TULANE STUDIES IN GEOLOGY AND PALEONTOLOGY

Volume 29, Number 3 February 26, 1997

CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION. PART XII – THE SUBFAMILY OCENEBRINAE (IN PART)

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CONTENTS

I. ABSTRACT

Sixteen species assigned to the muricid subfamily Ocenebrinae are treated, comprising only those species characterized by having (in all but possibly one case) a sealed siphonal canal. Nine genus-groups are included, of which three, all from the Haywood Landing Member of the Belgrade Formation (latest Oligocene, North Carolina), are new. These are: *Fenolignum* (type: *F. umbilicatum*, n. sp.), *Argyrobessa* (type: *Murex kellumi* Richards, 1943), and *Pteropurpura (Odontopurpura)*, n. subgen. (type: *Tritonalia festivoidea* Vokes, 1963). There are few taxa in any of the genus-groups; six are monotypic, including the three new taxa, and the previously described genera *Miocenebra, Ocinebrina,* and *Ceratostoma*. The remaining genus-groups have only a small number of species included: *Pteropurpura* s.s. (3); *Pterorytis* s.s. (3), and *Pterorytis (Microrhytis)* (4). Of the 16 species treated, four are new: *Ocinebrina francesae* and *Pterorytis (Microrhytis) christopheri*, from the Early Miocene Cantaure Formation, Venezuela; *Pteropurpura (Pteropurpura) boesei*, from the Santa Rosa beds, Veracruz, Mexico; and *Fenolignum umbilicatum*, from the Haywood Landing Member, Belgrade Formation, North Carolina. The genera treated are largely extinct, at least in the western Atlantic, although *Ocinebrina* and *Ceratostoma* survive elsewhere, and only one of the included species, *Pteropurpura bequaerti*, still lives in the waters of the western Atlantic.

II. INTRODUCTION

The Muricidae is a large family of neogastropods comprising at least eight subfamilies, all united by the presence of an accessory boring organ in the foot. Some of the component subfamilies, such as the Trophoninae, have received little study and are recognized mainly on the basis of primitive characters; but others, such as the Muricinae, Ocenebrinae, and Rapaninae, have been the subjects of intense anatomical investigation, and are reasonably well-defined clades.

In this paper we treat the subfamily Ocenebrinae in part. After surveying the group's characters, we have limited this work to include only the fossil and living western Atlantic ocenebrines with a sealed siphonal canal, although one of the taxa (*Argyrobessa*, new genus) possibly may have had an open canal. A complete list of taxa now included in the subfamily

Ocenebrinae may be found in the Appendix at the end of this work.

III. ACKNOWLEDGMENTS

The writers are profoundly grateful to a number of persons and institutions for the loan of material, as well as valuable information on distribution of species. The institutions include the Academy of Natural Sciences, Philadelphia (Gary Rosenberg, Elana Benamy), the United States Museum of Natural History (Thomas R. Waller, Warren C. Blow), and the Naturhistorisches Museum, Basel, Switzerland (Peter Jung). Among individuals our greatest debt is to Susan B. Stephens, Sanibel, Florida, who generously provided much of the material figured herein. Others include Lyle Campbell, Spartanburg, South Carolina; Mr. and Mrs. William J. Fulton, Chamblee, Georgia; the late Robert V. Blow, Portsmouth, Virginia; Andrew and Greta Murray, Bradenton, Florida; Mr. and Mrs. Jack Gibson Smith, Surrey, England; Lauck W. Ward, Virginia Museum of Natural History, Martinsville, Virginia; William K. Emerson, American Museum of Natural History (Emeritus); and Joseph G. Carter, University of North Carolina, Chapel Hill, North Carolina. GJV acknowledges partial funding of this research by NSF Grant EAR-94-05537.

ABBREVIATIONS FOR REPOSITORY INSTITUTIONS

MCZ – Museum of Comparative Zoology, Harvard University, Cambridge, MA
NMB – Naturhistorisches Museum, Basel, Switzerland
PRI – Paleontological Research Institution, Ithaca, NY
TU – Tulane University, New Orleans, LA
UCMP – University of California, Museum of Paleontology, Berkeley, CA
UF – Florida Museum of Natural History, Gainesville, FL
USNM – United States National Museum of Natural History, Washington, DC

IV. SYSTEMATIC PALEONTOLOGY

Family MURICIDAE Rafinesque, 1815
Subfamily OCENEBRINAE Cossmann, 1903

Discussion: Cossmann (1903) was the first author to divide the Muricidae into subfamilies. He proposed the Ocenebrinae for muricids with a purpuroid operculum and a varicate shell. The Rapaninae also have a purpuroid operculum, but their shells lack varices. Distinction on the basis of these characters, however, is inadequate. There are many Ocenebrinae without varices, and some varix-bearing muricids with a purpuroid operculum appear to belong to subfamilies other than Ocenebrinae. Many members of the Ergalataxinae, for example, have a purpuroid operculum as well as a shell characterized by one or more varices (see Houart, 1995).

In her subfamilial revision, Vokes (1964) concluded that the operculum provided no diagnostic characters to distinguish the Muricinae from the "Tritonaliinae" (= Ocenebrinae). According to Vokes, the only conchological feature useful for separating muricids at the subfamilial level is the sealed siphonal canal, which is found only in the Ocenebrinae and Typhinae. The latter subfamily differs dramatically from the Ocenebrinae in shell characters such as the presence of tubular shoulder spines, and the two groups are probably not closely related. Other muricid subfamilies, as well as many Ocenebrinae, have an open siphonal canal.

Vokes (1964) argued that the radula provides the best characters for separating muricid subfamilies. Members of the Ocenebrinae have a central rachidian tooth on which there are three larger teeth in the central part, flanked by numerous smaller teeth on the margins. Vokes (1971) transferred *Homalocantha* (with a purpuroid operculum and open siphonal canal) and *Purpurellus* (with a muricine radula and operculum and a sealed canal) to the subfamily Muricinae. She also removed from the Ocenebrinae the genera *Eupleura, Urosalpinx,* and *Crassilabrum.* In 1971, therefore, it was Vokes' view that the Ocenebrinae comprised the genera *Ocenebra* (formerly *Tritonalia*), including the subgenera *Hadriania, Miocenebra,* and *Ocinebrina; Jaton,* with subgenera *Pterorytis* and *Ceratostoma;* and *Pteropurpura,* with subgenera *Ocinebrellus, Calcitrapessa,* and *Poropteron.* All

these genera have a sealed siphonal canal. Vokes (1971, p. 7) noted that "*Eupleura,* together with *Vitularia, Crassilabrum, Hanetia,* and *Urosalpinx,* belong in yet another subfamily characterized by having an open siphonal canal, a purpuroid operculum, and a radula similar to that of the Ocenebrinae."

Following Kool (1993) and Vermeij and Kool (1994), we now include as members of the Ocenebrinae not only the above mentioned genera with a sealed siphonal canal, but also *Eupleura, Crassilabrum,* and *Urosalpinx*, as well as a probable clade of "*Thais*-like" genera in which the non-varicate collabral sculpture is reduced or wholly absent. These genera include *Acanthina, Acanthinucella, Chorus, Ecphora, Haustrum, Lepsiella, Nucella, Spinucella, Trochia,* and *Zulloia,* and a genus of Neogene labral-tooth-bearing species being described by T.J. DeVries and G.J. Vermeij. Other ocenebrine genera with an open siphonal canal and well-developed collabral sculpture include *Forreria, Pterynopsis, Namamurex,* and *Vokesinotus.*

Using shell characters, we define the Ocenebrinae as follows: muricids with crenulated, planar outer lip; inner side of outer lip smooth or with denticles, usually deeply recessed; lirae on inner side of outer lip absent; anal notch absent (except in *Hadriania* and *Miocenebra*); inner lip smooth; posterior end of aperture broadly rounded, not angulated or adapically pointed; apical end of outer lip not adapically extended; parietal rib and columellar folds absent.

Ocenebrines differ from many members of the Muricinae by lacking a parietal rib at the apical end of the inner lip. Those muricines lacking a parietal rib differ from Ocenebrinae by having lirae on the inner side of the outer lip. A few ocenebrines, including *Roperia* and individuals of *Acanthinucella spirata* (Blainville, 1832), *A. punctulata* (Sowerby, 1835), and *Nucella emarginata* (Deshayes, 1839), possess a parietal knob. They differ from members of the Muricinae by the absence of varices, by having a dentate rather than lirate outer lip, and by lacking the adapical extension of the outer lip.

The subfamily Ocenebrinae differs from Rapaninae by the absence of a subsutural cord, the absence of a parietal rib, and by having a rounded rather than angulate or pointed apical end of the aperture. Rapanines tend to have the apical end of the outer lip adapically slightly extended, often forming a gutter-like extension of the aperture by virtue of the presence of the parietal rib on the apical end of the inner lip (see Vermeij and Kool, 1994). Many members of the Rapaninae possess an anal notch or sinus, one or more folds on the columella, and lirae on the inner side of the outer lip, all features lacking in Ocenebrinae.

Some members of the Ergalataxinae resemble many Ocenebrinae in possessing varices. They differ from ocenebrines by having a lirate outer lip, a parietal rib, and usually one or more folds on the anterior part of the columella.

Although a sealed anterior siphonal canal occurs in several unrelated muricid groups, it is especially characteristic of a number of genera in the Ocenebrinae, including *Ocenebra, Ceratostoma, Pteropurpura, Fenolignum* (new genus), *Ocinebrina, Jaton, Hadriania, Miocenebra, Pterorytis,* and several undescribed taxa. All are characterized by strong axial sculpture, which in many cases includes varices. Here we treat western Atlantic representatives of these taxa.

The groups treated in this paper are unusual in having left few living descendants. Of the sixteen species we deal with in this paper, only one is still living in the western Atlantic. The muricid fauna of the Haywood Landing Member of the Belgrade Formation (latest Oligocene) of North Carolina is especially remarkable for the large number of unusual genera and species. In this paper, we treat no less than four monotypic genera, three of which are newly proposed, and none of which is known beyond Early Miocene time.

Genus OCENEBRA Gray, 1847

Tritonalia FLEMING, 1828, History British Animals, p. 564 (index) and corrigenda (? *n.n. pro Triton* Montfort, 1810, *non* Linnaeus, 1758).

Type species: *Murex erinaceus* Linnaeus,

1758, by subsequent designation, Gray, 1847.

Ocenebra "Leach MS" GRAY, 1847, Ann. Mag. Nat. Hist., v. 20, p. 269 (?October); GRAY, 1847, Zool. Soc. London, Proc., pt. 15, p. 133 (November).

Type species: *Murex erinaceus* Linnaeus, 1758, by monotypy (?Oct.) or original designation (Nov.).

Inermicosta JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex fasciatus* "Sowerby, 1841" (not *M. fasciatus* Gmelin, 1791 = *Tritonalia inermicosta* Vokes, 1964), by original designation.

Discussion: The names *Ocenebra* and Ocenebrinae have replaced the questionably proposed *Tritonalia* Fleming, 1828, and Tritonaliinae by a ruling of the International Commission on Zoological Nomenclature, Opinion 886, 1969. The use of "*Ocinebra*" represents an incorrect spelling of *Ocenebra*.

In the past, *Ocenebra* has been used as a grab-bag for a wide variety of fossil and living ocenebrines*. We here restrict the taxon *Ocenebra* to a relatively small number of Miocene to Recent species from western Europe, the Mediterranean region, and tropical West Africa. These are characterized by the tendency to form three varices on the last whorl, by the presence of six to eight primary spiral cords on the last whorl, a crenulated outer lip without a labral tooth, an adherent or very lightly erect inner lip, and six weak to strong denticles on the inner side of the outer lip. In species with varices, the latter are separated from each other by a single intervarical node. There appears to be considerable variation in expression of axial sculpture in the type species, *O. erinaceus*. Many individuals lack varices on the last whorl and instead are characterized by sharp-edged axial ribs that are not differentiated into varices and intervarical nodes.

Two fossil western Atlantic species discussed below may be related to *Ocenebra*, but they differ in several significant ways from the type species, *O. erinaceus* (Linnaeus), and other closely related members of *Ocenebra*. One of these fossil species, originally described by Vokes (1963) as *Tritonalia (Miocenebra) silverdalense*, is treated here as belonging to the distinct genus *Miocenebra* Vokes, 1963. For the other, we propose the new genus *Fenolignum*. Inter-relationships among taxa of the Ocenebrinae cannot be resolved until all the genera are considered in a phylogenetic context. Rather than considering *Miocenebra* and *Fenolignum* as subgenera of *Ocenebra*, we have elected to treat them as full genera pending the outcome of phylogenetic analysis.

*For example, Abbott (1974, p. 184) referred to the genus *Ocenebra* several western Atlantic species that we believe are better placed in the Muricopsinae (see Vokes, 1994). These are: *muricoides, schrammi,* and *rosea* [now referred to *Muricopsis (Risomurex)*]; *minirosea* and *micromeris* [now *Favartia*]; and *emipowlusi* [now *Murexsul*].

Genus FENOLIGNUM, n. gen.

Type species: *Fenolignum umbilicatum,* new

PLATE 1

Figures Page

1-5. *Fenolignum umbilicatum*, n. sp 74

1. (X 2) USNM 488706 (holotype); height 24.1 mm, diameter 15.2 mm.
2. (X 2) USNM 488707 (paratype A); height 24.6 mm, diameter 16.0 mm.
3. (X 6; X 10) USNM 488708 (paratype B); height 7.5 mm, diameter 5.0 mm.
4. (X 2) Fulton Collection (paratype C); height 19.0 mm, diameter 13.3 mm.
5. (X 3) USNM 488709 (paratype D); height 16.0 mm (incomplete); diameter 10.6 mm (incomplete).

Locality of all: same as holotype.

6. *Miocenebra silverdalensis* (Vokes) 75

(X 2) USNM 644380 (holotype); height 28.5 mm, diameter 12.4 mm.
Locality: TU 562; Haywood Landing Member, Belgrade Formation.

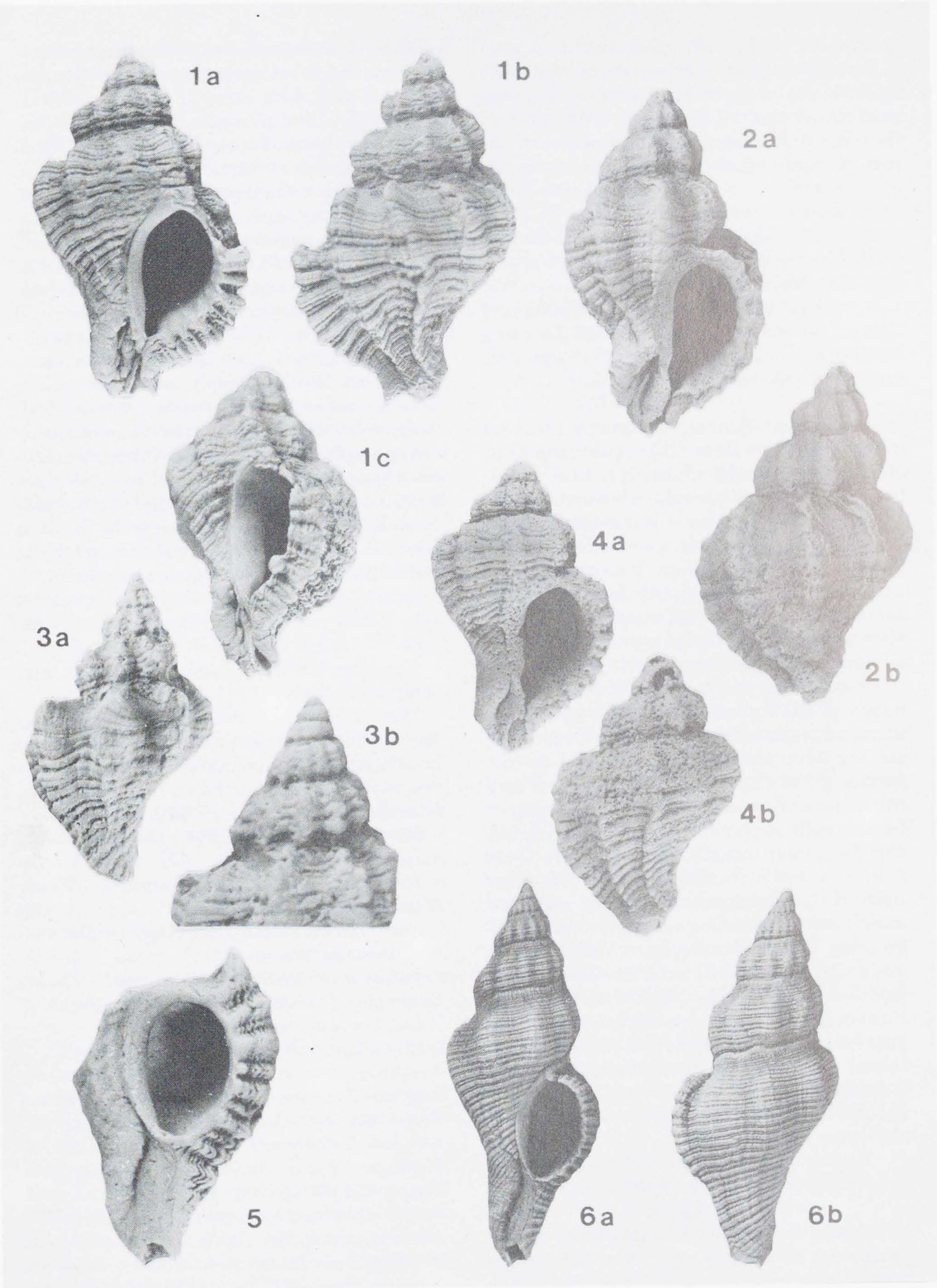

PLATE 1

species.

Description: Fusiform ocenebrine shell with external sculpture consisting of eight strong axial ribs crossed by about nine spiral cords on the body whorl; one of the spiral cords near the base terminating on the outer lip in a small, blunt labral tooth; anterior siphonal canal short, sealed; inner side of outer lip with about eight weak elongate denticles; outer lip erect in adults; inner lip adherent along its entire length; umbilical slit present.

Etymology: fenum (Latin: hay) and *lignum* (Latin: wood), for the Haywood Landing Member of the Belgrade Formation, type stratum for the type species.

Discussion: Among the many unusual muricids in the Late Oligocene beds near Silverdale, North Carolina, is a small broadly fusiform species whose combination of characters places it outside the limits of any ocenebrine genus recognized thus far. It differs from *Ocenebra* by the presence of a labral tooth formed at the termination of a basal cord, and by the absence of differentiated varices and intervarical nodes, instead having axial ribs that extend from a low shoulder to the base. *Fenolignum* is similar to some European species such as *"Ocenebra" curvicosta* (Grateloup, 1847) and *"O." striaeformis* (Michelotti, 1841) from the Early Miocene of France and Italy in having a labral tooth at the end of a spiral cord, but the European taxa differ strongly from *Fenolignum* by having a thickened outer lip and by having abaperturally reflected axial ribs terminating on the labral tooth-bearing cord. *Fenolignum* also bears a superficial resemblance to *"Ocenebra" lugubris* (Broderip, 1833) living in the Panamic Province, but the latter species possesses strongly recurved varices and a labral tooth arising from a groove rather than from a cord. Moreover, the Panamic species lacks dentition on the inner side of the outer lip.

FENOLIGNUM UMBILICATUM, n. sp.
Plate 1, figures 1-5

Description: Shell with six teleoconch whorls; protoconch of two and one-half small, conical whorls; teleoconch ornamentation beginning gradually, there being no line of demarcation between protoconch and teleoconch. Axial sculpture on first teleoconch whorl consisting of twelve rounded ridges, becoming increasingly inflated with each successive whorl; on body whorl eight axial ribs. On about fourth teleoconch whorl, small open flanges appearing on abapertural side of ridges, consisting of multiple laminae, best developed on siphonal canal. Spiral ornamentation consisting of heavy spiral cords, approximately nine on body whorl and two additonal ones on canal. Numerous fine spiral threads covering entire shell surface, including primary spiral cords. Adapertural faces of axial ribs fimbriated elaborately in harmony with primary and secondary spiral ornamentation. Suture deeply impressed, giving whorls a rounded contour with a low shoulder. Aperture oval; inner lip narrow, adherent along entire length, smooth; margin of outer lip crenulated by spiral cords; about eight weak, elongate denticles on inner side of outer lip. Fifth primary cord counting from suture ending in blunt labral tooth on edge of outer lip above base of canal. Siphonal canal short, broad, sealed by an extension from the columellar lip to apertural side. Small umbilical slit below continuous fasciole.

Holotype: USNM 488706; height 24.1 mm, diameter 15.2 mm.

Type locality: TU 866, Haywood Landing Member, Belgrade Formation (= "Silverdale beds"); marl pit on north side of Webb Creek and east side of unnumbered county highway, Silverdale, Onslow County, North Carolina.

Paratype A: USNM 488707; height 24.6 mm, diameter 16.0 mm.

Paratype B: USNM 488708; height 7.5 mm, diameter 5.0 mm.

Paratype C: Fulton Collection; height 19.0 mm, diameter 13.3 mm.

Paratype D: USNM 488709; height 16.0 mm (incomplete), diameter 10.6 mm (incomplete).

Locality of all, same as holotype.

Etymology: from the umbilicate shell form.

Occurrence: Haywood Landing Member, Belgrade Formation, North Carolina; Kirkwood Formation, Delaware.

Figured specimens: Fig. 1, USNM 488706 (holotype). Fig. 2, USNM 488707 (paratype A). Fig. 3, USNM 488708 (paratype B). Fig. 4, Fulton Collection (paratype C). Fig. 5, USNM 488709 (paratype D). Other occurrence: locality 91LW53, near Dover, Kent County, Delaware (Virginia Museum of Natural History Coll.).

Discussion: Comparisons of *Fenolignum*

umbilicatum to other superficially similar ocenebrines are given under the discussion for the genus. In addition to the Silverdale specimens from the Haywood Landing Member of the Belgrade Formation, L.W. Ward has collected several poorly preserved examples (in the collections of the Virginia Museum of Natural History) from an outcrop he assigns to the Kirkwood Formation. This occurrence in Delaware is somewhat younger than that in the Haywood Landing Member. Sugarman *et al.* (1993) have dated the Kirkwood Formation as Burdigalian (late Early Miocene), which would make this formation comparable in age to the Chipola Formation of Florida. Based on the occurrence of the diatom *Actinoptychus heliopelta,* Ward (in press) correlates the Kirkwood Formation in its type area at Shiloh, New Jersey, and in its Delaware outcrop, with his "bed 3-A" (Ward, 1992, p. 6) near the base of the Calvert Formation of Maryland.

Genus MIOCENEBRA Vokes, 1963

Miocenebra VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 162.

Type species: *Tritonalia (Miocenebra) silverdalense* Vokes, 1963, by original designation.

