TULANE STUDIES IN GEOLOGY AND PALEONTOLOGY

Volume 24, Numbers 1, 2 May 8, 1991

CYPRAEOIDEA AND LAMELLARIOIDEA (MOLLUSCA: GASTROPODA), FROM THE CHIPOLA FORMATION (LATE EARLY MIOCENE) OF NORTHWESTERN FLORIDA

LUC DOLIN
*SAINT-DENIS, FRANCE**

CONTENTS

I. ABSTRACT

This contribution increases the number from eleven previously known species (six described from the Chipola Formation) to 20 species of Cypraeoidea and six of Lamellarioidea living in Florida during the late Early Miocene, a total that makes the Chipola assemblage the most diversified lower Miocene cypraeid fauna in the New World, second only to western Europe in the entire world.

Siphocypraea chilona (Dall, 1900) is recognized from the Dominican Republic and from France, and is documented from the Aquitanian to the Tortonian. *Talparia (Talparia) dominicensis* (Gabb, 1873), *Mauritia (Mauritia) campbelliana* (Pilsbry, 1922), and *Erronea (Adusta) spurcoides* (Gabb, 1873), described from the Dominican Republic and also found in the Chipola Formation, have their geographic distribution expanded. The first of these is present in the Early Miocene of Aquitaine (France) and the second appears in the Late Oligocene of the same basin. These observations are the result of ongoing work on the cypraeid faunas of the Middle Tertiary of western Europe.

Fourteen new species and one new subspecies are described, and their relationships are discussed. The genera *Zoila* (Southwestern Australian Province), *Trona* (West-African Province), *Talparia* (s.s.), *Mauritia* (s.s.), *Erronea* (s.l.), *Lyncina*, and *Bistolida* (Indo-Pacific Province), are noted for the first time in the New World.

The genus *Siphocypraea*, the Ovulidae (with four species), and the Triviidae (with five species) enhance the essential components of the Recent Caribbean and Panamic Provinces. Numerous elements of this fauna, situated in a basin between the Indo-Pacific and Atlantic Provinces, suggest a more than usual biogeographic interest.

II. INTRODUCTION

This study is based principally on material collected by Emily and Harold Vokes (Tulane University, New Orleans, Louisiana), and by the late Shirley Hoerle and her husband Robert Hoerle, which is now deposited at the U. S. National Museum of Natural History (Smithsonian Institution, Washington, D.C.). Supplemental material

*2, Place du Caquet, A/19 93200 Saint-Denis, France.

was collected in the course of field work in the Chipola area during July, 1985, directed by Emily and Harold Vokes and including Mary and David T. Dockery III (Mississippi Bureau of Geology), Therese and Luc Dolin (material deposited in the MNHN Paris, Malacology). These collections represent most of the material extracted from the outcrops along the Chipola River and its tributaries, which is conserved in public collections.

Dall (1890, p. 166) first referred to the "Chipola red sand, West Florida (Burns collector)," in connection with *Zoila willcoxi*, the holotype of which comes from the ?Hawthorn Formation at White Beach, near Osprey, southwestern Florida. The list of species in Dall (1903, pp. 1574-1580) reflects the lack of previous work; only *Zoila willcoxi* (Dall, 1890) and *Siphocypraea chilona* (Dall, 1900) are listed there.

Subsequently, Maury (1910, pp. 26-27[114-115]) added one species of *Trivia* and one of *Hespererato* to the fauna of the Chipola Formation. Later, Ingram (1948) described *"Cypraea" (= Cypraeorbis) hertleini*, *"Cypraea" apalachicolae (= Cypraeorbis hertleini)*, and *"Cypraea" alumensis (= Zoila willcoxi)* from the Chipola Formation. As noted by Olsson and Petit (1968, p. 280), in a discussion of *Siphocypraea henekeni*, "between 1939-1947, W. M. Ingram worked on *Cypraea*, visited many museums and indiscriminately described a large number of fossil forms without knowledge of variation or geologic occurrence."

Gardner (1926-1950) revised the molluscan fauna of what is now termed the Alum Bluff Group of Florida, including a map of localities. The Cypraeoidea/Lamellarioidea of the Chipola Formation listed by Gardner (1947, pp. 540-543) include four species: *Siphocypraea chilona* (Dall, 1900); *Erronea (Adusta) heilprinii* (Dall, 1890); *Trivia chipolana* Maury, 1910; and *Hespererato chipolana* (Maury, 1910). *Cypraea (Cypraeorbis) tapeina* Gardner, 1947 (= *Siphocypraea chilona*) and *Trivia vaughani* Gardner, 1947, were described from the Middle Miocene Shoal River Formation.

Including *Zoila willcoxi* and the four species listed by Gardner, *Cypraeorbis hertleini*, plus *Cypraeorbis ballista* (Dall, 1915) and *Erronea (Adusta) tumulus* (Heilprin, 1886), described from the Tampa Limestone but also found in the Chipola, the three species *Talparia (Talparia) dominicensis* (Gabb, 1873), *Mauritia (Mauritia) campbelliana* (Pilsbry, 1922), and *Erronea (Adusta) spurcoides* (Gabb, 1873), named from the Dominican Republic but also found in the Chipola Formation, there is a total of 11 previously described species. Fourteen new species and one new subspecies are described herein, for a total of 26 species in the Chipola Formation.

With six species of Bernayinae, five of Cypraeinae, five of Erroneinae, four of Simniinae, one of Eratoinae and five of Triviinae, the Chipola Formation has the richest assemblage of Cypraeoidea/Lamellarioidea known from Early Miocene deposits in the New World. Schilder and Schilder (1971) list 30 species in the Burdigalian of the Aquitaine Basin (France) and 35 species in the Turin Hills (Italy).

The Chipola Formation is, however, marked by the notable absence of the genera *Erosaria* (Erosariinae, Cypraeidae) and *Jenneria* (Eocypraeinae, Ovulidae). These taxa have at times abounded in the Caribbean and Panamic Neogene. Schilder (1939, pp. 18-20) described five species of Erosariinae, and Olsson (1967, pp. 3-5) described five "species" in the *Jenneria gabbiana* (Guppy, 1876) and *Jenneria pustulata* (Solander, 1786) complex. A species, which may be referred to the Recent *Erosaria (E.) spurca acicularis* (Gmelin, 1791), is found in the Baitoa Formation, Dominican Republic (loc. TU 1226, E. and H. Vokes collectors).

A comparison of the Chipola cypraeid fauna with Recent Cypraeidae of the Panamic (6 endemic species and 3 Indo-Pacific species) and Caribbean (6 species) biotic provinces, causes the latter to appear depauperate. The Early Miocene must be considered as an opulant time period.

The faunal similarity between the Chipola Formation and the Burdigalian of Aquitaine is remarkable. Of the 16 Chipola species of Cypraeidae, four are in common with Aquitaine, the likelihood being sufficiently rare to merit being highlighted:

1. *Siphocypraea chilona*, although belonging to a typically Caribbean stock, nevertheless appears in Aquitaine.

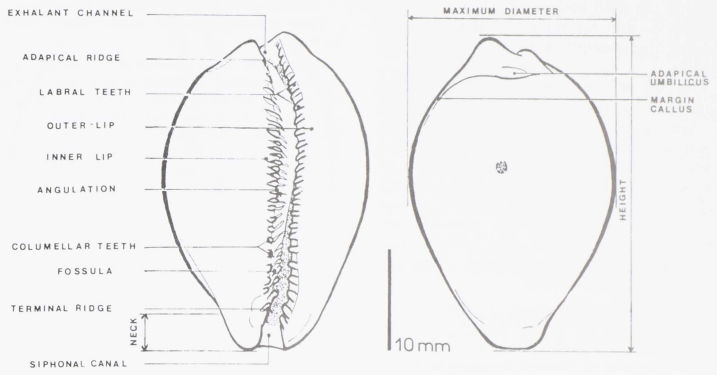


Figure 1. Terminology applied to the cypraeid shell. Ventral and dorsal views: *Erronea (Adusta) shirleyae* Dolin, n. sp.

2. *Trona leporina calhounensis* Dolin, n. subsp., seems misplaced in the New World, being a subspecies of the typical European form.

3. *Talparia (Talparia) dominicensis* (Gabb, 1873) represents a genus that is probably of Mesogean origin.

4. *Mauritia (Mauritia) campbelliana* (Pilsbry, 1922), described from the Dominican Republic but occurring in the Chipola Formation, appears in the Late Oligocene of the Adour Basin (France), in a reefal environment (Lozouet *in* Dolin *et al.*, 1985, p. 10).

There seem to be in other groups as well (*e. g.*, Muricidae, Bursidae, Tonnidae, etc.), species that are identical in the Chipola Formation and the beds of Europe. Vokes (1986, p. 177) reported from the Chipola Formation *Eudolium (Galeodolium) subfasciatum* Sacco, 1890, a species described from the Turin Hills of Italy. Like the majority of the Cypraeidae (see Wilson, 1985), these groups have a larval development with a long pelagic phase (Richter and Thorson, 1975, pl. 8, figs. 52-54).

III. ACKNOWLEGMENTS

I wish to thank all of the many persons and organizations who have helped to make this paper possible. First among these I would place Emily and Harold Vokes, who from the beginning to the completion of this work – more than seven years – entrusted all of their cypraeid material to an obscure amateur. I will always be grateful to them.

For the loan of type and other specimens, I would like to thank the following persons and their respective institutions: Warren Blow, United States National Museum, Washington, D.C.; Peter Hoover, Paleontological Research Institution, Ithaca, New York; Peter Rodda, California Academy of Sciences, San Francisco, California. I include for the same reasons: Thora Whitehead, Brisbane, Australia; John Stanisic of the Queensland Museum, Brisbane; and Fred Wells of the Western Australian Museum, Perth.

Photography of specimens under ultraviolet light are by Harold and Emily Vokes; all the others are by my "accomplice" Pierre Lozouet. He and Philippe Bouchet

(both of the Museum National d'Histoire Naturelle, Paris), have never ceased to provide me with counsel, help me with information, and have corrected many successive manuscripts. I include them in my thanks.

The job of translating my French into English fell upon Emily Vokes and Emilio F. Garcia, University of Southwestern Louisiana, Lafayette, Louisiana. To them I rend hommage. Alison Kay, University of Hawaii at Manoa, Honolulu, and Lindsey T. Groves, Natural History Museum of Los Angeles County, California, critically reviewed the manuscript and added valuable comments and suggestions. They are gratefully acknowledged.

ABBREVIATIONS FOR REPOSITORY INSTITUTIONS

ANSP–Academy of Natural Sciences of Philadelphia, Pennsylvania, USA
CAS–California Academy of Sciences, San Francisco, California, USA
MNHN–Museum National d'Histoire Naturelle, Paris, France
NMB–Naturhistorisches Museum, Basel, Switzerland
PRI–Paleontological Research Institution, Ithaca, New York, USA
UCMP–University of California, Museum of Paleontology, Berkeley, California, USA
USNM–United States National Museum of Natural History, Washington, D. C., USA
WFIS–Wagner Free Institute of Science, Philadelphia, Pennsylvania, USA

IV. SYSTEMATIC DESCRIPTIONS

For convenience the Schilder and Schilder (1971) classification (which treats fossil species and genera extensively) is used (see Wilson, 1985, p. 268). But the phylogeny of Gosliner and Liltved (1985, pp. 116-119, pl. 1, fig. 35) is followed. Generic shell characteristics are redefined herein (figure 1). The terminology of Schilder and Schilder (1938, p. 125) is modified as recommended by Cox *in* Moore (1960, pp. I106-I155, figs. 64, 66-80). Schilder's inappropriate term "hind top of the inner lip" is replaced by "adapical ridge."

Superfamily CYPRAEOIDEA Rafinesque, 1815
Family CYPRAEIDAE Rafinesque, 1815
Subfamily BERNAYINAE Schilder, 1927

Genus CYPRAEORBIS Conrad, 1865

Cypraeorbis CONRAD, 1865, Amer. Jour. Conchology, v. 1, p. 31 (as *Cypraea* subgenus).

Type species: *Cypraea sphaeroides* Conrad, by monotypy.

Description: Shell hemispheric in shape, spire slightly projecting, siphonal canal straight, forming a neck, elevated relative to ventral area in majority of cases; terminal ridge straight, obsolete, abaxially flat, declivous; its inner edge at 45°, flat and spatulated; fossula deep, concave, ear-shaped, with thickened inner margin; inner lip teeth short, regular, restricted to angulation of columellar area; abapical columellar teeth making a thick crest, dominating the thickening formed by remains of the canal in the subjuvenile.

Discussion: Schilder and Schilder (1971, p. 28) considered the *Cypraeorbis* line as extinct; living "heirs apparent" of *Cypraeorbis sphaeroides* are placed in *Zoila* Jousseaume, 1884, and an ancestral *Zoila, Z. willcoxi* (Dall, 1890) appears in *Cypraeorbis,* with *Siphocypraea chilona* (Dall, 1900) in synonymy. The Schilders probably never saw material from the Chipola Formation.

Wilson and McComb (1967) have produced a remarkable synthesis of these groups, as understood herein, illustrating their radulae. They suggest that Australian species of "*Zoila*" have "a close evolutionary affinity." It probably will be necessary in the future to make *Zoila* a subgenus of *Cypraeorbis.*

CYPRAEORBIS EMILYAE Dolin, n. sp.
Figure 2

Description: Large bulbous shell, somewhat egg-shaped; in lateral profile the ventral side adapically depressed, but regularly inflated; aperture following axis, weakly parasigmoidal; siphonal canal deep, elongate, in the shape of a long neck; each of the tips pearled; terminal ridge adaxially flat, plunging regularly inside aperture; fossula trigonal, rather concave, the angulation at right angles; columellar teeth extending into aperture about 3 mm on columella area, bounded by the angle, strong, binoduled and regularly disposed at equal length; labral teeth calloused, on adapical two-thirds extending abaxially across basal side of outer lip. A color pattern perceptible on portion of shell not corroded, consisting of a creamy callus dotted by little blotches and, dorsally, an orange cloud of points irregularly disposed, sometimes agglomerated in large spots.

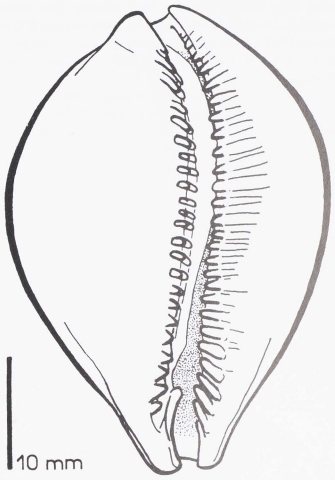


Figure 2a. *Cypraeorbis emilyae* Dolin, n. sp.; USNM 438580 (holotype).

Holotype: USNM 438580; height 41.7 mm, maximum diameter 28.7 mm, dorso/ventral diameter 25.8 mm; 23 columellar teeth, 27 labral teeth; E. and H. Vokes collectors (fig. 2).

Type locality: TU 458; Chipola Formation, Chipola River, east bank, about 1/3 mile above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype.

Discussion: In spite of the extreme morphologic variability that is present in specimens from the Chipola Formation of certain related species – notably *C. ballista* – the unique specimen of this species cannot be confused with any others. The general outline, the convexity of the ventral area, the well-detached neck, the exhalant channel forming a bridge, and the dense denticulation of the inner lip, distinguish it.

Cypraeorbis emilyae is descended from *C. alabamensis ventripotens* (Cossmann, 1903) (see Dockery, 1977, p. 58, pl. 6, figs. 2-4) from the Late Eocene of Mississippi. It differs by the size and the color pattern, although these criteria do not necessarily distinguish species.

Zoila schilderi Dey *in* Schilder, 1941 (see Dey, 1962, p. 71, pl. 6, figs. 3-7), from the Early Miocene of the Quilon Limestone, Padappakara (Kerala, India) is similar to *C. emilyae;* it has the same aspect, with the prolonged, adaxially flexed posterior canal. *Zoila schilderi* differs by the size of the shell (height 50.2 mm), the more attenuate siphonal canal, with the margins enlarged in the anterior quarter, the more open and acuminate exhalent channel, by the columellar teeth, which are stronger and less numerous (only 19 in number). Schilder (1941, pl. 8, fig. 9) noted the presence in *Z. schilderi* of two or three small transverse teeth surmounting the terminal ridge.

Etymology: I respectfully dedicate this species to Emily Vokes, as a token of my true affection, my sincere gratitude, and my admiration.

CYPRAEORBIS HERTLEINI (Ingram)
Figures 3, 4

Cypraea hertleini INGRAM, 1948, California Acad. Sci., Proc., (Ser. 4) v. 26, no. 6, p. 125, pl. 2, figs. 1, 2.

Cypraea apalachicolae INGRAM, 1948, California Acad. Sci., Proc., (Ser. 4) v. 26, no. 6, p. 126, pl. 2, figs. 6, 8.

Description: "Shell bulbous, sloping steeply in lateral profile from the dorsum toward the anterior and posterior canals; spire obscured; sides of shell calloused; callosity of sides extends over lateral margins of dorsum, leaving an undulating pattern on top of the dorsum; pattern superficially recalls the dorsal pattern of *Cypraea spadicea* Swainson; a 4 mm wide shelf is present dorsally over anterior canal, shelf lacking over posterior canal; base convex, upturned at lateral margins, leaving a barely visible ridge at dorsal margin of upturned basal sides, and recalling a similar condition in *Cypraea arenosa* Gray; anterior canal extremity straight ventrally, strongly curved to the left dorsally; posterior canal turned toward the left; anterior canal lips of equal length; anterior canal 3 mm broad by 4 mm wide; terminal ridge of anterior canal sunken; anterior region of outer lip declivous; outer lip teeth approximately 4 mm long; outer lip teeth along anterior one-half of lip have interstices of approximately 1 mm; along posterior one-half interstices are approximately 1.50 wide; anterior columellar teeth over anterior two-fifths of lip exist as nodules, the longest two extending 2 mm into the aperture on the columella of the shell; three poorly developed nonnoduled teeth are present on the central fifth of

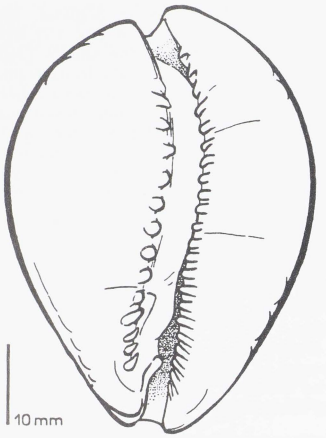


Figure 3a. *Cypraeorbis hertleini* (Ingram); USNM 438581.

the columella; posterior two-fifths of the columella without teeth; barely noticeable depression on columella just posterior to the terminal ridges; columella from terminal ridge to approximately mid-point of its length slightly concave; columella from mid-point to posterior extremity convex; columellar surface just behind terminal ridge approximately 10 mm deep; aperture 5 mm wide anteriorly just behind terminal ridge, and narrowing posteriorly to 3 mm just in front of posterior canal." (Ingram, 1948)

Type material: CAS 8044 (holotype-*hertleini*); height 40 mm, maximum diameter 29.5 mm, dorso/ventral diameter 22.5 mm; about 14 columellar teeth, 21 labral teeth. CAS 8045 (holotype-*apalachicolae*); height 48 mm, maximum diameter 37 mm, dorso/ventral diameter 28 mm; 15 columellar teeth, 22 labral teeth; locality CAS 578, E. L. Packard collector.

