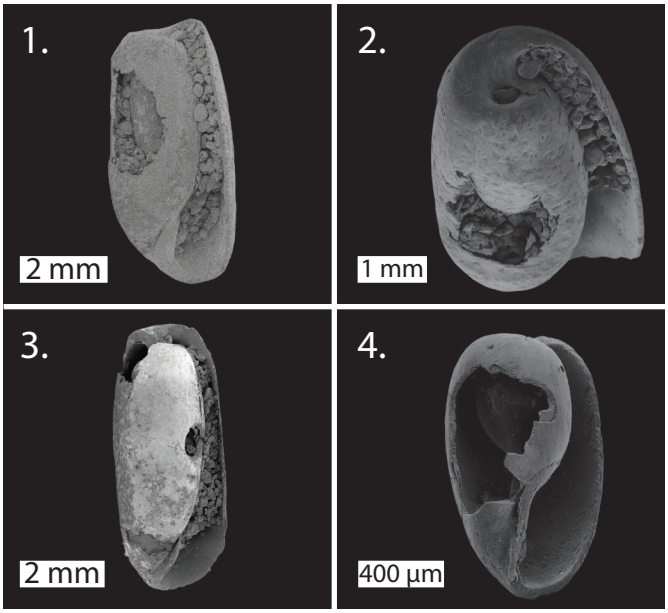
Type material.—Holotype, PRI 305, from the Wilcox Group of Clarke County, Alabama.

Other material examined.—Six measured individuals, USNM PAL 788794, 788795, 788796, 788797, 788798, and 788799, plus complete adult and juvenile shells and fragmental material representing at least 33 individuals from Locality A (samples A-1, A-2, A-5, A-6, A-7, A-8).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell moderately small, moderately slender subcylindrical; spire involute, apically truncated, with rather narrow apical perforation that remains open throughout ontogeny. Teleoconch whorls nearly straight-sided to very gently convex medially, sometimes slightly expanded anteriorly. Spiral sculpture of close-set, fine, shallow striae that can be very faint on upper two-thirds of whorl. Aperture narrow posteriorly, rising slightly above and bent slightly over outer margin of apex, becoming broad, rounded, and slightly patulous anteriorly; outer lip thin, nearly straight-sided, and parallel to axis except near apex and base; columellar lip thickened, calloused, slightly flattened anteriorly, reflected over columella, partially or completely obscuring narrow umbilicus; parietal wall with very thin, weakly adherent callus that tends to be preserved only toward apex and base. Columella sturdy, relatively short, straight, slightly leftward sloping, bearing



Text-fig. 55. *Retusa* (*Cylichnina*) aff. *sylvaerupis* (Harris, 1899), sample A-1, SEM. (**1, 2**) USNM PAL 788794, in apertural (**1**) and oblique apical (**2**) views. (**3**) USNM PAL 788795, apertural view. (**4**) USNM PAL 788798, sample A-6, apertural view.

single low but moderately distinct, rounded, highly oblique fold at posterior end that merges with thickened outer edge of columellar lip.

Remarks.—The Brightseat *Retusa* is very closely related to *Retusa* (*Cylichnina*) *sylvaerupis* (Harris, 1899), which is distributed in the lower Eocene (lower Ypresian) Bashi Formation in Alabama as well as in the deposits of equivalent age in Louisiana and possibly in the upper Paleocene (late Thanetian) Tuscahoma Formation in Alabama. The Eocene shells generally tend to be slightly larger and relatively longer than those of the Brightseat. In addition, the posterior margin of the aperture of the Eocene species is narrower at the tip and rises more or less straight upward with little tendency to curve adaxially over the outer margin of the apex as in the Brightseat specimens. Also, the columellar fold in *Retusa* (*Cylichnina*) *sylvaerupis* is usually narrower and more strongly defined as it crosses the columellar lip to merge with the lower lip margin. Similar differences in morphology can be cited to distinguish the Brightseat *Retusa* from *Retusa* (*Cylichnina*) *galba* (Conrad, 1833), which is widely distributed in middle Eocene deposits throughout the Gulf Coastal Plain. Palmer (1937: 480) discussed the close relationship between *Retusa* (*Cylichnina*) *galba* and *Retusa* (*Cylichnina*) *sylvaerupis*.

The differences in morphology that serve to distinguish the Brightseat shells from *Retusa* (*Cylichnina*) *galba* and *Retusa* (*Cylichnina*) *sylvaerupis* are relatively minor when compared to the degree of intraspecific variability documented by Lemche (1948) for modern retusids. Nevertheless, the apparent consistency of expression of these differences strongly suggests the possibility that the Brightseat form is an early geographic variant of a long-ranging, Gulf-centered species complex and is worthy of separate taxonomic designation. However, examination of additional well-preserved material is necessary before the exact taxonomic position within the species complex can be fixed.