Description: "Shell greatly elongated, spire much elevated, constricted above the shoulder with an appressed suture. Formation of the varices irregular, with one always present at the aperture, although the others may be reduced to strong nodes. Aperture oval, margin complete, outer lip slightly crenulated. Canal elongated and completely closed over to form a tubular structure." (Vokes, 1963)

Discussion: Miocenebra resembles *Ocinebrina* in having a single terminal varix, but the aperture is more like that of *Pteropurpura,* being small and ovate with an entire peristome. *Ocenebrina* has several strong denticles on the inner side of the outer lip, as in *Ceratostoma* and *Ocenebra* but unlike *Miocenebra* (compare pl. 1, fig. 6, with pl. 2, figs. 1, 7). *Miocenebra* is most similar to the European genus *Hadriania,* which shares with *Miocenebra* the unusual anal sulcus as well as the high spire. The American genus differs from *Hadriania* principally in having irregularly placed varix-like axial ribs and in its exceptionally high spire. More material may reveal that *Miocenebra* is an unusual American *Hadriania* that left no descendants beyond the Late Oligocene.

MIOCENEBRA SILVERDALENSIS (Vokes)

Plate 1, figure 6

Tritonalia (Miocenebra) silverdalense VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 162, pl. 2, figs. 6, 7.

[Miocenebra] silverdalense (Vokes).VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 126.

Description: "Shell moderate in size, spire greatly elevated, whorls constricted above the shoulder, with an appressed suture that is sinuated by the axial nodes. Six adult whorls, nucleus unknown. Axial sculpture on the early whorls consists of about 12 equal nodes, which gradually diminish to about seven unequal nodes on the body whorl. Of these seven nodes, three are stronger, giving the appearance of varices, but there is no evidence of a break in the shell deposition, so that these are not true varices except at the aperture. Spiral sculpture consists of irregularly alternating weak and strong cords. Each strong cord has a medial groove which separates it into what appears to be two, however, if the shell is worn this groove disappears and the cord seems to be a single wide one. There are perhaps as many as 30 primary spirals on the body whorl and pillar of an adult specimen. Aperture oval, slightly crenulated within the labrum by grooves which correspond to the major external cords. Siphonal canal long, completely closed over by an extension from the columella, to form a tubular structure." (Vokes, 1963)

Holotype: USNM 644380; height 28.5 mm, diameter 12.4 mm.

Type locality: TU 562, Haywood Landing Member, Belgrade Formation (= "Silverdale beds"); Onslow County marl pit, near Silverdale, Onslow County, North Carolina.

Occurrence: Haywood Landing Member, Belgrade Formation, North Carolina.

Figured specimen: USNM 644380 (holotype).

Discussion: We have no additional material and there is nothing that can be added to the original description.

Genus OCINEBRINA Jousseaume, 1880

Ocinebrina JOUSSEAUME, 1880, Le Naturaliste, Année 2, no 42, p. 335; JOUSSEAUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 332.

Type species: *"Fusus corallinus"* Scacchi, 1836, by original designation [*Murex corallinus* Scacchi, 1836 = *Murex aciculatus* Lamarck, 1822].

Corallina BUCQUOY, DAUTZENBERG, and DOLLFUS, 1882, Moll. Mar. Roussilon, v. 1, p. 24.

Type species: *Murex aciculatus* Lamarck, 1822, by original designation.

Ocenebrina COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 38. Emendation.

Dentocenebra MONTEROSATO, 1917, Boll. Soc. Zool. Ital., (Ser. 3) v. 4, p. 21.

Type species: *Murex edwardsi* (Payraudeau, 1826), by subsequent designation, Lamy, 1919.

Description: "Shell with rather elevated conical spire, whorls ornamented by numerous longitudinal ribs, cut by circular striae, aperture oval with columellar margin appressed and much less curved than the outer margin, the latter internally denticulate; canal very short and closed anteriorly." (Jousseaume, 1882, p. 332, *translated*)

Discussion: Vokes (1971, p. 8) considered *Ocinebrina* as a subgenus of *Ocenebra,* but studies of egg capsules (D'Asaro, 1991) reveal marked differences between the two groups, implying that *Ocenebra* and *Ocinebrina* are not closely related. Shell characters further support this distinction. Species of *Ocinebrina* lack true varices, their axial sculpture consisting instead of rounded scaly ribs. The outer lip forms a terminal varix in the adult, and is thickened on its inner side by a deeply recessed ridge, which bears about six denticles. In some individuals of the type species, *O. aciculata* (Lamarck, 1822), the lowermost of the nine spiral cords on the body whorl above the canal is slightly extended as a short, blunt labral tooth. In the Pliocene Mediterranean *O. scalaris* (Brocchi, 1814), the entire lower sector of the outer lip may be extended ventrally as a lobe. These features do not occur in the Recent Mediterranean *O. edwardsi* (Payraudeau, 1826) or in the several Recent northeastern Pacific species, such as *O. gracillima* (Stearns, 1872), *O. interfossa* (Carpenter, 1864), and *O. lurida*

PLATE 2

Figures Page

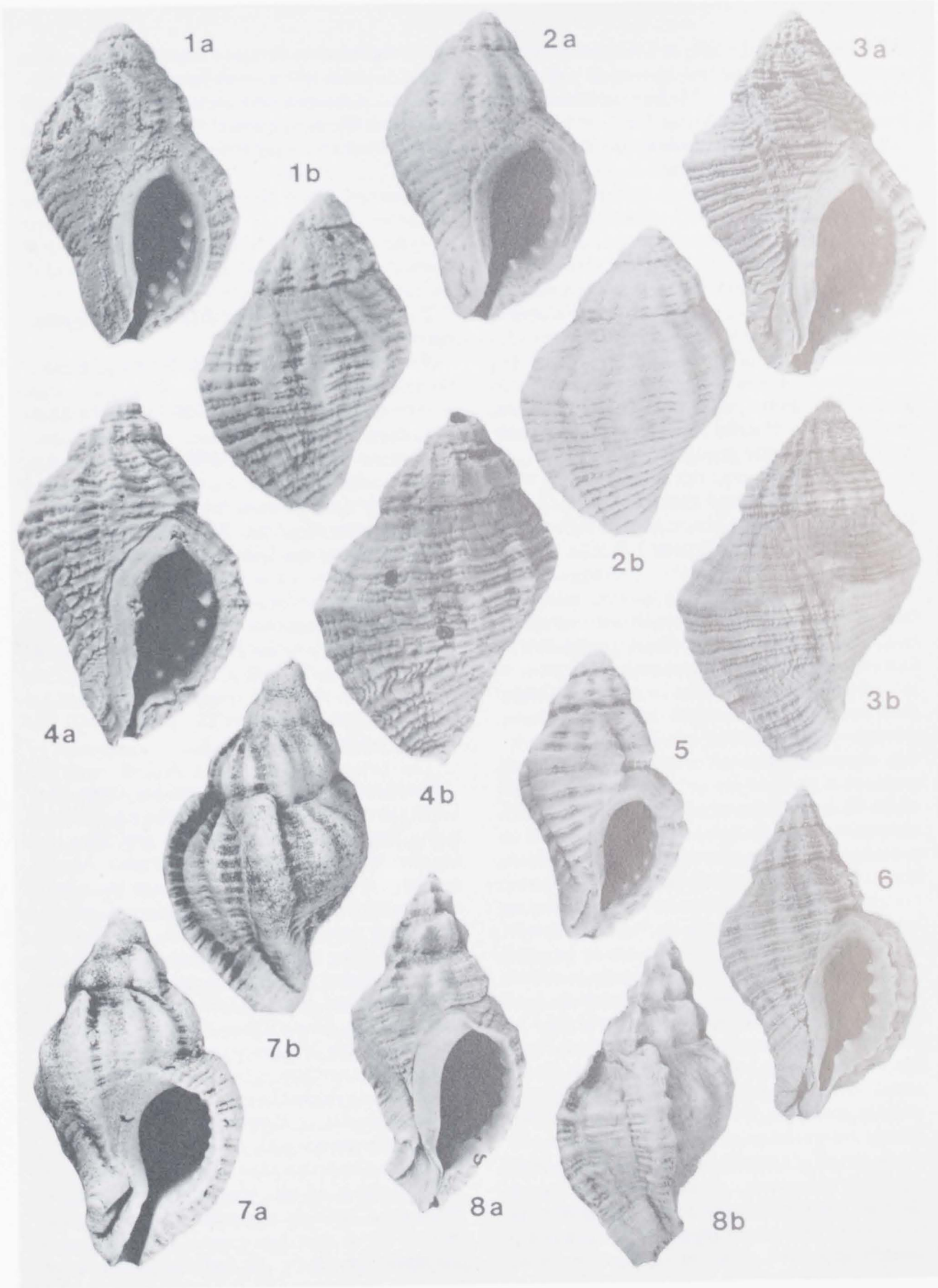

PLATE 2

(Middendorff, 1848), which have been assigned to *Ocenebra* by most previous authors but which McLean (1996) has transferred to *Ocinebrina.*

The discovery of *Ocinebrina francesae*, n. sp., from the Early Miocene Cantaure Formation of Venezuela, fills a wide biogeographical gap between the eastern Atlantic and northeastern Pacific members of the genus. Given that *Ocinebrina* is one of the oldest known genera of the Ocenebrinae, being represented in Europe by the Eocene species *O. bicostata* (Deshayes, 1835), it is likely that *O. francesae* represents a westward expansion of the genus, and that the temperate northeastern Pacific members are derived from this Atlantic group.

OCINEBRINA FRANCESAE
Gibson Smith and Gibson Smith MS, n. sp.
Plate 2, figures 1-5

Description: Shell broadly biconic, with four teleoconch whorls, and a protoconch of about two and one-half smooth, bulbous whorls, line of demarcation between protoconch and onset of teleoconch ornamentation imprecise. Outer shell surface translucent tan calcite, inner layer creamy white aragonite, resulting in decortication of surface on most examples. Axial ornamentation on earliest ornamented whorls of about 15 low ridges, gradually diminishing to nine on body whorl. Axial ribs best developed at periphery, varying greatly in strength from almost invisible to strongly angulate, the latter resulting from strong spiral cord running between axials. Numerous axial growth lamellae giving a fimbriate appearance to area between spiral cords. Usually only terminal varix thickened, but on some individuals from three to five additional varices developed on body whorl. Spiral ornamentation of about 16 low rounded cords on body whorl and siphonal canal. Of these, four on body whorl portion slightly stronger. On penultimate and earlier whorls intersection of axial ridges and spiral cords giving a cancellate appearance; on body whorl spiral ornamentation dominating. Suture shallow, resulting in a globular appearance for the shell. Aperture large, oval; inner lip smooth, appressed along entire length; outer lip patulous, with five (rarely six) strong denticles. On well-preserved specimens, at margin of aperture between first and second anterior denticles, a small labral tooth formed at end of spiral cord, enlarged only on adapertural side of terminal varix. Siphonal canal short, broad, sealed over by an extension of the columellar wall.

Holotype: NMB H-17656; height 15.7 mm, diameter 10.8 mm.

Type locality: NMB 17516, Cantaure Formation (lower beds); Paraguaná Peninsula, Falcón State, Venezuela (= TU 1269).

Paratype A: NMB H-17657; height 14.2 mm, diameter 9.6 mm.

Paratype B: NMB H-17665; height 17.8 mm, diameter 12.0 mm.

Paratype C: NMB H-17666-1; height 17.0 mm, diameter 11.5 mm.

Paratype D: NMB H-17666-2; height 12.0 mm, diameter 7.1 mm.

Locality of all, same as holotype.

Etymology of name: For Frances Gibson Smith, of Battersea, London, England, daughter of Mr. and Mrs. Jack Gibson Smith, Surrey, England, the collectors.

Occurrence: Cantaure Formation, Venezuela.

Figured specimens: Fig. 1, NMB H-17656 (holotype). Fig. 2, NMB H-17657 (paratype A). Fig. 3, NMB H-17665 (paratype B). Fig. 4, NMB H-17666-1 (paratype C). Fig. 5, NMB H-17666-2 (paratype D).

Discussion: In the collections from the Cantaure Formation, Paraguaná Peninsula, Venezuela, made by Mr. and Mrs. J. Gibson Smith, formerly of Caracas, there are over 100 specimens of an undescribed species of *Ocinebrina*. The original collectors long ago recognized this species as new and they intended to name it *"francesae,"* in honor of their daughter Frances, who collected many of the specimens in the type lot. The Gibson Smith Collection is now at the Naturhistorisches Museum, Basel, Switzerland, and we are pleased to be able to include their new taxon herein.

This species is similar to the northeastern Pacific species *O. lurida* (Middendorff, 1848) in that the closure of the canal is very slight if at all. Most specimens of *O. francesae* (which are extremely "beach-worn") have an open canal; however, one paratype (pl. 2, fig. 5) does have traces of closure, indicating that *Ocinebrina* is the proper place for the form, the only species

of this genus in the western Atlantic.

Although all species of *Ocinebrina* are frustratingly similar, *O. francesae* is perhaps most like *O. sublavata* (Basterot, 1825), a common Early and Middle Miocene species from France (pl. 2, fig. 6), which has a somewhat more extended siphonal canal.

Genus ARGYROBESSA, n. gen.

Type species: *Murex kellumi* Richards, 1943.

Description: Fusiform ocenebrine with trivaricate teleoconch whorls; between each pair of varices two to four axial ribs extending to the base of the canal; varices crossed by about eight spiral cords on last whorl; outer lip crenulate, planar, without labral tooth; inner side of outer lip with ten denticles; inner lip adherent along entire length; umbilical slit present. Siphonal canal open in unique specimen, possibly closed in well-preserved material.

Etymology: argyros (Greek: silver) and *bessa* (Greek: a wooded glen), for the Silverdale beds (Haywood Landing Member of the Belgrade Formation), the stratum from which the type species was described.

Discussion: Vokes (1964, p. 23) suggested that *Murex kellumi* Richards, 1943, from the Late Oligocene "Silverdale beds" [= Haywood Landing Member of the Belgrade Formation] of North Carolina, be placed in the genus *Ceratostoma*. Although the shell of the single available specimen is worn, it differs markedly from *Ceratostoma* by the absence of a labral tooth, by possibly having an open, rather than a sealed, siphonal canal, and by having two to four long intervarical ribs, instead of one intervarical node between adjacent varices. No other ocenebrine is at all similar to *Murex kellumi*. For this reason we propose the new genus *Argyrobessa* to accommodate it. The most similar living species of *Ceratostoma* is the Japanese *C. rorifluum* (Adams and Reeve, 1849), which differs by having four varices, a single intervarical rib between varices, and a closed canal (see pl. 2, fig. 8).

As originally noted by Richards (1943, p. 524), *Argyrobessa kellumi* superficially resembles species assigned to the muricine genus *Chicoreus* sensu lato. Richards (1943) compared *A. kellumi* to a species from the Dominican Republic that was then undescribed, but which was subsequently named *Chicoreus (Chicoreus) dujardinoides* (Vokes, 1963) (see Vokes, 1989a, p. 35, plate 2, fig. 11). *Argyrobessa kellumi* also closely resembles the Recent Indo-West Pacific *Chicoreus (Rhizophorimurex) capucinus* (Lamarck, 1822) in lacking spines and in having two or three intervarical ribs. Species of *Chicoreus* s.l. differ from *Argyrobessa* by having a lirate rather than denticulate outer lip, by the presence of a parietal rib at the apical end of the inner lip, and by having shorter intervarical ribs or nodes, rather than long ribs that extend to the base.

ARGYROBESSA KELLUMI (Richards)
Plate 2, figure 7

Murex kellumi RICHARDS, 1943, Jour. Paleontology, v. 17, p. 524, pl. 85, figs. 3, 4.

[Ceratostoma] kellumi (Richards). VOKES, 1964, Malacologia, v. 2, no. 1, p. 23; VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 62.

Description: "Shell subfusiform, five whorls, three varices, two to four ribs between the varices. Revolving lines prominent. Primary concentric ridges are separated from each other by two narrow grooves. Aperture suboval, with canal slightly deflected to the left. Ten aperture teeth. Conspicuous groove to the left of the canal." (Richards, 1943)

Holotype: ANSP 15838; height 42.5 mm, diameter 25.0 mm.

Type locality: Haywood Landing Member, Belgrade Formation; Gillette's marl pit, on the left side of Webbs Creek, half a mile southeast of Silverdale, Onslow County, North Carolina.

Occurrence: Haywood Landing Member, Belgrade Formation, North Carolina.

Figured specimen: ANSP 15838 (holotype).

Discussion: Unfortunately, no specimens of *A. kellumi* have come to light since Richards (1943) described the species on the basis of a single worn shell.

Genus CERATOSTOMA Herrmannsen, 1846

Cerostoma CONRAD, 1837, Acad. Nat. Sci. Philadelphia, Jour., v. 7, p. 263.

Type species: *Murex (Cerostoma) nuttalli* Conrad, 1837, by monotypy.

Ceratostoma HERRMANNSEN, 1846, Indicis Generum Malacoz., v. 1, p. 206. New name for *Cerostoma* Conrad, 1837, *non* Latreille, 1802.

Spinostoma COEN, 1943, Acta Pont. Acad. Sci., v. 11, p. 90.

Type species: *Murex nuttalli* Conrad, 1837, by subsequent designation, Vokes, 1964.

Description: "Shell as in the genus *Murex*; labrum with an erect tooth as in *Monoceros*." (Conrad, 1837)

Discussion: The name *Ceratostoma* has been used for a variety of trivaricate ocenebrines possessing a labral tooth. Here we restrict *Ceratostoma* to ocenebrines with three or four varices on the body whorl, cancellate sculpture on early teleoconch whorls, a single intervarical node between adjacent varices, and spiral sculpture consisting of strong cords, three to seven of which cross each intervarical node. The anterior siphonal canal is closed in the adult, and the inner side of the outer lip usually bears denticles. The labral tooth is formed at the end of a spiral groove below the intervarical nodes. The outer lip is erect, as is the basal sector of the inner lip in most species. There is no umbilical slit.

The genus *Pteropurpura* is similar to *Ceratostoma* in having a trivaricate shell in which the early teleoconch whorls bear a cancellate sculpture. It differs from *Ceratostoma* by having a much smaller aperture and by lacking a labral tooth.

Living species of *Ceratostoma* are confined to the temperate northeastern and northwestern Pacific. During the Early to Middle Miocene, however, the genus was also represented in Europe and in eastern North America; and a Pliocene species (*C. notiale*) was described by Vokes (1988) from the Esmeraldas beds of Ecuador. *Ceratostoma*, therefore, represents an intriguing example of a group that became regionally extinct in tropical waters and in the Atlantic Ocean but that survives in the temperate North Pacific.

CERATOSTOMA VIRGINIAE (Maury)
Plate 3, figures 1, 2

Murex virginiae MAURY, 1910, Bulls. Amer. Paleontology, v. 4, no. 21, p. 25(143), pl. 6(23), fig. 5.

Pteropurpura virginiae (Maury). GARDNER, 1947, U.S. Geol. Survey, Prof. Paper 142-H, p. 525.

[Pteropurpura] virginiae (Maury). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 116.

Description: "Shell small with some resemblance to *Typhis*, trigonal, biconic; whorls six; the two later being sharply carinated at the shoulders. Varices six, the alternate three being much more pronounced and giving the shell its triangular form. Spiral sculpture of raised threads which on the last whorl alternate with one or two finer, intercalated lines. Fainter, longitudinal threads form with the spirals a fine cancellation on the last whorl. Aperture oval, slightly more than half the length of the shell; canal narrow, reflexed." (Maury, 1910)

Holotype: PRI 3460; height 15.0 mm, diameter 8.0 mm.

Type locality: Chipola Formation; "Bailey's Ferry, Florida."

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 1, USNM 488710; height 19.3 mm, diameter 11.8 mm; locality TU 830. Fig. 2, USNM 488711; height 18.7 mm, diameter 11.1 mm; locality TU 830. Other occurrences: TU localities 457, 458, 459, 546 (common), 547, 548, 549, 554, 555, 708, 787, 806, 807, 817, 818, 819, 820, 821, 823, 824, 825, 828, 830 (common), 831, 949, 950, 951, 998, 999, 1021, 1048, 1050, 1196.

Discussion: In 1971 Vokes referred this common Chipola species to the genus *Pteropurpura* because most of the examples do not have the labral tooth preserved and the fimbriate shell is much like that of species of *Pteropurpura*. However, in rare examples this tooth is developed (see pl. 3, fig. 2c) and, even without the labral tooth present, the open denticulate aperture is more typical of *Ceratostoma* than *Pteropurpura*. This species also has the early whorls with a finely cancellate sculpture in contrast to the lamellar varices seen in the other species heretofore attributed to *Ceratostoma* in the western Atlantic. These others are now placed in

Pterorytis (Microrhytis) below, leaving *C. virginiae* as the only valid representative of the genus *Ceratostoma* in the area.

The holotype is a small specimen, our largest example (TU 546) measures 22.5 mm in height.

Genus PTEROPURPURA Jousseaume, 1880

Pteropurpura JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 345; JOUSSEAUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 334.

Type species: *Murex macropterus* Deshayes, 1839, by original designation.

Centrifuga GRANT and GALE, 1931, San Diego Soc. Nat. Hist., Mem., v. 1, p. 706.

Type species: *Murex centrifuga* Hinds, 1844, by original designation.

Shaskyus BURCH and CAMPBELL, 1963, Jour. de Conchyl., v. 103, p. 201.

Type species: *Murex festivus* Hinds, 1844, by original designation.

Description: "Shell with spire elongated to triangular pyramid, whorls ornamented by three wide lamellar varices reaching almost the middle of the canal; aperture small, oval, margins continuous and detached; canal wide at the base, subulate anteriorly." (Jousseaume, 1882, p. 334, *translated*)

Discussion: The genus *Pteropurpura* is characterized by having a trivaricate shell, very small rounded to broadly ovate aperture, erect outer and inner apertural lips, and a closed canal. The varices on adjacent whorls usually do not form connecting buttresses across the suture as they do in *Jaton*. There is no labral tooth. Spiral sculpture usually consists of fine cords or threads, which in some species are obsolete.

The Californian *Murex festivus* Hinds, 1844, has been made type of the genus *Shaskyus*, but we regard the distinction between *Shaskyus* and *Pteropurpura* as minor. *Pteropurpura festiva* differs from other species of the subgenus by having abaperturally recurved, instead of erect, alate varices, and by having the varices on adjacent whorls touching in a buttress-like fashion (see pl. 3, fig. 4). The Californian *P. vokesae* Emerson, 1964 (*n.n. pro Murex rhyssus* Dall, 1919, *non M. rhysus* Tate, 1888) is morphologically intermediate between *P. festiva* and the other northeastern Pacific species of *Pteropurpura*.

M. Smith (1940, p. 244, pl. 2, fig. 3; holotype UF 174297) named *Murex gaza* from the Gulf of Mexico. Sunderland and Sunderland (1994, p. 14) have figured the holotype and we believe that this specimen is only a juvenile *Pteropurpura festiva*, and the locality given for *M. gaza* is erroneous (see pl. 3, fig. 5).

The presence of labral denticles is an inconsistent character in the genus *Pteropurpura*. In the type species of the genus, *P. macropterus* (Deshayes), the inner side of the outer lip is usually smooth, but occasional specimens have small denticles. Two other eastern Pacific species, *P. festiva* and *P. erinaceoides* (Valenciennes, 1832), sometimes have these denticles (pl. 3, fig. 4a). The three fossil and Recent western Atlantic species considered below have five denticles on the inner side of the outer lip (pl. 4, figs. 2c, 4a). These denticles are much smaller than those in *Ceratostoma*. As in other species of *Pteropurpura*, the aperture of the Atlantic species is small and rounded instead of large and markedly ovate as in *Ceratostoma*.