Type locality: CAS 578; Chipola Formation, marl bed about twenty feet above the water level, on the left bank of the Apalachicola River, about 3 1/2 miles above Bristow [*sic* = Bristol], at Alum Bluff, Calhoun Co. [*sic* = Liberty Co.], Florida.

Occurrence: Chipola Formation, Florida.

Figured specimens: USNM 438581; height 48.5 mm, maximum diameter 35 mm, dorso/ventral diameter 28.6 mm; 14 columellar teeth, 21 labral teeth; locality TU 458, E. and H. Vokes collectors (fig. 3). USNM 438582; height 50.8 mm; 18 columellar teeth; locality TU 457, E. and H. Vokes collectors (fossula, fig. 4).

Material studied: The two holotypes of Ingram's species were not examined but excellent photographs made by E. and H. Vokes were available. The two specimens figured here (figs. 3, 4) are the only ones seen.

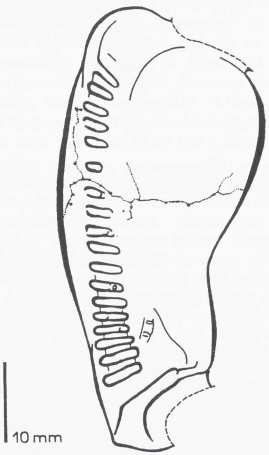
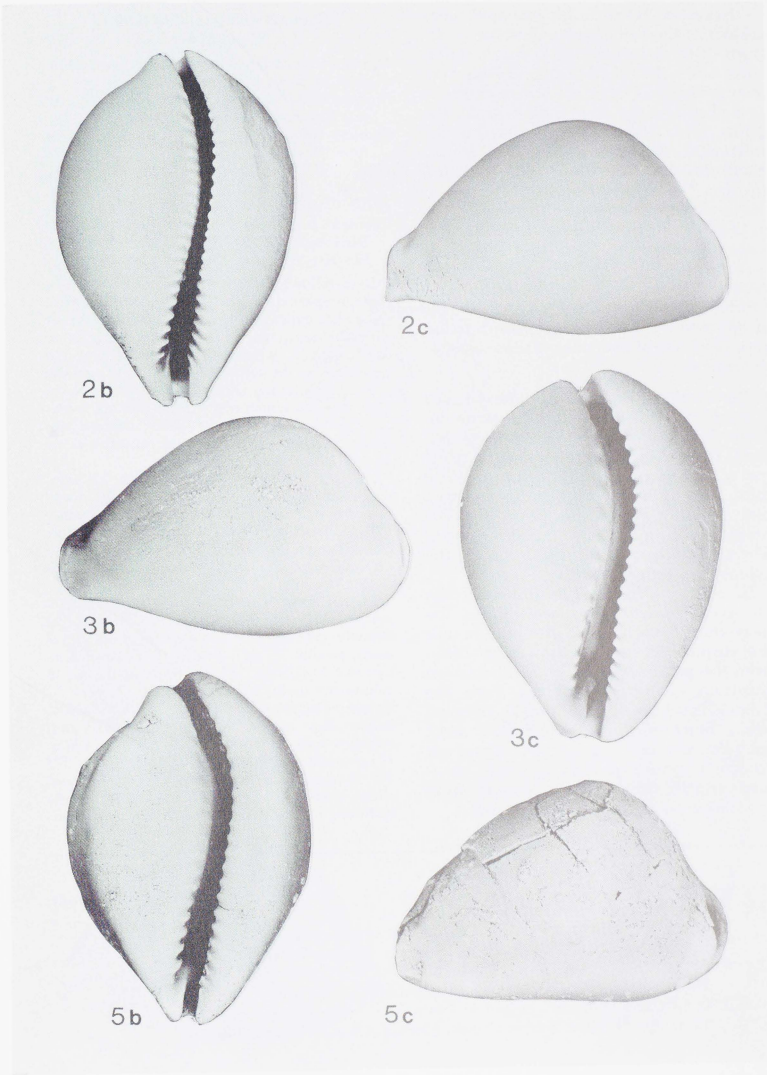


Figure 4. *Cypraeorbis hertleini* (Ingram); USNM 438582.

Figures Page


2b
2c
3b
3c
5b
5c

Discussion: Because his two specimens are not at the same stage of maturity, Ingram (1948) described them as two different species. The shell in *Cypraeorbis hertleini* is distinctly more calloused, ventrally as well as dorsally, than is average for the genus. This tendency involves the development of unusual characters. On one hand, "the upturned margins" of the ventral area "leave a series of small, smooth, barely discernible nodules" (Ingram, 1948, p. 126); but, on the other hand, in all cases, a slightly excavated dorsal sulcus extends up to the angulation of the neck, with the rounding of the back, almost to the zone overhanging the submerged apex. This longitudinal depression corresponds to the zone of joining of two lobes of the mantle of the animal.

Cypraeorbis hertleini is differentiated easily from similar forms in the same deposits by the extreme heaviness of the shell, by the flat dorsoventral outline, by the concave ventral area in the abapical third, convex in the adapical two-thirds, and by the beaded aspect of the less numerous teeth on the columellar margin. The smooth fossula is well detached; the columellar ridge is heavy.

In certain characteristics, notably the massive silhouette that accentuates the heaviness of the shell, *C. hertleini* recalls the Recent *C. venusta* (Sowerby, 1846), from the biotic province of Southwestern Australia. The latter differs from the Chipola fossil by its neck, and its siphonal canal detached relative to the basal area, itself concave and flat, marginate and not convex. *Cypraeorbis venusta* and *C. decipiens* (Smith, 1880) may have come from the cladogenesis of *C. ballista* (below).

CYPRAEORBIS BALLISTA (Dall)
Figures 5-9

Cypraea ballista DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 85, pl. 6, figs. 9-11.

Prolyncina ballista (Dall). SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 45.

Cypraea ballista Dall. INGRAM, 1939, Bulls. Amer. Paleontology, v. 24, no. 84, p. 4(322), pl. 3(21), figs. 3, 4; INGRAM, 1942, Bulls. Amer. Paleontology, v. 27, no. 104, p. 12(102), pl. 1(8), figs. 1, 2.

Cypraeorbis willcoxii ballista (Dall). SCHILDER and SCHILDER, 1971, Mem. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 28.

Description: "Shell small, pyriform, with a slight dimple over the spire, the sides of the base somewhat expanded by callus; aperture rather wide flexuous, with . . . sharp-edged lirae or denticulations, which do not extend over the base, but on the left side pass deeply into the aperture; these are separated by interspaces of greater width which on the right side are somewhat excavated, on the left side rather less so; posterior sinus curved upward, anterior sinus direct." (Dall, 1915)

Holotype: USNM 165098; height 27 mm, maximum diameter 19 mm, dorso/ventral diameter 16 mm; 20 columellar teeth, 25 labral teeth.

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough Co., Florida.

Occurrence: Tampa Limestone, Chipola Formation; Florida.

Figured specimens: USNM 438583; height 51.4 mm, maximum diameter 36.7 mm, dorso/ventral diameter 33 mm; 15 columellar teeth, 22 labral teeth; locality TU 547, E. and H. Vokes collectors (fig. 5). USNM 438584; height 49.9 mm; 18 columellar teeth; locality TU 458, E. and H. Vokes collectors (fossula, fig. 6). USNM 438585; height 48 mm, maximum diameter 32.4 mm (compressed), dorso/ventral diameter 29.4 mm; 17 columellar teeth, 25 labral teeth; locality TU 555, S. and R. Hoerle collectors (fig. 7; 7 c-d under ultra-violet light). USNM 214736; height 40.7 mm, maximum diameter 29 mm, dorso/ven-

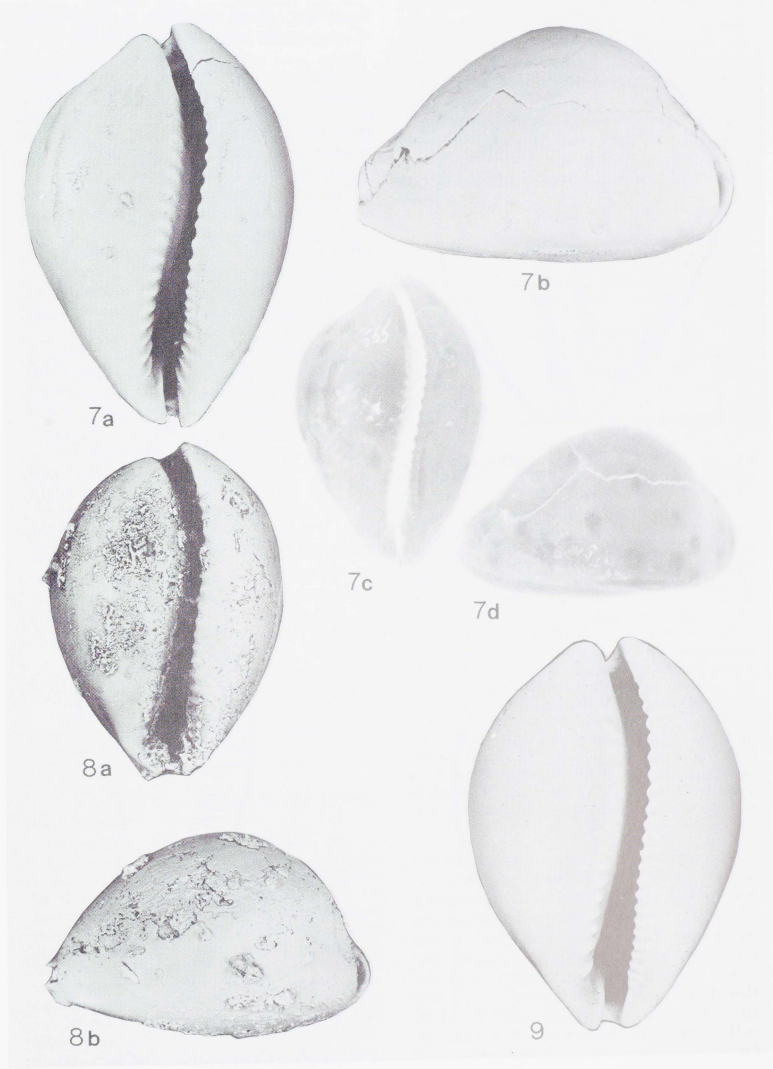
---

Figures Page

7. (7a, b, x 1.5; 7c, d, x 1) USNM 438585; height 48 mm.
Locality: TU 555, Chipola River, Florida. Chipola Formation.

8. (x 1.4) USNM 214736; height 40.7 mm.
Ballast Point, Tampa Bay, Florida. Tampa Limestone.

9. (x 1.6) USNM 438586; height 42.4 mm.
Locality: TU 1049, Farley Creek, Florida. Chipola Formation.


7a
7b
7c
7d
8a
8b
9

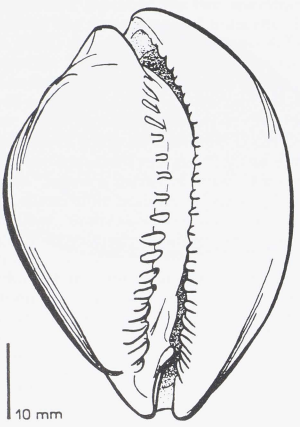


Figure 5a. *Cypraeorbis ballista* (Dall); USNM 438583.

tral diameter 25.4 mm; locality, Ballast Point, E. J. Post collector (fig. 8). USNM 438586; height 42.4 mm, maximum diameter 33.5 mm, dorso/ventral diameter 28.5 mm; 16 columellar teeth, 25 labral teeth; locality TU 1049, E. and H. Vokes collectors (fig. 9).

Material studied: In addition to the holotype, a topotype (fig. 8), was studied. The Hoerle and Vokes collections contain respectively five and ten specimens from the Chipola Formation, distributed thus: on the Chipola River – localities TU 551 (1), 554 (3), 950 (3), 547 (2), 458 (1), 555 (1); on Farley Creek – localities TU 825 (2), 821 (1); on Tenmile Creek – locality TU 951 (1). In the collections of the U. S. National Museum, a specimen (locality USGS 2213; USNM 114099) in the Chipola material studied by Dall was also examined.

Discussion: In the typical form (holotype and fig. 5) the outline is hemispheric in lateral profile, well defined by the thickening of the base at its periphery. Breaking the convexity from the basal side of the juvenile shell, the massive, coarse, anterior flanges cause an upturning of the siphonal canal, characteristic of this species. In the atypical form (figs. 8 and 9), with numerous examples (? sexual dimorphism), the outline is bulging; the margins are regularly inflated. Both morphs may show a large variability in the number of teeth on the inner as well as on the outer lip.

The two specimens from the Tampa Limestone have more modest dimensions, and have a straighter aperture than these from the Chipola Formation; however, a stratigraphic subspecies cannot be recognized with such a poor sampling.

Cypraeorbis ballista has inherited characters appearing notably in *C. spaeroides* (Conrad, 1847) (see MacNeil and Dockery, 1984, pl. 28, figs. 23, 24), from the Early Oligocene of Mississippi. The closest ancestor is a large undescribed species, from the Stampian (Early Oligocene) of Gaas (Adour Basin, France).

Zoila kendengensis Schilder (1941, p. 117, pl. 8, fig. 10), from the Pliocene Poetjangan volcanic facies, of Mt. Goewo (Java, Indonesia), with which *Zoila caputavisensis* Beets (1986, p. 107, pl. 8, figs. 1-9), from the Plio-Pleistocene Klasaman Formation of West Irian (New Guinea), may be a synonym, has a more swollen and heavier shell. The general aspect, the disattachment of the flat basal callus and the free anterior neck, suggests

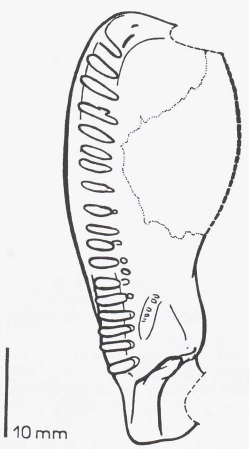


Figure 6. *Cypraeorbis ballista* (Dall); USNM 438584.

both *C. ballista* and *C. decipiens* (Smith, 1880). Schilder (1941) compared his species to the latter. However *Zoila kendengensis* has unusual characters at the level of the posterior canal, which suffice to differentiate it from these two species: extremely deep, it is flanked by two massive auricles, increasing below the spiral zone that is submerged by them.

Cypraeorbis ballista resembles above all *C. decipiens* from the Recent fauna of Broome, Western Australia (see Wilson and McComb, 1967, p. 478, pl. 335, figs. 1-6). The two species are so similar that, originally, the author was tempted to designate *C. ballista* as a Miocene subspecies. Morphologically difficult to separate, the two forms vary in the proportion of the characteristics of the shell. Examination under ultra-violet light indicates that the chromatic characters of *C. ballista* (figs. 7 c-d) anticipate those of *C. decipiens*.

Because of the stratigraphic and geographic separation, it is difficult to consider them conspecific. The Recent species shows a slightly more projecting spire, a shorter outer lip, a more rectilinear aperture and a delicate fossula, which is sufficient to identify it. Retaining taxonomic separation of the two species does not detract from the closeness of the degree of relationship.

Genus ZOILA Jousseaume, 1884

Zoila JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 89.

Type species: *Cypraea scottii* Broderip (= *Cypraea friendii* Gray), by original designation.

Gigantocypraea SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 86 (as *Umbilia* subgenus).

Type species: *Cypraea gigas* McCoy, by original designation.

Description: Shell of large size, fusoid, cabochon-shaped, multiwhorl spire having a slight projection; ventral area totally flattened by development of circumbasal callosity, remarkably bordering extremities; siphonal canal tubular, turned up dorsally and often truncated; aperture regularly parasigmoidal, slightly dilated anteriorly; terminal ridge, fossula, and inner lip cypraeorbiform; posterior canal deep, bordered by extension of broad rounded vertical flanges at posterior extremities of two margins.

Discussion: Certain large examples of *Z. friendii thersites* (Gaskoin, 1849), have an obsolete denticulation on the inner lip, a criterion used to distinguish the genus *Gigantocypraea* from *Zoila*. Therefore, as suggested by Wilson and McComb (1967, p. 467), *Gigantocypraea* is considered a synonym of *Zoila*.

Individuals of *Zoila*, as do those of *Cypraeorbis (sensu* author), feed on sponges and are commonly found perched on sponges in the open (Wilson and McComb, 1967, p. 465).

ZOILA WILLCOXI (Dall)
Figures 10-12

Cypraea willcoxi DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, no. 1, p. 166, pl. 5, figs. 12b, 12c.

Cypraea willcoxii Dall. SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10 pp. 98, 143.

Cypraea willcoxi Dall. INGRAM, 1942, Bulls. Amer. Paleontology, v. 27, no. 104, p. 16(106), pl. 3(10), figs. 8, 9.

Cypraea alumensis INGRAM, 1948, California Acad. Sci., Proc., (Ser. 4) v. 26, no. 6, p. 127, pl. 2, figs. 3, 4.

Cypraeorbis willcoxii willcoxi (Dall). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 28.

Description: "Shell ovate, sloping gently in lateral profile toward the anterior and posterior canals; shelves over both canals, anterior one 2 mm broad, posterior one 4 mm broad; lateral

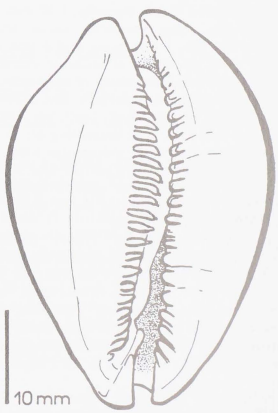


Figure 10a. *Zoila willcoxi* (Dall); USNM 438587.