Superfamily **PHILINOIDEA** Gray, 1850 (1815)
Family **SCAPHANDRIDAE** G. O. Sars, 1878
Genus ***SCAPHANDER*** Montfort, 1810

Type species.—*Bulla lignaria* Linnaeus, 1758, by original designation.

Subgenus ***PRISCAPHANDER*** Finlay and Marwick, 1937

Type species.—*Haminea cingulata* Marshall, 1917, by original designation.

Scaphander (*Priscaphander*) *potomacensis* Govoni n. sp.
Text-fig. 56, Table 4

Scaphander (*Priscaphander*) *potomacensis* Govoni, 1983: 195–198, pl. 15, figs. 1–3 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:0AB81829-CC83-48BB-B59A-B63966769D31.

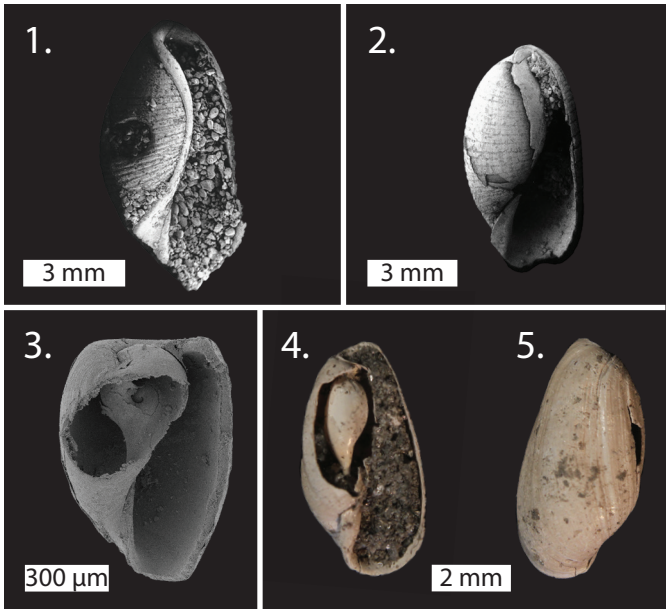
Type material.—Holotype USNM PAL 788789 from Locality A (sample A-1); paratype USNM PAL 788791 from Locality A (sample A-6).

Other material examined.—Three measured specimens, USNM PAL 788790, 788792, and 788793, plus numerous fragments and immature shells representing more than 55 individuals from Locality A (samples A-1, A-2, A-6, A-7, A-8, A-9), Locality B (samples B-1, B-2), and Locality C (sample C-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named for the valley of the Potomac River and its tributaries, the region in which it was discovered.



Text-fig. 56. *Scaphander* (*Priscaphander*) *potomacensis* Govoni n. sp. (**1**) Holotype, USNM PAL 788789, sample A-1, SEM, apertural view. (**2**) Paratype, USNM PAL 788791, sample A-6, SEM, apertural view. (**3**) USNM PAL 788792, sample A-6, SEM, apertural view. (**4, 5**) USNM PAL 788793, sample A-6, light photographs, in apertural (**4**) and dorsal (**5**) views.

Diagnosis.—Slightly tapering, inflated subcylindrical, spirally striated scaphandrid; aperture continuous, gently arcuate, curving up above and partially over callus-filled apical pit; parietal lip well calloused; columellar lip reflected over straight columella and well out onto shell base.

Description.—Shell moderately small, inflated subcylindrical, apically imperforate, involute. Protoconch completely submerged, heterostrophic, with axis of coiling plunging slightly anteriorly. Teleoconch whorls gently convex medially earlier in ontogeny, becoming more flattened adaperturally and slightly tapered posteriorly in mature specimens. Shallow apical pit bounded by narrowly rounded margin and floored by apertural callus visible in immature specimens; pit wholly filled and obscured beneath strong callus plug in mature shell. Spiral sculpture of usually strongly incised, narrow, flat-bottomed, more or less evenly spaced grooves; grooves tending to become narrower and more closely spaced toward base and apex; spirals well developed over entire shell surface in mature shell but can be weak or absent medially in submature whorls and be totally lacking in earliest whorls. Axial sculpture usually restricted to subdued growth lines that sometimes strengthen enough posteriorly to make grooves below apex appear pseudopunctate. Aperture continuous, gently arcuate, elongate, narrow posteriorly, broad and rounded anteriorly; outer lip thin at margin, thickening somewhat within, curved anteriorly, rather straight sided medially, curving up above and partially over apex to meet and adhere to extension of parietal callus, which here forms apical plug filling and rising slightly above level of apical pit; parietal lip consisting of relatively thick, usually closely adherent callus with abrupt, medially incurved margin; columellar lip calloused, extending in mature shell in moderately narrow arc over columella and well out onto shell base, to which it usually adheres lightly. Columella relatively long, straight, slightly leftward sloping, without fold.