The genus *Pteropurpura* is represented in Recent seas by species in West Africa, the western Atlantic, tropical eastern Pacific, and warm-temperate northeastern and northwestern Pacific. The oldest member of the genus is *P. delbosiana* (Grateloup, 1847), from the Burdigalian (Early Miocene) of southwestern France. In the New World, the genus is first represented by *P. boesei*, n. sp., from the probably Late Miocene Santa Rosa beds, Veracruz, Mexico (see below). All Pacific records of *Pteropurpura* are from the Pliocene or younger. The genus *Poropteron* Jousseaume, 1880, comprises a related group of six species from southern Africa and the island of St. Helena, distinguished by having an adapically and ventrally curving spine at the posterior end of the varices. We separate as *Odontopurpura*, n. subgen., a species of *Pteropurpura, P. festivoidea* (Vokes, 1963), characterized by a labral tooth formed as the

extension of a spiral cord. It is possible that this species is not closely related to other species of *Pteropurpura*.

Subgenus PTEROPURPURA s.s.

PTEROPURPURA (PTEROPURPURA) BOESEI, n. sp.

Plate 4, figure 1

Pteropurpura aguilari (Böse). PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 81, pl. 40, figs. 5-10 (*not* of Böse).

Description: Shell with seven teleoconch whorls, protoconch lacking in type material. Shell composed of two layers: a translucent outer calcitic layer and a creamy aragonitic inner layer. Earliest whorls decorticated; axial ornamentation on first decorated whorl of 12 small lamellar flanges, gradually gaining in strength and reducing in number to six per whorl. On about sixth teleoconch whorl every other flange disappearing to leave three varices and three heavy, rounded intervarical nodes per whorl. Varices thick at base, composed of a single lamina of shell material on abapertural side, but multiple layers on adapertural side, giving a faint fimbriation to varical face. Spiral ornamentation on early teleoconch whorls of two cords; gradually weakening and by fourth teleoconch whorl totally disappearing; visible only on adapertural varical faces as three strong grooves in the fimbriated surface. Suture impressed. Aperture elongate-oval; inner lip smooth, narrow, briefly appressed at posterior end. Inner side of outer lip with five small denticles. Siphonal canal moderately long, narrow, slightly recurved at distal end; completely sealed over by an extension from columellar wall.

Holotype: USNM 283714; height 30.9 mm, diameter 19.0 mm.

Type locality: USGS 23737, Santa Rosa beds; 3 km northeast of Santa Rosa [now Istal], formerly on the Veracruz to Santa Lucretia [now Jesus Carranza] railroad [which now exists only as the highway right-of-way to Istal], Veracruz, Mexico.

Paratype: USNM 350019; height 6.2 mm, diameter 3.9 mm; locality USGS 9995, 3 km northeast of Santa Rosa, Veracruz, Mexico.

Etymology of name: For Emil Böse, in honor of his pioneering work on the Tertiary faunas of Mexico.

Occurrence: Santa Rosa beds, Veracruz, Mexico.

Figured specimen: USNM 283714 (holotype).

Discussion: The three specimens that Perrilliat figured from the Santa Rosa fauna as *P. aguilari* Böse are not that species but are a more inflated shell with three strong folds on the apertural face of the varix. The smallest specimen (USNM 350019) that Perrilliat figured (1972, pl. 40, figs. 9, 10) shows well the cancellate early whorls typical of *Pteropurpura*.

The material from Santa Rosa was originally collected by Bruce Wade in 1920. Part of the collection went to the U.S. National Museum and was given the locality number 9995 and part originally went

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PLATE 3

Figures Page

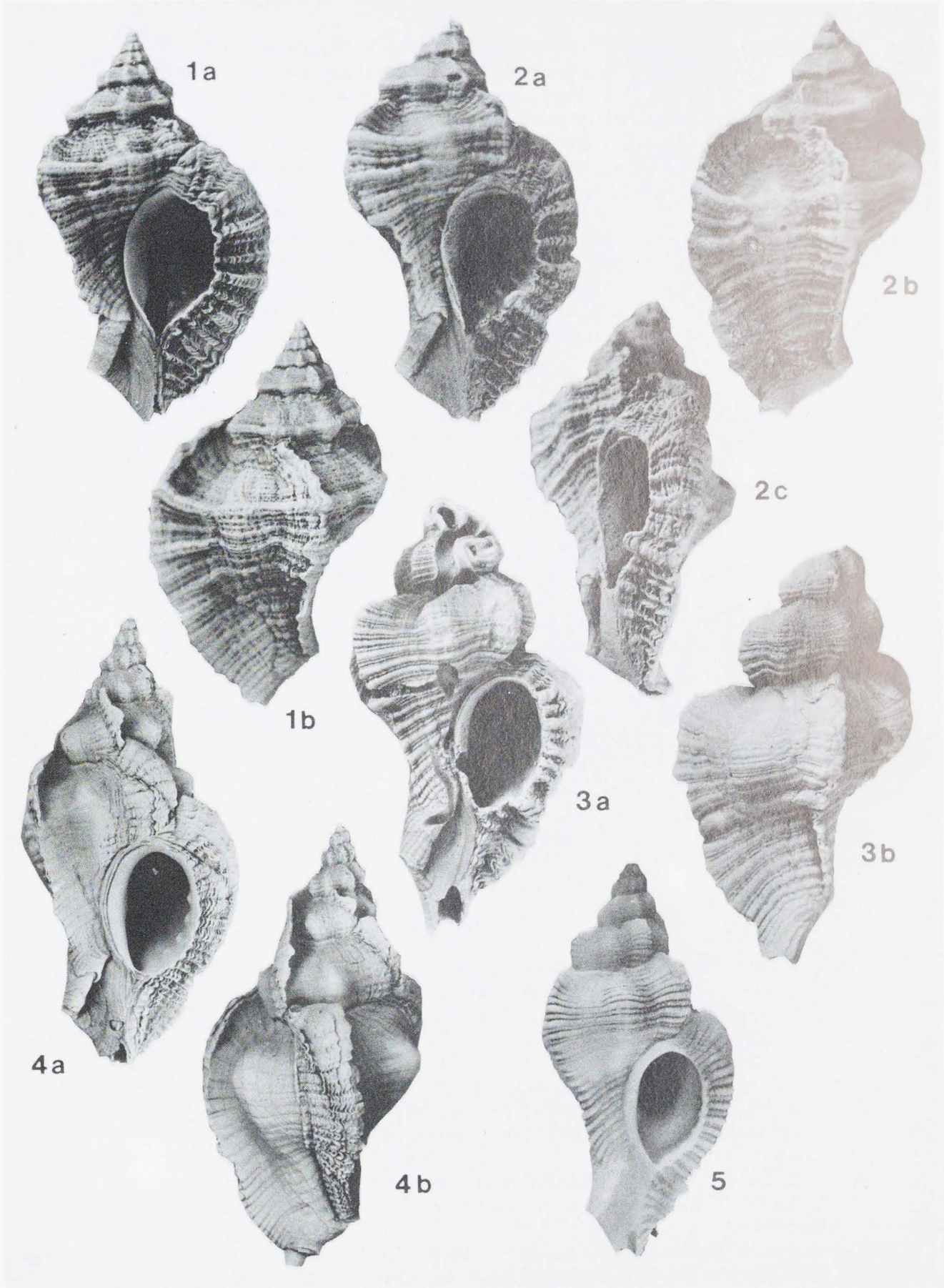


PLATE 3

to the Johns Hopkins University Collections. Subsequently, this material also was placed in the U.S. National Museum and given the locality number 23723. As was discussed in Vokes (1994, p. 138) this remarkable locality, thought to be of Late Miocene age, has never been located and is assumed to be buried by subsequent soil erosion. Like the shell bed at Bowden, Jamaica, to which it is similar, Santa Rosa probably represents a gravity-flow of shallow-water material into deeper water and, also like the Bowden shell bed, was a very restricted outcrop.

PTEROPURPURA (PTEROPURPURA) AGUILARI (Böse)

Plate 4, figures 2, 3

Murex (Pteropurpura) aguilari BÖSE, 1910, Jahr. K.K. Geol. Reichsanst., v. 60, p. 233, pl. 12, fig. 11; TOULA, *ibid.*, p. 262.

[Pteropurpura] aguilari (Böse). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 14.

Not *Pteropurpura aguilari* (Böse). PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 81, pl. 40, figs. 5-10 [= *P. boesei*, n. sp.].

Description: Shell with seven teleoconch whorls, and a protoconch of from one and one-half to two and one-half smooth, bulbous whorls (exact line of demarcation uncertain due to shell decortication). Shell composed of two layers, a translucent outer calcitic layer, easily decorticated, and a creamy aragonitic inner layer. Axial ornamentation on first decorated whorl of 12 small lamellar flanges, gradually reducing in number but gaining in strength, about fourth teleoconch whorl only three strong wing-like varices remaining, with one large intervarical node between each pair. Varices composed of a single lamina of shell material on abapertural side, but multiple layers on adapertural side, giving a faint fimbriation to varical face. Spiral ornamentation on early teleoconch whorls of three cords, one at shoulder and two anterior to it. Spiral cords persisting up to about fourth teleoconch whorl, disappearing at about same place as the multiple varical laminae. Last three teleoconch whorls almost completely smooth, only a hint of presence of former cords on varical face, primarily at shoulder. Suture deeply impressed. Aperture elongate-oval; inner lip smooth, narrow, briefly appressed at posterior end. Inner side of outer lip with five small denticles. Siphonal canal moderately long, narrow, slightly recurved at distal end; completely sealed over by an extension from columellar wall.

Holotype: Unknown; height 26.8 mm, diameter 13 mm (*fide* Bosë, 1910, p. 234).

Type locality: Concepcion Inferior Formation; Kilometer 70 on the Tehuantepec Railroad [5 km north of Almagres, Veracruz, Mexico] (= TU 1321).

Occurrence: Concepcion Inferior Formation, Veracruz, Mexico.

Figured specimens: Fig. 2, UCMP 39881; height 30.3 mm, diameter 18.8 mm; locality UCMP S-2647, Texistepec, Veracruz, Mexico.

PLATE 4

Figures

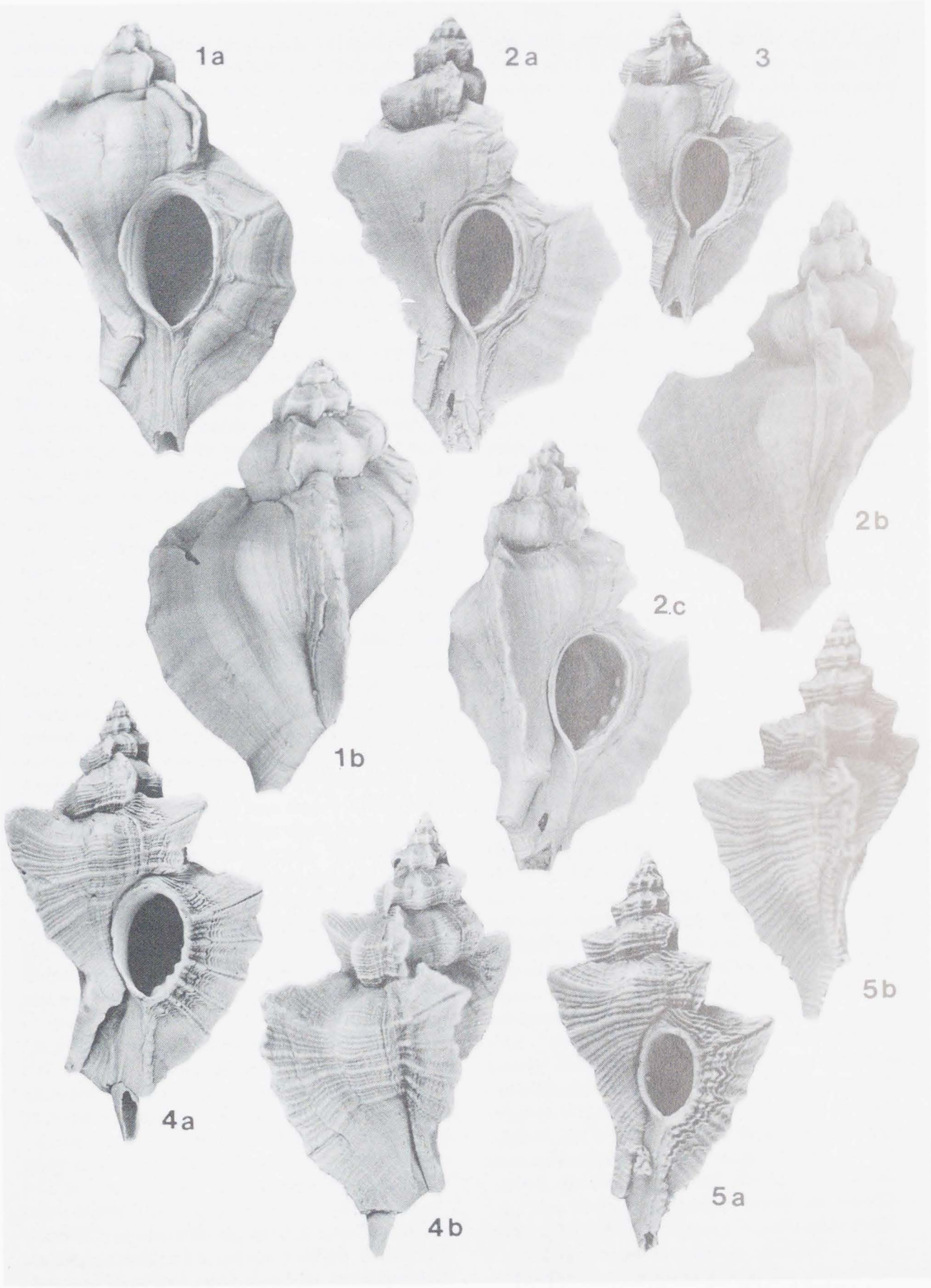


PLATE 4

Fig. 3, UCMP 39882; height 21.7 mm, diameter 13.5 mm; locality UCMP S-4276 [Veracruz, Mexico; no data available]. Other occurrences: TU localities 1025, 1318, 1514, 1515.

Discussion: Originally named from the famous "Kilometer 70" locality on the Isthmus of Tehuantepec Railroad, we now have several examples of this species from the Concepcion Inferior Formation in the Isthmus of Tehuantepec. The beds of the Concepcion Inferior have been dated as Neogene Zone N.19, Early Pliocene in age, and are thought to represent deposition in depths of 180-200 meters (Kohl, 1985, p. 25).

Böse's original description (1910, p. 233, pl. 12, fig. 11), based upon the broken holotype, is not very diagnostic but his excellent illustration leaves no question as to the identity of this species, which differs from *P. bequaerti* in having a much smoother shell in contrast to the elaborate surface ornamentation of the younger species.

PTEROPURPURA (PTEROPURPURA) BEQUAERTI
(Clench and Pérez Farfante)
Plate 4, figures 4, 5

Murex (Pteronotus) macropterus Deshayes. DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 201; M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 5, pl. 11, fig. 8 (*not* of Deshayes).

Murex (Pteropurpura) bequaerti CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 40, pl. 21, figs. 1, 2.

Murex (Pterynotus Sect. *Pteropurpura) bequaerti* Clench and Pérez Farfante. ABBOTT, 1954, Amer. Seashells, p. 205.

[Pteropurpura] bequaerti (Clench and Pérez Farfante). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 23.

Pteropurpura bequaerti (Clench and Pérez Farfante). ABBOTT, 1974, Amer. Seashells, Second Ed., p. 177, fig. 1868; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 129, pl. 22, fig. 1; FAIR, 1976, The Murex Book, p. 25, pl. 22, fig. 344; KAICHER, 1980, Card Cat. World-wide Shells, Pack no. 25, Muricidae (Part V), card no. 2513; ABBOTT and DANCE, 1982, Compendium of Seashells, p. 141 (color figure); D'ATTILIO and MYERS, 1983, Festivus, v. 15, no. 3, p. 33, figs. 1-7 [fig. 3, protoconch; fig. 4, operculum; fig. 5, radula]; SUNDERLAND and SUNDERLAND, 1994, Amer. Conchologist, v. 22, no. 1, p. 14 (holotype).

Pteropurpura (Pteropurpura) bequaerti (Clench and Pérez Farfante). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, back cover (color figure).

Description: "Shell from 17 to 37 mm (about three-fourths to one and one-half inches) in length, solid and provided with three strong, wing-like varices. Whorls about seven and rather strongly convex. Color a dull white with irregular areas of cream on the base of the varices and on the intervarical ridges. Spire extended. Suture rather deeply impressed. Aperture small, oval, and entire, notched slightly above the opening to the siphonal canal. Both parietal and palatal lips are thin and erect. Siphonal canal short, broad and completely inclosed, with the distal end turned slightly toward the right. Previous siphonal canals exist as very short scales. Axial sculpture consists of three wing-like varices which are broad at the base and knife-like at the outer edge. The front surface of the varices consists of many very low laminae, which are built forward in overlapping layers. There is a single knot-like ridge between the varices. Spiral sculpture consists of numerous, large and small alternating threads. This sculpture passes over the intervarical ridges and up on the back surface of the varices. Postnuclear whorls similar to the later whorls. Periostracum absent." (Clench and Pérez Farfante, 1945)

Holotype: UF 11986; height 25 mm, diameter 15.5 mm (*fide* Clench and Pérez Farfante, 1945, p. 40).

Type locality: Off Delray Beach, Palm Beach County, Florida, in 80 fathoms [146 meters]; collected by F.B. Lyman.

Occurrence: Late Pleistocene and Recent, Gulf of Mexico to North Carolina.

Figured specimens: Fig. 4, USNM 488712; height 42.6 mm, diameter 22.8 mm; locality TU 977. Fig. 5, USNM 880170; height 19.3 mm, diameter 10.4 mm; locality, off Anna Maria Key, Florida, in 40 meters.

Discussion: Although Clench and Pérez Farfante do not note it in the original description, *P. bequaerti*, as well as the earlier western Atlantic species, bears five

small denticles on the inner side of the outer lip (see pl. 4, fig. 4a). The protoconch is of one and one-half rounded whorls and the early teleoconch whorls are strongly cancellate, with initially about twelve lamellae, diminishing to ten and then to six on the third and fourth teleoconch whorls, becoming three varices with three strong intervarical nodes at about the fifth teleoconch whorl. The size is also larger than the original authors realized; some examples measure almost 50 mm.

In the Tulane Collections this species in moderately common in the Late Pleistocene beds from "Mud-Lump 90" off the Mississippi River delta, in beds estimated to have been deposited in 60 meters depth (Morgan *et al.*, 1963, p. 41).

Subgenus ODONTOPURPURA, n. subgen.

Type species: *Tritonalia festivoidea* Vokes, 1963.

Description: Ocenebrine differing from *Pteropurpura* s.s. by the presence of a long intervarical rib between adjacent varices, by the presence of a narrow umbilical slit, and by the presence of a labral tooth at the termination of a basal spiral cord at the edge of the outer lip.

Etymology: Greek prefix *odonto-* referring to tooth, coupled with *Purpura.*

Discussion: Another unusual form found in the Late Oligocene "Silverdale beds" of North Carolina was originally given the specific name *festivoidea* by Vokes (1963) because of the close morphological similarity to *Pteropurpura festiva* (Hinds, 1844), a species living today on the coast of California. Although the Oligocene fossil has three varices and a single intervarical node as in *P. festiva, P.(O.) festivoidea* possesses a strong labral tooth not seen in the living species (compare pl. 3, figs. 3a, 4a).

The eastern Atlantic Miocene to Recent genus *Jaton* is superficially similar to the subgenus *Odontopurpura* in having a trivaricate shell and by virtue of the presence of a labral tooth in the type species, *J. decussatus* (Gmelin, 1791). As in *Odontopurpura*, the labral tooth of *J. decussatus* is formed at the terminus of a spiral cord. However, whereas the cords of *Odontopurpura* are indistinct and weak, those of *Jaton* are broad and prominent. In *Jaton*, the labral tooth arises from a small cord anterior to the second broad primary cord (counting from the shoulder). The intervarical node in *Jaton* is relatively shorter than that in *Odontopurpura*, and is bounded on its apertural side by the shoulder cord (cord 1) and the tooth-bearing cord (cord 2). In *Odontopurpura* the labral tooth arises from the lowest of four cords.

PTEROPURPURA (ODONTOPURPURA) FESTIVOIDEA (Vokes)
Plate 3, figure 3

Tritonalia (Tritonalia) festivoidea VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 161, pl. 2, fig. 5.

[Ocenebra] festivoidea (Vokes). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 121.

Description: "Shell moderate in size, spire elevated, suture deeply constricted giving a much inflated aspect to the individual whorls. Nucleus unknown, about five post-nuclear whorls in the adult. Axial ornamentation consists of three wing-like varices, which are sculptured with minute imbrications on the apertural side. Between each pair of varices is one very strong node. Spiral ornamentation consists of coarse threads alternating with usually three finer threadlets between each pair; about 18 primary threads on the body whorl and pillar. At the juncture of the body whorl and the pillar there is a raised rib which corresponds to an ill-defined anterior apertural tooth and is a conspicuous spiral ridge. Aperture oval, labium distinct, not appressed. Outer margin of the aperture denticulate with about four weak teeth. Canal moderate, slightly recurved, completely roofed over to form a tubular structure typical of *Tritonalia* [= *Ocenebra*]." (Vokes, 1963)

Holotype: USNM 644379; height (incomplete) 24.0 mm, diameter 14.0 mm.

Type locality: TU 562; Haywood Landing Member, Belgrade Formation (= "Silverdale beds"), Onslow County marl pit, near Silverdale, Onslow County, North Carolina.

Occurrence: Haywood Landing Member, Belgrade Formation, North Carolina; Kirkwood Formation, Delaware.

Figured specimen: USNM 644379 (holotype). Other occurrence: locality 92LW22, near Dover, Kent County, Delaware (L.W. Ward Coll.).

Discussion: The holotype of this unusual species is incomplete, as are two additional specimens in the type lot and another two examples collected by L.W. Ward from an outcrop of the Kirkwood Formation near Dover, Delaware. As discussed further under *Fenolignum umbilicatum*, the Delaware specimens are somewhat younger (of late Early Miocene age) than those from the Haywood Landing Member of the Belgrade Formation (Late Oligocene).

Genus PTERORYTIS Conrad, 1863

Pterorytis CONRAD, 1863, Acad. Nat. Sci. Philadelphia, Proc., v. 14, p. 560.

Type species: *Murex umbrifer* Conrad, 1832, by monotypy.

Pterorhytis CONRAD, 1868, Amer. Jour. Conch., v. 4, p. 64. ?Emendation.

Not *Pterorhytis* CONRAD, 1875, Rept. North Carolina Geol. Survey, v. 1, Appendix A, p. 21 [a pelecypod].

Neurarhytis OLSSON and HARBISON, 1953, Acad. Nat. Sci. Philadelphia, Mon. 8, p. 252.

Type species: *"Purpura (Pterorhytis) fluviana"* Dall, 1903, by original designation [= *Pterorhytis fluviana* Dall, 1903].