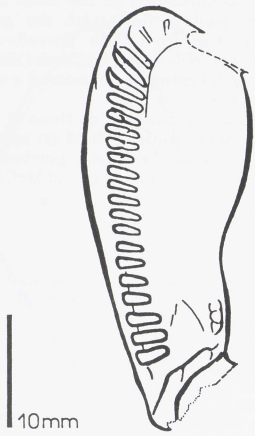


Figure 11. *Zoila willcoxi* (Dall); USNM 438588.

margins calloused; base calloused, convex, angled upward at its union with shell sides; terminal [anterior] ridge extends directly back from columellar side of aperture and bends dorsad into shell; fossula absent; anterior canal straight ventrally, curved to left dorsally, 1.50 mm wide and 3.50 mm long; posterior canal slightly curved to the left, 2 mm wide and 4 mm long; outer lip teeth declivous at anterior extremity; outer lip teeth with interstices of approximately .50 mm, confined to the aperture, and extending dorsad around lip into shell; teeth very minute caudad on outer lip, and extending on to posterior canal; first anterior columellar tooth very elongate, narrow, next two nodule-like, remainder of teeth elongate, fine with broader interstices than those of anterior three teeth." (Ingram, 1948, as *C. alumensis)*

Type material: USNM 112441 (holotype-*willcoxi*); height 46 mm, maximum diameter 32 mm, dorso/ventral diameter 25 mm; 22 labral teeth. CAS 8043 (holotype-*alumensis*); height 28.5 mm, maximum diameter 20.5 mm, dorso/ventral diameter 14.5 mm; 17 columellar teeth, 19 labral teeth; locality CAS 578, Apalachicola River, Liberty Co., Florida; E. L. Packard collector.

Type locality: ?Hawthorn Formation, White Beach, northern part of Little Sarasota Bay, near Osprey, Sarasota Co., Florida.

Occurrence: ?Hawthorn Formation, Chipola Formation; Florida.

Figured specimens: USNM 438587; height 39.3 mm, maximum diameter 25.9 mm, dorso/ventral diameter 20.7 mm; 23 columellar teeth, 22 labral teeth; locality TU 828, E. and H. Vokes collectors (fig. 10). USNM 438588; height 35.8 mm; 20 columellar teeth; locality TU 820, E. and H. Vokes collectors (fossula, fig. 11). USNM 438589; height 33.6 mm, maximum diameter 22.8 mm, dorso/ventral diameter 18.6 mm; 19 columellar teeth, 20 labral teeth; locality TU 820, E. and H. Vokes collectors (fig. 12).

Material studied: The holotype and a specimen from the Chipola Formation cited by Dall (1890 – locality USGS 2213; USNM 112074) were examined. Excellent photographs of the holotypes of Ingram were also studied. In the USNM material collected at the lower beds at Alum Bluff by Burns, there is a sinistral specimen (locality USGS 2211; USNM 114104). No material from White Beach was available.

This species is abundant in the Chipola Formation, the Hoerle and Vokes collections have 34 and 25 specimens, respectively, distributed as follows: Chipola River – localities TU 551 (1), 950 (3), 554 (1); Farley Creek – localities TU 821 (11), 820 (10), 818 (1), 819 (1), 999 (2), 825 (28), 828 (1).

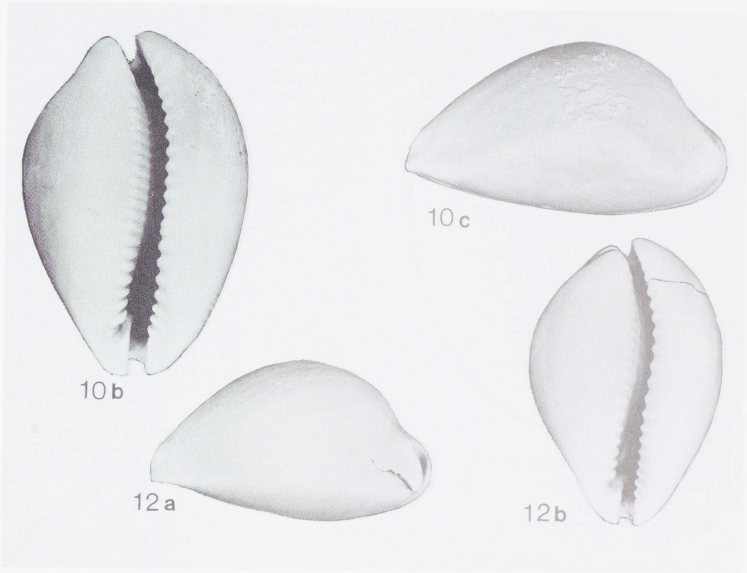
Discussion: As with the majority of living *Cypraeorbis*, *Zoila*, and *Siphocypraea* (Wilson, 1985, pp. 276-279), *Zoila willcoxii* had a direct development. A juvenile specimen shows a spherical paucispiral protoconch (maximum diameter 1.6 mm).

With the depressed outline, the upturned circumbasal callus, the numerous denticulations, Z. *willcoxi* differs from Z. *arlettae* from the same deposits (see below). There is no other species with which to compare it.

Schilder and Schilder (1971, p. 29) considered *Cypraeorbis perplexa* Schilder (1939, p. 22, fig. 22) to be a subspecies of Z. *willcoxi*. Because the specimens from Trinidad are poorly preserved internal molds, this concept is uncertain.

Zoila arlettae Dolin, n. sp.
Figures 13-16

Description: Shell moderately large to large, cabochon-shaped, dorsal side weakly, but regularly inflated and ventral area entirely flat; spire prominent, covered; aperture regularly parasigmoidal, slightly abaxial; deep, straight siphonal canal in basal view; tubular, truncated and pipelike, dorsally rolled up, turned to left in front profile; exhalant channel deeper adaxially toward the left and lengthened by auriform extremities of lips; circumbasal callus not upturned at lateral margins, making a true ridge



Figures Page

10, 12. *Zoila willcoxi* (Dall, 1890) 11

10. (x 1.5) USNM 438587; height 39.3 mm.
Locality: TU 828, Farley Creek, Florida. Chipola Formation.

12. (x 1.5) USNM 438589; height 33.6 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.

---

line; abapical crease abaxially flat to rather concave; columellar teeth bounded by angulation of columellar area, strong, short (less than 2 mm), regularly spaced, sometimes poorly developed over posterior two-fifths of inner lip in sub-adult samples; labral teeth also strong, disposed at equal length and bounded at adaxial margin of outer lip, short, especially on anterior portion; terminal ridge declivous, at approximately 45°; fossula shallow, concave, inner margin calloused, making a border. Color pattern on dorsum of minute points, concentrated apically; under ultraviolet light juvenile color streaks appearing on dorsum, circumbasal callus dotted by medium-sized points, with a very large dark blotch, adaxially centered, marking base of inner lip, midway between extremities.

Holotype: USNM 438590; height 45.5 mm, maximum diameter 32.5 mm, dorso/ventral diameter 23.6 mm; 18 (+ 1) columellar teeth, 22 labral teeth; S. and R. Hoerle collectors (fig. 13).

Paratype A: USNM 438591; height 46.9 mm, maximum diameter 30.9 mm, dorso/ventral diameter 24.5 mm; about 16 (sub-adult) columellar teeth, 20 labral teeth; locality TU 1050, S. and R. Hoerle collectors (fig. 14).

Paratype B: USNM 438592; height 44 mm; 18 columellar teeth; locality TU locality TU 819, T. and L. Dolin collectors (fig. 16, under ultraviolet light).

Type locality: TU 820; Chipola Formation, Farley Creek, north bank, just east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

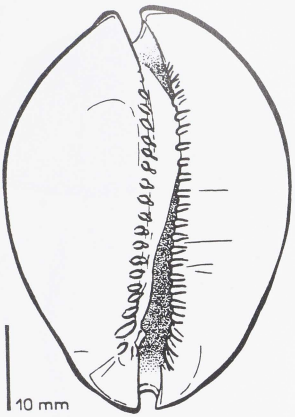


Figure 13a. *Zoila arlettae* Dolin, n. sp.; USNM 438590 (holotype).

Occurrence: ?Hawthorn Formation, Chipola Formation; Florida.

Material studied: Dall (1890, p. 166) included a specimen of this species (paratype-*Z. willcoxi*, USNM 112440, from the ?Hawthorn Formation, White Beach) with the one he dedicated to Mr. Willcox. There are six specimens collected by Hoerle and Vokes, distributed thus: Chipola River – localities TU 456 (1), 1050 (1), 459 (1); Farley Creek – localities TU 818 (1), 820 (2); and one in the Dolin collection (TU 819). Another example of this species was identified in the material from the Chipola Formation studied by Dall (locality USGS 2213; USNM 114099).

Discussion: *Zoila willcoxi* and *Z. arlettae* are related; however, the latter is always larger. The difference in the median length is, respectively: 46 mm against 60 mm in the ?Hawthorn Formation (southern Florida); 33.7 mm against 43.7 mm in the Chipola Formation (northern Florida). Both species attained a larger size in southern Florida. *Zoila arlettae* differs from *Z. willcoxi* in the flat ventral area, the exhalant channel prolonged into flattened auricles, and the looser denticulation for a medium-large size.

"Zoila" gendinganensis Martin (1899, p. 167, fig. 385), from the Pliocene(?) of the Sunda Islands (Indonesia), resembles *Z. arlettae* in the outline, the cabochon-shaped aspect, and the dimensions of the flat base, but it differs radically by its siphonal canal and exhalent channel, its well-separated, deep bridges, and by the more dense and heavy denticulation. The original illustration suggests that *"Zoila" gendinganensis* may be an atypic member of another genus, *Barycypraea* Schilder, 1927.

Indeed, it is to *Z. marginata* (Gaskoin, 1849) (see Wilson and McComb, 1967, p. 479, pl. 335, figs. 7-9; pl. 342) and especially *Z. rosselli* Cotton, 1948 (*ibid.*, p. 481, pl. 335, figs. 10-12) that *Z. arlettae* is most closely related, both morphologically and chromatically. The Recent forms present a circumbasal callus even more margined, a denticulation much more numerous, and a spire slightly more projecting; the generic characters (terminal ridge, fossula) appear "blurred."

Etymology: I dedicate this species to my mother, Arlette Dolin, who encouraged my brother and I in our paleontologic passion from a young age.

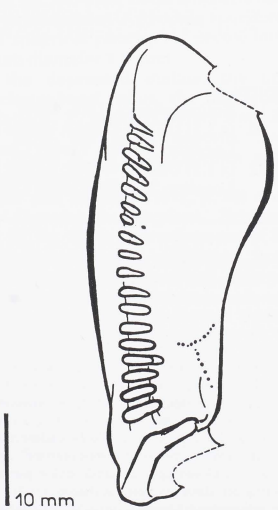
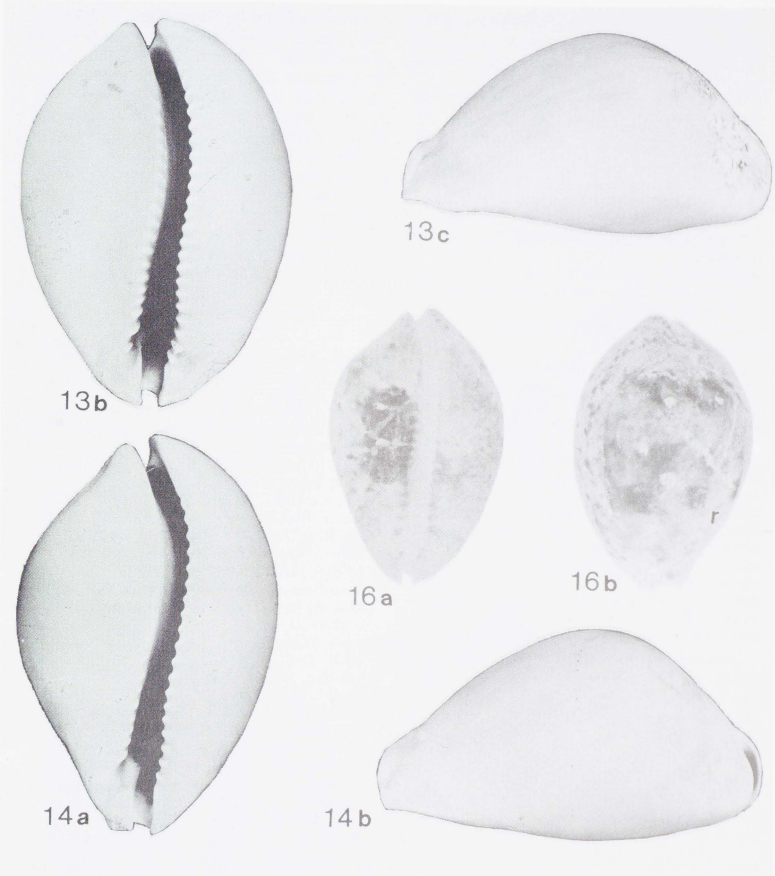


Figure 15. *Zoila arlettae* Dolin, n. sp.; USNM 438592 (paratype B).



Figures Page

13, 14, 16. *Zoila arlettae* Dolin, n. sp 12

13. (x 1.4) USNM 438590 (holotype); height 45.4 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.

14. (x 1.4) USNM 438591 (paratype A); height 46.9 mm.
Locality: TU 1050, Farley Creek, Florida. Chipola Formation.

16. (x 1.1) MNHN (paratype C); height 42.5 mm.
Locality: TU 819, Farley Creek, Florida. Chipola Formation.

Genus SIPHOCYPRAEA Heilprin, 1886

Siphocypraea HEILPRIN, 1886, Wagner Free Inst. Sci., Trans., v. 1, p. 86 (as *Cypraea* subgenus).

Type species: *Siphocypraea problematica* Heilprin, by monotypy.

?*Cypraeactaeon* WHITE, 1887, Arch. Mus. Nac. Rio de Janeiro, v. 7, p. 176.

Type species: *Cypraeactaeon pennai* White (? = *Cypraea henekeni* Sowerby), by monotypy.

Muracypraea WOODRING, 1957, Nautilus, v. 70, p. 89.

Type species: *Cypraea mus* Linné, by original designation.

Akleistostoma GARDNER, 1948, U. S. Geol. Surv., Prof. Paper 199-B, p. 213 (as *Cypraea (Cypraeorbis)* section).

Type species: *Cypraea carolinensis* Conrad, by monotypy.

Description: Shell turtle-shaped with a smooth ventral area, strongly humped, spire depressed; siphonal canal forming a neck, set off relative to level of ventral area; most often prolonged by spatulate horizontal extensions of two margins; terminal ridge and its inner edge having a tendency to be elongated horizontally; fossula deep and concave, becoming reduced and disappearing after the Pliocene; likewise, the abrupt inner margin having a tendency to be depressed; exhalant channel very deep; "a deep comma-shaped sulcus or depression, occupying the apical portion of the shell, and which, as the posterior continuation of the aperture, is curved dextrally around the axis of involution" (Heilprin, 1886, p. 86) exceptionally developed.

Discussion: According to Cernohorsky (1965, p. 124), Heilprin and subsequent workers have exaggerated the importance of the deepening and prolonging of the exhalant channel, which developed from the offsetting of the two margins. This evolution appears to have given rise to the Miocene species. In the type species this spiral depression appears almost pathologic.

As Liltved and Le Roux (1988, p. 402) reveal, fossil as well as living members of *Muracypraea* (Woodring, 1957) and *Barycypraea* (Schilder, 1927) appear conchologically close. It may be necessary to synonymize the latter also, if additional data confirm this similarity.

Petuch (1979, pp. 217-220, fig. 2) has summarized the habits and the anatomy of the single Recent species of this typically Caribbean genus (although two Aquitanian species of *Siphocypraea* are herein reported from the environs of Bordeaux, France.

SIPHOCYPRAEA CHILONA (Dall)
Figures 17-21

Cypraea chilona DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, pl. 39, figs. 1, 3; not in text.

Cypraea sp. COOKE, 1919, Carnegie Inst. Washington, Publ. 291, no. 4, p. 115 (*fide* Woodring, 1959).

Cypraea chilona Dall. SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 98.

Cypraea chilona Dall. INGRAM, 1939, Bulls. Amer. Paleontology, v. 24, no. 84, p. 4(322), pl. 1(21), figs. 3, 4; INGRAM, 1942, Bulls. Amer. Paleontology, v. 27, no. 104, p. 13(103), pl. 1(8), figs. 7, 8.

Siphocypraea angustirima hyaena SCHILDER, 1939, Abhandl. Schweizer. Palaeont. Gesell., v. 62, p. 23, fig. 24.

Cypraea (Cypraeorbis) chilona Dall. GARDNER, 1947, U. S. Geol. Surv., Prof. Paper 142-H, p. 541, pl. 54, figs. 4, 5.

Cypraea (Cypraeorbis) tapeina GARDNER, 1947, U. S. Geol. Surv., Prof. Paper 142-H, p. 541, pl. 54, figs. 7, 8.

Cypraea cf. *chilona* Dall. WOODRING, 1959, U. S. Geol. Surv., Prof. Paper 306-B, p. 193.

Siphocypraea (Siphocypraea) chilona (Dall). OLSSON and PETIT, 1964, Bulls. Amer. Paleontology, v. 47, no. 217, p. 560, pl. 83, fig. 6.

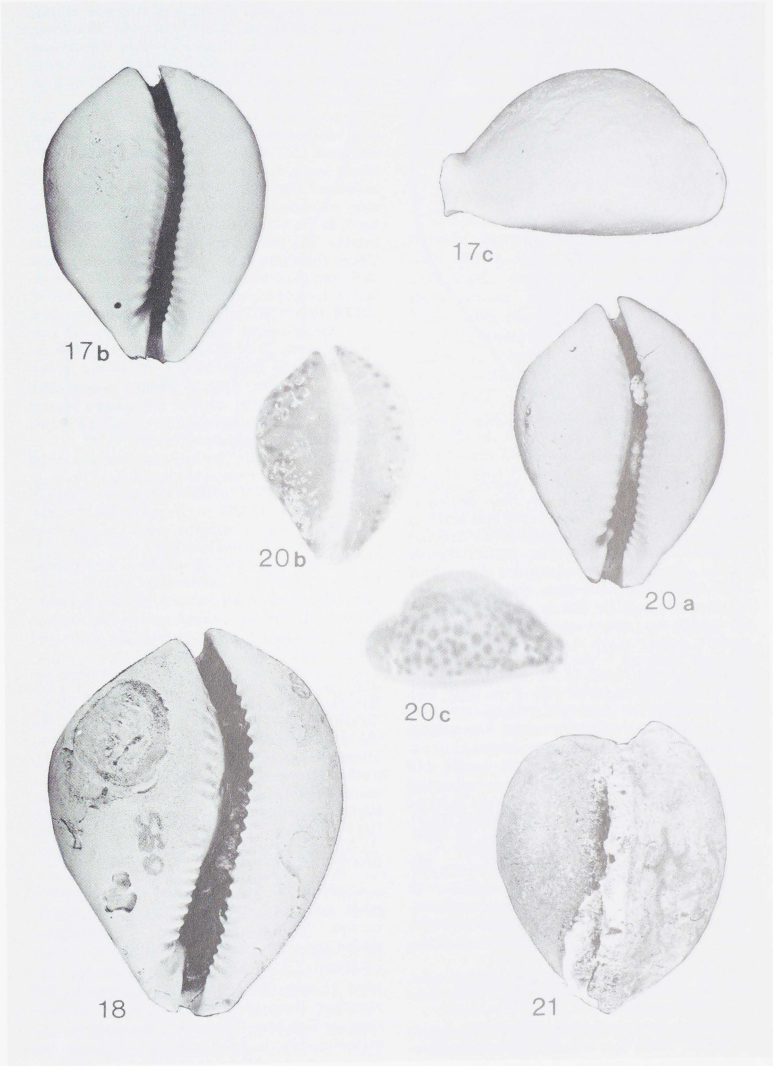
Figures Page

17. (x 1.7) USNM 438593; height 30.4 mm.
Locality: TU 825, Farley Creek, Florida. Chipola Formation.