Remarks.—The genus *Priscaphander* was established by Finlay and Marwick (1937: 31) to accommodate a single scaphandrid species from the lower Paleocene (Danian) "Wangaloan" deposits of New Zealand. They differentiated the genus from typical members of *Scaphander* on the basis of its more regularly oval outline, strongly calloused apex, less expanded aperture, straightened rather than curved columella, and the broad basal extension of its columellar lip. With the exception of its shape, which is more subcylindrical than ovate, the new Brightseat species possesses all of the primary characters used to separate the Austral taxon from other scaphandrids and thus appears assignable to it.

Finlay and Marwick (1937) were unable to clearly demonstrate the presence of *Priscaphander* in the Paleogene of the Northern Hemisphere, but did note (1937: 92) the apparently close relationship between it and *Mirascapha* Stewart, 1927, a subgenus of *Scaphander* recognized in the Eocene of California, Alabama, and the Paris Basin (Stewart, 1927: 438). The new Brightseat species does indeed most closely approach in size and overall form *Scaphander* (*Mirascapha*) *ligniticus* Aldrich, 1897, from the lower Eocene (lower Ypresian) Bashi Formation in Alabama. However, the aperture of the Eocene *Mirascapha* is less curved posteriorly and rises more sharply above the apex, which retains a shallow apical pit in the mature shell. The Eocene form also consistently lacks the relatively thick and closely adherent parietal callus present on the Paleocene shell. In addition, the columellar lip of *Mirascapha*, although sturdy and reflected, does not normally approach the breadth of that developed in *Priscaphander*, and the columella itself is gently curved rather than straight.

Despite the obvious and apparently consistent differences in detail, comparison of the North American *Priscaphander* and *Mirascapha* nevertheless clearly reinforces Finlay and Marwick's (1937) assumption of a close relationship between the Paleocene and Eocene taxa. Consequently, it does not seem reasonable to segregate *Priscaphander* as a genus distinct from *Scaphander* to accommodate such a small number of related forms. Therefore, *Priscaphander* is considered here to be reduced to subgeneric rank and is placed close to *Mirascapha* within the genus *Scaphander*.

Superorder **PYLOPULMONATA**
Superfamily **PYRAMIDELLOIDEA** Gray, 1840
Family **PYRAMIDELLIDAE** Gray, 1840
Genus ***EVALEA*** A. Adams, 1860

Type species.—*Odostomia elegans* A. Adams, 1860, by subsequent designation (Verrill and Bush, 1900).

Evalea sp. indet.
Text-fig. 57, Table 4

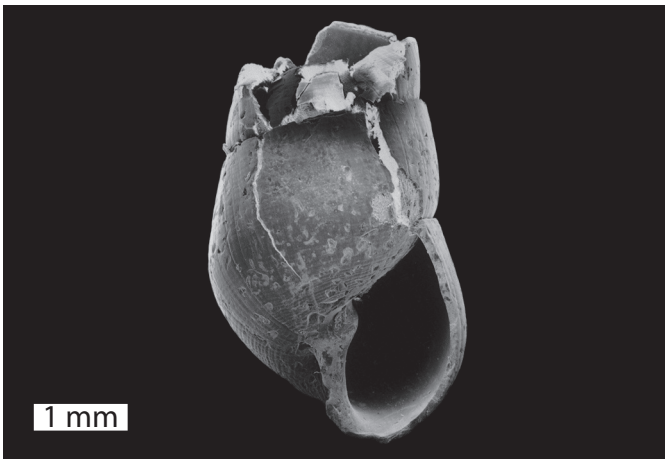
Menestho (*Evalea*) sp. Form A. Govoni, 1983: 174, 175, pl. 12, fig. 6.

Material examined.—Single figured specimen, USNM PAL 788765 from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell moderately small, glazed, anomphalous. Whorls flattened above and truncated abruptly at the posterior suture, becoming gently rounded just above anterior suture, giving whorls a very narrowly turreted aspect. Aperture



Text-fig. 57. *Evalea* sp. indet., USNM PAL 788765, sample A-1, SEM, apertural view.

subquadrate, angulated posteriorly, rounded anteriorly. Outer lip sturdy, marked internally by 10 narrow, raised spiral ridges that extend from interior of shell to within approximately one-fifth of turn of aperture; moderately broad columellar lip calloused, reflected. Columella bearing single moderately strong, oblique fold near upper margin. Axial sculpture consisting of moderately well marked, vaguely opisthocyrt growth lines; spiral sculpture consisting of rather faint, shallow, closely spaced grooves on upper whorl surfaces, and somewhat more deeply incised and better defined, very closely and subequally spaced narrow grooves on basal surface.

Remarks.—This form is represented by a single specimen consisting of the final two and one-quarter volutions of a moderately small shell. The nature and extent of the spiral sculpture exhibited by this form appears to set it apart from all other Atlantic and Gulf Coastal Plain Paleogene taxa assigned to *Evalea*. However, the specimen at hand is insufficiently complete to allow either comprehensive comparison with related forms or to justify specific designation.