Description: "Fusiform; six prominent recurved foliated ribs; aperture ovate, channel closed." (Conrad, 1863)

Discussion: The original spelling of this genus by Conrad was as *"Pterorytis,"* without the "h." Subsequently (1868), he spelled it as *Pterorhytis,* and most authors have followed that orthography. Unfortunately, the *Code of Zoological Nomenclature* is explicit on the subject of subsequent spellings and according to Article 32(b) the original spelling is to be preserved unaltered. In addition to the *Pterorytis-Pterorhytis* spellings, there have been numerous other errors, cited in Vokes (1964, p. 22).

It is surprising that, in the original description, Conrad failed to note the single most dramatic character of this genus, the extremely large, projecting labral tooth. The name indicates that to Conrad the most striking characteristic is the sharp fold in the lamellar varices (*ptero* = wing; *rhytis* = fold), formed by the spiral cord at the periphery. The original illustration has no suggestion of a labral tooth, and the specimen does not seem to have had one, as Tuomey and Holmes (1856, p. 141) note: "Mr. Conrad informs us it is but lately that specimens of this shell have been discovered with the erect tooth on the labrum." Presumably, it is one of the latter specimens Conrad illustrated later (1868, pl. 5, fig. 7; refigured here, text-fig. 1), which does show the tooth. Perhaps the Tuomey and Holmes specimen (which is *P. fluviana* Dall) influenced him for, at that time (*ibid.*, p. 63), he re-described *Murex umbrifer* as having four varices, but his specimen has five.

PLATE 5

Figures Page

1-5. *Pterorytis (Pterorytis) umbrifer* (Conrad) 90

1. (X 1 1/4) USNM 488713; height 52.1 mm, diameter 42.0 mm. Locality: TU 613; Yorktown Formation.
2. (X 1 1/2) USNM 488714; height 33.5 mm, diameter 20.5 mm. Locality: Chuckatuck, Virginia (Blow Coll.); Yorktown Formation.
3. (X 1 1/2) USNM 488715; height 37.8 mm, diameter 30.0 mm. Locality: Day's Point, James River, Virginia (Blow Coll.); Yorktown Formation.
4. (X 1 1/2) USNM 488716; height 36.0 mm, diameter 25.4 mm. Locality: Yadkin, City of Chesapeake, Virginia (Campbell Coll.); Yorktown Formation.
5. (X 4, X 10) USNM 488717; height 10.9 mm, diameter 6.0 mm. Locality: Rock Wharf, Smithfield, Virginia (Campbell Coll.); Yorktown Formation.

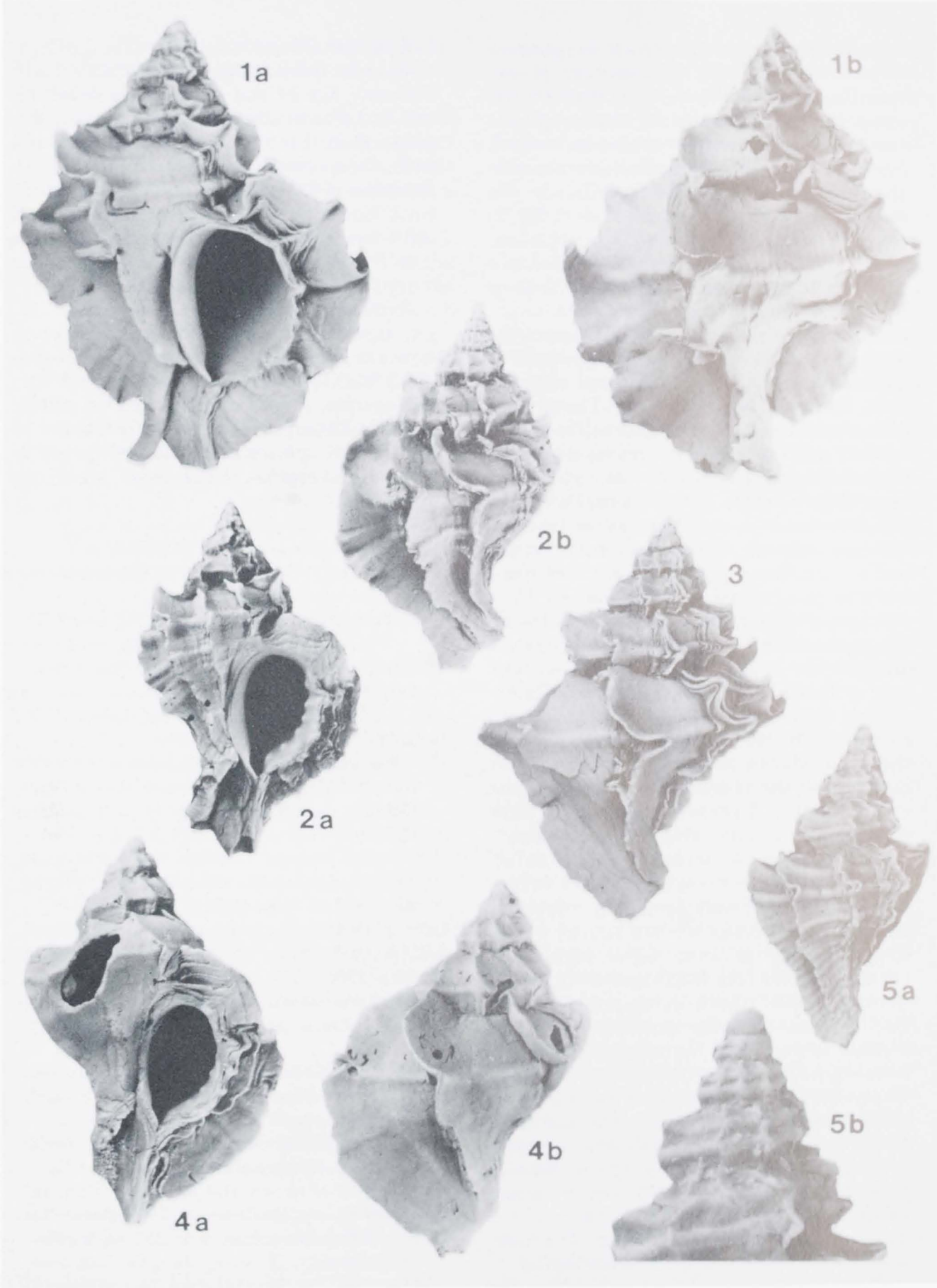


PLATE 5

Because *Pterorytis* was originally described as having six varices, Olsson and Harbison (1953, p. 252) erected the subgenus *Neurarhytis* for those species having only four varices on the last whorl. *Pterorytis umbrifer* is much more variable than Olsson and Harbison realized. We have material with from four (pl. 6, fig. 1) to nine varices (pl. 5, fig. 2) on the last whorl. In general, juvenile shells have more varices, mature shells have four or five varices on the body whorl.

Pterorytis shares with *Ceratostoma* the presence of a labral tooth near the base of the outer lip, situated at the end of a distinct external groove or fold. The genera differ in sculpture, however. The early whorls of *Ceratostoma* are cancellate, whereas those of *Pterorytis* bear about ten lamellar varices. On later whorls, *Ceratostoma* possesses three to four varices, between which is an intervarical node. In *Pterorytis* s.s., four to nine varices per whorl are connected by a strong peripheral keel, and there are no intervarical nodes or ribs. The subgenus *Microrhytis* is intermediate between the two, with three varices and strong intervarical nodes on each whorl, similar to *Ceratostoma,* but with lamellar varices on the early whorls, as in *Pterorytis*. It is our belief that the resemblance between the trivaricate *Microrhytis* line and *Ceratostoma* is the result of convergence.

There may be a close relationship between *Pterorytis* and *Ocinebrellus*. Indeed, Vokes (1988) described *Pterorytis* as an *Ocinebrellus* with a labral tooth. Typical species of *Ocinebrellus,* such as *O. inornatum* (Recluz, 1851) and *O. aduncus* (Sowerby, 1834), both living on temperate Pacific coasts of Asia, occasionally possess a small labral tooth formed just below the basal-most of four principal spiral cords. These cords are elaborated as points on the varices, which vary in number from three to seven, and which are unusual among muricids in being adaperturally reflected. The presence of three rather than four cords, and the abapertural instead of adapertural reflection of varices, distinguish *Pterorytis* from *Ocinebrellus*.

Although the genus *Pterorytis* does not persist in the western Atlantic past the end of the Pliocene (see Lyons, 1991, p. 146-150, for arguments for the Late Pliocene age of the formations in which the last *Pterorytis* specimens occur), the group is still living in the eastern Pacific with the species *P. hamatus* (Hinds, 1844). Emerson (1985) has illustrated a magnificent Ecuadorian specimen, having an ocenebrine radula and operculum, very like *P. umbrifer*, but with a denticulate outer lip, as in form *P. seminola*.

Radwin and D'Attilio (1976, p. 121, pl. 14, fig. 2) have figured as *"?Ocenebra hamata"* another very large specimen (66.8 mm) that seems to represent a different species, as Emerson suggested (1985, p. 16). Their shell cannot be assigned to any known species and may well prove to be a second species of *Pterorytis*, occurring off the coast of Peru.

Subgenus PTERORYTIS s.s.

PTERORYTIS (PTERORYTIS) UMBRIFER (Conrad)

Plate 5, figures 1-5; Plate 6, figures 1-5; Plate 7, figures 1-7; Text-figure 1

Murex umbrifer CONRAD, 1832, Fossil Shells Tert. Formations North America, v. 1, no. 1, p. 17, pl. 3, fig. 1 [reprinted by Harris, 1893, p. 31].

Not *Cerostoma umbrifer* (Conrad). TUOMEY and HOLMES, 1856, Pleiocene Fossils South Carolina, p. 141, pl. 28, fig. 14 [= *P. fluviana* Dall].

Not *Murex umbrifer* Conrad. EMMONS, 1858, Rept. North Carolina Geol. Survey, p. 247, fig. 104a [= *P. fluviana* Dall].

Murex (Pterorytis) umbrifer Conrad. CONRAD, 1863, Acad. Nat. Sci. Philadelphia, Proc., v. 14, p. 560.

Murex (Pterorhytis) umbrifer Conrad. CONRAD, 1868, Amer. Jour. Conch., v. 4, p. 64, pl. 5, fig. 7.

Ocenebra (Pterorhytis) umbrifer (Conrad). COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 43.

Purpura marshalli MANSFIELD, 1930, Florida State Geol. Survey, Bull. 3, p. 84, pl. 11, fig. 4.

Pterorhytis (Pterorhytis) umbrifer (Conrad). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Philadelphia, Mon. 8, p. 252, pl. 35, fig. 2 ("paratype").

Pterorytis (Pterorytis) umbrifer (Conrad). EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 3, fig. 1 ("paratypes").

Pterorytis (Neurarhytis) marshalli (Mansfield). EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 5.

Pterorhytis umbrifer (Conrad). HALL, 1959, Jour. Paleontology, v. 33, no. 3, p. 432, pl. 63, fig. 6 (after Olsson and Harbison, 1953); PETUCH, 1994, Atlas Florida Foss. Shells, p. 9, pl. 44, fig. A.

Pterorhytis seminola OLSSON and PETIT, 1964, Bulls. Amer. Paleontology, v. 47, no. 217, p. 550, pl. 81, fig. 4; PETUCH, 1994, Atlas Florida Foss. Shells, pl. 44, fig. I only [fig. G = depauperate *P. fluviana* Dall].

Not *Pterorhytis (Neurarhytis) marshalli* (Mansfield). OLSSON and PETIT, 1964, Bulls. Amer. Paleontology, v. 47, no. 217, p. 549, pl. 81, figs. 3, 3a [= *P. fluviana* Dall].

[Pterorytis] umbrifer (Conrad). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 113.

[Pterorytis] marshalli (Mansfield]. VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 123.

[Pterorytis] seminola Olsson and Petit. VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 126.

Not *Pterorytis umbrifer* (Conrad). CAMPBELL, 1974, South Carolina Geol. Notes, v. 18, no. 4, p. 79; CAMPBELL, CAMPBELL, and CARTER, 1995, Tulane Stud. Geol. Paleont., v. 27, nos. 1-4, p. 175 [= smooth form of *P. fluviana* Dall].

Pterorhytis umbrifer (Conrad). WARD and BLACKWELDER, 1980, U.S. Geol. Survey, Bull. 1482-D, p. D28.

Pterorytis umbrifer (Conrad). WARD and BLACKWELDER, 1980, U.S. Geol. Survey, Bull. 1482-D, p. D48; EMERSON, 1985, Nautilus, v. 99, no. 1, p. 16; CAMPBELL, 1993, Virginia Div. Nat. Res., Publ. 127, p. 76, pl. 33, fig. 367; WARD and GILINSKY, 1993, Virginia Mus. Nat. Hist., Mem. 3A, p. 18, table 5.

Not *Neurarhytis marshalli* (Mansfield). PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 19, fig. 9 [= *P. fluviana* Dall].

Pterorhytis marshalli (Mansfield). PETUCH, 1994, Atlas Florida Foss. Shells, pl. 44, fig. C.

Description: "Fusiform, with 6 foliated reflected laminae; whorls angular and carinated; aperture obovate; beak recurved." (Conrad, 1832)

"Fusiform, with four [five!] very prominent, lamelliform ribs on the body whorl; whorls 6, angular, with a prominent revolving rib on the angle; two small ribs, the lowest one obsolete, on the body whorl, distant from the upper one; aperture ovate, surrounded by a raised margin, with a prominent, erect tooth near the base of the labrum; canal closed." (Conrad, 1868)

Shell with seven teleoconch whorls, protoconch of one and one-half rounded whorls. Shell surface completely smooth; of two layers: an outer translucent, easily decorticated calcitic layer; and a creamy, opaque aragonitic layer lining aperture. Axial ornamentation on first three teleoconch whorls of about ten lamellar flanges, reducing to nine on next two whorls, and then to seven by sixth teleoconch whorl. Usually four or five varices on seventh whorl; varices beginning as simple lamellae, gradually becoming more complex with multiple shell layers on adapertural face. Spiral ornamentation on earliest teleoconch whorls of two cords, that at periphery increasing in strength as that on shoulder ramp gradually weakens. On body whorl a third small cord sometimes developed anterior to major cord at periphery, and occasionally two additional smaller threads anterior to that. At intersection of spiral cords and axial lamellae abaperturally-directed folds developed, including on shoulder ramp, where the cord itself may no longer be apparent. In mature adult usually three major abaperturally-directed folds on each varix, sometimes forming hook-like extensions, largest at peripheral cord, smaller at secondary cords. Aperture oval, inner lip narrow and smooth, appressed only at posteriormost portion. Inner edge of outer lip extended well in advance of apertural varix; outer lip crenulated in harmony with spiral cords, smooth on most examples but some specimens with six elongate denticles on inner side of outer lip (especially in form *seminola*). On anterior portion of outer lip a strong tooth formed as a projection of outer varical lamella, coated by enamel of inner lip. Siphonal canal sealed over by a plate extending from columella wall to meet varical side; slightly recurved distally, causing former canals to diverge as spurs.

Lectotype: ANSP 79605; height 48.3 mm, diameter 32.5 mm (here designated).

Type locality: James River [Day's Point], Yorktown, Virginia.

Occurrence: Eastover Formation (Cobham Bay Member), Virginia; Yorktown Formation, Virginia and North Carolina; Raysor Formation and Goose Creek Limestone, South Carolina;

Jackson Bluff Formation and lower Pinecrest beds, Florida.

Figured specimens: PLATE 5: Fig. 1, USNM 488713; height 52.1 mm, diameter 42.0 mm; locality TU 613. Fig. 2, USNM 488714; height 33.5 mm, diameter 20.5 mm; locality, Chuckatuck, Virginia (Blow Coll.). Fig. 3, USNM 488715; height 37.8 mm, diameter 30.0 mm; locality, Day's Point, James River, Virginia (Blow Coll.). Fig. 4, USNM 488716; height 36.0 mm, diameter 25.4 mm; locality, Yadkin, City of Chesapeake, Virginia (Campbell Coll.). Fig. 5, USNM 488717; height 10.9 mm, diameter 6.0 mm; locality, Rock Wharf, Smithfield, Virginia (Campbell Coll.). PLATE 6: Fig. 1, USNM 488718; height 45.0 mm, diameter 30.0 mm; locality TU 60. Fig. 2, USNM 488719; height 12.5 mm, diameter 7.5 mm; locality TU 60. Fig. 3, USNM 488720; height 42.2 mm, diameter 30.5 mm; locality TU 60. Fig. 4, Stephens Collection; height 49.0 mm, diameter 33.6 mm; locality TU 1524. Fig. 5, Stephens Collection; height 57.9 mm, diameter 41.2 mm; locality TU 1512. PLATE 7: Fig. 1, USNM 488721; height 38.8 mm, diameter 26.7 mm; locality TU 730. Fig. 2, USNM 488722; height 27.9 mm, diameter 18.2 mm; locality TU 730. Fig. 3, USNM 488723; height 37.0 mm, diameter 23.7 mm; locality TU 932. Fig. 4, USNM 488724; height 32.6 mm, diameter 19.6 mm; locality TU 729. Fig. 5, USNM 488725; height 32.7 mm, diameter 25.0 mm; locality TU 729. Fig. 6, USNM 488726; height 30.8 mm, diameter 23.1 mm; locality TU 729. Fig. 7, USNM 488727; height 19.2 mm, diameter 12.7 mm; locality TU 729. Other occurrences: TU localities 534, 728, 789, 796, 797, 842, 855, 980, 1044.

Discussion: In the collections of the Academy of Natural Sciences, Philadelphia, there are three specimens indicated as "syntypes" of *Murex umbrifer* Conrad. The best of these (ANSP 13787; height 50.8 mm) is the one figured by Olsson and Harbison (1953, pl. 35, fig. 2) as a "paratype" and later figured by Emerson (1959, fig. 1) as "paratypes" (although his three views are all of the same specimen). But there is no evidence that there is either a holotype or a lectotype (Conrad's work predates such taxonomic constraints) and, thus, this specimen is properly a syntype (ICZN Code, Art. 73b). All things being equal, this specimen perhaps should be designated as the lectotype. However, there is a second specimen (ANSP 79605; height 48.3 mm), which is clearly the one illustrated by Conrad in 1868 (see text-fig. 1). Therefore, this second specimen is here designated as the lectotype and specimen no. ANSP 13787 becomes a paralectotype*. There is also a third, smaller specimen (ANSP 13787; height 20.8 mm), which becomes a second paralectotype.

Originally *P. umbrifer* was named from the Yorktown Formation, Virginia, and no one seems to have been willing to admit the possiblity that it might also occur as far south as Florida. (Now, of course, we recognize numerous species in common between the Yorktown, Jackson Bluff, and Pinecrest units). When Mansfield described *P. marshalli*, he compared it with *P. fluviana* Dall, noting that *P. marshalli* has "more erect and thinner varices" than *P. fluviana*, which is true; but they

*Moore's citation of ANSP 13841 as "possible syntype" for *Murex umbrifer* (1962, Proc. Acad. Nat. Sci. Philadelphia, v. 114, no. 2, p. 106) is an error. That number refers to a specimen of *Fasciolaria (Triplofusus) scalarina* Heilprin figured by Olsson and Harbison (1953, pl. 35, fig. 1a).

PLATE 6

Figures Page

1-5. *Pterorytis (Pterorytis) umbrifer* (Conrad) 90

1. (X 1 1/4) USNM 488718; height 45.0 mm, diameter 30.0 mm. Locality: TU 60; Jackson Bluff Formation.
2. (X 4) USNM 488719; height 12.5 mm, diameter 7.5 mm. Locality: TU 60; Jackson Bluff Formation.
3. (X 1 1/4) USNM 488720; height 42.2 mm, diameter 30.5 mm. Locality: TU 60; Jackson Bluff Formation.
4. (X 1 1/4) Stephens Collection; height 49.0 mm, diameter 33.6 mm. Locality: TU 1524; Pinecrest beds.
5. (X 1) Stephens Collection; height 57.9 mm, diameter 41.2 mm. Locality: TU 1512; Pinecrest beds.

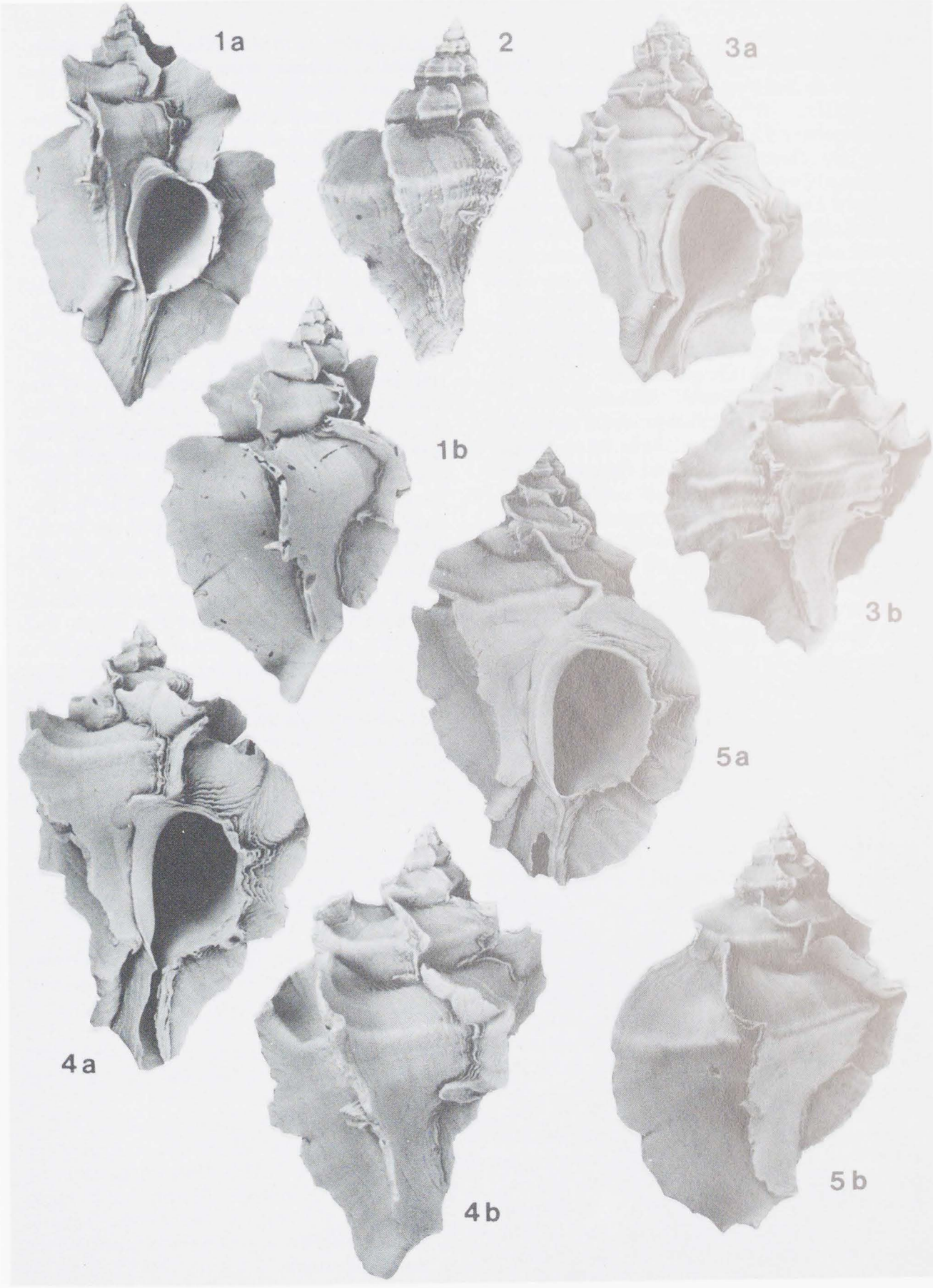


PLATE 6

are identical to those in *P. umbrifer*.