18. (x 1.1) USNM 438594 (giant specimen); height 59.1 mm.
Locality TU 550, Chipola River, Florida. Chipola Formation.

20. (20a, x 1.4; 20b, 20c x 1) USNM 438596; height 36.3 mm.
Locality: TU 825, Farley Creek, Florida. Chipola Formation.

21. (x 1.7) USNM 438597 (internal mold); height 30.8 mm.
Locality: TU 196, Tenmile Creek, Florida. Chipola Formation.


17b
17c
20b
20a
20c
18
21

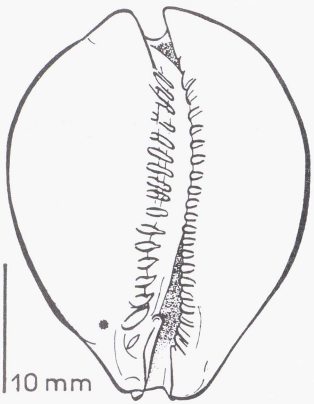


Figure 17a. *Siphocypraea chilona* (Dall); USNM 438593.

Description: "Shell rotund, heavy, anterior canal very slightly produced; base angled at outer margins on both columellar and outer lip sides; anterior canal straight, about 4 mm broad at point of maximum width; posterior canal curved, about 5 mm broad at point of maximum width; the strange curvature of the aperture at the center is possibly due to a malformation of the shell in this region; anteriorly the aperture is straight, posteriorly it is curved to the left; the aperture is about 6 mm broad at the point of maximum width; teeth heavy, rounded, indefinite toward the posterior end of the base; incisures between the teeth broad." (Ingram, 1939)

Type material: USNM 498388 (*ex* USNM 164928 [Dall's fig. 1], lectotype-*chilona*, designated by Ingram 1939, p. 5[323]); height 44.8 mm, maximum diameter 36.5 mm, dorso/ventral diameter 25.6 mm; 18 columellar teeth, 24 labral teeth. USNM 497120 (*ex* USNM 164928 [Dall's fig. 3], paratype-*chilona*, designated by Gardner, 1947, p. 541); maximum diameter 51.1 mm; height incomplete. USNM 497854 (holotype-*tapeina*); height 33 mm, maximum diameter 24 mm, dorso/ventral diameter 19 mm; 15 columellar teeth, 19 labral teeth; locality USGS 14436, Shoal River Formation, Whites Creek, near Argyle, Walton Co., Florida.

Type locality: USGS 2211; Chipola Formation, lower bed, Alum Bluff, Apalachicola River, Liberty Co., Florida.

Occurrence: Curamichate Sand, Venezuela (Schilder, 1939); Quebrancha Limestone Member, Caimito Formation, Panama; Emperador Limestone Member, Culebra Formation, Panama; Anguilla Formation, Anguilla Island; Güines Limestone, Cuba (all *fide* Woodring, 1959); Aquitanian, France; Baitoa Formation, unnamed Late Miocene formation, Dominican Republic; Chipola Formation, Shoal River Formation, Florida.

Figured specimens: USNM 438593; height 30.4 mm, maximum diameter 22.8 mm, dorso/ventral diameter 17.2 mm; 16 (+ 1) columellar teeth, 21 labral teeth; locality TU 825, E. and H. Vokes collectors (fig. 17). USNM 438594; height 59.1 mm, maximum diameter 45.3 mm (top is broken); 19 (+ 1) columellar teeth, 15 labral teeth; locality TU 550 (giant specimen), E. and H. Vokes collectors (fig. 18). USNM 438595; height 35.6 mm; 17 columellar teeth; locality TU 830, S. and R. Hoerle collectors (fossula, fig. 19). USNM 438596; height 36.3 mm, maximum diameter 26.6 mm, dorso/ventral diameter 21.4 mm; 15 columellar teeth, 22 labral teeth; locality TU 825, S. and R. Hoerle collectors (fig. 20; 20 b,c under ultra-violet light). USNM 439597; height 30.8 mm, maximum diameter 25 mm, dorso/ventral diameter 20 mm (internal mold); locality TU 196, E. and H. Vokes collectors (fig. 21).

Material studied: The lectotype and paratype and the other specimens studied by Dall (locality USGS 2211, USNM 164928 – 3 specimens; USGS 2213, USNM 112074 – 2 specimens) were examined. The specimens cited by Gardner were verified to be this species.

Rare and localized, *S. chilona* is reported herein from Breyra in the Aquitanian (lower Early Miocene) of Bordeaux (Gironde, France). Three of the six specimens in private collections were examined. They are strongly calloused and average 35 mm in height.

The species is also found in the Baitoa Formation (loc. TU 1226) and an unnamed Late Miocene formation (loc. TU 1443) (E. and H. Vokes collectors) in the Dominican Republic. In the Chipola Formation, it is one of the more abundant species. In the Hoerle and Vokes collections there are seven and eight specimens, respectively, distributed as follows: Chipola River – localities TU 550 (1), 551 (1), 547 (1), 553 (1); Farley Creek – localities TU 825 (5 + 2), 999 (1); Tenmile Creek – localities TU 196 (1 internal mold), 830 (1), 951 (1).

Discussion: Siphocypraea chilona had a wide geographic and stratigraphic distribution. The Panamanian, Venezuelan, and Cuban formations attributed to the Chattian (Late Oligocene) or to the Aquitanian (Early Miocene) may prove to be younger than thought by Cooke, Woodring, or Schilder. However, the species unquestionably is found in the Aquitanian (lower Early Miocene) beds at Breyra (Gironde, France), which are placed in the

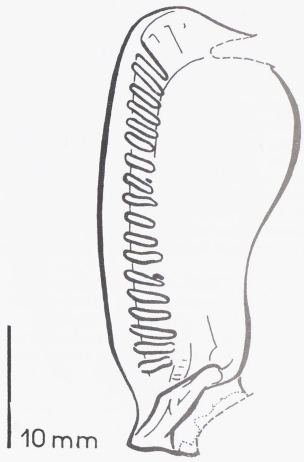


Figure 19. *Siphocypraea chilona* (Dall); USNM 438595.

nannofossil zone NN 1 of Martini, by Magne *et al.* (1987, p. 105, tab. 2). It also occurs in the Chipola Formation, which Akers (1972, p. 9) placed in planktic foraminiferal zones N.7-8 (= NN 4-5). In the Dominican Republic, it is present in the Baitoa Formation and in an unnamed formation that is the equivalent of the Cercado Formation. Saunders *et al.* (1986, p. 36) place the first of these formations in nannofossil zone NN 4-6, the second at the top of zone NN 11.

Siphocypraea chilona is recognizable by its turtle-shape, with a flat smooth base, margined at 90°, and its labral teeth, which are numerous and fine (as if pinched). Despite a larger size, the species named *Cypraea (Cypraeorbis) tapeina* by Gardner (1947) cannot be separated. *Siphocypraea chilona* cannot be confounded with *Zoila willcoxi* in the Chipola Formation.

Siphocypraea angustirima hyaena Schilder (1939, p. 23, fig. 24), described from the Curamichate Sand (?Early Miocene), Venezuela, is based upon an altered and truncated specimen. Thus, the characteristics of the siphonal canal, the terminal ridge, the fossula (still in the matrix), and the outer lip are unknown. However, the dimensions of the specimen (height about 36 mm), the width of the circular, callused base, strongly margined posteriorly, the straightness of the inner lip, "tuberculiform then elongated," but narrow, and the color pattern visible on the circumbasal callus and on the dorsal area, composed of "heavy brown drops as in *Barycypraea fultoni*," leaves no doubt as to its synonymy with *C. chilona*.

The chromatic characters cited above by Schilder are visible under ultra-violet light (figs. 20 b, c) in all of the specimens examined, as well as in the related *Barycypraea zietsmani* Liltved and Le Roux (1988, fig. 3). They may have evolved from *Cypraeorbis* and may be considered ancestral (plesiomorphs). It is by coalescence of the heavy points on the ventral area that the basal and circumbasal flamules of *S. henekeni* (Sowerby, 1850) (see Pflug, 1961, p. 30, pl. 5, figs. 1-8), *S. transitoria* Olsson and Petit (1968, pl. 18, fig. 1), and *S. mus* (Linné, 1758) (Olsson and Petit, 1968, pl. 18, fig. 3) are derived.

Morphologically, *S. chilona* is most closely related to *S. henekeni* (with which it is sympatric in the Dominican Republic) and to *S. orbignyana* (Grateloup, 1845), (see Cossmann and Peyrot 1924, as *Cypraea (Bernaya)*, p. 375, pl. 9, figs. 19, 20; pl. 17, figs. 26, 27). It has the same outline, the same siphonal canal raised relative to the ventral area, and the adapical extension of the lips. In *S. henekeni*, the anterior extremities of the two lips are widened and prolonged by two horizontal flanges that are observed in many Pliocene species of the group; also, the enlarged circumbasal callosity ascends and forms two horns above, which sometimes accompany a third dorsal swelling.

In Aquitaine (France), *S. chilona* and *S. orbignyana* cannot be confused. The latter has a thin shell, with fine, elongate columellar teeth, a straight siphonal canal, a convex basal area, and a more recurved posterior canal.

Subfamily CYPRAEINAE Gray, 1824
Genus TRONA Jousseaume, 1884

Trona JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 89.
Type species: *Cypraea stercoraria* Linné, by

monotypy.

Basterotia BAYLE *in* JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 95 (not *Basterotia* Hoernes, 1859)

Type species: *Cypraea leporina* Lamarck, by monotypy.

Cavicypraea COSSMANN, 1896, Feuille Jeunes Naturalistes (3), v. 26, no. 303, p. 48 (nom. nov. pro *Basterotia* Bayle *in* Jousseaume, 1884 (as *Cypraea* subgenus).

Description: Shell of large size, ovoid to hemispheric, ventral area flattened by development of lateral margin callus, bordering extremities; spire multiwhorl, slightly projecting; aperture parasigmoidal, widely spread on anterior third; siphonal canal orthogonally truncated, underscored by spatulate abapical extension of margins; terminal ridge sunken, merging with first elongated teeth of inner margin; inner edge denticulated abaxially, passing without true limit to a wide, deep, and strongly excavated spoon-like fossula, which characterizes the genus; inner margin forming a sort of fold, crowning teeth in beads, extending over aperture; fossula crossed by long, more or less interrupted cords, or by pustules, or by a combination of the two; teeth of inner margin extended deeply on columellar area.

Discussion: The related group of *Macrocypraea* Schilder, 1930 (type species: *C. zebra* Linné) differs from the genus *Trona* in the terminal ridge and fossula, recalling the genus *Mauritia* (s.l.) of Troschel. Members of the genus *Trona*, which first appeared in the Late Oligocene, are an important characteristic component of the European Miocene fauna. *Trona* is represented in the Recent fauna only by the West African species *T. stercoraria* (Linné, 1758).

Trona leporina calhounensis Dolin, n. subsp.
Figure 22

Description: Large, light-weight, subcylindrical shell, posteriorly swollen; in lateral profile the dorsal curvature, regularly attenuated abapically, joining two extremities; ventral area slightly convex in anterior two-thirds; spire projecting, covered by adapical callus; sides rounded, not calloused; aperture parasigmoidal, anteriorly dilated by hemispherical expansion, affecting each lip in first third; siphonal canal deep, abaxially asymmetrical and abapically orthogonally truncated; exhalant channel deeper, limited by parallel lips; five strong anterior columellar teeth, well spaced; other numerous inner lip teeth parallel, bituberculated, 6 mm in length on the columellar area, abrupt; all restricted to angulation of basal and columellar planes; first third of labral lip teeth stretched out on constricted, depressed, hemicircular area; remainder short, heavier; terminal ridge obsolete, flexuous, merging into abapical edge, fringed with denticles from fossula into inner margin; the deep, concave, spoon-like fossula covered by ridges, sometimes interrupted, joining fossular denticulation to anterior columellar teeth. Ventral area and dorsal zone spotted; dorsal bands of juvenile appearing under ultra-violet light.

Holotype: UNSM 438598, height 60.8 mm, maximum diameter 39.3 mm; 28 + 1 columellar teeth, 28 labral teeth; E. and H. Vokes collectors (figs. 22).

Paratype: USNM 438599; height 49.2 mm (deformed), 29 columellar teeth, 27 labral teeth; locality TU 820, E. and H. Vokes collectors.

Type locality: TU 820, Chipola Formation, Farley Creek, north bank, just east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W). Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: In addition to the holotype and the paratype, four specimens coming from the Hoerle collection were examined. A seventh example (paratype MNHN, locality TU 819) is unfortunately worn. This subspecies has been collected only in the beds along Farley Creek (localities TU 819, 820, 825, and 999).

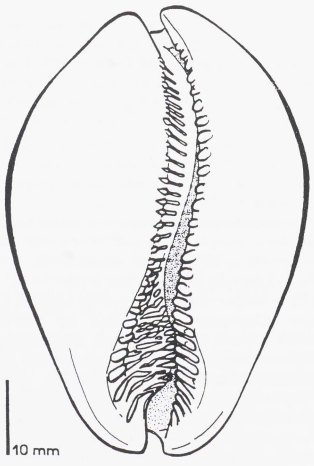
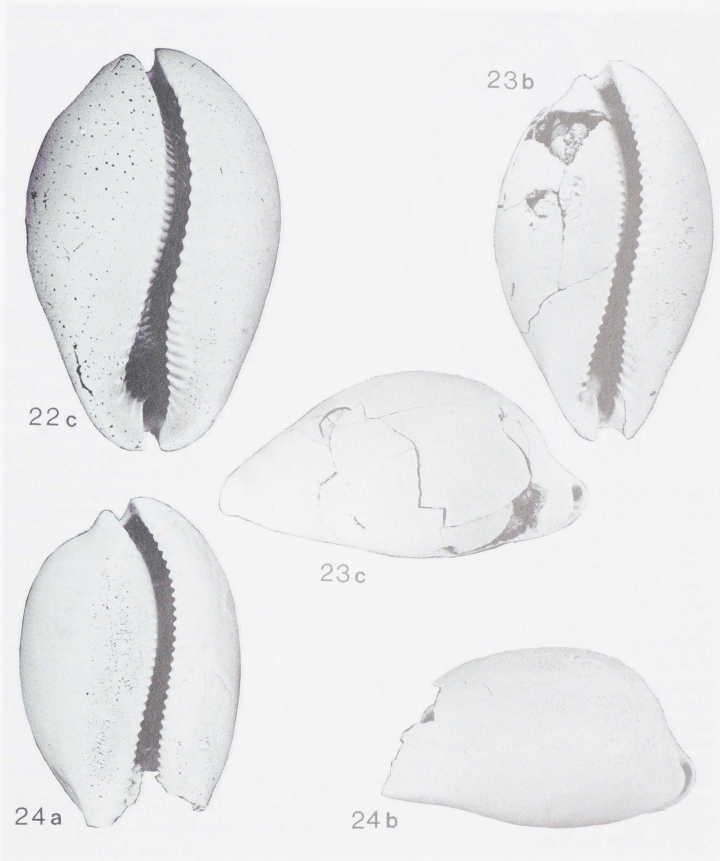


Figure 22a. *Trona leporina calhounensis* Dolin, n. subsp.; USNM 438598 (holotype).



Figures Page

22. *Trona leporina calhounensis* Dolin, n. subsp 20
(x 1.2) USNM 438598 (holotype); height 60.8 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.

23, 24. *Talparia (Talparia) dominicensis* (Gabb, 1873) 23

23. (x 1.4) USNM 438600; height 48 mm.
Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.

24. (x 1.4) USNM 438601; height 41 mm (siphonal canal broken).
Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.

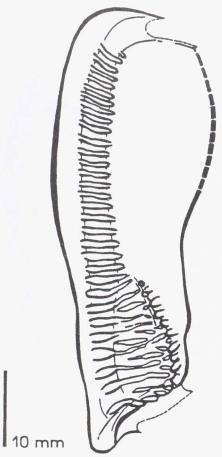


Figure 22b. *Trona leporina calhounensis* Dolin, n. subsp.; USNM 438598 (holotype).

Discussion: Trona leporina calhounensis is the second example of the genus in the New World. The specimen of *Trona*, erroneously referred to *trinitatensis* Mansfield, 1925, by Schilder (1939, p. 30, fig. 32), from the early Middle Miocene Grand Bay Formation, Carriacou Island, differs little from the Chipola Formation specimens; both have the same fusiform outline, the dense denticulation of the inner margin, and the pointed posterior extremity. The figures given by Jung (1971, pl. 8, figs. 1-3) do not adequately show details of the fossula for comparison with Florida and European specimens.

Trona leporina leporina (Lamarck, 1810) (see Cossmann and Peyrot, 1924, pl. 9, figs. 11-12) from the Burdigalian (late Early Miocene), at the type locality of Moulin de Cabanes, Parish of St. Paul-les-Dax (Landes, France) is more cylindrical, less basally flattened, and has a thickened lateral marginal callus. A calloused collar surrounds the exhalant channel. The fossula is sculptured by an alteration of heavy, interrupted ridges, and by fine aligned punctations. These characters are found only in the synchronous population from the Turin Hills (Italy), denominated *Cypraea lyncoides* Brongniart, 1823.

In the late Burdigalian in the vicinity of Mont-de-Marsan (Landes, France) there is another undescribed form. The outline is more ovoid than cylindrical and the fossula is irregularly sculptured by wide, heavy pustules.

Observations of these populations reveal that the species may be ovoid, or flattened (by development of the lateral margin callus), or cylindrical; the fossula may be sculptured by ridges, or tubercules, or both. Evolutionary or adaptative indicators may be responsible for the modification of the silhouette of the shells. The sculpture of the fossula may be an expression of ecophenotypic variation or an expression of reproductive isolation. *Trona stercoraria* (type of the genus), despite a distinct dimorphism (sexual ?), is an extremely stable species in all of its characteristics.

Taxonomic problems of the Chipola Formation fauna must be resolved. The population of the Chipola Formation cannot be confused with the more or less synchronous populations from the European Burdigalian; it is biogeographically parapatric. *Trona leporina calhounensis* is defined to indicate its taxonomic distinctness at the subspecific level. The definition of this subspecies bestows a purely typological value expressed by the author. It does not definitely demonstrate the sequence of changes leading to the Recent *T. stercoraria*, nor does it show the process of sporadic changes that could have happened – notably at the Paleogene/Neogene boundary – between the two peri-Atlantic faunalistic provinces, now disjunct.

Etymology: This subspecies is named for Calhoun County, Florida.

Genus TALPARIA Troschel, 1863
Subgenus TALPARIA Troschel, 1863

Talparia TROSCHEL, 1863, Das Gebiss der Schnecken, v. 1, pp. 204, 206 (as *Cypraea* subgenus).