Subfamily **ODOSTOMIINAE** Pelseneer, 1928
Genus ***ODOSTOMIA*** Fleming, 1813

Type species.—*Turbo plicatus* Montagu, 1803, by subsequent designation (Gray, 1847).

Subgenus ***BRACHYSTOMIA*** Monterosato, 1884

Type species.—*Odostomia rissoides* Hanley, 1844, by original designation.

Odostomia (*Brachystomia*) aff. *insignifica* (Aldrich, 1897)
Text-fig. 58, Table 4

Odostomia (*Brachystomia*) aff. *O.* (*B.*) *insignifica* Aldrich. Govoni, 1983: 175–177, pl. 12, fig. 7.

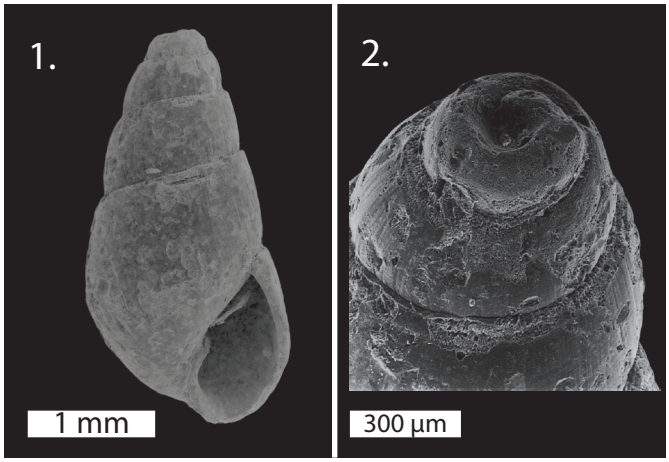
Material examined.—Single figured specimen, USNM PAL 788766, from Locality A (sample A-1).

Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Description.—Shell small, glazed, subconic. Columella short, curved, with single, moderately strong, highly oblique fold at upper end. Aperture auriform, somewhat angulate posteriorly, rounded and probably rather patulous anteriorly; interior of outer lip bearing four raised spiral ridges that extend from interior of shell but do not reach lip margin. Axial sculpture limited to fine, gently sinuous growth lines that bow in extremely gentle prosocyrt arc on upper whorl surface and recurve in equally gently opisthocyrt arc across whorl base. Unworn portions of whorl surfaces can exhibit, under high magnification, numerous extremely faint, shallow spiral striae.

Remarks.—A single worn and damaged specimen of a very small *Odostomia* that differs in general shape as well as other characters from the other Brightseat pyramidellids is present in the collections. The overall size and shape, and the presence of the spiral ridges on the interior surface of the outer lip, combine to form the basis for placement of this form in the subgenus *Brachystomia*. The Brightseat specimen appears to be



Text-fig. 58. *Odostomia* (*Brachystomia*) aff. *insignifica* (Aldrich, 1897), USNM PAL 788766, sample A-1, SEM, in apertural (**1**) and oblique apical (**2**) views.

very similar to *O. insignifica* from the upper Paleocene (late Thanetian) age Greggs Landing Member of the Tuscahoma Formation in Alabama, differing from that species primarily in its somewhat narrower outline and weaker and much more oblique columellar fold. A single complete specimen attributed to *O. insignifica* from the lower Kincaid Formation (Danian) in Texas, described but not illustrated by Gardner (1935: 309, 310, in part), is not available for study but appears from its description to be quite close to the Brightseat form. The Brightseat specimen might also be related to an *Odostomia* from the overlying Aquia Formation (Selandian) in Maryland and Virginia. However, the Aquia form, assigned by Clark and Martin (1901: 156) to the middle Eocene species *O. trapaquara* (Harris, 1895), is larger, more gradually tapering, possesses a subquadrate aperture, and displays a somewhat more prominent and less obliquely inclined columellar fold than does the Brightseat shell.

Subfamily **TURBONILLINAE** Bronn, 1849
Genus ***CREONELLA*** Wade, 1917

Type species.—*Creonella triplicata* Wade, 1917, by original designation

Creonella obscuriplica Govoni n. sp.
Text-fig. 59, Table 4

Creonella obscuriplica Govoni, 1983: 179–181, pl. 13, figs. 1–5 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:B2007AED-06BB-4322-8D14-738A6B5C9F1E.

Type material.—Holotype USNM PAL 788769 from Locality A (sample A-7); paratype USNM PAL 788770 from Locality A (sample A-2).

Other material examined.—Measured specimen USNM PAL 788771, plus 18 additional individuals from Locality A (samples A-1, A-2, A-6, A-7, A-8) and Locality B (sample B-1).