There seems to be a slight stratigraphic difference between the two species of *Pterorytis*. According to Ward and Blackwelder (1980, p. D28) *Pterorytis umbrifer* first appears in the latest Miocene Cobham Bay Member of the Eastover Formation and material provided by L.W. Ward confirms the identification. Based on our collections, *P. umbrifer* occurs in the Pliocene beds of the Yorktown Formation, Jackson Bluff, and lower Pinecrest beds. In South Carolina it also occurs in the Raysor Formation and the lower Goose Creek Limestone (L.D. Campbell, pers. comm.). Although *P. fluviana* first appears together with *P. umbrifer* in the Pinecrest beds in southern Florida, it really begins to flourish only with the disappearance of *P. umbrifer* and is found in the lower Caloosahatchee and Nashua formations in Florida, the correlative lower Waccamaw and Cypresshead formations in South Carolina, and at Aurora, North Carolina (TU 1022), in beds that Ward and Blackwelder (1987, p. 116) assign to the Early Pleistocene James City Formation but which Lyons (1991, p. 148) convincingly argues are more likely to be of Late Pliocene (lower Caloosahatchee Formation equivalent) age.

Along the Kissimmee River between Ft. Basinger and the north side of Lake Okeechobee there is a most enlightening sequence of occurrence of the two species, which documents the above statement. Table 1 shows the replacement of *P. umbrifer* by *P. fluviana*.

Pterorytis umbrifer is extremely variable, as we have attempted to demonstrate in pls. 5-7. L. Campbell (1993, p. 76) has given a good discussion of the various forms, noting that there are three distinct varical patterns, almost certainly environmentally controlled. These are: (1) "varices low, thick, and massive (*P. seminola* Olsson and Petit, 1964), apparently reflective of high energy conditions" [see pl. 5, fig. 4; pl. 7, figs. 3, 4]; (2) the typical form with "thin, erect blades with fluting at intersection of spiral cords, and frilled lamellae on apertural side of varix," coming from quiet water habitats [see pl. 5, figs. 1, 2]; and (3) with "very thin, erect, recurved blades with strongly recurved open spines at intersection of spiral cords, a form apparently from sheltered habitats" [see pl. 5, fig. 3].

In southern Florida there is yet another form, which we will call "form no. 4," with thin, erect *unfluted* varices, lacking the typical shoulder carina. Although we have a single example from Jackson Bluff (TU 60; pl. 6, fig. 1), it is common in a restricted area along the Kissimmee River (TU 729; pl. 7, figs. 5, 6), where it occurs together with the *"seminola"* morphotype, and seems to represent the "last gasp" of the species in the geologic record. In addition to the loss of the shoulder carina, the shells often have either a greatly reduced labral tooth, or none at all, suggesting that the loss of the labral tooth seen in *P. roxaneae* (below) is an orthogenetic trait. However, it should be noted that "toothless" examples can occur anywhere in the section, such as at TU 730, one of the oldest occurrences (pl. 7, fig. 2).

Not only does the number and nature of the varices display great variation, but also the absence or presence of denticles on the inner side of the outer lip. The heavy, short-varixed form named *P. seminola* always has these denticles, but they also appear sporadically in the typical *P. umbrifer* form (pl. 5, fig. 2), as well as in the holotype of *P. marshalli* (see Mansfield, 1930, pl. 11, fig. 4).

PTERORYTIS (PTERORYTIS) FLUVIANA Dall
Plate 8, figures 1-7; Plate 9, figures 1-5; Plate 10, figures 1-8; Text-figures 2, 3

Cerostoma umbrifer (Conrad). TUOMEY and HOLMES, 1856, Pleiocene Foss. South Carolina, p. 141 (in part), pl. 28, fig. 14 (*not* of Conrad).

Murex umbrifer Conrad. EMMONS, 1858, Rept. North Carolina Geol. Survey, p. 247, fig. 104a (*not* of Conrad).

Murex (Pterorhytis) conradi DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 143, pl. 12, figs. 8, 11 [as *Pterorhytis conradi*] (for *Cerostoma umbrifer* Tuomey and Holmes, 1856, *not* of Conrad). Not *Murex conradi* d'Orbigny, 1850, unnecessary *n.n. pro Murex mantelli* Conrad.

Pterorhytis (Conradiana Dall var.?) *fluviana* DALL, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1633 [pl. expl.], pl. 60, figs. 20,

21 [not in text].

Ocenebra (Pterorhytis) Conradi (Dall). COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 43, text-fig. 2 [incorrectly labeled fig. 3].

Murex (Pterorhytis) conradi Dall. MARTIN, 1904, Maryland Geol. Survey, Miocene, p. 200, pl. 50, figs. 9, 9a (after Dall, 1890).

Purpura fluviana (Dall). MANSFIELD, 1930, Florida State Geol. Survey, Bull. 3, p. 83, pl. 11, fig. 7 (holotype).

Pterorhytis (Neurarhytis) fluviana (Dall). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Philadelphia, Mon. 8, p. 253, pl. 35, fig. 3.

Pterorytis (Neurarhytis) fluviana (Dall). EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 4, fig. 2 (after Dall, 1903); EMERSON, 1985, Nautilus, v. 99, no. 1, p. 16.

Pterorytis (Neurarhytis) conradi (Dall). EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 5, fig. 3 (after Dall, 1890).

Pterorhytis (Neurarhytis) marshalli (Mansfield). OLSSON and PETIT, 1964, Bulls. Amer. Paleontology, v. 47, no. 217, pl. 81, figs. 3, 3a (*not* of Mansfield).

[Pterorytis] conradi (Dall). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 34.

[Pterorytis] conradiana Dall. VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 120.

[Pterorytis] fluviana Dall. VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 121.

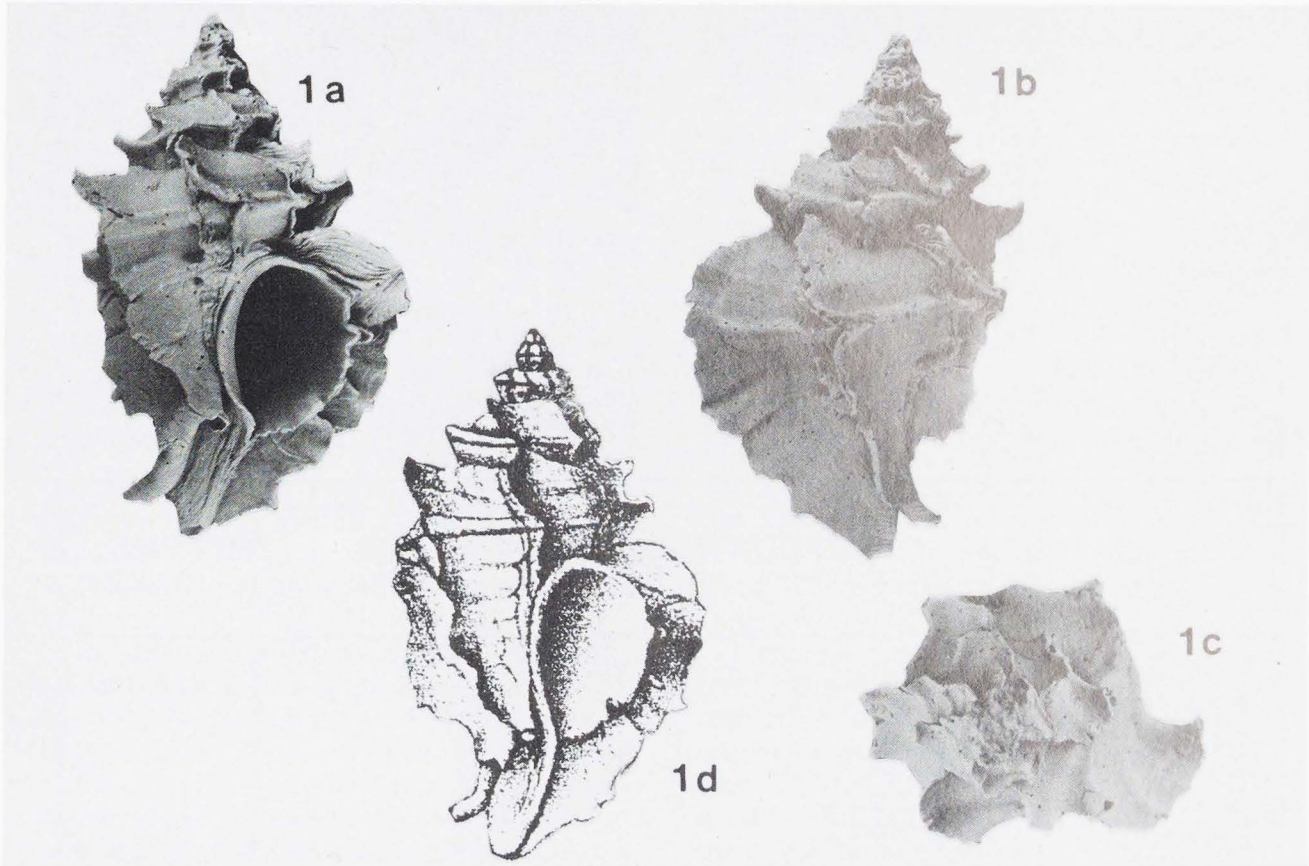
Pterorytis conradi (Dall). CAMPBELL, 1974, South Carolina Geol. Notes, v. 18, no. 4, p. 79; WARD and GILINSKY, 1993, Virginia Mus. Nat. Hist., Mem. 3A, p. 18, table 5.

Pterorytis umbrifer (Conrad). CAMPBELL, 1974, South Carolina Geol. Notes, v. 18, no. 4, p. 79; CAMPBELL, CAMPBELL, and CARTER, 1995, Tulane Stud. Geol. Paleont., v. 27, nos. 1-4, p. 175 (*not* of Conrad).

Pterorhytis conradi (Dall). WARD and BLACKWELDER, 1987, Smithsonian Cont. Paleobiol., no. 61, p. 174, pl. 39, figs. 7, 8; LYONS, 1991, Florida Mus. Nat. Hist., Bull. (Biol. Sci.), v. 35, no. 3, p. 148.

Pterorhytis fluviana (Dall). PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 51, pl. 13, fig. 5; PETUCH, 1994, Atlas Florida Foss. Shells, pl. 44, fig. B.

Neurarhytis marshalli (Mansfield). PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 19,



Text-figure 1. *Pterorytis (Pterorytis) umbrifer* (Conrad). A-C, ANSP 79605 (lectotype; here designated); height 48.3 mm, diameter 32.5 mm; locality, James River, Virginia. D, Conrad, 1868, pl. 5, fig. 7. (X 1)

fig. 9 (*not* of Mansfield).

Pterorhytis lindae PETUCH, 1994, Atlas Florida Foss. Shells, p. 282, pl. 44, figs. J, K.

Pterorhytis squamulosa PETUCH, 1994, Atlas Florida Foss. Shells, p. 283, pl. 44, figs. D, E.

Pterorhytis wilsoni PETUCH, 1994, Atlas Florida Foss. Shells, p. 284, pl. 44, fig. F.

Pterorhytis seminola Olsson and Petit. PETUCH, 1994, Atlas Florida Foss. Shells, pl. 44, fig. G only (*not* of Olsson and Petit).

Description: "This fine species has, like most of the species of this genus, only four varices. The spire is much shorter than in *M. umbrifer* and the form of the varices is different." (*Murex conradi* Dall, 1890)

"Shell of moderate size, solid, with about 1 1/2 corroded nuclear and 4 strong angulated postnuclear whorls. Whorls rapidly enlarging; body whorl about three-fourths the shell length. Suture deep, not appressed. Axial sculpture of 4 reflected, rather thin, facially undulated, marginally sinuate varices on the later whorls and of about 9 ribs on the early whorls. Face of varices with thin marginally crenulated laminae which are very faint between the varices. Spiral sculpture of about 3 faint, rounded lines situated at and below the periphery. Aperture broadly ovate; outer lip with a small denticle situated at anterior part. Canal closed, moderately twisted." (*P. fluviana* Dall – Mansfield, 1930)

Holotype: USNM 163801; height 35.1 mm, diameter 24.7 mm.

Type locality: Caloosahatchee Formation; USGS 3300, Shell Creek, Charlotte County, Florida (= TU 539B).

Occurrence: Pinecrest beds (upper beds only), lower Caloosahatchee and Nashua formations, Florida; Waccamaw and Cypresshead formations, South Carolina; Waccamaw, Duplin and "James City" (of Ward and Blackwelder, 1987) formations, North Carolina.

Figured specimens: PLATE 8: Fig. 1, USNM 114122; height 22.5 mm, diameter 14.0 mm; locality USGS 2280, Natural Well, North Carolina (= TU 376). Fig. 2, USNM 488728; height 32.0 mm, diameter 20.8 mm; locality TU 1022. Fig. 3, Stephens Collection; height 45.0 mm, diameter 25.0 mm; locality TU 1022. Fig. 4, USNM 488729; height 24.0 mm, diameter 15.2 mm; locality TU 558. Fig. 5, USNM 488730; height 25.5 mm, diameter 18.2 mm; locality, Calabash, North Carolina (Campbell Coll.). Fig. 6, USNM 488731; height 32.4 mm, diameter 19.6 mm; locality TU 870. Fig. 7, UF 20435; height 12.5 mm, diameter 6.0 mm; locality TU 558. PLATE 9: Fig. 1, Stephens Collection; height 37.4 mm, diameter 25.0 mm; locality TU 1512. Fig. 2, Stephens Collection; height 36.0 mm, diameter 21.2 mm; locality TU 1512. Fig. 3, Stephens Collection; height 12.8 mm, diameter 9.0 mm; locality TU 1512. Fig. 4, USNM 488732; height 32.1 mm, diameter 22.1 mm; locality TU 768. Fig. 5, Stephens Collection; height 45.5 mm, diameter 33.2 mm; locality TU 1000. PLATE 10: Fig. 1, USNM 488733; height 35.4 mm, diameter 24.7 mm; locality TU 728. Fig. 2, USNM 488734; height 36.9 mm, diameter 22.1 mm; locality TU 729. Fig. 3, USNM 488735; height 32.4 mm, diameter 22.5 mm; locality TU 729. Fig. 4, USNM 488736; height 37.2 mm, diameter 21.0 mm; locality TU 729. Fig. 5, USNM 488737; height 32.5 mm, diameter 19.2 mm; locality TU 729. Fig. 6, Stephens Collection; height 39.4 mm, diameter 25.7 mm; locality TU 1000. Fig. 7, USNM 488738; height 42.8 mm, diameter 27.7 mm; locality TU 729. Fig. 8, Stephens

North <----------> South
Pinecrest <----------> Caloosahatchee

TU locality	730	932	728	729	769	770
P. umbrifer	28	30	0	0	0	0
f. *"seminola"*	5	3	1	21	0	0
f. "no. 4"	0	0	0	27	0	0
P. fluviana	9	39	12	155	2	31
f. *"lindae"*	0	0	0	8	0	5
f. *"squamulosa"*	0	0	0	2	1	0

Table 1. Distribution of species of *Pterorytis* along Kissimmee River, Okeechobee County, Florida. For descriptions of the various "forms" see text.

Collection; height 31.9 mm, diameter 19.8 mm; locality TU 729. Other occurrences: TU locality nos. 68, 376, 520, 523, 539B, 559, 726, 759, 767, 769, 770, 1493.

Discussion: The nomenclature of this species is more complicated than most. Originally, Tuomey and Holmes (1856, pl. 28, fig. 14) illustrated a shell, which they identified as *Cerostoma umbrifer* (Conrad), stating that it came from "Smith's, Goose Creek." Dall (1890, p. 143) pointed out that their specimen was not the same as Conrad's *umbrifer* and so named it *Murex conradi*, repeating the Goose Creek locality and adding to it, "St. Mary's River, Maryland."

Unfortunately, the name *Murex conradi* had already been used by d'Orbigny in his *Prodrome de Paléontologie* (1850, p. 364) as an unnecessary new name for *Murex mantelli* Conrad, 1833. This work of d'Orbigny is a paleontologic nomenclator, in which the author renamed a vast number of preoccupied and misidentifed species. In the majority of the cases, the new names are justified and have come into the literature as the correct name for the species in question. In the case of *Murex conradi* there is no known reason for such a replacement name; nevertheless it was validly proposed and, therefore, must preoccupy *Murex conradi* Dall.

Whether Dall became aware of the d'Orbigny work, or whether it was a simple lapsus, in 1903 Dall named a second taxon, "*Pterorhytis (Conradiana* var.?*) fluviana.*" The name is not mentioned in the text, but only in the plate explanation, and this is the only reference to a change of name for *Murex conradi* Dall. Boss, Rosewater, and Ruhoff (1968, p. 88) take the position that this is an emendation for *M. conradi*, but we really have no way of knowing.

To further complicate the matter, *P. fluviana* is just a less fimbriate variety of *M. conradi*, as Dall suggested (compare text-figures 2, 3). Thus, we have three possible names for this species: *P. conradi, P. conradiana,* and *P. fluviana*. Given the ambiguous nature of the proposals for both *Murex conradi* d'Orbigny and *Pterorhytis conradiana* Dall, it seems in the best interest of nomenclatorial stability to accept *P. fluviana* Dall as the valid name.

A major factor in choosing *P. fluviana* as the correct name is the fact that not only is the taxonomy of *Murex conradi* confused but the locality information is as well. The species does not occur in the Goose Creek fauna (see Campbell and Campbell, 1995, p. 99) or the St. Mary's River fauna. Ward and Blackwelder (1987, p. 174) discussed the problems involved, concluded the locality data had been switched, and recommended that Wilmington, North Carolina, be designated as the type locality. If one accepts that in 1890 "Wilmington" could have included an area stretching some 40 miles to the west and south, this is as good a solution as possible. The type specimen has the scabrous surface typical of the elaborately ornamented form that occurs in the lower Waccamaw Formation, at such places as Calabash, North Carolina (see pl. 8, fig. 5), and it is probable that the type specimen actually came from the Waccamaw River. In the Tulane Collections we have specimens identical to the type from near Myrtle Beach, South Carolina (TU 558; pl. 8, fig. 4).

There is also a problem with the reference to the Goose Creek fauna. As noted above, the species does not occur in the Goose Creek Limestone; however, Campbell and Campbell (1995, p. 63) have indicated that the Tuomey and Holmes species said to be from "Smith's, Goose Creek" are a mixture of both the moldic Goose Creek Limestone and a well-preserved molluscan fanule of lower Waccamaw-aged material, which they assign to the lower Cypresshead Formation. Thus, there is no reason that the "Goose Creek" locality of Tuomey and Holmes should be replaced, only the idea that it came from the Goose Creek Limestone.

Although Schuchert *et al.* (1905, p. 420) list "cotypes" for *Murex (Pterorhytis) conradi* from St. Mary's River, Maryland, the original catalogue indicates a single specimen (USNM 87749), which is that one figured by Dall (1890, pl. 12, figs. 8, 11). This may just be a mistake or, perhaps, they were including the Tuomey and Holmes figured specimen as one of the "cotypes"; if

so, it is lost. According to Dr. W.K. Emerson (*in litt.*, 7/20/95) this specimen is not in the Tuomey and Holmes material at the American Museum of Natural History. Presumably the mislabeled "St. Mary's" specimen is the only one in the actual type lot and should be considered the holotype.

In the northern area this species replaces *P. umbrifer* in all of the beds above the Yorktown, including the Duplin Formation. Although P. umbrifer has been reported in the literature from the Duplin Formation (S. Campbell, 1974, p. 79; Campbell, Campbell, and Carter, 1995, p. 175) all of the material seen from Natural Well (TU 376, and USNM 114121, 114122) and Tearcoat Branch (Campbell Coll,) is referable to *P. fluviana* (pl. 8, fig. 1).

In Florida it occurs in all of the units from the Pinecrest (often occurring together with *P. umbrifer*, as noted above) through the lower Caloosahatchee Formation in the south and the Nashua Formation in northeastern Florida (specimen UF 74450, from locality PU004, Putnam County, in the collections of the Florida Museum of Natural History). We have a single specimen from locality TU 759, which otherwise seems to be "pure" Bermont, but with spoil-pile collecting one is never certain. At none of the other "unequivocal" Bermont localities do we have any specimens, and it seems probable that the one from locality TU 759 is actually from the Caloosahatchee Formation.

This lack of *P. fluviana* in the Early Pleistocene Bermont Formation tends to corroborate Lyons's (1991, p. 148) argument that the "James City Formation" of Ward and Blackwelder (1987) should be correlated with the Late Pliocene portion of the Caloosahatchee Formation. He (*ibid.*, p. 150) makes a very telling point when he states: "It is doubtful that the thermophilic taxa that characterized the Caloosahatchee fauna could have survived in the Carolinas an event [the onset of the Nebraskan Glacial Stage] that caused their extinction and replacement in south Florida."

The original differentiation between *P. conradi* and *P. fluviana* was primarily geographic, with *P. conradi* from the Carolinas and *P. fluviana* from Florida. But we have specimens from southern Florida that are as squamose as the type of *P. conradi*. As with *P. umbrifer*, this is an extremely variable species, ranging from the highly ornamented form named *P. conradi* (and *P. squamulosa* Petuch, 1994) (pl. 10, figs. 1-3, 6, 8) to relatively smooth shells named *P. fluviana* (and *P. wilsoni* Petuch, 1994) (pl. 9, figs. 1, 2, 5). Some examples along the Kissimmee River at locality TU 729 develop elaborately recurved varices and have been named *P. lindae* Petuch, 1994 (pl. 10, fig. 7). Perhaps the most ornate specimens of all are those that come from the Waccamaw Formation, to the southwest of Wilmington (pl. 8, figs. 4-6). But it is also possible to find examples so smooth as to be hard to distinguish from *P. umbrifer* (pl. 10, fig. 4), leading to Campbell's (1974, p. 79) and

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PLATE 7

Figures Page

1-7. *Pterorytis (Pterorytis) umbrifer* (Conrad) 90

1. (X 1 1/2) USNM 488721; height 38.8 mm, diameter 26.7 mm.
   Locality: TU 730; Pinecrest beds.
2. (X 1 1/2) USNM 488722; height 27.9 mm, diameter 18.2 mm.
   Locality: TU 730; Pinecrest beds.
3. (X 1 1/2) USNM 488723; height 37.0 mm, diameter 23.7 mm.
   Locality: TU 932; Pinecrest beds.
4. (X 1 1/2) USNM 488724; height 32.6 mm, diameter 19.6 mm.
   Locality: TU 729; Pinecrest beds.
5. (X 1 1/2) USNM 488725; height 32.7 mm, diameter 25.0 mm.
   Locality: TU 729; Pinecrest beds.
6. (X 1 1/2) USNM 488726; height 30.8 mm, diameter 23.1 mm.
   Locality: TU 729; Pinecrest beds.
7. (X 2 1/2; X 10) USNM 488727; height 19.2 mm, diameter 12.7 mm.
   Locality: TU 729; Pinecrest beds.