Type species: *Cypraea talpa* Linné, by subsequent designation (Schilder, 1924).

Tessellata JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 97.

Type species: *Cypraea tessellata* Swainson, by original designation.

Basilitrona IREDALE, 1930, Mem. Queensland Mus., v. 10, p. 83.

Type species: *Cypraea isabella* Linné, by original designation.

Fossacypraea SCHILDER, 1939, Arch. Mollusk., v. 71, pp. 167, 178.

Type species: *Cypraea hieroglyphica* Schilder, by original designation.

Description: Shell cylindriform, spire very slightly projecting, with a bridge-like neck, set off, separated relative to ventral area; terminal ridge short, submerged in a thickened horizontal plane, forming a "T" with vertical internal lamella, flattened and spatulate at extremity; in early species fossula totally smooth, spoon-like, excavated; fossula of later species always deep, but more weakly concave, crossed by ridges issuing from inner margin; internal peristome in every case crowned by heavy teeth forming projections into aperture; inner margin remarkably straight; denticulation limited basally by angulation of basal and columellar areas.

Discussion: Cernohorsky (1965, p. 124) has pointed out that *Talparia talpa* (Linné, 1758), *Basilitrona isabella* (Linné, 1758), *Luria cinerea* (Gmelin, 1791), and *Tessellata tesselata* (Swainson, 1822), have a common "R2" radula pattern (see Kay, 1960, p. 280, figs. 2, 3) and display a similar mantle pattern. Conchological features of fossil and living species agree with this combination. The monospecific genus *Fossacypraea* Schilder, 1939, from the Middle Miocene of Hungary, is also synonymized here.

The subgenus *Luria* Jousseaume, 1884 (type species: *C. lurida* Linné, 1758) differs by its siphonal canal, which is in the plane of the ventral area, by the collar, which constitutes a massive posterior bridge and, especially, by the clearly depressed inner margin; the denticulation of the inner margin appears, in this case, at the angulation and is elongated on the basal area. This last criterion may permit the discrimination of the fossil species of *Talparia* s.s., differentiated since the Late Oligocene (Dolin, in prep.), from the earliest species of *Luria*.

TALPARIA (TALPARIA) DOMINICENSIS (Gabb)
Figures 23, 24

Cypraea dominicensis GABB, 1873, Amer. Phil. Soc., Trans., v. 15, p. 236; PILSBRY, 1922, Acad. Nat. Sci. Philadelphia, Proc., v. 73, p. 364, pl. 30, figs. 7, 8.

Luria dominicensis (Gabb). SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 101.

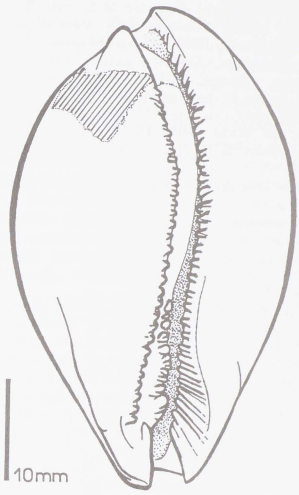


Figure 23a. *Talparia (Talparia) dominicensis* (Gabb); USNM 438600.

Jousseauma joossi SCHILDER, 1939, Abhandl. Schweizer. Palaeont. Gesell., v. 62, p. 23, fig. 23.

Cypraea fossula INGRAM, 1947, Bulls. Amer. Paleontology, v. 31, no. 121, p. 4(128), pl. 1(8), fig. 3.

Macrocypraea cervinetta fossula (Ingram). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 33.

Jousseauma joossi Schilder. SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 39.

Luria dominicensis dominicensis (Gabb). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 40.

Description: "Shell very similar to *C. lurida* in form, sides subparallel, anterior end tapering more than the posterior, base slightly flattened; inner lip flexuous in advance, teeth small, very numerous and not extended over the base." (Gabb, 1873)

Type material: ANSP 3003 (lectotype-*dominicensis*, designated by Pilsbry, 1922, p. 364); height 39.5 mm, maximum diameter 23.5 mm, dorso/ventral diameter 19 mm; 29 columellar teeth, 36 labral teeth; locality unknown, Dominican Republic. NMB 1835 (holotype-*joossi*); height 37 mm, maximum diameter 26

mm, dorso/ventral diameter 18.25 mm; 23 columellar teeth, 21 labral teeth (internal mold, broken); locality "Old Adivinanza Quarry" near San Fernando, Cocoa Estate, Trinidad, E. Strasser collector. UCMP 35526 (holotype-*fossula*); height 43 mm, maximum diameter 36 mm, dorso/ventral diameter 21 mm; 20 columellar teeth, 28 labral teeth; UCMP locality S-8360 (Venezuela), S. B. Henry and J. P. Bailey collectors.

Type locality: Dominican Republic (Gabb, 1873).

Occurrence: Brasso Formation, Trinidad (Schilder, 1939); Cantaure Formation, Venezuela (Ingram, 1947); Burdigalian, France; ?Baitoa Formation, Dominican Republic; Chipola Formation, Florida.

Figured specimens: USNM 438600; height 48 mm, maximum diameter 28.3 mm, dorso/ventral diameter 24.3 mm; 30 columellar teeth, 33 labral teeth; locality TU 546, E. and H. Vokes collectors (fig. 23). USNM 438601; height 41 mm (siphonal canal broken), maximum diameter 28 mm, dorso/ventral diameter 24.3 mm; 31 columellar teeth, 30 (+ ?) labral teeth; locality TU 546, S. and R. Hoerle collectors (fig. 24).

Material studied: Primary types were not examined but hypotypes from the Chipola Formation were studied. This is the first report of the species from Europe, in the beds at Moulin de Cabanes, Parish of St. Paul-les-Dax (Landes, France). Two specimens from there were examined (MNHN, H. Senut and P. Lozouet collectors).

Discussion: Gabb augmented the diagnosis of his species *dominicensis* by comparing it with related Recent species, notably *Talparia (Luria) lurida* (Linné, 1758); he specifies that in *T. (T.) dominicensis* the teeth are, in comparison, "small, regular, uniform and end abruptly along a straight line" (Gabb, 1873, p. 236). He reveals thus, inadvertantly, a character having subgeneric value. Pilsbry (1922, p. 364) added that the shell is much more produced, and acuminate at the extremities.

The characteristics of the terminal ridge, as well as of the inner edge, and of the fossula, are unknown, but it is possible to reconstruct them on the basis of other examples studied. The terminal ridge is constituted by a heavy, horizontal, axial lamella; its inner edge is imbricated, prolonged by a spatulate termination, projecting adaxially. The fossula is clearly separated by a depression, which is spoon-like, although less well developed and excavated than in the genus *Trona*. The shell is perfectly smooth, naked, lacks ridges, and has seven or eight inner denticles in beads thickening the peristome.

This species is further distinguished by its dimensions, the cylindrical outline, the fine, dense denticulation, the extremities underscored by the heavy lateral margin callus, conferring on the ventral area a flat, marginated aspect. The rare examples show little variation.

Paradoxically, the two specimens from the Chipola Formation differ more between themselves than all the other specimens together. They display an exhalant channel exaggeratedly recurved adaxially. Specimens from the Burdigalian of the Adour Basin (France) have a thicker, less dense denticulation, recalling very much the lectotype.

Sufficient evidence is not available to differentiate the specimen of *Cypraea fossula* Ingram, 1947, from the Early Miocene Cantaure Formation of Venezuela, from those in Florida or in France. Ingram (1947) stated, "one of the most notable characteristics of this species is the huge fossula," but this characteristic is common to all the species of this genus from the Late Oligocene into the Early Miocene. The holotype possesses fewer columellar teeth than specimens from Florida or France.

Jousseauma joossi Schilder, 1939, is based on a single truncated internal mold. Despite of the state of preservation, it is closely allied with *T. (T.) dominicensis*. The inner margin and the outer lip are ornamented by fine, short, numerous teeth; the fossula is very wide and concave; the abrupt inner margin presents a slope to the level of the columellar area, and the outline is cylindrical and very squatty. Based on the description by Schilder (1939) it is likely that *T. dominicensis* and *T. joossi* are conspecific.

In spite of a faint but constant variability, *T. (T.) dominicensis* cannot be confused with any similar Neogene species, Caribbean or Mesogean. As for the direct origins of the Recent Indo-Pacific *T. talpa* (Linné, 1758), it is no longer represented in the Atlantic waters. The Recent species is less elongate and differs from the Miocene species by the more numerous denticulation, especially by the denticulation of the inner margin, which is more prolonged on the abrupt columellar area, than on the fossula.

TALPARIA (TALPARIA) MARIAELISABETHAE
Dolin, n. sp.
Figures 25-27

Description: Medium-sized, cylindrically-oblong shell; in lateral profile the dorsal outline regularly rounded, with greatest height in posterior-most third, not forming a siphonal canal bridge abapically; ventral area varying from swollen to flat; lateral margins weakly calloused; circumbasal callosity creating abapically two dimples on either side of anterior portion of siphonal canal; spire projecting, covered; aperture straight, narrow, adapically slightly curved abaxially; siphonal canal short, surrounded relative to ventral area, abaxially asymmetrical, limited by acuminate, declivous extremities; exhalant channel deep, U-shaped, calloused; inner lip straight; teeth short, numerous, of equal size and limited to the first millimeter inside columellar area; terminal ridge straight, "T" shaped, obsolete and depressed; anterior edge spatulate; fossula deep, slightly concave, and in some cases, covered by beaded ridges joining together the five to six inner denticles to the seven anterior teeth on inner lip; outer lip teeth short, equal in strength, becoming obsolete on right side. Preserved enamel showing dark spots, irregularly disposed on the margins as in the Recent *Mauritia (Mauritia) scurra* (Gmelin, 1791).

Holotype: USNM 438602; height 22.2 mm, maximum diameter 11 mm, dorso/ventral diameter 14 mm; 21 columellar teeth, 27 labral teeth; E. and H. Vokes collectors (fig. 25).

Paratype A: USNM 438603; height 23.5 mm, maximum diameter 11.9 mm, dorso/ventral diameter 14.4 mm; 24 columellar teeth, 24 labral teeth; locality TU 820, E. and H. Vokes collectors (sub-juvenile, fig. 26).

Paratype B: USNM 438604; height 29.2 mm, maximum diameter 18.7 mm, dorso/ventral diameter 15.5 mm; 25 columellar teeth, 20 labral teeth; locality TU 547, E. and H. Vokes collectors (giant specimen).

Paratype C: USNM 438605; height 22.9 mm, dorso/ventral diameter 12.3 mm; 20 columellar teeth; locality TU 825, S. and R. Hoerle collectors (fossula, fig. 27).

Type locality: TU 825; Chipola Formation, 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.

Occurrence: Chipola Formation, Florida.

Material studied: Twenty specimens of this species were examined. In addition to the type material other specimens examined are: Farley Creek, localities TU 821 (2), 819 (one unfigured paratype, MNHN, T. and L. Dolin collectors), 1048 (3), 1196 (7); Chipola River, localities TU 547 (2 giant specimens), 555 (1).

Discussion: Talparia (Talparia) mariaelisabethae differs from *Mauritia (Mauritia) campbelliana* (Pilsbry, 1922) by the denticulation of the inner margin, which is more densely arranged and more regular, and by its oliviform, slightly cylindrical outline. Larger than *T. (T.) mariaelisabethae* (32 mm *vs.* 23 mm), *M. (M.) campbelliana* has a very slightly depressed inner margin, with finer denticulation that is more elongated on the median third and which extends across the angulation of the columellar and the basal area. Enlargement of the circumbasal callosity, characteristic of *M. (M.) campbelliana*, confers upon the shell a very different lozenge-shaped outline.

Talparia (Talparia) mariaelisabethae is closely allied with *T. (T.) hieroglyphica* (Schilder, 1939) from Lapugy, Hungary, which has the same denticulation of both lips and the slightly concave fossula. However, *T. (T.) hieroglyphica* has the lateral outline of the living *Talparia (Luria) cinerea* (Gmelin, 1791).

Talparia (T.) mariaelisabethae resembles in shape the Recent species-complex of *Mauritia (M.) scurra* (Gmelin, 1791) and

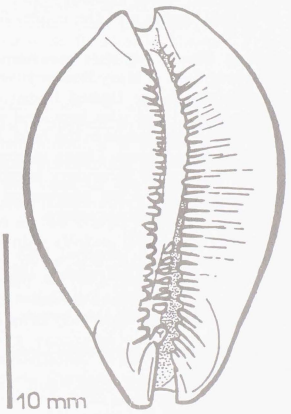


Figure 25a. *Talparia (Talparia) mariaelisabethae* Dolin, n. sp.; USNM 438602 (holotype).

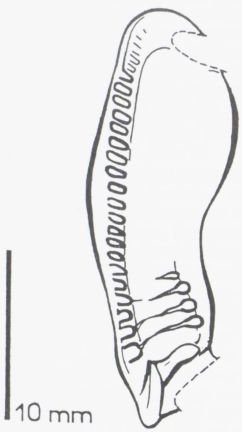


Figure 27. *Talparia (Talparia) mariaelisabethae* Dolin, n. sp.; USNM 438605 (paratype C).

M. (M.) eglantina (Duclos, 1833). They are larger and differ by their terminal ridge, and by the extension of the denticulation of the inner margin, which extends systematically over the fossula and the columellar area.

Etymology: This pretty species is named in acknowledgment of Mary Dockery, who was my hostess in the United States on several occasions, and who provided me with much assistance while in the field. By combining the two names, I have attempted to avoid a possible secondary homonymy, but in addition, I am addressing to her a friendly and personal gesture.

Genus MAURITIA Troschel, 1863
Subgenus MAURITIA Troschel, 1863

Mauritia TROSCHEL, 1863, Das Gebiss der Schnecken, v. 1, p. 208 (as *Cypraea* subgenus).

Type species: *Cypraea mauritiana* Linné, by tautonomy.

Mauxiena JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 89.

Type species: *Cypraea mauritiana* Linné, by original designation.

Arabica JOUSSEAUME, 1884, Bull. Soc. Zool. France., v. 9, p. 90.

Type species: *Cypraea arabica* Linné, by original designation.

Etronsa JOUSSEAUME, 1886, Le Naturaliste, p. 220.

Type species: *Cypraea mauritiana* Linné, by original designation.

Pseudozonaria SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 115 (as *Zonaria* subgenus).

Type species: *Cypraea arabicula* Lamarck, by original designation.

Description: Shell semi-ovoid, more or less elongated and gibbous, ventral area feebly convex, even depressed, concave; spire multiwhorl, strongly projecting; circumbasal callosity enlarged to the point of forming a marginal bulge; siphonal canal orthogonally truncate, set off in relation to basal plane; terminal ridge straight, projecting slightly; internal laminae at a 45° angle, spatulate at its extremity; fossula deep and ear-shaped, concave, well delimited and sculpted by strong ridges surrounding interior peristome with heavy teeth; inner margin similar in all components to that of species in the preceding genus.

Discussion: It is possible to distinguish three phylogenetic relationships in this subgenus; one is represented in the Chipola Formation, the second includes the unique *M. (M.) mauritiana* (Linné, 1758), which has a concave ventral area accentuated by an enlarged circumbasal callosity. The latter criterion characterizes the monospecific subgenus *Pseudozonaria* Schilder, 1927, of the Pacific-Panamic biotic province, similar in all characteristics to *M. (M.) mauritiana.*

The subgenus *Leporicypraea* Iredale, 1931 (type species: *C. mappa* Linné) differs only in the development of a neck, forming a bridge created by the thickening of the margins bordering the siphonal canal.

Members of *Talparia* s.l. and *Mauritia* s.l. share a color pattern, undoubtedly derived from a common origin. Sharply distinct by the Miocene, these groups only differ morphologically today by their terminal ridge and their spire.

MAURITIA (MAURITIA) CAMPBELLIANA
(Pilsbry)
Figure 28

Cypraea campbelliana PILSBRY, 1922, Acad. Nat. Sci. Philadelphia, Proc., v. 73, p. 365, pl. 30, figs. 9, 10.

Luria campbelliana (Pilsbry). SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 101.

Luria cinerea campbelliana (Pilsbry). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 40.

Description: "The shell is oblong-oval, but slightly produced at the ends, moderately calloused laterally, the callouses dappled with rather small dark spots; dorsal outline evenly arched, spire concealed. Outer lip having 24 teeth. Inner lip with 20 short teeth, not running inward as in *C. cinerea*. In the lower part of the columella [fossula] an inner series of 5 short teeth may be seen." (Pilsbry, 1922)

Holotype: ANSP 3000; height 30.3 mm, maximum diameter 15 mm, dorso/ventral diameter 18.7 mm; 20 columellar teeth, 24 labral teeth; locality unknown, Dominican Republic.

Type locality (here restricted): TU 1226, Baitoa Formation, east bank of the Río Yaque del Norte, below the village of Baitoa, and above the confluence of the Río Yaque del Norte and the Río Bao, Dominican Republic.

Occurrence: Chattian, France; Baitoa Formation, Dominican Republic; Chipola Formation, Florida.

Figured specimen: USNM 438606; height 23.1 mm, maximum diameter 15.7 mm, dorso/ventral diameter ?(broken); 23 columellar teeth, 21 labral teeth; locality TU 820, E. and H. Vokes collectors (fig. 28).

Material studied: The primary type material (holotype and three paratypes cited by Pilsbry) was not examined, as the species was well figured in the original description. A magnificent specimen from the Baitoa Formation (Early Miocene) located geographically and stratigraphically (loc. TU 1226, E. and H. Vokes collectors) was available. A single incomplete example was collected in the Chipola Formation (fig. 28).

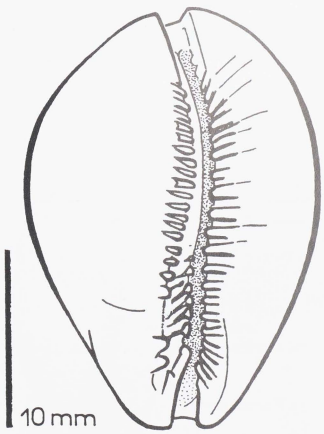


Figure 28a. *Mauritia (Mauritia) campbelliana* (Pilsbry); USNM 438606.

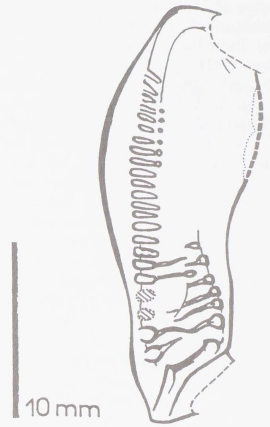


Figure 28b. *Mauritia (Mauritia) campbelliana* (Pilsbry); USNM 438606.

The species is especially well represented in the Chattian (Late Oligocene) beds at Abesse, Parish of St. Paul-les-Dax (Landes, France) by 15 specimens (MNHN, T. and L. Dolin, P. Lozouet collectors).