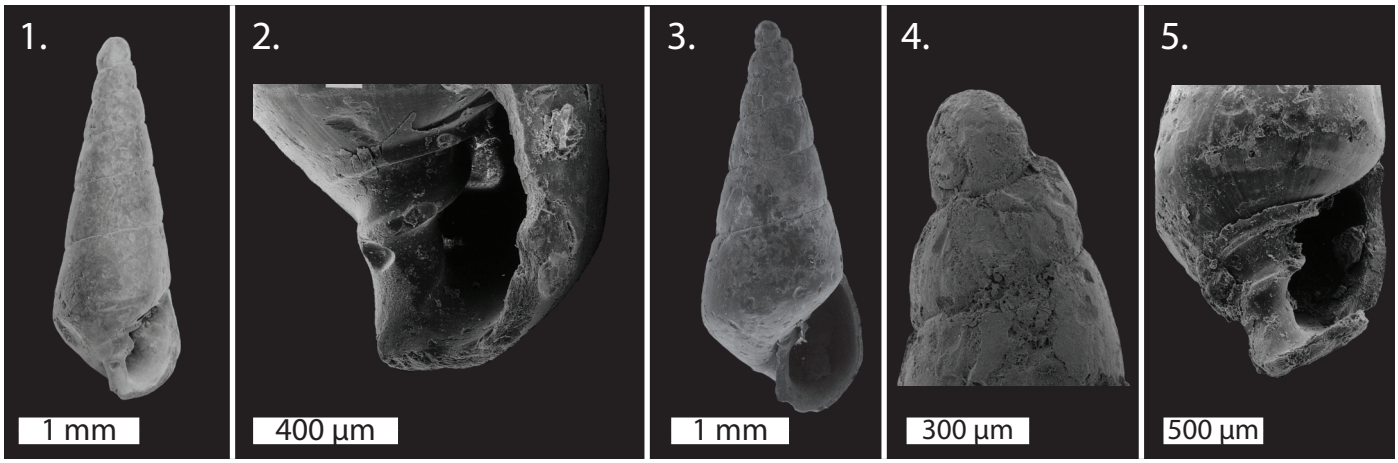
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named from the Latin *obscurus*, "indistinct," and *plico*, "fold," referring to the extreme reduction of the anterior columellar plication.

Diagnosis.—Slender *Creonella* with flat-sided whorls and sharply rounded to subangulate basal periphery; aperture subquadrate; inner lip bearing one sharp parietal plication and strong posterior columellar plication; anterior columellar fold lacking or reduced to very gentle, obscure swelling at base of columella.

Description.—Shell small, slender, subulate, anomphalous or with very narrow pseudumbilical slit. Protoconch moderately large, erect, heterostrophic, low turbiniform, of approximately two and one-half smooth whorls with axis of coiling directed obliquely downward. Teleoconch of five to eight flat-sided, glazed volutions; last whorl flat-sided above, with sharply rounded to subangulate basal periphery, and steeply sloping, flattened to very gently rounded base. Suture nar-



Text-fig. 59. *Creonella obscuriplica* Govoni n. sp., SEM. (**1, 2**) Holotype, USNM PAL 788769, sample A-7, in apertural (**1**) and aperture detail (**2**) views. (**3, 4**) Paratype, USNM PAL 788770, sample A-2, in apertural (**3**) and protoconch (**4**) views. (**5**) USNM PAL 788771, sample A-6, detail of aperture and columellar plications.

rowly impressed to channel-like. Axial sculpture consisting of very faint, sinuous growth lines that curve abaperturally on upper third of whorl side and recurve below to form very broad, gentle, adaperturally directed arc with vertex centered upon basal angulation. Spiral sculpture faint and limited to extremely fine, often indistinct, shallow, closely spaced striae on upper whorl surfaces. Aperture subquadrate, higher than wide, posteriorly angulated, rounded below with very short, extremely gentle, very slightly reflected basal emargination that can appear in broken or less mature individuals to form more strongly canaliculate and reflected siphonal notch; outer lip sturdy, flat-sided above, steeply sloping, gently rounded, somewhat forward projected below; interior surface of lip smooth or bearing up to four raised spiral ridges that do not reach lip margin; inner lip calloused, reflected over moderately thick, straight columella. Inner lip plicate, bearing sharp, narrow, raised fold near base of parietal wall; second much stronger plication, placed near top of columella, extends as narrow, highly oblique ridge from shell interior, but thickens and becomes much more gently angled at aperture of last whorl of mature individuals; columellar plication separated from parietal fold by deep channel; third plication typical of genus completely obsolete or reduced to very gentle, generally obscure swelling just inside aperture at base of columella, and bounding emargination at base of outer lip; this obscure anterior swelling appears in some cases to strengthen somewhat interiorly.

Remarks.—The genus *Creonella* is predominantly a Late Cretaceous taxon, being most diverse and abundant in deposits of the *Exogyra costata* Zone (upper Campanian through Maastrichtian) in the Gulf Coastal Plain (Sohl, 1964b: 310). The genus has been shown by Rosencrantz (1970: 437) to extend into the lower Paleocene of West Greenland where it is represented by a single species, *Creonella sonjae* Rosenkrantz, 1970, from the middle Danian Agatdal Formation. Recently, Garvie (2021) described *Creonella hebetertia* Garvie, 2021 from the Danian Tehuacana Limestone of Texas. The genus has also been recognized in the upper part of the Danian to lower Thanetian age Oichinger Schichten in Austria by Traub (1981: 58), who described a form closely resembling the North American Cretaceous species, *Creonella subangulata* Sohl, 1964b.