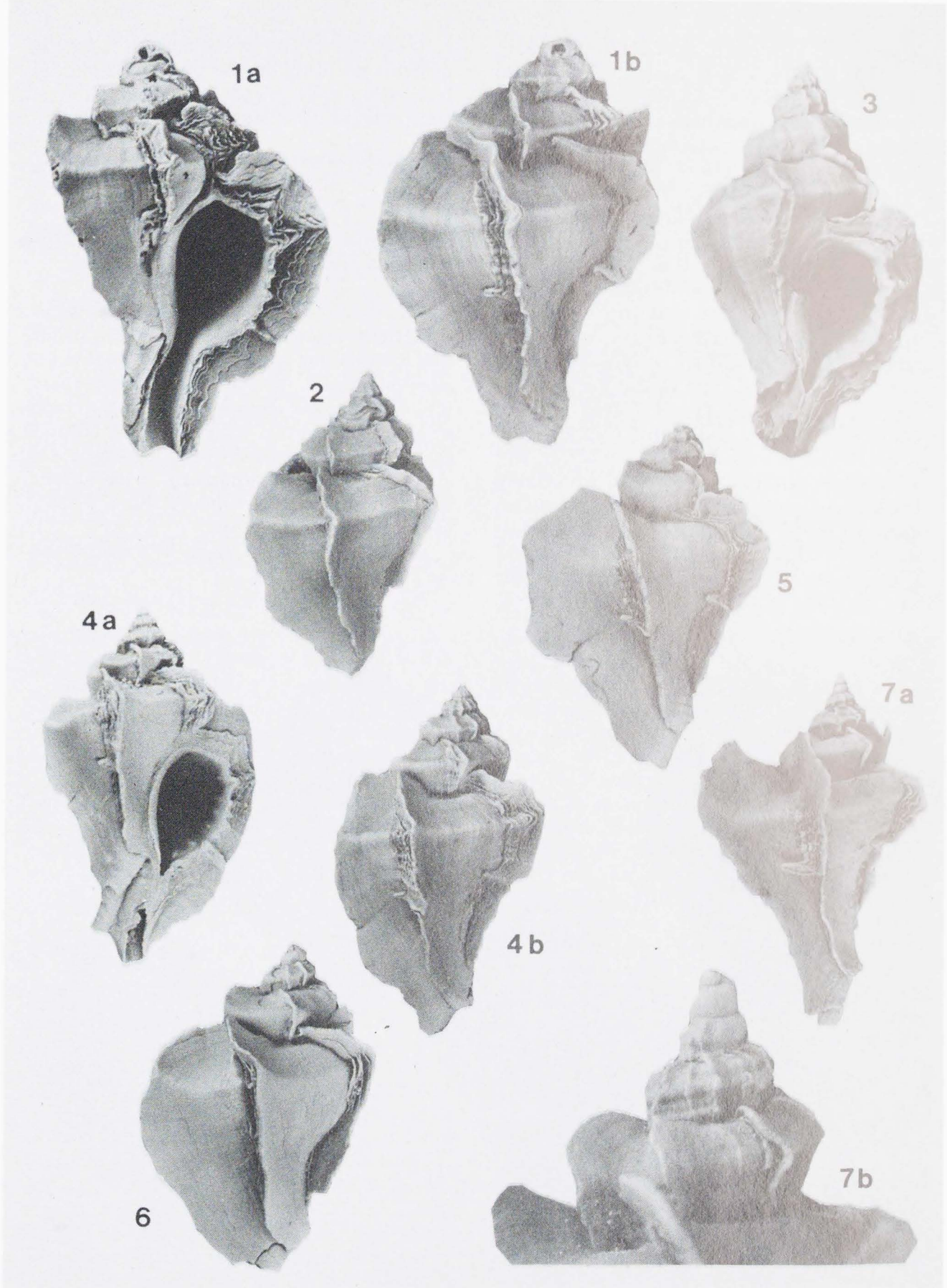


PLATE 7

Campbell, Campbell, and Carter's (1995, p. 175) citations of *P. umbrifer* from the Duplin Formation. Although rare, some specimens of *P. fluviana* exhibit labial denticles; such a specimen (presumably) was figured by Petuch (1994, pl. 44, fig. G) as *"P. seminola"* (pl. 10, fig. 5).

With so much variablity in both *P. umbrifer* and *P. fluviana*, one wonders where to draw the line between the two species. And the only absolute means of separation is the fact that in *P. umbrifer* the intervarical area is *always* completely smooth, even though there may be a fimbriate adapertural face to the varices. In *P. fluviana*, the intervarical area may be relatively smooth, but faint fimbriations are always present. In *P. umbrifer* the varices are thinner, and almost invariably there is a abapertural fold at the shoulder, even on those specimens where the shoulder cord is barely present. In *P. fluviana* the varices have no fold at the shoulder and they are more abaperturally recurved. In truth, given any one specimen it may be difficult deciding on the proper placement, but with a suite of specimens, the differentiation becomes easier.

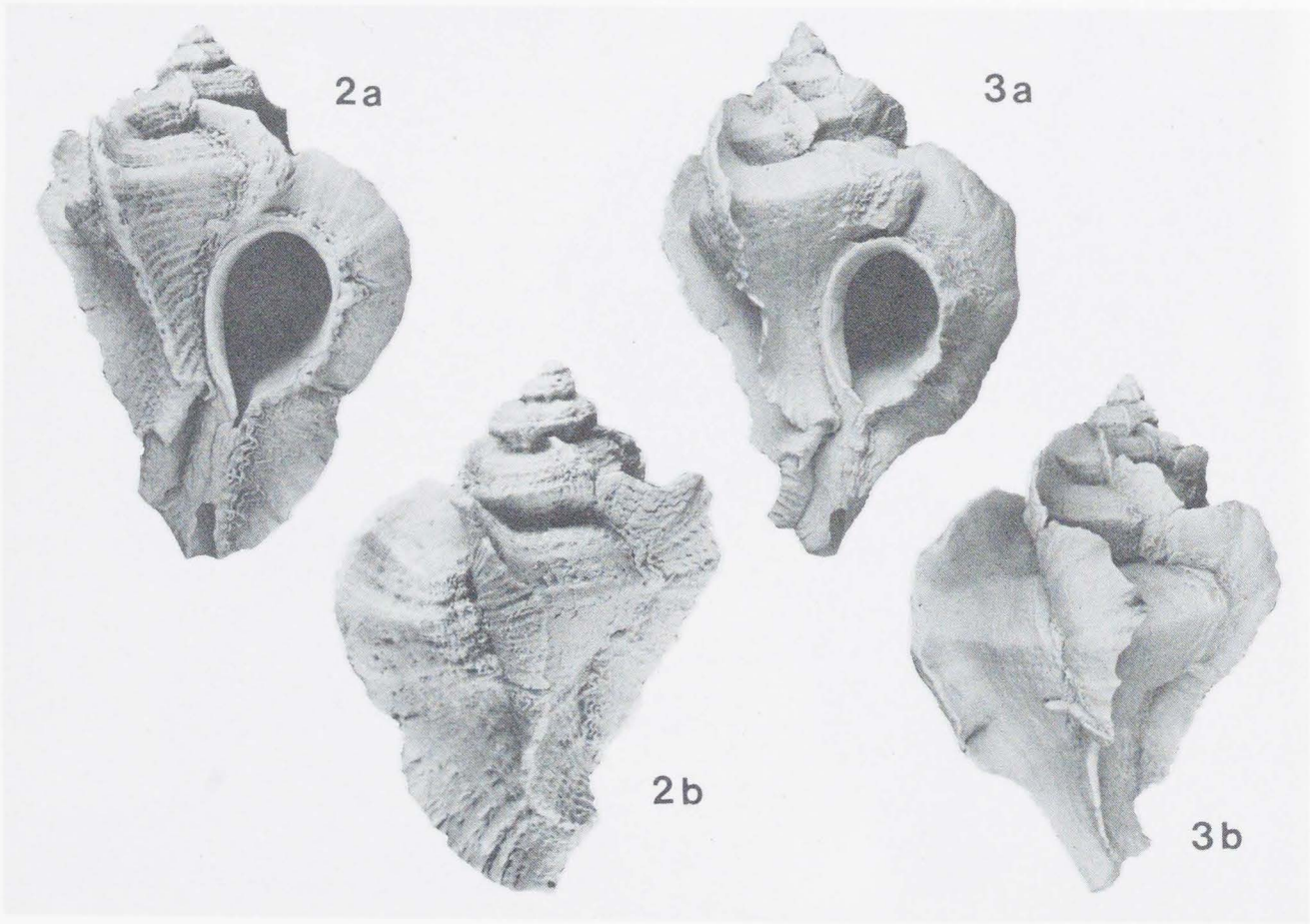
PTERORYTIS (PTERORYTIS) ROXANEAE Petuch
Plate 11, figures 1-4

Pterorhytis roxaneae PETUCH, 1994, Atlas Florida Foss. Shells, p. 283, pl. 44, fig. H.

Description: "Shell of average size for genus, thin, lightweight, inflated, with 4 thin, blade-like varices per whorl; shoulder angled but slightly rounded, without strong shoulder cord; intervarical areas smooth, waxy, without axial or spiral sculpture; wings smooth, without sculpture; aperture wide, open; lip edged with small crenulations; apertural tooth absent; siphonal canal proportionally short, without sculpture." (Petuch, 1994)

Holotype: UF 66254; height 33.3 mm, diameter 21.5 mm.

Type locality: Pinecrest beds (uppermost beds



Text-figure 2. *Pterorytis (Pterorytis) conradi* (Dall), USNM 87749 (holotype); height 35.2 mm, diameter 26.2 mm; locality "St. Mary's River, Md. (Clark)" [? = Wilmington, North Carolina]. Text-figure 3. *Pterorytis (Pterorytis) fluviana* Dall, USNM 163801 (holotype); height 35.1 mm, diameter 24.7 mm; locality USGS 3300, Shell Creek, Charlotte Co., Florida. (Both X 1 1/2)

only), from Petuch Unit 3, Phase 6 pit, Quality Aggregates, Inc., Sarasota, Sarasota County, Florida (= TU 1524).

Occurrence: Pinecrest beds (uppermost only), Florida.

Figured specimens: Fig. 1, Stephens Collection; height 34.2 mm, diameter 21.6 mm; locality TU 1524. Fig. 2, Stephens Collection; height 27.1 mm, diameter 18.4 mm; locality TU 1524. Fig. 3, Stephens Collection; height 26.1 mm, diameter 17.6 mm; locality TU 1524. Fig. 4, Stephens Collection; height 51.0 mm, diameter 36.0 mm; locality TU 1000.

Discussion: Petuch (1994, p. 283, pl. 44, fig. H) described *P. roxaneae* from his Unit 3 ("uppermost Pinecrest beds") in the Phase 6 Pit, Quality Aggregates, Inc., Sarasota, Florida (= TU 1524). These beds contain typical Caloosahatchee fossils, such as *Cypraea problematica* Heilprin, 1886, as well as endemics like the muricid *Hexaplex jameshoubricki* Petuch, 1994, and may be part of the so-called "*Trochita* beds" (Lyons, personal communication), of uppermost Pinecrest age.

Pterorytis roxaneae is unique in the absence of a labral tooth, and has a relatively thin shell. The varices are blade-like and slightly recurved, lacking a fold on the shoulder. In the original description, Petuch characterizes the varices as "wings smooth, unsculptured" and the intervarical surface as "smooth, waxy, without axial or spiral sculpture" (1994, p. 283). However, the varices are adorned by slightly abaperturally curved points, including one at the shoulder. The holotype of *P. roxaneae* is a worn shell, lacking the labral varix. Most specimens, however, have traces of fimbriation in the intervarical area (pl. 11, figs. 2, 3) and are distinctly fimbriate on the varical faces.

The relatively smooth intervarical areas in *P. roxaneae* resemble those of specimens of *P. fluviana* from the Caloosahatchee Formation in the area to the west of Lake Okeechobee, including St. Petersburg (TU 68; see Olsson and Harbison, 1953, pl. 35, fig. 3), Arcadia (TU 1512; pl. 9, figs. 1, 2), Shell Creek (TU 539B; see Dall, 1903, pl. 60, fig. 21), and the Caloosahatchee River (TU 768; see pl. 9, fig. 4). In the Stephens Collection there is one beautiful example of the smooth form of *P. fluviana* from the APAC pit at Sarasota (TU 1000; pl. 9, fig. 5), across the road from the type locality of *P. roxaneae*. We assume this specimen comes from the Caloosahatchee Formation portion of the section.

Subgenus MICRORHYTIS Emerson, 1959

Microrhytis EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 6.

Type species: *Pterorytis (Microrhytis) pecki* Emerson, 1959, by original designation.

Description: "Shell purpuroid, small for the genus, with three low varices per whorl; ventral surface of each varix weakly sculptured with lace-like lamellae. Spinose apertural tooth retained by varices of the body whorl; apertural tooth small, anteriorly located on nodose inner lip." (Emerson, 1959)

Discussion: As discussed further in a study of the muricids of the Angostura Formation of Ecuador (Vokes, 1989b, p. 113), *Microrhytis* differs from the genus *Ceratostoma* in the nature of the early teleoconch whorls. In *Ceratostoma* there are no varices but the whorls are simply cancellate until approximately the fifth teleoconch whorl, at which point three varices (per whorl) develop. In *Microrhytis*, on the early teleoconch whorls there are about 12 small lamellar varices, which on about the fifth teleoconch whorl reduce in number to three per whorl. Although previously considered as a subgenus of *Ceratostoma* because of the large denticulate aperture and strong intervarical nodes (Vokes, 1989b, p. 113), work on the western Atlantic species demonstrated the strong resemblance of the early whorls in *Microrhytis* to those in *Pterorytis* and we have concluded that Emerson's original placement is a more accurate assessment of the relationship of the group.

PTERORYTIS (MICRORHYTIS) CHRISTOPHERI Gibson Smith and Gibson Smith MS, n. sp.
Plate 12, figures 1-3

Description: Teleoconch of six to seven whorls; protoconch missing in all material. Outer shell layer of translucent tan calcite, inner layer creamy white aragonite, causing severe decortication in most specimens. Axial sculpture on earliest whorls of about 12 equi-spaced lamel-

lae; by third teleoconch whorl every third lamella becoming a small varix, the two intermediate remaining as small riblets; by fourth whorl, one riblet disappearing, leaving one strong intervarical node between each of three foliaceous varices per whorl. Spiral sculpture beginning with a strong peripheral cord adjacent to anterior suture and a weaker cord at shoulder. On body whorl nine or ten primary spiral cords, with numerous secondary and tertiary intercalated threads; axial growth lamellae rendering these extremely scabrous in intervarical area. Varical margins scalloped by major spiral cords, especially on abapertural side; adapertural side of varices fimbriated by multiple laminae. Suture deeply impressed. Aperture broadly ovate, inner lip smooth; inner side of outer lip with six or seven small denticles, and a long, rectangular labral tooth located at juncture of body whorl and siphonal canal, causing a strong infolding of outer margin of terminal varix. Siphonal canal short, broad, recurved dorsally, sealed over by a plate of shelly material extending from columellar side of canal.

Holotype: NMB H-17659; height 42.1 mm, diameter 26.9 mm.

Type locality: NMB 17516, Cantaure Formation (lower beds); Paraguaná Peninsula, Falcón State, Venezuela (= TU 1269).

Paratype A: NMB H-17663; height 26.9 mm, diameter 15.7 mm.

Paratype B: NMB H-17660; height 26.2, diameter 16.3 mm.

Locality of both, same as holotype.

Etymology of name: For Christopher Gibson Smith, Ph.D., of Guilford, Surrey, England, son of Mr. and Mrs. Jack Gibson Smith, Surrey, England, the collectors.

Occurrence: Cantaure Formation, Venezuela.

Figured specimens: Fig. 1, NMB H-17659 (holotype). Fig. 2, NMB H-17663 (paratype A). Fig. 3, NMB H-17660 (paratype B).

Discussion: In the Gibson Smith Collection of material from the Cantaure Formation of the Paraguaná Peninsula, Venezuela, now in the collections of the Naturhistorisches Museum, Basel, Switzerland, there are 15 specimens of a species recognized long ago by the Gibson Smiths as new, which they intended to name *christopheri,* in honor of their son. It gives us pleasure to publish this taxon, first identified by this astute pair of paleontologists.

Pterorytis (Microrhytis) christopheri, n. sp., bears a strong resemblance to the Early and Middle Miocene Floridian *P.(M.) dryas* (Gardner). Like *P. dryas*, the immature shells are more elaborately ornamented than the adult, but unlike *P. dryas*, in the adult shell the abapertural faces of *P. christopheri* are markedly crenulated by the spiral cords in contrast to the almost flat abapertural surface in *P. dryas*. The aperture of *P. christopheri* is larger, more broadly ovate than that of *P. dryas*, and lacks the posteriormost labral denticle, which in *P. dryas* forms an anal channel.

From both *P. dryas* and the younger *P. ecuadorius* (Vokes), *P. christopheri* differs in having a more inflated body whorl, with

PLATE 8

Figures Page

1-7. *Pterorytis (Pterorytis) fluviana* Dall 94

1. (X 2) USNM 114122; height 22.5 mm, diameter 14.0 mm. Locality: USGS 2280, Natural Well, Duplin County, North Carolina (= TU 376); Duplin Formation.
2. (X 1 1/2) USNM 488728; height 32.0 mm, diameter 20.8 mm. Locality: TU 1022; "James City Formation."
3. (X 1 1/2) Stephens Collection; height 45.0 mm, diameter 25.0 mm. Locality: TU 1022; "James City Formation."
4. (X 2) USNM 488729; height 24.0 mm, diameter 15.2 mm. Locality: TU 558; Waccamaw Formation.
5. (X 2) USNM 488730; height 25.5 mm, diameter 18.2 mm. Locality: Calabash, North Carolina (Campbell Coll.); Waccamaw Formation.
6. (X 2) USNM 488731; height 32.4 mm, diameter 19.6 mm. Locality: TU 870; Waccamaw Formation.
7. (X 10) UF 20435; height 12.5 mm, diameter 6.0 mm. Locality: TU 558; Waccamaw Formation.

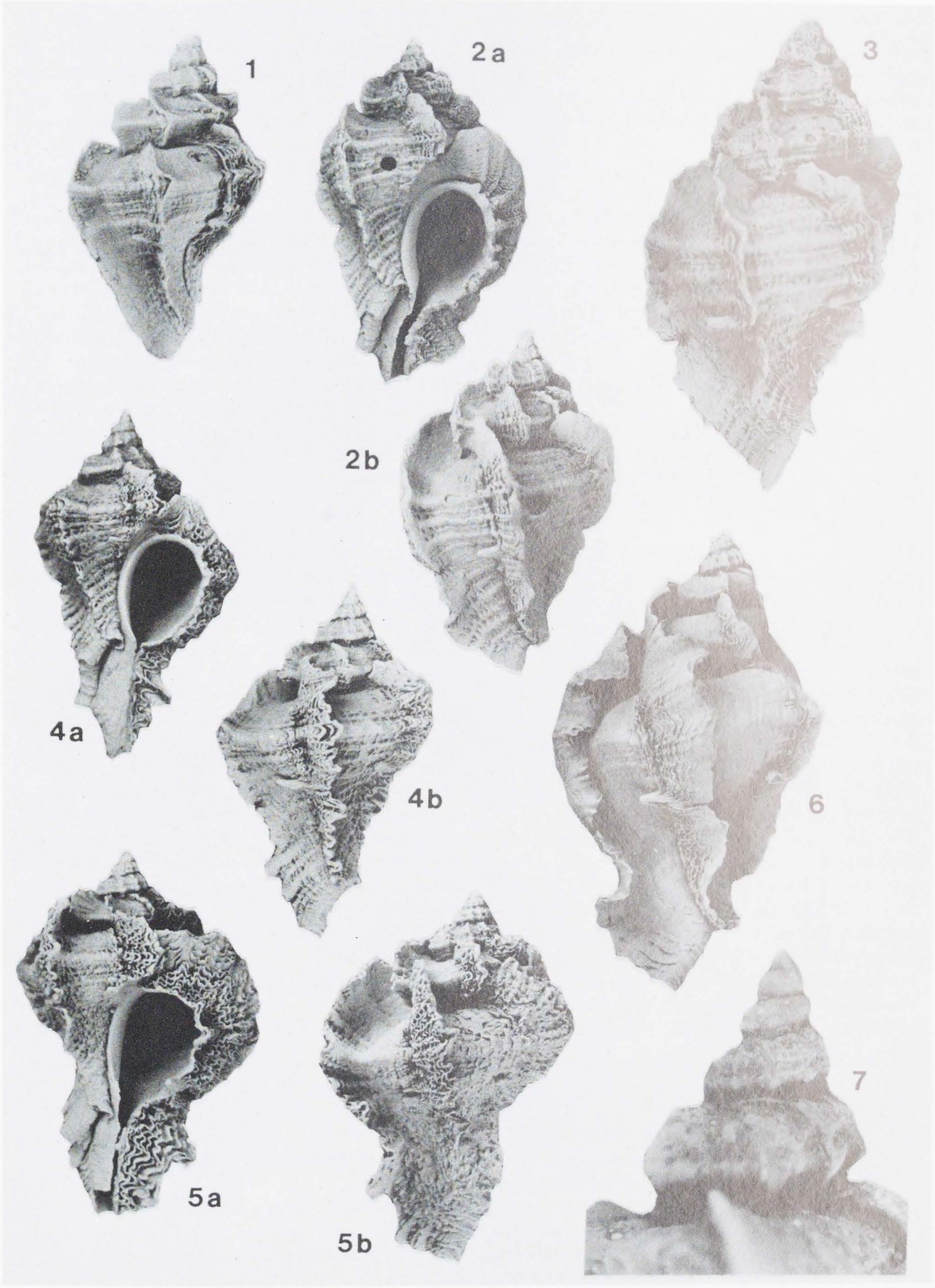


PLATE 8

stronger intervarial nodes. From both species it also differs in having an extremely long labral tooth, which is squared off at the terminal end rather than pointed.

The species of *Microrhytis* nearest in age to *P. christopheri* is *P.(M.) pecki* (Emerson), from the Middle Miocene of Veracruz, Mexico; however, this species bears the least resemblance to *P. christopheri*. The Mexican species is lower spired, with relatively inconspicuous varices, and the labral tooth, as in the other younger species is small and pointed.

PTERORYTIS (MICRORHYTIS) DRYAS (Gardner)
Plate 13, figures 1-3

Pteropurpura dryas GARDNER, 1947, U.S. Geol. Survey, Prof. Paper 142-H, p. 525, pl. 53, fig. 9.

[Ceratostoma] dryas (Gardner). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 121.