Discussion: Mauritia (Mauritia) campbelliana appears to have preferred a reefal environment; it is abundant in two outcrops representing coralline bioherms, as is the case in the Chattian of Abesse, France (Lozouet *in* Dolin *et al.*, 1985, p. 10) and in the Baitoa Formation, Dominican Republic (Vokes, 1979, p. 107, text-fig. 1).

Schilder and Schilder (1971, p. 40) included *M. (M.) campbelliana* in the subgenus *Luria*, as a subspecies of the living *Talparia (L.) cinerea*, but they probably never examined a specimen of *M. (M.) campbelliana*. In the same synonymy they include *Cypraea (Luria) cinerea catiana* Weisbord, 1962, described from the Pleistocene of Venezuela, which is radically different from the Oligo-Miocene species of Pilsbry.

Species of *Mauritia* s.l. are numerically and qualitatively major components of the tropical Indo-Pacific fauna (Schilder and Schilder, 1971, pp. 33-35). Previously a pre-Pliocene ancestry has not been recognized and *M. (M.) campbelliana* can only be compared with *M. (M.) depressa* (Gray, 1824). The latter species differs slightly from *M. (M.) campbelliana* by the less dense denticulation of the inner margin, which continues deeply over the columellar area, where it forms a second row of denticules; the lateral margin callus enlarges to give a lunate contour, while the ventral area is lightly depressed in the center – almost convex – giving the species its name *depressa*.

Genus LYNCINA Troschel, 1863

Lyncina TROSCHEL, 1863, Das Gebiss der Schnecken, v. 1, p. 208 (as *Cypraea* subgenus).

Type species: *Cypraea lynx* Linné, by subsequent designation (Tryon, 1885).

Ponda JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 95.

Type species: *Cypraea achatina* Perry *non* Dillwyn (= *C. ventriculus* Lamarck), by original designation.

Callistocypraea SCHILDER, 1927, Archiv. Naturgesh., v. 91, no. A/10, p. 104 (as *Pustularia* subgenus).

Type species: *Cypraea aurantium* Gmelin, by original designation.

Arestorides IREDALE, 1930, Mem. Queensland Mus., v. 10, no. 1, p. 82.

Type species: *Cypraea argus* Linné, by original designation.

Mystaponda IREDALE, 1930, Mem. Queensland Mus., v. 10, no. 1, p. 83.

Type species: *Cypraea vitellus* Linné, by original designation.

Miolyncina SCHILDER *in* QUENSTEDT, 1932, Fossil. Catalog., v. 1/55, p. 131 (as *Callistocypraea* subgenus).

Type species: *Cypraea subovum* Orbigny sensu Schilder (= *C. tumida* Grateloup), by original designation.

Description: Shell ovoid, subglobulose, spire conspicuous; siphonal canal elevated relative to ventral area, forming a neck; aperture somewhat sinuous; terminal ridge oblique; inner edge at a right angle, recurved, spatulate at extremity; fossula deep, concave, crossed by strong ridges crowning peristome with heavy, projecting teeth; inner margin rectilinear; denticulation limited to angulation of basal and columellar areas.

Discussion: The genus *Cypraea* (type species: *C. tigris* Linné) is characterized by a concave base, a depressed inner margin, a less evident oblique terminal ridge, and especially by denticulation that rises from the angulation of the basal and columellar areas, extending onto the ventral area of the inner margin. *Cypraea* and *Lyncina* have been isolated since the Early Miocene. Revising what she considered the subgenus *Lyncina*, Kay (1963, p. 61) confirmed its validity on the basis of the radulae, as that of *C. tigris* differs sufficiently to exclude the species of *Lyncina* from *Cypraea* s.s. Because the fossil *Miolyncina* cannot be differentiated conchologically from *Lyncina*, they are here synonymized.

LYNCINA THERESAE Dolin, n. sp.
Figures 29-31

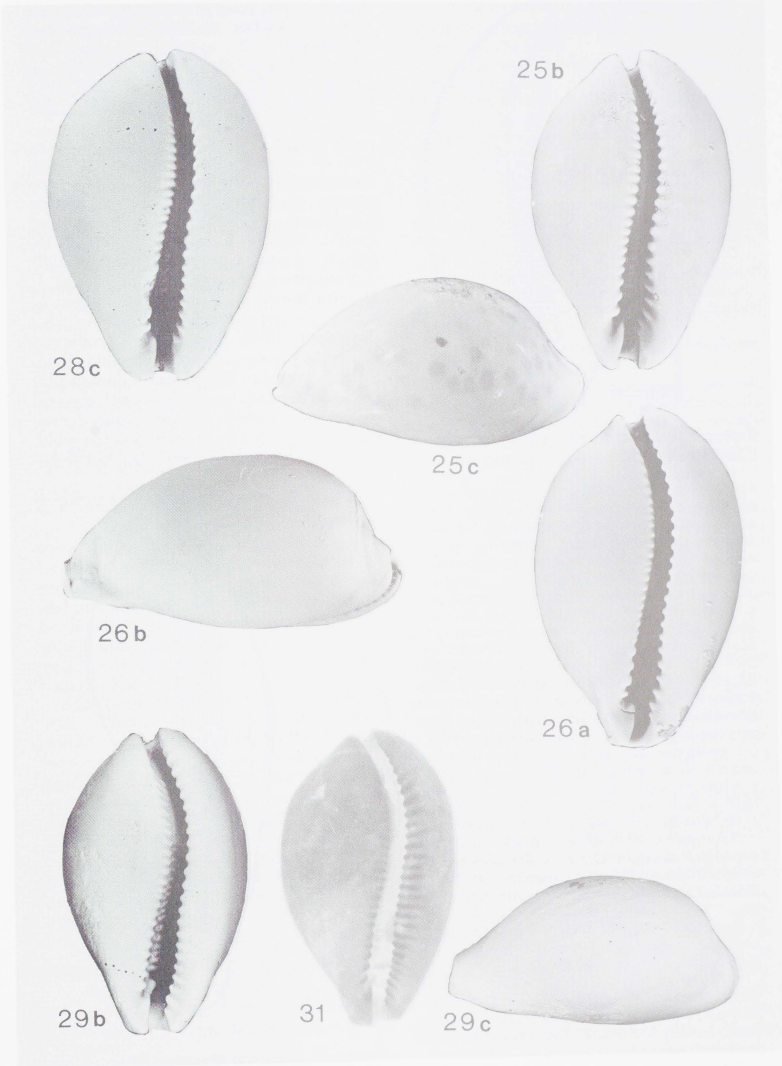
Description: Large pyriform shell, ventral area slightly swollen, inner and outer sides slightly flattened; lateral margins regularly rounded; spire not too prominent, covered;

Figures Page

25, 26. *Talparia (Talparia) mariaelisabethae* Dolin, n. sp. 25
25. (x 2.6) USNM 438602 (holotype); height 22.2 mm.
Locality: TU 825, Farley Creek, Florida. Chipola Formation.
26. (x 2.6) USNM 438603 (paratype A, sub-juvenile); height 23.5 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.

28. *Mauritia (Mauritia) campbelliana* (Pilsbry, 1922) 26
(x 2.5) USNM 438606; height 23.1 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.

29, 31. *Lyncina theresae* Dolin, n. sp. 28
29. (x 1.4) USNM 438607 (holotype); height 37.6 mm.
Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.
31. (x 1) MNHN (paratype B); height 49.3 mm.
Locality: TU 547, Chipola River, Florida. Chipola Formation.


25b
28c
25c
26b
26a
29b
31
29c

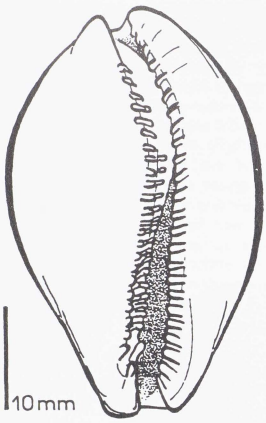


Figure 29a. *Lyncina theresae* Dolin, n. sp.; USNM 438606 (holotype).

aperture adapically curved in abaxial sense; siphonal canal deep, abaxially asymmetrical, surrounded in relation to ventral area, forming a bridge; adapical canal narrow, equally lengthened by both extremities; inner lip slightly parasigmoidal; teeth numerous, anteriorly strong, then finer; limited to angulation of basal and columellar areas, stretching into flattened, abrupt columellar area forming a second tooth line; horizontal terminal ridge lightly calloused, broken at right angle by a vertical strip (inner edge); fossula slightly concave, covering ridges joining thick inner denticles to columellar teeth; labral teeth less numerous, short, limited to adaxial peristome of lip, slightly parasigmoidal, a few declivous abapically. Dorsal area from best samples showing medium-sized orange dots and a white circumbasal callus; under ultra-violet light a dark color pattern marking inner and outer lip teeth, characteristic of the species.

Holotype: USNM 438607; height 37.6 mm, maximum diameter 19.5 mm, dorso/ventral diameter 22.9 mm; 23 (+ 2) columellar teeth, 23 (+ 3) labral teeth; E. and H. Vokes collectors (fig. 29).

Paratype A: USNM 438608; height 53 mm; 27 (+ 4) columellar teeth; locality TU 546, S. and R. Hoerle collectors (fossula, fig. 30).

Paratype B: MNHN; height 49.3 mm, maximum diameter 26 mm, dorso/ventral diameter 30.5 mm; 5 (+ 3) columellar teeth, 25 (+ 8) labral teeth; locality TU 547, T. Dolin collector (color pattern, fig. 31).

Type locality: TU 546; Chipola Formation, Tenmile Creek, about 1 1/2 miles west of Chipola River (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: A total of ten specimens (Chipola River, locality TU 547; Tenmile Creek, locality TU 546) were examined.

Discussion: In the Mesogean of Europe, from the Late Oligocene the group is dominated by the species-complex of the type species of *Miolyncina: Lyncina tumida* (Grateloup, 1834) (see Cossmann and Peyrot, 1924, pl. 9, figs. 13, 14, 21; pl. 10, figs. 3, 4) and *L. peyroti* Schilder, 1932 (Cossmann and Peyrot, 1924, pl. 10, figs. 1, 2). The former anticipates the Recent *L. carneola* (Linné, 1758) and *L. ventriculus* (Lamarck, 1810), the latter *L. broderipii* (Sowerby, 1832), all from the the Indo-Pacific. Together they define a lineage that is characterized by the thick-set general aspect of the shell, the pronounced concavity of the sunken fossula, and the weak development of the extremities, not forming a true bridge.

Indeed, *L. theresae* seems more surely to

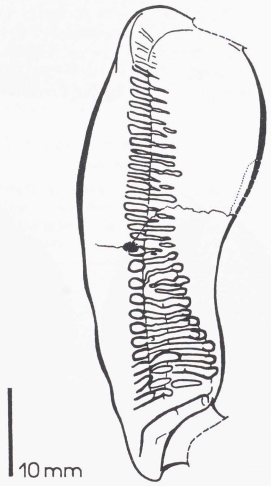


Figure 30. *Lyncina theresae* Dolin, n. sp.; USNM 438608 (paratype A).

be the ancestor of *L. lynx* (Linné, 1758), from the Indo-Pacific domain, and *L. camelopardalis* (Perry, 1811), endemic to the Red Sea. *Lyncina theresae* differs from *L. lynx* by the pyriform outline, the less developed circumbasal callosity, the medium-sized siphonal canal, the deep fossula, the flat ventral area, and the abrupt inner margin.

Lyncina theresae differs from *L. camelopardalis* in the finer, more numerous columellar teeth, more dense and elongated in the median third, the labral teeth slightly pinched, the neck and the exhalant channel bridge-like, prolonged, the aperture adapically less narrow than in *L. lynx*, turned adaxially and regularly channeled by the parallel margins. In the Recent species, the inner margin is always depressed, the circumbasal callosity is more developed in the adult, elongated and underscoring particularly the extremities.

Lyncina theresae displays a color pattern similar to that of the dorsal zone of *L. lynx* and *L. camelopardalis*, but is distinctive in one discrete difference. In the Recent species there are interstices between the teeth (on both margins in *L. lynx;* on the inner margin of *L. camelopardalis)* that are set off by a "touch" of color (red-orange and black, respectively); but in the Chipola Formation species it is the teeth themselves that appear colored on both margins, over the clear background of the basal callus.

Etymology: I dedicate this species to my wife, Therese Dolin, without whom I would not be able to enjoy the freedom necessary to reconcile my professional obligations and my "hobby." For amateurs – even more than for professionals – to conduct research activities requires on the part of kin, understanding, devotion, and permanent support; this dedication is only a modest tribute to one of those considerate but effective spouses, who make the investigator.

Subfamily ERRONEINAE Schilder, 1927
Genus ERRONEA Troschel, 1863

Erronea TROSCHEL, 1863, Das Gebiss der Schnecken, v. 1, pp. 205, 210 (as *Aricia* subgenus).

Type species: *Cypraea errones* Linné, by subsequent designation (Schilder, 1924).

Subgenus ADUSTA Jousseaume, 1884

Adusta JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 93.

Type species: *Cypraea adusta* Lamarck, by original designation.

Gratiadusta IREDALE, 1931, Mem. Queensland Mus., v. 18, p. 82 (as *Palmadusta* subgenus).

Type species: *Cypraea pyriformis* Gray, by original designation.

Ipserronea IREDALE, 1935, Austr. Zoologist, v. 8, p. 131.

Type species: *Ipserronea problematica* Iredale (= *C. pyriformis* Gray), by original designation.

Solvadusta IREDALE, 1935, Austr. Zoologist, v. 8, p. 127.

Type species: *Gratiadusta vaticina* Iredale (= *C. subviridis* Reeve), by original designation.

Ficadusta HABE and KOSUGE, 1966, Venus, Jap. Jour. Malac., v. 14, p. 314.

Type species: *Cypraea pulchella* Swainson, by original designation.

Description: Shells of medium size, pyriform, ventral area slightly convex, apical zone umbilicate; siphonal canal elongate, forming a straight bridge; terminal ridge "oblique type" of Schilder and Schilder (1938, p. 135), merging with vertical internal lamella; fossula rather deep, flat, and poorly delimited; columellar area "ribbed" (*ibid.*); inner margin rectilinear, abrupt in Miocene species, gradually becoming rounded in younger forms; teeth of inner margin fine and numerous, extending onto fossula and columellar area, without passing beyond angulation; outer lip constricted abapically, ornamented by narrow and separated teeth.

Discussion: The nebulous tribe of the Erroneini (Schilder, 1927), which Schilder and Schilder (1971, pp. 42-56) elevated to the rank of subfamily, represents almost one half of the Recent cowries. However, the majority of genera catalogued do not include valid fossils, and the tribe appears without paleontologic history.

The species of *Erronea* s.s. demonstrate a distinct tendency toward the reduction of the terminal ridge and the fossula, which is accompanied by a rounding, a weakening of the inner margin. Schilder and Schilder (1971) placed *Cypraea heilprinii* Dall, 1890, *C. tumulus* Heilprin, 1886, and *C. spurcoides* Gabb, 1873, in the genus *Zonaria* Jousseaune, 1884. In the fossil and living species of *Zonaria* the fossula is completely reduced and the columellar area is smooth (see Dolin, 1987, pp. 24-25, text-fig. 15 a-b, pl. 2, figs. 19-36). Erroneinae of the Chipola Formation are placed in the subgenus *Adusta*.

Only by establishing the phylogenetic relationships of lineages, such as *Zonaria* (separated by the mid-Miocene), *Neobernaya* Schilder, 1927, and *Notoluponia* Schilder, 1935, can *Cypraeovula* Gray, 1824, or *Bistolida* Cossmann, 1920, be adequately comprehended.

ERRONEA (ADUSTA) TUMULUS (Heilprin)
Figures 32, 33

Cypraea tumulus HEILPRIN, 1886, Wagner Free Inst. Sci., Trans, v. 1, p. 111, pl. 16, figs. 49, 49a.

Cypraea pinguis Conrad. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, no. 1, p. 164 (in part, *not* of Conrad, 1854), pl. 11, figs. 1, 1a.

Cypraea tumulus Heilprin. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 84, pl. 3, figs. 1, 12.

Cypraea tumulus Heilprin. INGRAM, 1942, Bulls. Amer. Paleontology, v. 27, no. 104, p. 16(106), pl. 3(10), fig. 5.

Zonaria (s.s.) *tumulus* (Heilprin). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 44.

Description: "Shell completely involute, inflated, very convex, the greatest elevation being immediately back of the apex; the dome abruptly truncated posteriorly, sloping more gradually in the direction of the anterior extremity; aperture narrow, subcentral, slightly flexuous, directed obliquely over the apex; outer lip produced somewhat beyond the inner lip posteriorly, with about twenty-five evenly placed dental plications; columellar surface flattened, the teeth less prominent; surface of shell covered with very fine revolving lines, which, however (in the specimens before me), are only visible in immediate proximity to the aperture; base gently convex." (Heilprin, 1886)

Holotype: WFIS 861; height 40.0 mm, maximum diameter 22.5 mm; 22 labral teeth.

Type locality: Tampa Limestone, Ballast Point, Tampa Bay, Hillsborough Co., Florida.

Occurrence: Tampa Limestone, ?Hawthorn Formation, Chipola Formation; Florida.

Figured specimens: USNM 646272; height 34.8 mm, maximum diameter 24.5 mm, dorso/ventral diameter 20 mm; 19 columellar teeth, 24 labral teeth; locality USGS 2084 (fig. 32). USNM 438609; height 28.8 mm; 19 columellar teeth; locality TU 830, S. and R. Hoerle collectors (fossula, fig. 33).

Material studied: The holotype was not studied but a well-preserved topotype (fig. 32) was examined. Besides the incomplete specimen figured from the Chipola Formation (fig. 33), only one other juvenile specimen (loc. TU 819) is known.

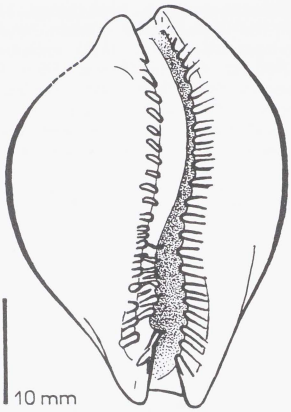


Figure 32a. *Erronea (Adusta) tumulus* (Heilprin); USNM 646272.

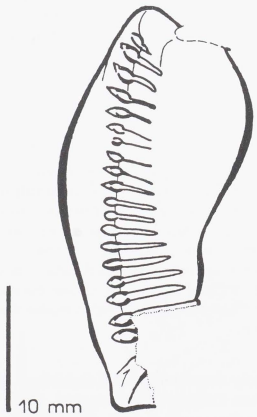


Figure 33. *Erronea (Adusta) tumulus* (Heilprin); USNM 438609.

Discussion: This rare species is distinguished from similar ones in the same beds by its wide aperture, the sinuous outer margin, the wide deep fossula, but especially by the pronounced spherical outline, which permits instant recognition. This aspect has caused it to be compared with *Cypraeorbis*, which also has the elevated dorsum. However, the denticulation of the fossula has not been considered.