Creonella obscuriplica n. sp. closely resembles both the Cretaceous form, *Creonella subangulata*, and Traub's Austrian species in general outline. The Brightseat species appears generally to be slightly narrower than *Creonella sonjae*, but its possession of a maximum of four spiral ridges on the interior of the outer lip would seem to ally it more closely with the West Greenland species than with either the North American Cretaceous taxa or the Austrian Paleocene species, all of which possess a maximum of five or six such ridges. The new Brightseat form is easily separated from all these taxa by the loss or extreme reduction of the anterior columellar plication. The Tehuacana species *Creonella hebetertia* also lacks the columellar plication, but the Brightseat form is distinguishable in having a larger apical angle and a relatively larger, more rounded aperture.

Genus ***PUPOSYRNOLA*** Cossmann, 1921

Type species.—*Auricula acicula* Lamarck, 1804, by original designation.

Puposyrnola toulmini Govoni n. sp.
Text-fig. 60, Table 4

Syrnola (*Puposyrnola*) *toulmini* Govoni, 1983: 177–179, pl. 12, figs. 8–10 (unpublished).

ZooBank LSID.—urn:lsid:zoobank.org:act:871A864E-2DF3-48AA-A347-1B94D56471C7.

Type material.—Holotype USNM PAL 788767 From Locality A (sample A-1); paratype USNM PAL 788768 from Locality A (sample A-6).

Other material examined.—Fifteen additional individuals from Locality A (samples A-1, A-2, A-6).

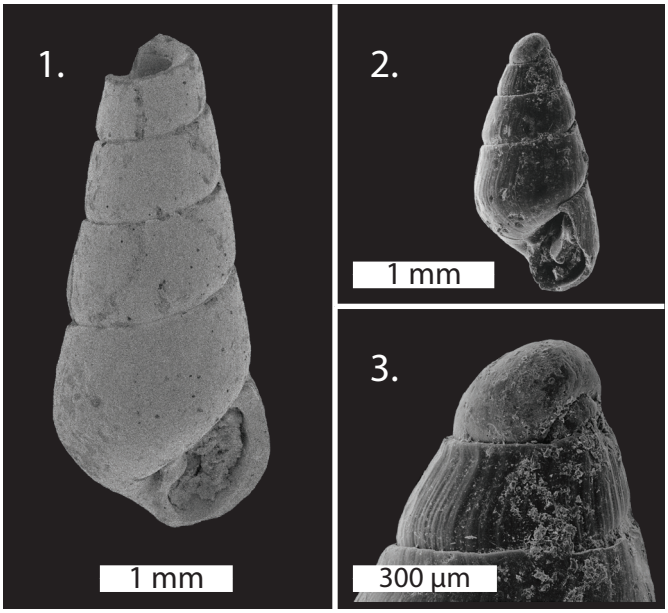
Measurements.—See Table 4.

Stratigraphic and geographic occurrence.—Maryland: Brightseat Formation (Danian).

Etymology.—This species is named in honor of the late Dr. Lyman D. Toulmin of Florida State University, in recognition of his valuable contributions to the stratigraphy and paleontology of the Paleogene of the Gulf Coastal Plain.

Diagnosis.—Slender, sturdy, subulate *Puposyrnola*; early apical whorls more broadly conical than those below; whorl sides very narrowly rounded and sharply inturned at posterior suture and forming narrow, obscure subsutural collar, becoming medially flattened and curved abruptly inward above anterior suture; aperture relatively small, auriform; columella short, concave; growth lines gently but distinctly sinuous.

Description.—Shell very small, sturdy, slender, rather subulate, anomphalous; earlier teleoconch whorls broadly conical, becoming more gently tapering below. Protoconch heterostrophic, depressed turbiniform, of between two and three smooth whorls raised well above teleoconch but obliquely



Text-fig. 60. *Puposyrnola toulmini* Govoni n. sp., SEM. (**1**) Holotype, USNM PAL 788767, sample A-1, apertural view. (**2, 3**) Paratype, USNM PAL 788768, sample A-6, in apertural (**2**) and protoconch (**3**) views.