Description: "Shell rather small for the group, stout, trivaricate, the maximum diameter falling behind the median horizontal. Aperture decidedly more than half as long as the entire shell. Whorls of spire inflated, obtusely angulated at the periphery, rapidly increasing in diameter. Body whorl relatively large, constricted at the base, rendered somewhat cuneate by the axial varices. Whorls of conch probably 6, closely appressed, separated by impressed linear sutures, undulated by the varices of both the whorl in front of the suture and that behind it. Protoconch not preserved but certainly small. Earliest whorl of conch sculptured with 9 subequal and equi-spaced axial ribs, the number gradually diminishing with the growth of the shell and the character changing; final whorl of spire and body triangulated by 3 rather broad, foliated flanges, the terminal flange the broadest of the 3, the dozen or more component laminae visible on the front of the varix; varix crenulated by the spiral sculpture and produced backward on the preceding whorl almost or quite to the periphery; intervarical rib on the later whorls reduced to a rather prominent peripheral tubercle. Spirals obscure and irregular, increasing in number and prominence with the growth of the shell; early whorls usually sculptured with 2 low, rounded lirations, the anterior the more prominent and outlining the obscure peripheral angle; posterior spiral on the later whorls of the type indicated chiefly by the outline of the margin of varices; a third spiral introduced directly behind the suture on the last whorl in the spire becoming on the body, almost but not quite so prominent as the peripheral spiral; 2 or 3 less prominent lirations on the base of the body and irregular secondaries intercalated in the much wider interspaces. Lirae on the anterior fasciole obscure. Aperture oblique, pyriform, broadly rounded behind. Outer lip varicated, the edge of the labral portion of the peristome broadly rounded and crenulated in harmony with the primary spirals; half a dozen obtuse denticles developed a short distance within the margin. Labium feebly convex, reinforced. Pillar sharply rounded and flexed at the entrance to the canal. Anterior canal less than half as long as the aperture including the canal, very narrow, with a backward twist, the margins parallel and proximate but not in contact. Anterior fasciole sharply differentiated, truncate at its extremity, the former fascioles, one to each varix, diverging slightly from the final fasciole." (Gardner, 1947)

Holotype: USNM 371855; height 29 mm, diameter 20 mm.

Type locality: USGS 5630, Oak Grove Sand;

PLATE 9

Figures Page

1-5. *Pterorytis (Pterorytis) fluviana* Dall 94

1. (X 1 1/2) Stephens Collection; height 37.4 mm, diameter 25.0 mm. Locality: TU 1512; Caloosahatchee Formation.
2. (X 1 1/2) Stephens Collection; height 36.0 mm, diameter 21.2 mm. Locality: TU 1512; Caloosahatchee Formation.
3. (X 4; X 10) Stephens Collection; height 12.8 mm, diameter 9.0 mm. Locality: TU 1512; Caloosahatchee Formation.
4. (X 1 1/2) USNM 488732; height 32.1 mm, diameter 22.1 mm. Locality: TU 768; Caloosahatchee Formation.
5. (X 1 1/4) Stephens Collection; height 45.5 mm, diameter 33.2 mm. Locality: TU 1000; (?) Caloosahatchee Formation.

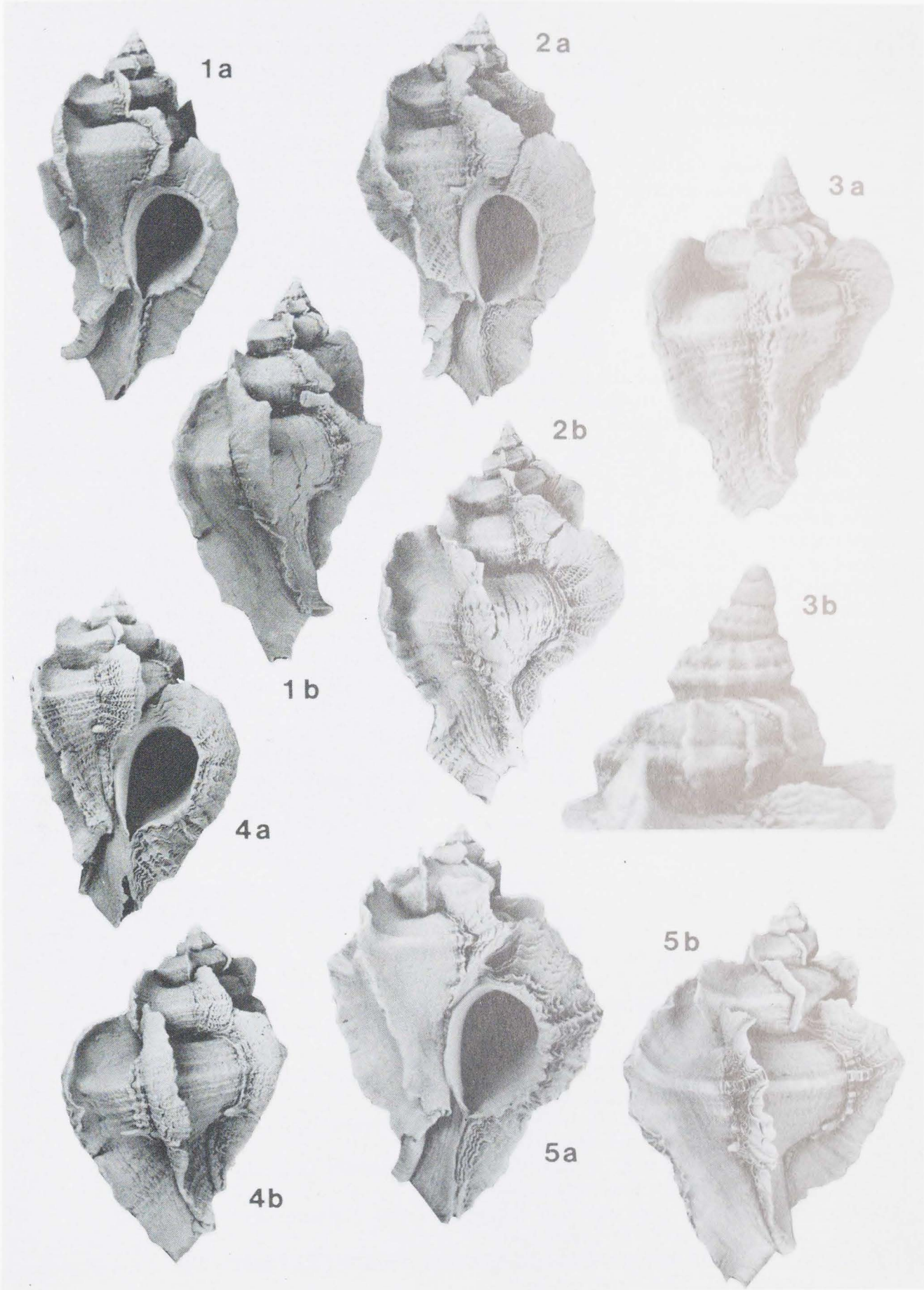


PLATE 9

100 yards below Oak Grove bridge, Yellow River, Okaloosa County, Florida (= TU 91).

Occurrence: Oak Grove Sand and Shoal River Formation, Florida; (?)Thomonde Formation, Haiti.

Figured specimens: Fig. 1, Murray Collection; height 17.2 mm, diameter 11.8 mm; locality UF-WL004 (? = TU 69A). Fig. 2, USNM 488739; height 14.8 mm, diameter 8.8 mm, locality TU 91. Fig. 3, USNM 481847; height 18.1 mm, diameter 12.4 mm; locality USGS 9908, Las Cahobas, Haiti.

Discussion: The northern *P. dryas*, as discussed above, is most similar to the Venezuelan *P. christopheri*, n. sp., but differs in having a less ornamented shell and a more narrow aperture with a smaller labral tooth. From its contemporary southern relative, *P. pecki* Emerson, *P. dryas* differs in having a higher spire, a more impressed suture giving rise to more rounded whorls, and a larger size. Evidently both latter species preferred a shallow, sandy environment, as we have specimens of *P. dryas* from both the Oak Grove Sand and the Shoal River Formation, but none from the Chipola Formation.

In the collections of the U.S. National Museum of Natural History, in material collected in the Thomonde Formation at Las Cahobas, Haiti, by Woodring *et al.* (1924) there is an example of what seems to be this species (pl. 13, fig. 3). In the same beds there is an example of another Shoal River muricid, *Chicoreus (Phyllonotus) aldrichi* (Gardner) (see Vokes, 1990, p. 63, pl. 9, fig. 12), and these Haitian beds seem to be correlative with those of the Shoal River.

PTERORYTIS (MICRORHYTIS) PECKI Emerson
Plate 12, figure 4

Pterorytis n. sp. DURHAM *et al.*, 1955, Geol. Soc. Amer., Bull., v. 66, p. 984.

Pterorytis (Microrhytis) pecki EMERSON, 1959, Amer. Mus. Novitates, no. 1974, p. 6, fig. 4; EMERSON, 1985, Nautilus, v. 99, no. 1, p. 16.

[Ceratostoma] pecki (Emerson). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 125.

Ceratostoma (Microrhytis) pecki (Emerson). VOKES, 1989, Tulane Stud. Geol. Paleont., v. 22, no. 4, p. 113.

Description: "Shell small for the genus, with four plus, post-nuclear whorls, nuclear whorls not preserved. Spire small, less than one-third of the height of shell. Body whorl ornamented with three prominent, rib-like varices and a low, rounded nodule centrally located on the weakly spirally sculptured intervarical surface. Ventral surface of varices minutely foliated; single apertural spine preserved on varices of body whorl. Aperture subovate, commonly closed, interior of outer lip with pustules or lirations. Apertural tooth small." (Emerson, 1959)

Holotype: UCMP 37690; height 23.0 mm, diameter 16.0 mm.

PLATE 10

Figures Page

1-8. *Pterorytis (Pterorytis) fluviana* Dall 94

1. (X 1 1/2) USNM 488733; height 35.4 mm, diameter 24.7 mm. Locality: TU 728; Pinecrest beds.
2. (X 1 1/2) USNM 488734; height 36.9 mm, diameter 22.1 mm. Locality: TU 729; Pinecrest beds.
3. (X 1 1/2) USNM 488735; height 32.4 mm, diameter 22.5 mm. Locality: TU 729; Pinecrest beds.
4. (X 1 1/2) USNM 488736; height 37.2 mm, diameter 21.0 mm. Locality: TU 729; Pinecrest beds.
5. (X 1 1/2) USNM 488737; height 32.5 mm, diameter 19.2 mm. Locality: TU 729; Pinecrest beds.
6. (X 1 1/2) Stephens Collection; height 39.4 mm, diameter 25.7 mm. Locality: TU 1000; Pinecrest beds.
7. (X 1 1/4) USNM 488738; height 42.8 mm, diameter 27.7 mm. Locality: TU 729; Pinecrest beds.
8. (X 1 1/2) Stephens Collection; height 31.9 mm, diameter 19.8 mm. Locality: TU 729; Pinecrest beds.

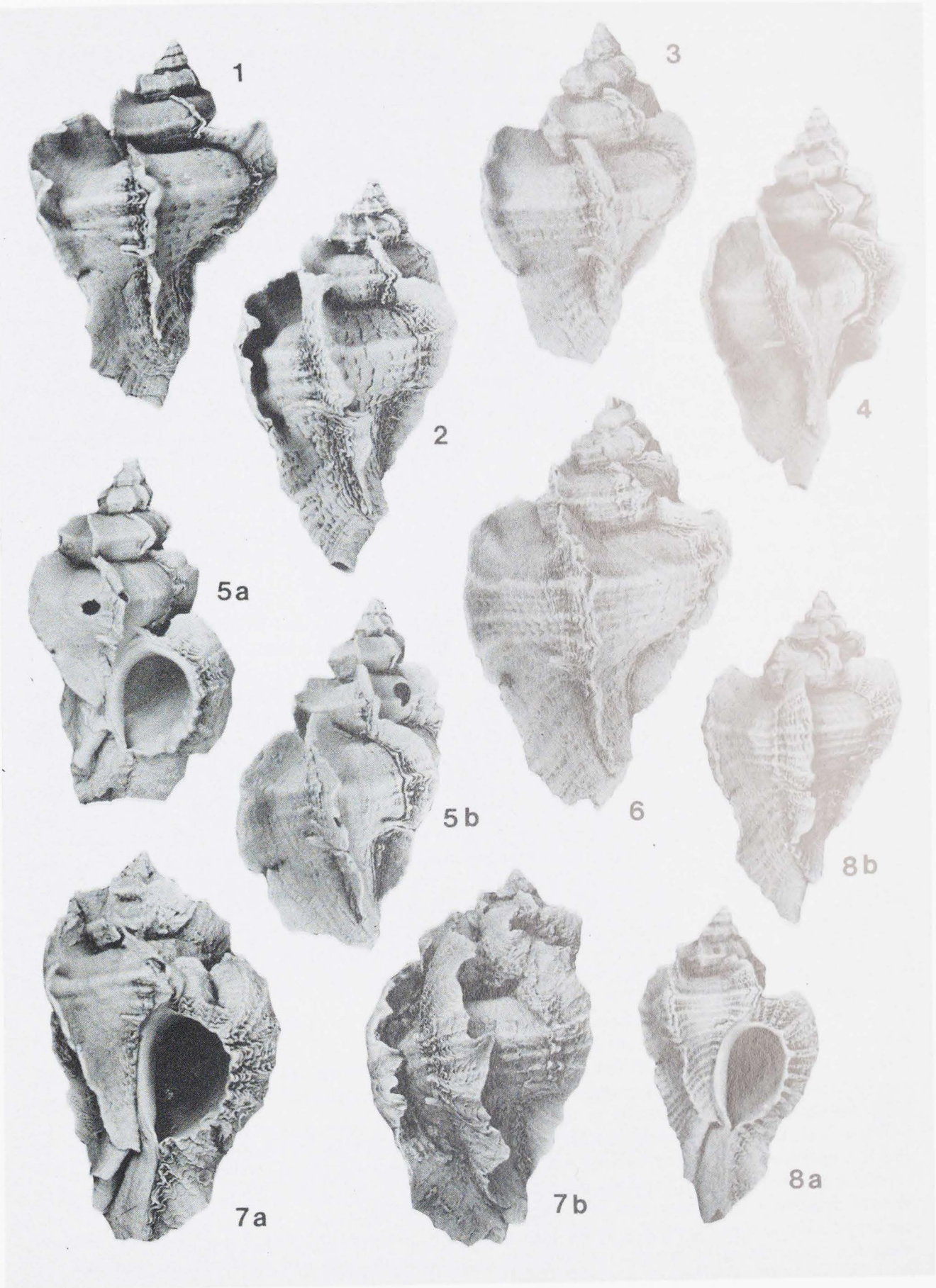


PLATE 10

Type locality: UCMP locality A-8125, unnamed formation; road-cut along Trans-isthmian highway from Salina Cruz to Coatzocoales [Coatzacoalcos], about 2.6 km south of Rio Jaltepec, Veracruz, Mexico (= TU 636).

Occurrence: Unnamed formation, Veracruz/Oaxaca line, Mexico.

Figured specimen: UCMP 37691 (paratype); height 22.8 mm, diameter 15.7 mm; locality UCMP A-8124 (= TU 635). Other occurrence: TU locality 635.

Discussion: As was noted by Vokes (1989b, p. 114), the locality for the holotype and paratypes of *P.(M.) pecki* (UCMP A-8125 and A-8124 = TU 636 and TU 635, respectively) have been dated as Neogene Zone N.13-N.14, or Middle Miocene in age. The molluscan assemblage at these localities consists of extremely shallow-water material, including a fair bit of gravel, together with a good planktic foraminiferal fauna, indicating a gravity-flow of probably intertidal material into the deeper environment.

PTERORYTIS (MICRORHYTIS) ECUADORIUS (Vokes)
Plate 13, figures 4-6

Ceratostoma (Microrhytis) ecuadorium VOKES, 1989, Tulane Stud. Geol. Paleont., v. 22, no. 4, p. 113, pl. 1, figs. 3, 4.

Description: "Shell of average size, probably six teleoconch whorls in adult; protoconch unknown. Spiral ornamentation on early teleoconch whorls of two strong cords, which persist up to the body whorl, where they form one weaker cord at the shoulder and another somewhat stronger cord just anterior to it. These supplemented by a third cord near base of the body whorl and numerous weaker threads between, and anterior to, the three major cords. Axial ornamentation on earliest whorls of approximately 12 small lamellar varices, crenulated by spiral cords; gradually reducing in number until on approximately the fifth teleoconch whorl becoming three varices with one strong intervarical node between each pair. Varices fimbriated on adapertural face, slightly recurved abaperturally, with a weak fold at shoulder. In addition to varices, the shell surface shagreened by numerous axial growth lines. At juncture of body whorl and siphonal canal a sharp adaperturally directed labral tooth, causing the varix to be enfolded behind it. Aperture large, ovate; columellar lip smooth, adnate posteriorly, free-standing anteriorly. Inner side of outer lip with approximately seven strong elongate denticles. Siphonal canal moderately long, wide, sealed over by an extension of shell material from columellar side; distal end slightly recurved." (Vokes, 1989)

Holotype: USNM 445399; height 23.2 mm, diameter 15.5 mm.

Type locality: TU 1507, Angostura Formation; Punta Verde, large point just east of Río Verde, or about 30 km east of Río Esmeraldas, Province of Esmeraldas, Ecuador.

Occurrence: Angostura Formation, Ecuador; Gatun Formation, Panama.

Figured specimens: Fig. 4, USNM 488740; height 37.2 mm, diameter 22.2 mm; locality TU 757. Fig. 5, USNM 488741; height 32.5 mm, diameter 18.5 mm; locality TU 757. Fig. 6, USNM 445400 (paratype); height 26.8 mm, diameter 16.9 mm; locality TU 1507.

Discussion: Two specimens from the Late Miocene Gatun Formation of Panama prove to be the same as a species described from the Pacific coast of Ecuador, in the Angostura Formation, which is correlative with the Gatun Formation. The only other species to which *P. ecuadorius* has a close resemblance is the slightly older and presumably ancestral *P. dryas*, which differs in having somewhat more pronounced spiral sculpture and a smaller labral tooth. It bears much less resemblance to the geographically closer Early Miocene *P.(M.) christopheri*, n. sp., which is assumed to have lived in a slightly deeper environment than *P. dryas* and *P. ecuadorius*.

V. LOCALITY DATA

The following are Tulane University fossil locality numbers:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW 1/4 Sec. 21, T1S, R4W), Leon Co., Florida.
68. Caloosahatchee Fm., North St. Petersburg, 70th Ave. at 9th St. N., Pinellas Co., Florida.
69A. Shoal River Fm., first ravine upstream from Shell Bluff, Shoal

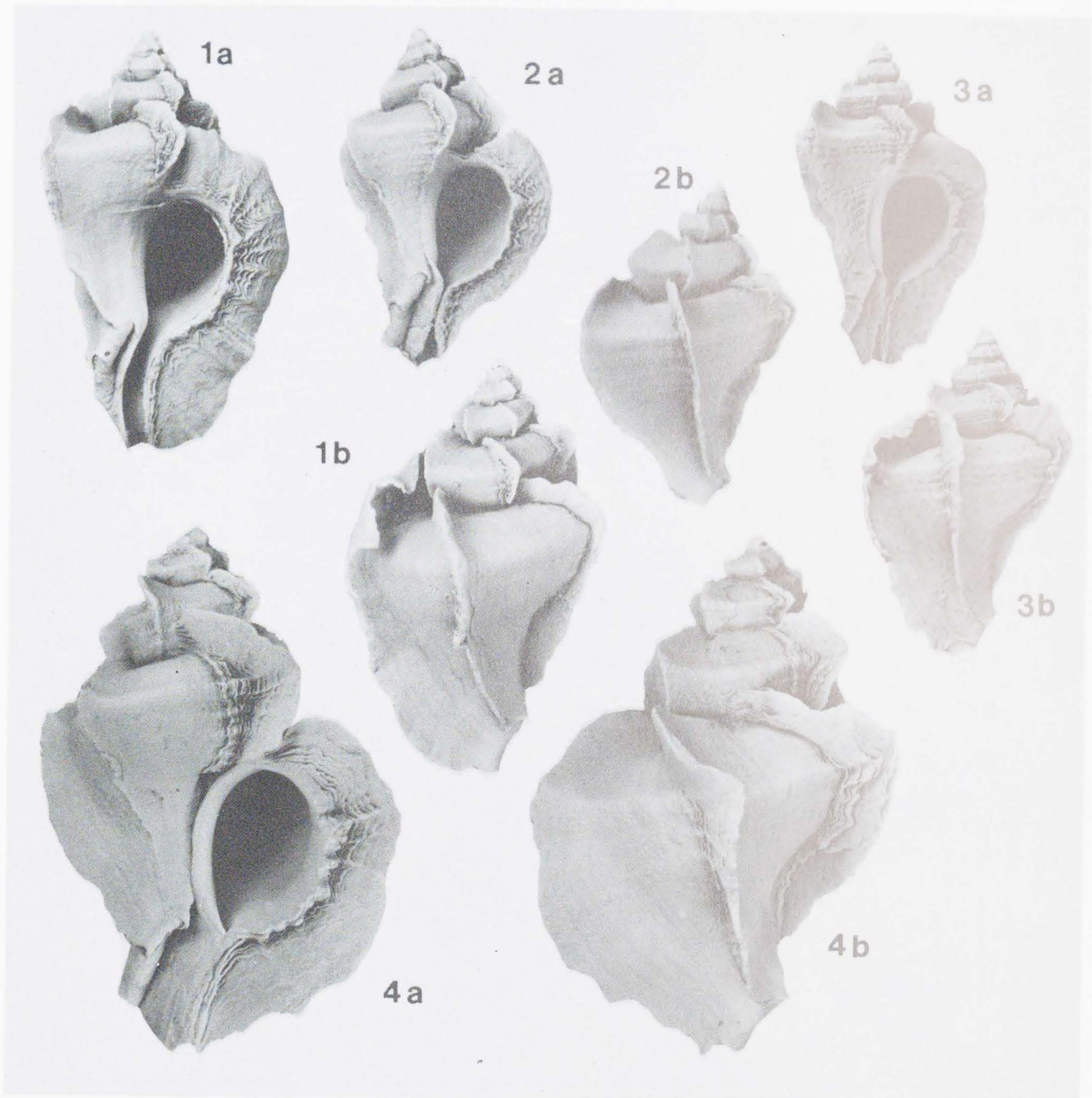


PLATE 11

Figures Page

1-4. *Pterorytis (Pterorytis) roxaneae* Petuch 100

1. (X 1 1/2) Stephens Collection; height 34.2 mm, diameter 21.6 mm. Locality: TU 1524; uppermost Pinecrest beds.
2. (X 1 1/2) Stephens Collection; height 27.1 mm, diameter 18.4 mm. Locality: TU 1524; uppermost Pinecrest beds.
3. (X 1 1/2) Stephens Collection; height 26.1 mm, diameter 17.6 mm. Locality: TU 1524; uppermost Pinecrest beds.
4. (X 1 1/4) Stephens Collection; height 51.0 mm, diameter 36.0 mm. Locality: TU 1000; uppermost Pinecrest beds.

River (NW 1/4 Sec. 4, T3N, R21W), about 3 1/2 miles north of Mossyhead, Walton Co., Florida.