Schilderia decorticata (Defrance, 1826) (see Glibert, 1952, pl. 4, figs. 1 a-c and 3 a-b only), from the Langhian (Middle Miocene) of the Touraine beds, France, has a similar spherical outline. The denticulation of the inner margin is heavier, and the French species does not exhibit the posterior extension of the two margins. From this point of view, *E. (A.) tumulus* can be compared only to the fossil *E. (Neobernaya) clifdenensis* (Cernohorsky, 1971), from the early Middle Miocene of New Zealand (Beu and Maxwell, 1990, p. 222, pl. 24, figs. 24c, f), and the Recent *E. (N.) spadicea* (Swainson, 1823), from California. They differ by their reduced fossula and depressed inner lip.

ERRONEA (ADUSTA) HEILPRINII (Dall)
Figures 34, 35

Cypraea Heilprinii DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 166, pl. 11, figs. 2, 2a.

Cypraea heilprinii Dall. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 85, pl. 3, figs. 2, 14.

Zonaria heilprinii (Dall). SCHILDER, 1927, Archiv Naturgesh., v. 90, no. A/10, pp. 119, 158.

Cypraea heilprini Dall. INGRAM, 1939, Bulls. Amer. Paleontology, v. 24, no. 84, p. 3(321), pl. 1(21), figs. 1, 2; INGRAM, 1942, Bulls. Amer. Paleontology, v. 27, no. 104, p. 14(104), pl. 2(9), figs. 5, 6.

Cypraea (Cypraeorbis) heilprinii Dall. GARDNER, 1947, U. S. Geol. Surv., Prof. Paper 142-H, p. 540, pl. 54, figs. 12, 13.

Zonaria (s.s.) *heilprinii* (Dall). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 44.

Description: Shell small, asymmetrically ovate, cylindrical, somewhat reflected, dorsal outline regularly curved; this curvature sharply depressed to the level of the apical area; spire covered; aperture almost rectilinear; terminations forming a bridge, anterior free; circumbasal callosity particularly heavy to level of outer lip, underscoring the dimples of bridges; terminal ridge oblique, interrupted at 90° by short, lamellar inner edge; fossula very weakly concave, crossed by ridges forming beaded inner denticles; denticulation of inner margin sharp, serrate, elongated on columellar area and slightly on basal area; outer lip anteriorly constricted, ornamented by strong but pinched and separate teeth, limited to peristome. Under ultra-violet light, lateral marginal calluses appearing dotted by alternation of spaced spots of irregular size; dorsal zone crossed by three or four transverse bands, more or less dark.

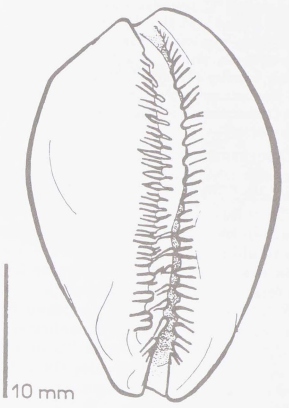


Figure 35. *Erronea (Adusta) heilprinii* (Dall); MNHN Paris.

Holotype: USNM 112073; height 26.5 mm, maximum diameter 15 mm, dorso/ventral diameter 17 mm; 18 columellar teeth, 22 labral teeth; E. J. Post collector.

Type locality: USGS 2115; Tampa Limestone, Ballast Point, Tampa Bay, Hillsborough Co., Florida.

Occurrence: Baitoa Formation, Dominican Republic; Tampa Limestone, ?Hawthorn Formation, Chipola Formation; Florida.

Figured specimens: USNM 114103, height 29 mm, maximum diameter 14.9 mm, dorso/ventral diameter 18 mm; 20 columellar teeth, 21 (+ 2) labral teeth; locality USGS 2212, F. Burns collector (fig. 34). MNHN; height 23.9 mm, maximum diameter 15.2 mm, dorso/ventral diameter 12.2 mm; 21 columellar teeth, 21 labral teeth; locality TU 547, T. and L. Dolin collectors (fig. 35).

Material studied: In addition to the holotype from Ballast Point, a specimen (fig. 34) from the Chipola Formation (USNM 114103) erroneously cited as the holotype by Ingram (1939a, 1942) and by Gardner (1947), and 20 specimens from the Tampa Limestone (USNM, labeled for the

most part as "*C. tumulus*") were examined.

The Vokes and Hoerle collections contain a half-dozen specimens from the Chipola Formation (Chipola River, locality TU 547; Tenmile Creek, locality TU 546). The species also lived in the Dominican Republic, in the Baitoa Formation (1 specimen, loc. TU 1226, E. and H. Vokes collectors).

Discussion: In the Chipola Formation, *Erronea (Adusta) heilprinii* can only be compared with *E. (A.) spurcoides* (Gabb, 1873), which follows. The latter, from the Gurabo and Chipola formations, displays the fundamental characters of *E. (A.) heilprinii* but is bigger and differs by the flatter fossula and the pyriform shell.

Schilder (1927, p. 158) compared *E. (A.) heilprinii* with *E. (Zonaria) annettae* (Dall, 1909); however, it is with "*Gratiadusta*" *travancorica* Dey *in* Schilder (1941, fig. 26) and the Recent *Palmadusta ziczac* (Linné, 1758), *P. lutea* (Gmelin, 1791) and *P. clandestina* (Linné, 1767) that *E. (A.) heilprinii* has the greatest affinity. It shares the same dimensions, outline, denticulation (of the outer lip in particuliar), and the color pattern of the living species on the flanks. It may be observed that in the Recent Indo-Pacific species the fossula is considerably reduced and the denticulation of the inner margin extends slightly on the ventral area and has a tendency to disappear on the columellar area.

ERRONEA (ADUSTA) SPURCOIDES (Gabb)
Figures 36-38

Cypraea spurcoides GABB, 1873, Amer. Phil. Soc., Trans., v. 15, p. 235.

Cypraea spurcoides Gabb. MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 115(279), pl. 19(45), figs. 7-9.

Cypraea spurcoides Gabb. PILSBRY, 1922, Acad. Nat. Sci. Philadelphia, Proc., v. 73, p. 365, pl. 30, figs. 4, 5.

Zonaria spurcoides spurcoides Gabb. INGRAM, 1939, Bulls. Amer. Paleontology, v. 24, no. 85, p. 11(337), pl. 1(22), fig. 4; INGRAM, 1947, Bulls. Amer. Paleontology, v. 31, no. 120, p. 14(56), pl. 2(6), fig. 17.

Zonaria (s.s.) *spurcoides* (Gabb). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 45.

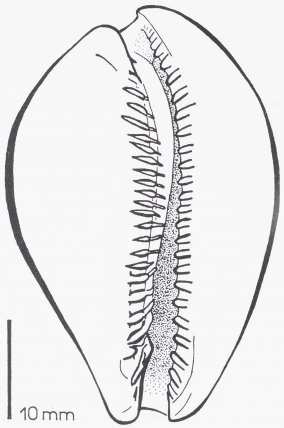
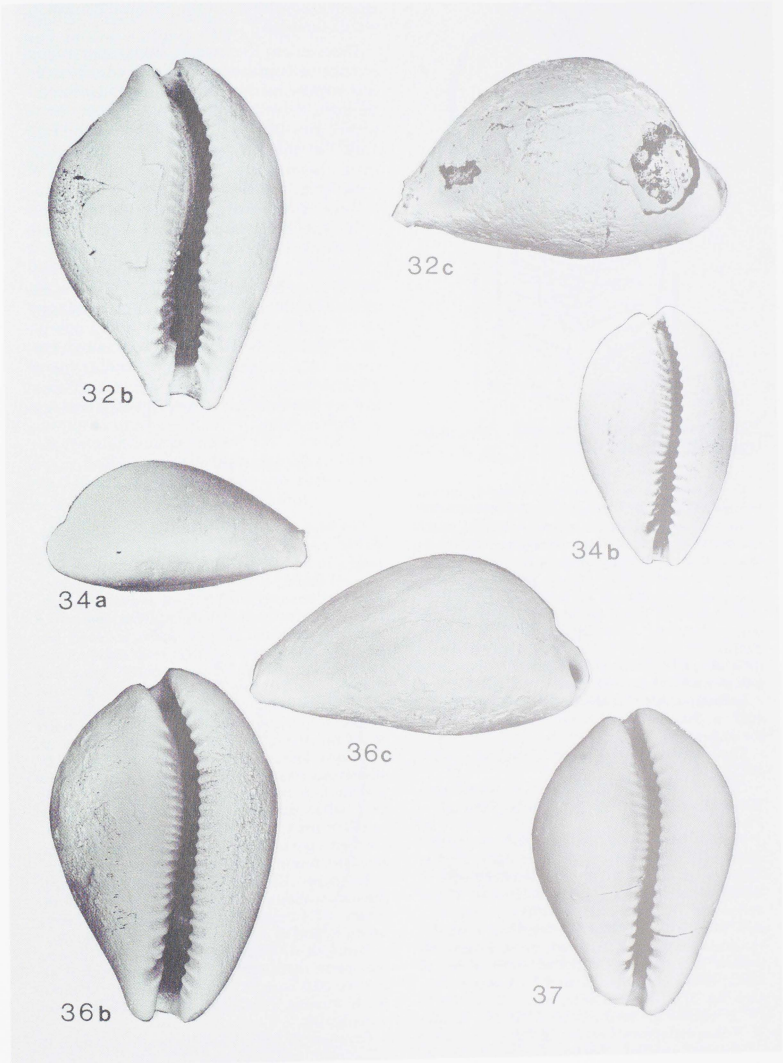


Figure 36a. *Erronea (Adusta) spurcoides* (Gabb); USNM 438610.

Description: "Shell similar in form to *C. spurca*, but somewhat broader and more narrowed in advance. Callous broad, convex below, and slightly expanded laterally, not crenulated above as in *C. spurca*. Crenulations of both lips well defined, more numerous on the inner than on the outer lip. Color pattern mottled irregularly." (Gabb, 1873)


32b
32c
34b
34a
36c
36b
37

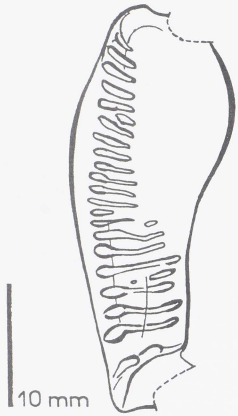


Figure 38. *Erronea (Adusta) spurcoides* (Gabb); USNM 438612.

Pyriform, becoming lozenge-shaped; lateral margin callus developing to reach level of basal area and angling considerably enlarged outer lip; terminal ridge oblique, strong and plunging, followed by obsolete inner edge; divided by comma-shaped ridge; fossula particularly flat, breaking continuity of extremity of edge, thinner on median third, elongating on fossula and columellar area; outer lip adapically recurved, distinctly extending edge of inner margin; only a little abapically constricted; labral teeth strong and pinched, short and distant.

Lectotype: ANSP 2999 (designated by Pilsbry, 1922, p. 365); height 32.8 mm, maximum diameter 20.3 mm.

Type locality: Dominican Republic (Gabb, 1873).

Occurrence: Gurabo Formation, Dominican Republic (Maury, 1917); Chipola Formation, Florida.

Figured specimens: USNM 438610, height 39.7 mm, maximum diameter 25.7 mm, dorso/ventral diameter 20.6 mm; 20 (+ 1) columellar teeth, 26 labral teeth; locality TU 457, E. and H. Vokes collectors (fig. 36). USNM 438611; height 27.5 mm (abapical terminus of inner lip broken), maximum diameter 18.3 mm, dorso/ventral diameter 14.6 mm; 19 columellar teeth, 20 labral teeth; locality TU 458, E. and H. Vokes collectors (fig. 37). USNM 438612; height 29.6 mm; 19 (+ 1) columellar teeth; locality TU 830, E. and H. Vokes collectors (fossula, fig. 38).

Material studied: Neither the lectotype nor the material of Maury was studied but four specimens collected in the Chipola Formation were examined.

Discussion: Erronea (Adusta) spurcoides cannot be confused with *E. (A.) heilprinii;* it is larger and develops a very characteristic lozenge-shape. Moreover, *E. (A.) heilprinii* may belong to the lineage of the Recent *Palmadusta*, and *E. (A.) spurcoides* may belong to that of the Recent *Ficadusta*, synonymized with *Adusta* s.s. Gabb did not recognize the true affinities of his species; and compared it only to the Erosariinae!

Erronea (A.) hungerfordi (Sowerby, 1888), from the western Pacific, is the most closely related species and it displays sharp and serrate columellar teeth, essentially limited to the columellar area. *Erronea (A.) hungerfordi* is, however, more globose and if the lateral margin calluses are equally enlarged, they develop curious glazed nodules.

Erronea (Adusta) shirleyae
Dolin, n. sp.
Figures 39-41

Description: Medium-sized oviform shell, regularly rounded; in lateral profile maximum height in middle; extremities slightly separated around flanks; siphonal canal short, U-shaped; exhalant channel weakly bent adaxially; adapical extremity of inner margin giving aperture a vaguely sigmoidal aspect; spire covered but slightly projecting (also in gerontic state) to center of adapical umbilicus; ventral area calloused, regularly concave, rounded; terminal ridge slightly plunging, bifurcated by doubling of transverse comma-shaped ridge; inner edge short but thick, making abaxial protrusion on aperture; fossula rather deep, flat, sculpted by numerous regular ridges; denticulation of inner margin fine, regularly disposed, becoming finer on median third and being prolonged on columellar area; outer lip with anteriorly constricted peristome and with denticulation pinched, few in number and dispersed.

Holotype: USNM 438613; height 32.3 mm, maximum diameter 21.9 mm, dorso/ventral diameter 17.4 mm; 22 columellar teeth, 24 labral teeth; E. and H. Vokes collectors (fig. 1; fig. 39).

Paratype A: USNM 438614; height 30.3 mm, maximum diameter 16.7 mm, dorso/ventral diameter 20.6 mm; 22 columellar teeth, 23 labral teeth; locality TU 830, E. and H. Vokes collectors (fig. 40).

Paratype B: USNM 438615; height 29.6 mm; 16 columellar teeth; locality TU 830, S. and R. Hoerle collectors (fossula, fig. 41).

Type locality: TU 546; Chipola Formation, Tenmile Creek, north bank about 1 1/2 miles west of Chipola River (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: In addition to the type lot, three examples of this species from localities TU 546 (young example), 830 (inner lip) and USGS 2213 (USNM 114099, Burns collector; misidentified by Dall) were studied.

Discussion: Erronea (Adusta) shirleyae differs from *E. (A.) spurcoides* by its oviform outline, flattened and not lozenge-shaped, with the neck poorly developed, the exhalant channel short, the base calloused, strongly convex, the internal lamella short and thick, the outer lip distinctly sigmoidal on the posterior third, abapically constricted. It is not comparable to any other species.

Such an explosion of synchronous species of Erroneini in one basin is not unique to the Tertiary of Florida. The genera *Notoluponia* Schilder, 1935, and *Notadusta* Schilder, 1935 (see Schilder, 1935, pp. 345-351, figs. 31-50) from the Tertiary of Australia, are an eloquent example.

Recently, Gosliner and Liltved (1985, pp. 112-116, fig. 33) have studied the forms of a closely related group, that of *Cypraeovula* Gray, 1824. They demonstrate that it is possible to define a certain number of species (proposed empirically on the basis of variable characters of the shell), using the anatomy, the radular characteristics, and the color of the animal.

Etymology: This species is named in honor of the late Shirley E. Hoerle, in recognition of her valuable contribution to Chipola Formation collections and studies.

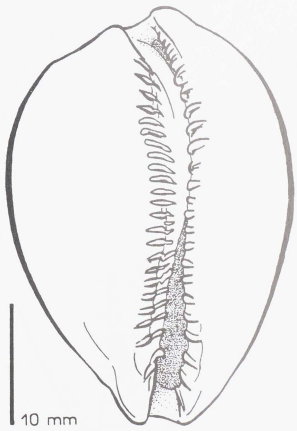


Figure 40a. *Erronea (Adusta) shirleyae* Dolin, n. sp.; USNM 438614 (paratype A).

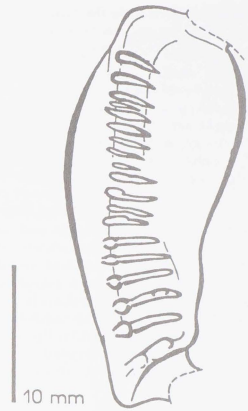


Figure 41. *Erronea (Adusta) shirleyae* Dolin, n. sp.; USNM 438615 (paratype B).

Genus BISTOLIDA Cossmann, 1920

Stolida JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 96 (not *Stolida* Lesson, 1832).

Type species: *Cypraea stolida* Linné, by original designation.

Bistolida COSSMANN, 1920, Revue Critique Paléozool., v. 24, p. 83 (nom. nov. pro. *Stolida* Jousseaume, 1884).

Talostolida IREDALE, 1931, Rec. Australian Mus., v. 18, no. 4, p. 219.

Type species: *Cypraea teres* Gmelin, by original designation.

Ovatipsa IREDALE, 1931, Rec. Australian Mus., v. 18, no. 4, p. 219 (as *Erronea* subgenus).

Type species: *Cypraea chinensis* Gmelin, by original designation.

Derstolida IREDALE, 1935, Austr. Zoologist, v. 8, p. 121.

Type species: *Derstolida fluctuans* Iredale (= *C. stolida* Linné), by original designation.

Description: Shell cylindrical, having an almond-shaped outline, extremities prolonged, with flattened ventral area and umbilicate spiral zone, siphonal canal elongated, forming distinct neck; straight terminal ridge, enlarging as a winged callosity, of type "bordering the outlet and slit" of Schilder and Schilder (1938, p. 125); inner edge thin, short and vertical; fossula somewhat deep, weakly concave, inner margin ornamented by stout inner denticles, projecting over aperture; columellar area flat and narrow, with right angle "denticulate within" (*ibid.*); inner lip teeth, strong at level of angulation, sometimes extended in certain populations of some species over entire ventral area; exhalant channel prolonged in a collar by callus extension of adapical area of outer lip; outer lip calloused, bent upward, strongly margined on entire length and ornamented by strong, evenly-spaced teeth.

Discussion: The group of *Cribrarula* Strand, 1929 (nom. nov. pro *Cribraria* Jousseaume, 1884, preoccupied) differs from *Bistolida* by the color pattern of the spots on the dorsal area. Furthermore, *B. chinensis* (Gmelin, 1791) is intermediate between the two groups. Lacking complementary information on the ecology of the species in question, *Cribrarula* cannot be placed in synonymy with *Bistolida*.

The morphologic similarity of *Erronea (Adusta)* and of *Bistolida* in the Miocene of the Chipola Formation is confusing, inasmuch as the two genera are well separated today. This similarity, which may be due to a common ancestor or to convergence, contradicts the nomenclatural splitting of two otherwise stable groups, in a plethora of unnecessary typological subgroups.