tilted so that earliest volution partially immersed. Teleoconch of at least five glazed volutions; upper whorl sides more or less flat-sided above, but curving abruptly inward short distance above anterior suture; posterior whorl margin very narrowly rounded and turned sharply inward immediately below suture, and can thicken very slightly giving appearance of forming narrow, obscure subsutural collar; whorl base broadly rounded. Suture impressed with appearance of being narrowly shelved due to shape of whorl sides. Axial sculpture consisting of fine, broadly sinuous growth lines that curve to form shallow but distinct opisthocyrt arc on upper quarter of whorl side and recurving more gently to form very broad, shallow, prosocyrt arc centered upon strongly incurved whorl side above anterior suture. Spiral sculpture very faint, limited to extremely fine, often indistinct, closely spaced spiral striae that can strengthen somewhat on shell base. Aperture relatively small, auriform, roundly angulate posteriorly, rounded below; outer lip generally rather thick, gently rounded to somewhat flattened above, rounded below; interior surface smooth or bearing up to three raised spiral ridges that do not appear to reach lip margin; inner lip calloused, rather strongly reflected over short, concave columella to form narrow pseudumbilical slit. Columella bearing single strong, slightly to moderately oblique, posteriorly situated spiral fold, separated from parietal wall by moderately broad channel.

Remarks.—This new species is erected on the basis of a number of specimens consisting of both immature individuals and single multiwhorl fragments of more mature shells that share similar whorl shapes, growth line traces, and apertural characters that, when combined, allow it to be distinguished from similar Gulf and Atlantic Coastal Plain forms. Assignment to the genus *Puposyrnola* is based largely on composite overall shape and apertural form.

Taken alone, immature individuals of this *Puposyrnola* can be confused with co-occurring *Odostomia* but can be readily separated from that genus by the profile of the upper whorl surface and the more markedly sinuous growth lines. The new Brightseat species is similar to *Syrnola propeacicula* (Cossmann, 1893) from the middle Eocene of Texas, Alabama, and South Carolina, but appears slightly broader and lacks the subsutural groove and medially concave whorl profile characteristic of that species.

Garvie (2021) described three new species of *Puposyrnola* from the Tehuacana Limestone of Texas: *Puposyrnola shirleyae* Garvie, 2021; *Puposyrnola multibaca* Garvie, 2021; and *Puposyrnola obliqua* Garvie, 2021; with an additional two forms questionably referred to the genus. Of these, the Brightseat species most closely resembles *Puposyrnola shirleyae,* sharing its small size, a larger apical angle than other Paleocene Coastal Plain forms, and a multiwhorled, partially immersed protoconch. The Brightseat form differs from this Danian Texas taxon in showing a more highly immersed heterostrophic protoconch at ~ 135° relative to coiling axis and more prominent axial ornament in the form of finely raised, gently arcuate growth line traces.

Multiple species of *Puposyrnola* have been reported in the Paleocene of the Paris Basin (Pacaud and Renaud, 1995).

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Appendix. Facsimile of an unpublished report and accompanying letter, dated 8 May 1951, from Dr. Julia Gardner of the United States National Museum of the Smithsonian Institution to Mr. R. R. Bennett of the United States Geological Survey, concerning the composition and age of a macrofaunal assemblage collected from the Brightseat Formation at its original type locality (Locality A of Bennett and Collins, 1952).

May 8, 1951

Robert R. Bennett
103 Latrobe Hall
Johns Hopkins University
Baltimore 18, Maryland

Dear Mr. Bennett:

This report is long overdue and I am sorry. Now, what shall I do with the specimens? Shall I return them immediately or hold them till some emissary drives over to get them? The preparation was so well made that the collection will stand most any kind of a trip.

You certainly have something more than the ordinary run of Aquia formation and it probably represents a northern phase of the Paleocene. In fact, the Lucinoma which is so common in your collection belongs to a group characteristic of cooler waters.

I hope I can get you some more information on the Stephenson and Little material. It is terrible that that collection has been here all these years and the significance of it was not recognized.

Sincerely yours,

Julia Gardner

JGardner:et
enclosure

REPORT ON REFERRED FOSSILS

Stratigraphic range: Paleocene — Kinds of fossils: mollusca

General locality: Prince George's County, Maryland — Shipment No.: WR-51-18

Referred by: Robert R. Bennett — Branch: Water Resources Division — Date: Apr. 15, 1951 (approximately)

Report prepared by: Julia Gardner — (Ground Water Branch) — Date: MAY 8 1951

Locality: About 1/4 mile south of the Sheriff Road on small branch which flows north across Sheriff Road 0.9 mile west southwest of Brightseat, Prince George's Co., Md.