91. Oak Grove Sand, type locality, west bank of Yellow River, about 100 yards below bridge at Oak Grove (NE 1/4 Sec. 20, T5N, R23W), Okaloosa Co., Florida.
376. Duplin Fm., "Natural Well," sinkhole on Matthews' farm, on North Carolina Highway 1003, 2 miles southwest of Magnolia, Duplin Co., North Carolina.
457. Chipola Fm., west bank of Chipola River, about 1/2 mile below Tenmile Creek (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.
458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
459. Chipola Fm., east bank of Chipola River, steep bank about 1500 feet above the mouth of Taylor Lake Branch (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
520. Pinecrest beds, spoil banks, canal 0.9 mile east of Brighton on Florida Highway 70 (Sec. 25, T37S, R32E), Highlands Co., Florida.
523. Pinecrest beds, Harney Pond Canal spoil banks, 6 miles northwest of Florida Highway 78, Brighton Indian Reservation (NW 1/4 Sec. 22, T39S, R32E), Glades Co.,.Florida.
534. Tamiami Fm., spoil bank at Port Charlotte Baptist Church, about 1/2 mile north of U.S. Highway 41, on road 1 1/2 miles southeast of Murdock (NE 1/4 Sec. 8, T40S, R22E), Charlotte Co., Florida.

539B. Caloosahatchee Fm., Shell Creek (lower beds), about 8 miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida.
546. Chipola Fm., Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
547. Chipola Fm., west bank of Chipola River, about 2000 ft. above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
548. Chipola Fm., west bank of Chipola River, at bend about 1800 feet south of mouth of Farley Creek (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
549. Chipola Fm., east bank of Chipola River, about 1/4 mile below Fourmile Creek (NE 1/4 Sec. 32, T1N, R9W), Calhoun Co., Florida.
554. Chipola Fm., east bank of Chipola River at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.
555. Chipola Fm., east bank of Chipola River, about 1000 ft. above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.
559. Waccamaw Fm., "Neill's Eddy Landing," south bank of Cape Fear River near Acme, Columbus Co., North Carolina.
562. Haywood Landing Member, Belgrade Fm. [= "Silverdale beds"], Onslow County marl pit, on south side of Webb Creek, near

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PLATE 12

Figures Page

1-3. *Pterorytis (Microrhytis) christopheri*, n. sp. 101

1. (X 1 1/2) NMB H-17659 (holotype); height 42.1 mm, diameter 26.9 mm. Locality: NMB 17516, Paraguaná Peninsula, Falcón State, Venezuela (= TU 1269); Cantaure Formation.
2. (X 2) NMB H-17663 (paratype A); height 26.9 mm, diameter 15.7 mm.
3. (X 2) NMB H-17660 (paratype B); height 26.2 mm, diameter 16.3 mm. Locality of both: same as holotype.

4. *Pterorytis (Microrhytis) pecki* Emerson 106
(X 2) UCMP 37691 (paratype); height 22.8 mm, diameter 15.7 mm. Locality: UCMP locality A-8124, about 2.3 km south of Río Jaltepec, Veracruz, Mexico (= TU 635); unnamed formation.

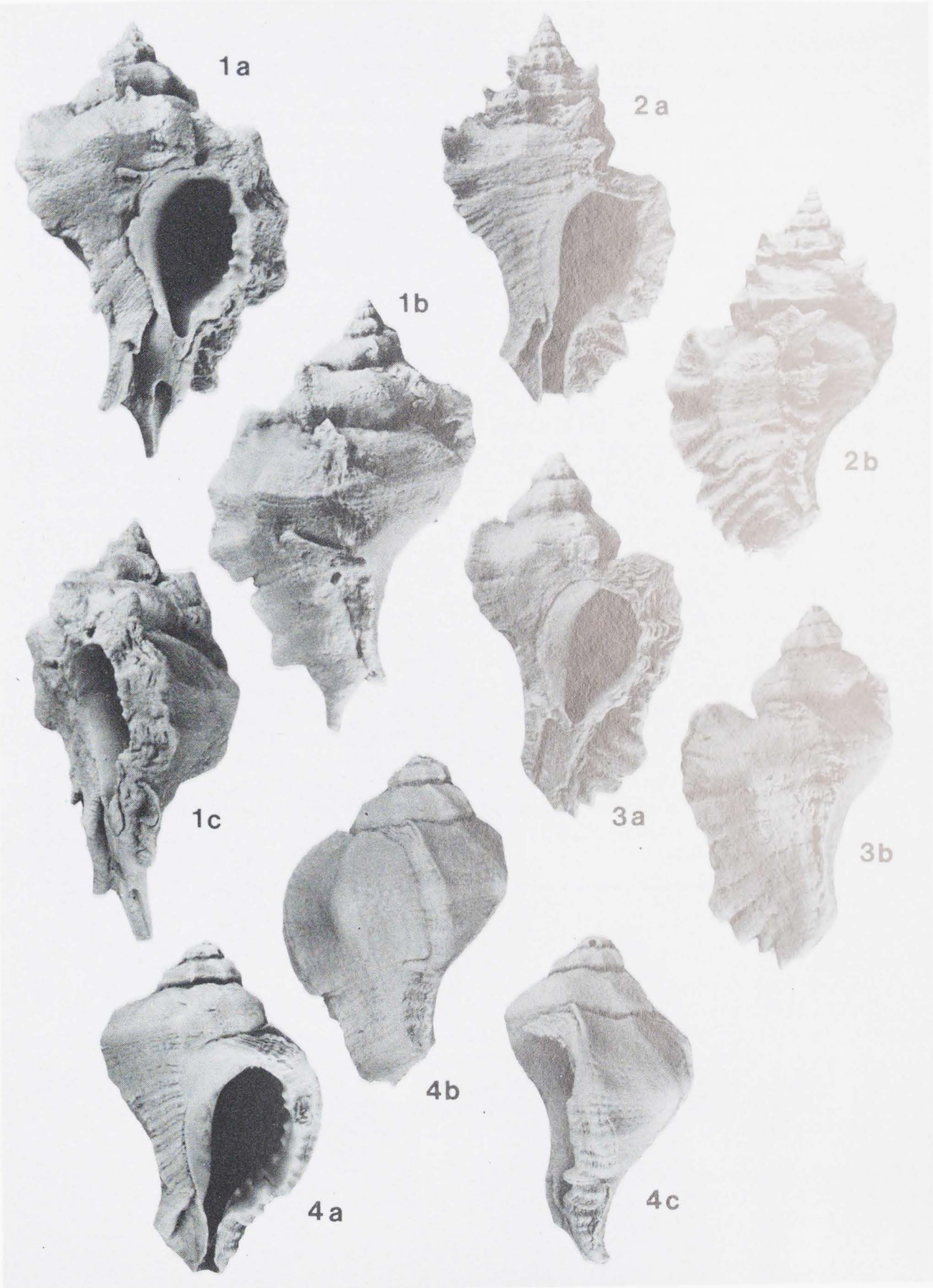

PLATE 12

Silverdale, Onslow Co., North Carolina.

613. Yorktown Fm., Rice's marl pit, Harris Creek Road, Hampton, York Co., Virginia.

635. Unnamed formation, roadcut on Mexico Highway 185, 1.4 miles (2.3 km) south of bridge over Río Jaltepec, at Oaxaca-Veracruz state line, Mexico (= University of California, Museum of Paleontology locality A-8124).

636. Unnamed formation, roadcut on Mexico Highway 185, 1.5 miles (2.4 km) south of bridge over Río Jaltepec, at Oaxaca-Veracruz state line, Mexico (= University of California, Museum of Paleontology locality A-8125).

708. Chipola Fm., at small waterfall on tributary to Tenmile Creek, south bank, about 1/4 mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

726. Caloosahatchee Fm., Hendry County rock pit, 1/2 mile north of Florida Highway 80, three miles west of La Belle (SE 1/4 Sec. 14, T43S, R28E), Hendry Co., Florida.

728. Pinecrest beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, just across from U.S. Corps of Engineers Structure 65-D (Sec. 33, T36S, R33E), Okeechobee Co., Florida.

729. Pinecrest beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately 1/2 mile south of U.S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee Co., Florida.

730. Pinecrest beds, embankment of Seaboard Airline Railroad, just west of Kissimmee River (NW 1/4 Sec. 20, T36S, R33E), Highlands Co., Florida.

757. Gatun Fm., roadcut on south side of Boyd-Roosevelt Highway at junction of road to "Refinería Panamá, S.A.," just east of Cativa, Prov. of Colón, Panama.

759. Bermont Fm., spoil banks north side of Caloosahatchee River, 2 miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E), Glades Co., Florida.

767. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of Caloosahatchee River, 5 miles west of Ortona Lock (NW 1/4 Sec. 36, T42S, R29E), Glades Co., Florida.

768. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of Caloosahatchee River, 5 1/2 miles west of Ortona Lock (NW 1/4 Sec. 35, T42S, R29E), Glades Co., Florida.

769. Pinecrest beds, spoil banks east side of Kissimmee River, 1 1/2 to 2 miles south of U.S. Corps of Engineers Structure 65-D (NE 1/4 Sec. 35, T36S, R33E), Okeechobee Co., Florida.

770. Pinecrest beds and Caloosahatchee Fm. mixed, spoil banks west side of Kissimmee River, 1 1/2 to 3 1/2 miles north of Florida Highway 70 (Secs. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.

787. Chipola Fm., Tenmile Creek, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

PLATE 13

Figures Page

1-3. *Pterorytis (Microrhytis) dryas* (Gardner) 104

1. (X 3) Murray Collection; height 17.2 mm, diameter 11.8 mm.
   Locality: UF-WL004 (? = TU 69A); Shoal River Formation.
2. (X 3) USNM 488739; height 14.8 mm, diameter 8.8 mm.
   Locality: TU 91; Oak Grove Sand.
3. (X 3) USNM 481847; height 18.1 mm, diameter 12.4 mm.
   Locality: USGS 9908, Las Cahobas, Haiti; Thomonde Formation.

4-6. *Pterorytis (Microrhytis) ecuadorius* (Vokes) 108

4. (X 1 1/2) USNM 488740; height 37.2 mm, diameter 22.2 mm.
   Locality: TU 757; Gatun Formation.
5. (X 1 1/2) USNM 488741; height 32.5 mm, diameter 18.5 mm.
   Locality: TU 757; Gatun Formation.
6. (X 2) USNM 445400 (paratype); height 26.8 mm, diameter 16.9 mm.
   Locality: TU 1507; Angostura Formation.

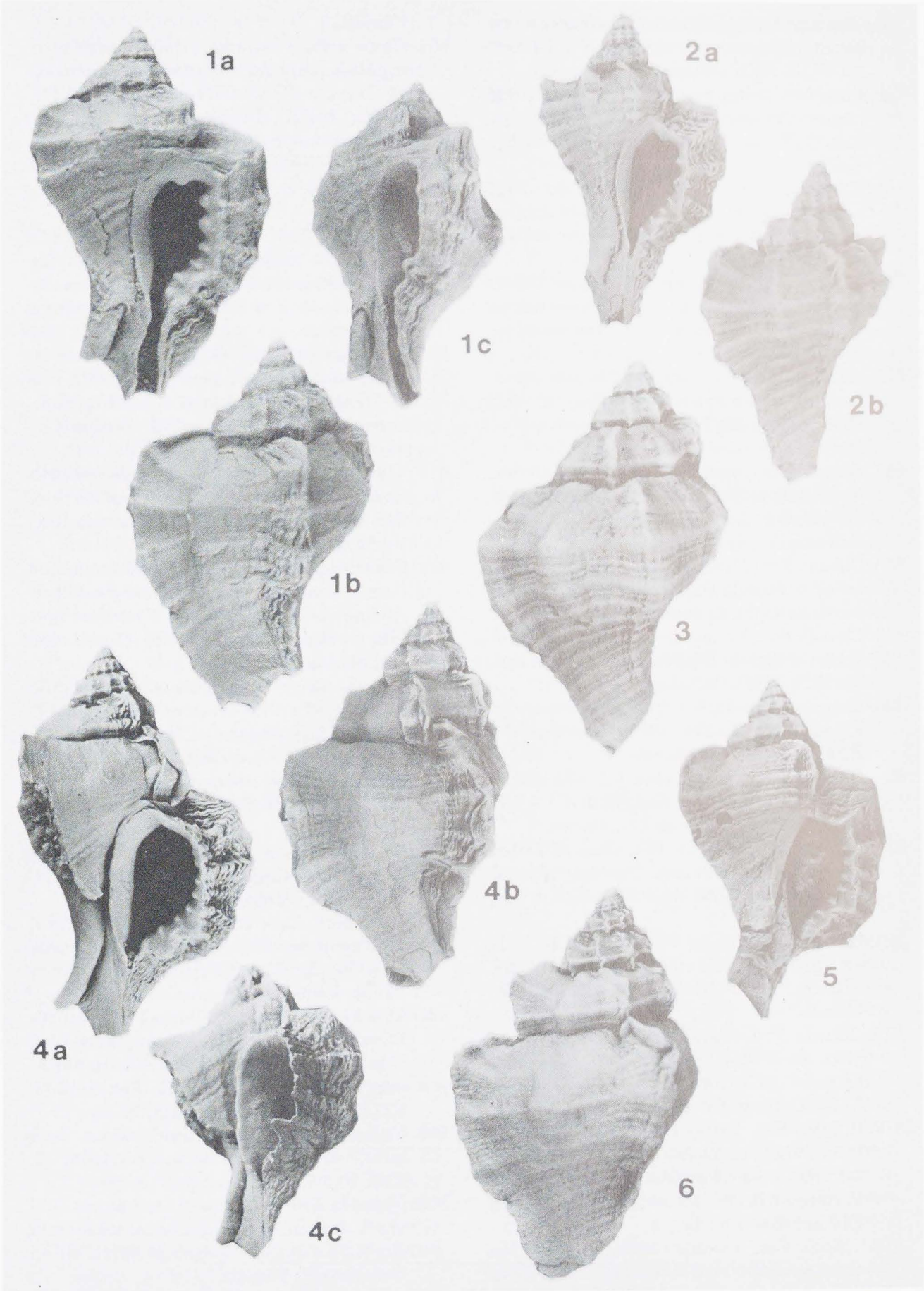

PLATE 13

789. Tamiami Fm., north side of Caloosahatchee River, 0.3 mile east of old lock (NW 1/4 Sec. 30, T42S, R30E), Glades Co., Florida.
796. Pinecrest beds, material exposed during construction of "Alligator Alley," 12.8 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.
797. Pinecrest beds, material exposed during construction of "Alligator Alley," 13.3 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.
806. Chipola Fm., west bank of Chipola River, about 1/2 mile below power line crossing (NW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
807. Chipola Fm., west bank of Chipola River, about 1/4 mile below power line crossing (NW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
817. Chipola Fm., south side of Tenmile Creek, large gully on the property of Mr. A. Sexton (1967) (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
818. Chipola Fm., Farley Creek, 0.1 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
819. Chipola Fm., Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
820. Chipola Fm., Farley Creek, at bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
821. Chipola Fm., Farley Creek, 0.1 mile east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
823. Chipola Fm., Farley Creek, about 2000 feet east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
824. Chipola Fm., Farley Creek, about 1/2 mile east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
825. Chipola Fm., Farley Creek at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
828. Chipola Fm., Farley Creek, just upstream from mouth of unnamed tributary about 3/4 mile downstream from bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
830. Chipola Fm., Tenmile Creek, at power line crossing about 1 mile west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
831. Chipola Fm., Tenmile Creek [lowest beds exposed], slightly less than one mile west of Chipola River (SW 1/4 Sec. 7, T1N, R9W), Calhoun Co., Florida.
842. Yorktown Fm., road metal quarry on Virginia Highway 238, 1.4 miles east of U.S. Highway 17 at Yorktown, York Co., Virginia.
855. Yorktown Fm., "Fort Boykins," Burwell's Bay, south bank of James River, one mile west of Mogart's Beach and approximately one mile north of Smithfield, Isle of Wight Co., Virginia.
866. Haywood Landing Member, Belgrade Fm. [= "Silverdale beds"], marl pit on north side of Webb Creek and east side of unnumbered county road, Silverdale, Onslow Co., North Carolina.
870. Waccamaw Fm., pits on east side of North Carolina Highway 130, 2.8 miles north of Old Dock School, Old Dock, Columbus Co., North Carolina.
932. Pinecrest beds, east side of Kissimmee Canal and 1/2 mile south of Seaboard Airline Railroad, south of Fort Basinger (SE 1/4 Sec. 20, T36S, R33E), Okeechobee Co., Florida.
949. Chipola River, west bank about 0.1 mile below power line crossing (SW Sec. 17, T1N, R9W), Calhoun Co., Florida.
950. Chipola Fm., Chipola River, west bank about 2000 feet above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
951. Chipola Fm., Tenmile Creek, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
977. Unnamed Late Pleistocene formation, mudlump no. 90, mouth of South Pass, Mississippi River delta, Plaquemines Parish, Louisiana.
980. Tamiami Fm., Port Charlotte Development, spoil banks on north side U.S. Highway 41, on canal 3.3 miles northwest of Florida Highway 771 (Sec. 3, T40S, R21E), Charlotte Co., Florida.
998. Chipola Fm., Tenmile Creek, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
999. Chipola Fm., Farley Creek, about 300 yards downstream from bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1000. Pinecrest beds, APAC pits at east end of

17th St., about 8 miles east of U.S. Highway 301 at Sarasota [now northwest corner of Fruitville Road exit I-75], (T36S, R19E) Sarasota Co., Florida.

1021. Chipola Fm., small tributary (not shown on USGS topographic map) on east bank of Chipola River about 1/2 mile below power line crossing (NE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

1022. "James City Fm.", Lee Creek Mine, Texasgulf, Inc., phosphate mine at mouth of Lee Creek, south bank of Pamlico River, near Aurora, Beaufort Co., North Carolina.

1025. Concepcion Inferior Fm., first roadcut on east side of old road from Nueva Teapa to Ixhuatlan, 0.8 km south of junction with highway to Coatzacoalcos [formerly Mexico Highway 180; new Highway 180 parallels this road slightly to the east], Veracruz, Mexico.

1044. Pinecrest beds, spoil banks, west side of L-28 Interceptor Canal, 3 1/2 miles north of junction with Hendry County Highway 833, north side of Big Cypress Indian Reservation (T47S, R33E), Hendry Co., Florida.

1048. Chipola Fm., Farley Creek, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

1050. Chipola Fm., west bank of Chipola River, immediately below power line crossing, and directly across from TU locality 554 (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.

1196. Chipola Fm., Farley Creek, about 0.8 mile east of bridge on Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

1269. Cantaure Fm., series of arroyos about 500 meters south of "Casa Cantaure" [which is literally one house and which is about 400 meters south of older, now abandoned, house that was the "Casa Cantaure" of Jung, 1965, and others], 14 km (by road) west of Pueblo Nuevo, Paraguaná Peninsula, Falcón State, Venezuela.

1318. Concepcion Inferior Fm., hillcut on pipeline just to northeast of Campo El Chapo, on old road from Nueva Teapa to Ixhuatlan, 4 km south of old road to Coatzacoalcos [formerly Mexico Highway 180; new Highway 180 parallels this poad slightly to east], Veracruz, Mexico.

1321. Concepcion Inferior Fm., "Kilometer 70," which is K 70 on Trans-Isthmus railroad south of Coatzacoalcos, and 5 km north of Almagres, Veracruz, Mexico

1493. Pinecrest beds, Arvida Pit, on Bird Road (= W. 40th St.), approximately 5 miles west of Florida Turnpike, on west side of Coral Gables, Dade Co., Florida.

1507. Angostura Fm., large point just east of Río Verde, or approximately 30 km east of Río Esmeraldas, Prov. of Esmeraldas, Ecuador.

1512. Pinecrest beds, Caloosahatchee Fm. and Bermont Fm. mixed, DeSoto Shell Company, pits 2 miles east of Florida Highway 31, about 12 miles south of Arcadia (T39S, R25E), DeSoto Co., Florida.

1514. Concepcion Inferior Fm., roadcuts 1.5 km south of old Mexico Highway 180 (now side road into Coatzacoalcos) on new bypass, which is 15 km east of old bridge at Coatzacoalcos, Veracruz, Mexico.

1515. Concepcion Inferior Fm., roadcuts 0.5 km south of intersection of old Mexico Highway 180 (now side road into Coatzacoalcos) on new bypass, which is 15 km east of old bridge at Coatzacoalcos, Veracruz, Mexico.

1524. Pinecrest beds, Quality Aggregate Pit, off Richardson Road, north side of Fruitville Road and east of highway I-75, east of Sarasota, Sarasota Co., Florida.

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VII. APPENDIX: GENUS-GROUP TAXA NOW INCLUDED IN THE OCENEBRINAE

Inasmuch as through the years there has been considerable shuffling about of

the various taxa now considered to be members of the subfamily Ocenebrinae, a complete list of the genus-group taxa presently considered to belong to the subfamily seems desirable. Names are listed in alphabetical order, as infra-taxa relationships are not certain in many cases, and those found only in the fossil record (at this time) are shown in bold face. For full bibliographic references and synonyms for most of these genera the reader is referred to Vokes, 1964.

GROUP I – species with a sealed canal (considered to be Ocenebrinae as of Vokes, 1971); subject of present work.

Calcitrapessa Berry, 1959
Ceratostoma Herrmannsen, 1846
Argyrobessa, n. gen.
Fenolignum, n. gen.
Genkaimurex Kuroda, 1953
Hadriania Bucquoy, Dautzenberg, and Dollfus, 1882
Heteropurpura Jousseaume, 1880
Jaton Pusch, 1837
Microrhytis Emerson, 1959
Miocenebra Vokes, 1963
Ocenebra Leach *in* Gray, 1847
Ocinebrellus Jousseaume, 1880
Ocinebrina Jousseaume, 1880
Odontopurpura, n. subgen.
Poropteron Jousseaume, 1880
Pteropurpura Jousseaume, 1880
Pterorytis Conrad, 1836
n. gen. (for *Murex lugubris* Broderip, 1833)

GROUP II – taxa now included in Ocenebrinae by Kool (1993), Vermeij and Kool (1994), and Vermeij (1995). In addition, a number of monotypic genera known only from the fossil record are questionably included, essentially for lack of a better idea about placement.

Subgroup A: Genera with open canal, and well-defined axial sculpture.

Austrotrophon Dall, 1902
Bedeva Iredale, 1924
Crassilabrum Jousseaume, 1880
Eupleura Adams and Adams, 1853
Forreria Jousseaume, 1880
Leptomurex Woodring, 1973
(?)**Lissomuricopsis** Merle, 1989
(?)**Lyropurpura** Jousseaume, 1880
Mariasalpinx Petuch, 1988
Namamurex Carrington and Kensley, 1969
(?)**Odontopolys** Gabb, 1860
Pterynopsis Vokes, 1973
Roperia Dall, 1898
(?)**Stephanosalpinx** Petuch, 1988
Urosalpinx Stimpson, 1865
Vaughtia Houart, 1995
(?)*Vitularia* Swainson, 1840
Vokesinotus Petuch, 1988
(?)**Yasila** Olsson, 1930
Zacatrophon Hertlein and Strong, 1951

Subgroup B: genera with open canal, predominantly spiral sculpture.

Acanthina Fischer de Waldheim, 1807
Acanthinucella Cooke, 1918
Chorus Gray, 1847
Ecphora Conrad, 1843
Entacanthus von Ihering, 1907
Haustrum Perry, 1811
Lepsiella Iredale, 1912
Nucella Roding, 1798
Spinucella Vermeij, 1993
Trochia Swainson, 1840
(?)**Zulloia** Petuch, 1994
n. gen. (for *Monoceros mirabilis* Moricke, 1896; DeVries and Vermeij, in press)