Nuculanids, 2 genera; neither form recognized
Ledina sp. cf. L. smirna Dall; differs from L. smirna Dall in absence of concentric grooves.
Cucullaea gigantea Conrad; the species is widespread in the Aquia formation.
Glycymeris sp., probably juvenile
Exogyra costata Say, reworked and juvenile
Crenella sp. I do not know any representative of the genus in the East Coast or Gulf Midway.
Venericardia (Venericor) sp. cf. V. (V.) regia Conrad, widespread in the Aquia formation of Maryland and Virginia; species questioned because they are all juveniles.
Venericardia (Venericor) regia Conrad; widespread in the Aquia formation of Maryland and Virginia.
Venericardia (Venericor) sp. cf. V. (V.) hijuana Gardner and Bowles; the fragments recall in the medium size and laterally terraced ribs V. (V.) hijuana described from the Clayton formation near Middleton, Hardeman County, Tennessee.
Crassatellites n. sp., related to Crassatellites alaeformis (Conrad), widespread in the Aquia formation of Maryland but warped and constricted anteriorly.
Miltha (Plastomiltha) claytonia (Harris)?, described from the Clayton limestone at the base of the Midway.
Phacoides (Lucinoma) n. sp.?, nothing very close to it, either described or undescribed seen in any other collection. The group, as a whole, is associated with cool water, due either to latitude or to depth.
"Lucina" sp. cf. "L." uhleri Clark, too high and the sculpture more flat than in the described form; and "L." aquiana Clark, too squarish.
Here (Cavilucina) sp.?
Leptonid?
Dosiniopsis sp. cf. D. lenticularis (Rogers and Rogers); the Rogers type species came from the Virginia Eocene from "the plantations of Mr. Bowen and Dr. Welford, in Stafford County, opposite to Fredericksburg, somewhat more than a mile from the town" or from "a locality near but a little east of Stafford." The figure is inadequate but the diameter of the shell is given by the Rogers as "about 2 inches," which is larger by about a third than the average diameter of the Maryland shells in question. I do not know where the Rogers types can be found. In the smaller race which is represented as U.S.G.S. 11986 as well as in the current collection, the pallial sinus is obliquely but steeply ascending. The relationship to the larger individuals with horizontally directed sinuses is not known.

92573

Report on referred fossils (page 2) MR-51-18:Bennett

"Cytherea pyga Conrad", closely related to and considered by Clark a subspecies of Cytherea ovata Rogers and Rogers described from the Eocene of Coggins Point, Virginia.
Venerids, probably new and related to Callocardia aequorea (Conrad)
Venerid?
Tellina n. sp.?
Tellina sp.
Tellinid?
Corbula sp. near C. subengonata Dall, smaller than individuals from Greggs Landing, Alabama
Turritella humerosa Conrad
Turritella sp. cf. T. mortoni Conrad, immature specimens
Turritella tips
Calyptraea? sp.
Naticoids, possibly near Polynices harrisii Gardner described from the Midway of Texas.
Aporrhais n. sp., an ancient type with a very sparse representation in the lower Eocene
Indeterminate gastropod
Strepsidura sp. near S. suiscalarina Heilprin, a lower Eocene species
Tornatellaea sp., a crushed and incomplete specimen
Tornatellaea sp. cf. T. bella Conrad, juv., widely distributed in the Eocene of the Gulf Province.
Gilbertina texana Gardner, hitherto recognized only in the Midway of Texas.
Foraminifera
Solitary coral
Otoliths
Teeth
Vertebrate remains

Age: Paleocene?

Among the species which seem definitely older than the usual fauna of the Aquia formation, are Ledina anima Dall, a characteristic species of the Midway group, the venericards with laterally terraced ribs, Miltha (Plastomiltha) claytonia (Harris)? and Gilbertina texana Gardner, characteristic of the Midway of Texas. The reworked Exogyras are interesting and indicate a time interval. Cucullaea gigantea Conrad, Venericardia regia Conrad, "Cytherea pyga Conrad" and the Turritellas are common associates in the Aquia formation. The Crassatellites n. sp. Phacoides (Lucinoma) n. sp., and Dosiniopsis sp. cf. D. lenticularis (Rogers and Rogers) are all of them at least fairly abundant. Both the Crassatellites and Dosiniopsis are present in U.S.G.S. 11986. Unfortunately, no locality, other than "Eocene near Brightseat" is given by the collectors, Stephenson and Little. Possibly when Dr. Stephenson comes back to town, he can remember a little more about the locality.

Julia Gardner

Gardner:fb 5/8/51

INDEX

Page numbers in **bold** refer to the primary discussion; numbers in *italics* refer to a Table or Text-figure.

PREPARATION OF MANUSCRIPTS

Bulletins of American Paleontology, the oldest continuously published, peer-reviewed paleontological journal in the Americas, seeks significant, larger monographs (> 50 printed pages, minimum 100 manuscript pages) in paleontological subjects or in neontological subjects that are strongly relevant to paleontological problems. Most contributions focus on systematics, placed in biostratigraphic, biogeographic, paleoenvironmental, paleoecological, and/or evolutionary contexts. Contributions have historically focused on fossil invertebrates, but papers on any taxon of any age are welcome. Emphasis is placed on manuscripts for which high-quality photographic illustrations and the large quarto format are desirable. Both single- and multi-authored (contributed proceedings) volumes are invited.

Submissions are welcome from authors of any institutional or organizational affiliation. Publication costs of the Bulletins are heavily subsidized by PRI, but authors are asked to pay illustration charges ranging from $35 per text-figure to $120 per full-page plate.

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