Bistolida praelatior Dolin, n. sp.
Figure 42

Description: Medium-sized, fusiform shell, dumpy, pointed at extremities; spire totally covered, enclosed; siphonal canal elongate, forming strong, well-detached bridge, strongly calloused; posterior channel deep, forming stout collar, raised in lateral profile; ventral area regularly convex like the prow of a ship; aperture somewhat rectilinear; circumbasal callosity well-developed, bordered on flanks, lateral outer margin leaving a series of barely discernible nodules; terminal ridge straight, obsolete and sunken then lamellose and projecting; inner edge plunging, short and lamellar; fossula very weakly concave and crossed by strong ridges, joining inner denticles to first teeth of crenulated inner lip; remainder of denticulation, regularly disposed, stronger at abrupt angulation of basal area and columellar area, extending deeply on latter; teeth of outer lip (barely bent) strong but pinched, few in number and very distant.

Holotype: USNM 438616; height 32.2 mm, maximum diameter 16.0 mm, dorso/ventral diameter 20.4 mm; 21 columellar teeth, 18 (+ 1) labral teeth; E. and H. Vokes collectors (fig. 42).

Type locality: TU 1196; Chipola Formation, Farley Creek, north bank, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype.

Discussion: Bistolida praelatior, n. sp., seems to be very closely related to the preceding species and is separable only by tenuous criteria. The terminal ridge is more horizontal and is terminated abapically by a lamellar projection. In shape, it is rather more elongated, the inner margin is thicker and rises higher on the flank; it carries a denticulation more massive and spaced than the species of *Erronea* s.l. in the Chipola Formation.

Bistolida praelatior recalls by its terminal ridge the species-complex of *B. teres* (Gmelin, 1791), with a wide Indo-Pacific

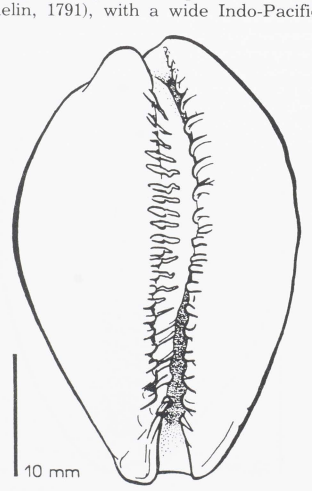
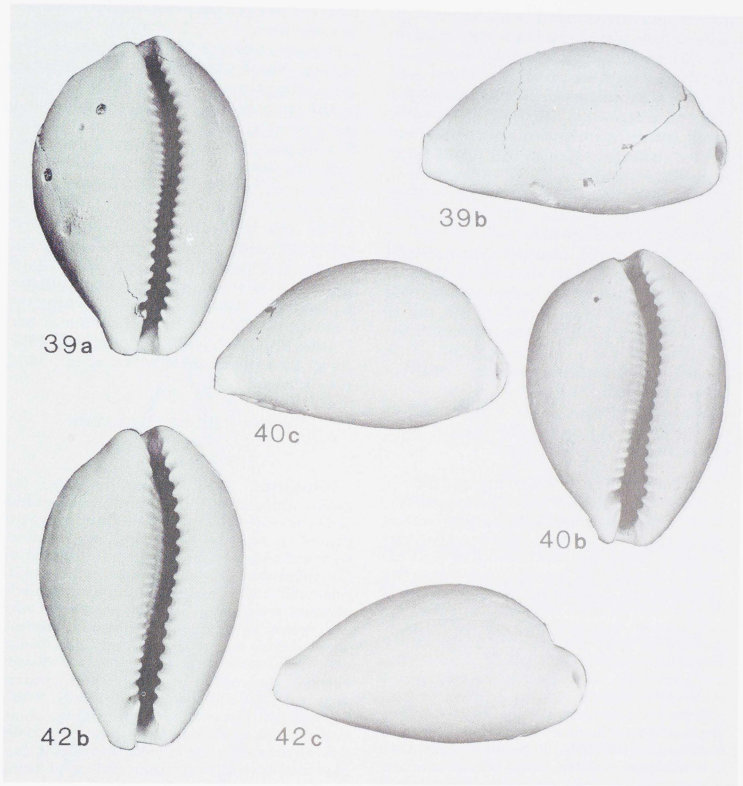


Figure 42a. *Bistolida praelatior* Dolin, n. sp.; USNM 438616 (holotype).



Figures Page

39, 40. *Erronea (Adusta) shirleyae* Dolin, n. sp. 36
39. (x 1.7) USNM 438613 (holotype); height 32.3 mm.
Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.
40. (x 1.7) USNM 438614 (paratype A); height 30.3 mm.
Locality: TU 830, Tenmile Creek, Florida. Chipola Formation.

42. *Bistolida praelatior* Dolin, n. sp. 38
(x 1.8) USNM 438616 (holotype); height 32.2 mm.
Locality: TU 1196, Farley Creek, Florida. Chipola Formation.

distribution. It has notably the beginnings of the terminal ridge and of the inner edge, the spaced denticulation on the outer margin; the fusiform shape of the ventral area due to the prolongation of the canals – the siphonal bridge-like, the posterior as a collar. It lacks, however, the cylindrical aspect. *Bistolida rashleighana* (Melvill, 1888), from the Hawaiian Islands, in this aspect, recalls more our Chipola species, with its high calloused flanks and the regular rounding of the dorsal line.

One hesitates to describe a new species on the basis of a unique example. Related species demonstrate a polymorphism and a polytypism (Burgess, 1983, p. 186, tab. 2) that incites prudence. Inasmuch as it is the first known Early Miocene fossil of the genus, it was deemed too important to remain unnamed.

Etymology: This species is named for its similarity to the variey *latior* Melvill, 1888, of the closest species *B. teres*.

Family OVULIDAE Fleming, 1828
Subfamily OVULINAE Fleming, 1828
Genus SIMNIA Risso, 1826

Simnia Risso, 1826, Hist. Nat. Europe Meridionale, v. 4, p. 235.

Type species: *Simnia nicaeensis* Risso, by subsequent designation (Gray, 1847).

Subgenus NEOSIMNIA Fischer, 1884

?Not *Calpurna* FLEMING, 1828, Hist. British Animals, p. 331 (?error pro *Calpurnus* Montfort, 1810).

Type species: *Ovula leathesi* Sowerby, by original designation.

Neosimnia FISCHER, 1884, Manuel de Conchyliologie, p. 664 (as *Ovula* subgenus).

Type species: *Bulla spelta* Linné, by original designation.

Description: Shell medium-sized for the genus, fusiform, prolonged and acuminated at both ends; spire involuted; sculpture consisting of fine faint spiral grooves, majority limited to dorsal zone of siphonal and exhalant channel; ventral area and lateral margins calloused; terminal ridge trumpet-shaped; fossula flat and columellar area reduced to minimal expression; adapical ridge mainly transverse, polished and not denticulate; outer lip thickened, with rounded, calloused peristome.

Discussion: In Schilder (1931, p. 54) *Neosimnia* is considered a distinct genus. However, Schilder and Schilder (1971) synonymize it with *Simnia*. *Neosimnia* and Cate's (1973) genera are considered herein as subgenera.

Despite common use of the name *Neosimnia*, Woodring (1928, p. 315) reestablished the name *Calpurna* Fleming, 1828, on the grounds that Fleming did not specifically refer to *Calpurnus* Montfort, 1810. Strictly speaking, the matter should be referred to the International Commission on Zoological Nomenclature. It appears unlikely (and most troublesome) that *Calpurna* and *Calpurnus* should have been coined independently in the same family. Herein *Calpurna* is considered to be an incorrect subsequent orthography of *Calpurnus* and *Neosimnia* Fischer (following similar usage by Maury, 1917; Cossmann and Peyrot, 1924; Schilder, 1931; Glibert, 1952; Jung, 1969; Ferrero Mortara *et al.*, 1984, etc.) is used.

Simnia (Neosimnia) cristata
Dolin, n. sp.
Figures 43-45

Description: Shell medium-sized for the genus, fusiform, slightly ventricose in middle and acuminated at each extremity; aperture expanded in adapical part; dorsal area glazed; neck and back of exhalant channel sculpted by fine spiral striae; siphonal canal deep; terminal ridge rectilinear, horizontal and particularly elongate and lamellar; no fossula; columellar and ventral areas regularly rounded, convex; adapical ridge twisted, heavy, crossed at 45° relative to axis, making a projection adaxially over aperture; prolonged rostrum of inner lip heavy, depressed, and slightly curved adaxially; exhalant channel somewhat deep, slightly open; outer lip calloused, rounded. Under ultra-violet light an unbroken line of color underlining passage from lateral margin callus to glaze of dorsal area.

Holotype: USNM 438617; height 12.3 mm, maximum diameter 4.8 mm, dorso/ventral diameter 3.8 mm; E. and H. Vokes collectors (fig. 43; 43-f under ultra-violet light).

Paratype A: USNM 438618; height 14.2 mm, maximum diameter 5.2 mm, dorso/ventral diameter 4.2 mm; locality TU 554, E. and H. Vokes collectors (fig. 44).

Paratype B: USNM 438619; height 14.3 mm, maximum diameter 5.7 mm, dorso/ventral diameter 4.4 mm; locality TU 546, E. and H. Vokes collectors (juvenile, fig. 45).

Type locality: TU 555; Chipola Formation, Chipola River, east bank, about 1000 ft. above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype and paratypes.

Discussion: Simnia (Neosimnia) cristata differs from all other members of the genus in the Caribbean Miocene. Its fusiform outline, pointed at each end, and a thickened transverse adapical ridge that projects over the aperture serve to distinguish it.

A very rare species erroneously identified as *Amphiperas (Neosimnia) speltum* mut. *miocaenicum* Sacco, 1894, by Cossmann and Peyrot (1924, p. 395, pl. 11, figs. 28-30) from the Burdigalian (late Early Miocene) of Saucats (France) is similar to this new species. Although of the same lineage, it is a much smaller, even more slender and thin species. However, *S. (N.) cristata* appears more closely related to *S. (N.) semen* (Defrance, 1825) (see Glibert, 1952, p. 264, pl. 3, figs. 5 a-b) from the Langhian (Middle Miocene) of Touraine (France). *Simnia (N.) semen* is characterized by very fine and closely spaced spiral striae, covering the entire dorsal area.

These three species define a lineage to which the Recent *S. (N.) avena* (Sowerby, 1832) from Pacific Panama and *S. (N.) acuminata* (Adams and Reeve, 1848) from Indonesia also belong. Of medium size and calloused, these related species share the characteristic of a twisted, heavy, adapical ridge, which extends the rostration of the inner margin, very slightly depressed adaxially.

Etymology: Latin *cristatus* = crested; in reference to the adapical ridge.

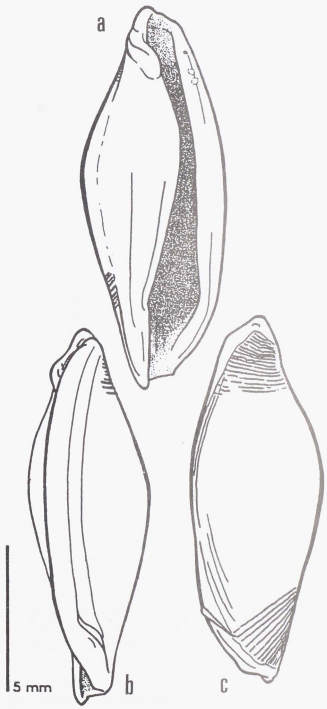


Figure 43a-c. *Simnia (Neosimnia) cristata* Dolin, n. sp.; USNM 438617 (holotype).

SIMNIA (NEOSIMNIA) PUELLA
Dolin, n. sp.
Figures 46, 47

Description: Shell of large size for the genus, regularly swollen, test thin; lozenge-shaped outline with extremities rounded; dorsal area sculpted by growth lines; neck and upper portion of exhalant channel incised by numerous, close, spiral striae, thicker abapically; aperture widened abapically; siphonal canal extremely short, almost nonexistent; ventral area rounded, calloused, forming longitudinal ridge; on abapical two-thirds a weak longitudinal depression marking smooth columella; terminal ridge short, curved; enrolled spirally; adapical ridge transverse, obsolete as in the juvenile, contouring in part collar of exhalant channel (not deep, poorly delimited and closed); a second ridge, parallel to the axis, conferring on adapical termination of inner margin a fan-like aspect; outer lip heavy, margined, ventrally smooth. As in preceding species, under ultra-violet light an unbroken line of color underlining passage from lateral margin callus to glaze of dorsal area.

Holotype: USNM 438620; height 16.1 mm, maximum diameter 6 mm, dorso/ventral diameter 4.6 mm; E. and H. Vokes collectors (fig. 46).

Paratype: USNM 438621; height 12.3 mm, maximum diameter 5 mm, dorso/ventral diameter 4.2 mm; locality TU 1196, S. and R. Hoerle collectors (juvenile, fig. 47).

Type locality: TU 458; Chipola Formation, Chipola River, east bank, about 1/3 miles above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype and paratype.

Discussion: Simnia (N.) puella resembles *S. (N.) immunita* Woodring (1928, p. 315, pl. 21, figs. 3, 4, 7, 8) from the Bowden Formation of Jamaica ("Middle Miocene" = basal Pleistocene). In the latter the rostrate extremity of the inner margin forms a projecting ridge in lateral view, and the exhalant channel is more open, with more of a collar. *Simnia (N.) immunita* is larger in size, and consistantly different from the new species, as confirmed by examination of additional material in the collections of the U. S. National Museum.

Contrary to the statement of Woodring (1928, p. 316), *S. (N.) wisewoodae* Maury (1917, p. 113[277], pl. 22[48], fig. 17) from the Cercado Formation (Late Miocene), Dominican Republic, is completely distinct from *S. (N.) immunita*. It is an unmistakable species, with a totally different outline that is humped and centrally subangulate. It closely resembles *S. (N.) hirasei* Pilsbry, 1913, from the western Pacific, which has the same short horizontal adapical ridge that does not contour the collar, and the prolongation of the inner margin is not rostrate but forms a trumpet-bell. This latter characteristic of *N. wisewoodae* is shared by *N. (N.) puella*.

Simnia (N.) puella resembles two other Recent species: *S. (N.) smithi* (Sowerby, 1894), from the Indian Ocean; and *S. (N.) barbarensis* (Dall, 1892), from California. They display a similar outline and size and combine the juvenile aspect of the adapical area and the non-rostrate extremity of the extension of the inner margin. *Simnia (N.) smithi* has a median swelling, which gives it a more lozenge-shaped form, and the siphonal canal is elongated, forming a slender neck. *Simnia (N.) barbarensis* has a thin, translucent test, and is more acuminate at the extremities.

Etymology: Latin *puella* a young woman; named for the youthful appearance of the characteristics of the shell.

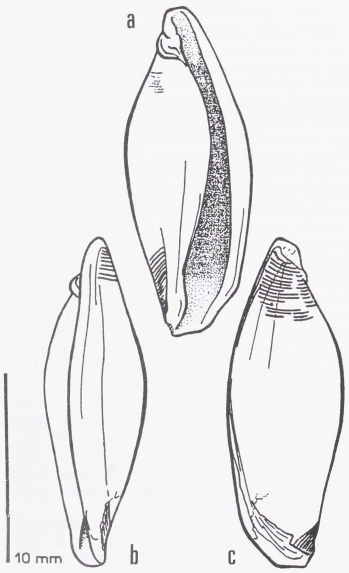


Figure 46a-c. *Simnia (Neosimnia) puella* Dolin, n. sp.; USNM 438620 (holotype).

Subgenus SPICULATA Cate, 1973

Spiculata CATE, 1973, Veliger, v. 15, suppl., p. 82.

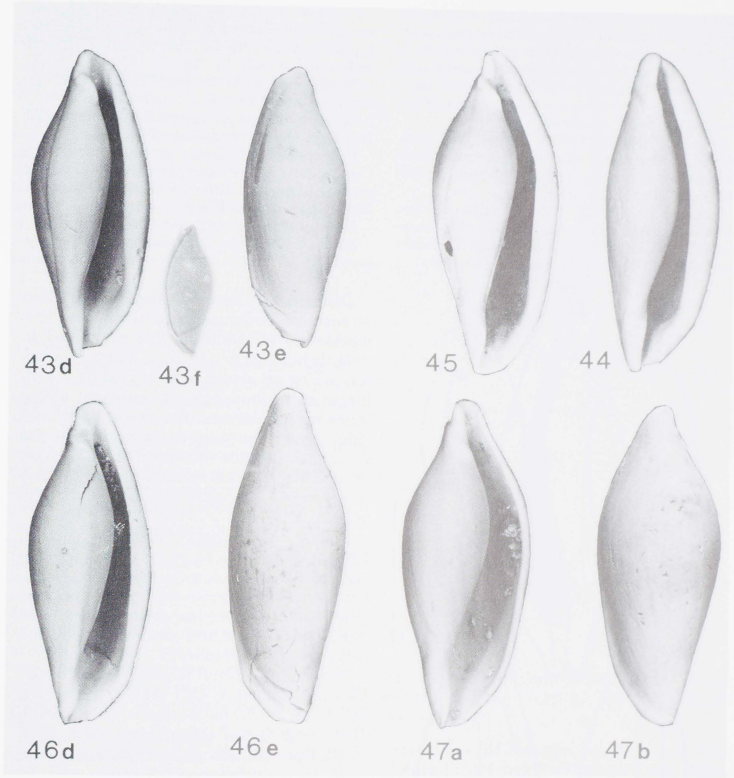
Type species: *Ovula loebbeckeana* Weinkauff, by original designation.

Description: "Shells are usually narrowly ovate, elongate, broader centrally, spindle-shaped, with terminals attenuating pointedly, especially adapically." (Cate, 1973)

Discussion: It is correct to retain Cate's name for those species of the genus *Simnia* that are more slender and more strongly rostrate.

Simnia (Spiculata) terminatincta Dolin, n. sp.
Figures 48-51

Description: Shell of large size for genus, fusiform, regularly acuminate at extremities; test thin, but ventral area calloused, porcellanous; dorsal surface very finely and densely striated longitudinally; neck and adapical area incised by regular spiral striae, perceptible only in juvenile; siphonal canal particularly elongate, delimited by callosity of outer lip (at first parallel curving in a regular arc); terminal ridge straight, thick but elongated; no fossula; slight longitudinal depression on columellar area; adapical ridge transverse, prolonged and exaggeratedly elongated in a slightly flattened rostrum, thick and very slightly twisted abaxially; posterior canal deep, straight and elongate, sharply deli-



Figures Page

43-45. *Simnia (Neosimnia) cristata* Dolin, n. sp. 40

43. (43d, e, x 4.4; 43f, x 2) USNM 438617 (holotype); height 12.3 mm.
Locality: TU 555, Chipola River, Florida. Chipola Formation.

44. (x 4) USNM 438618 (paratype A); height 14.2 mm.
Locality: TU 554, Chipola River, Florida. Chipola Formation.

45. (x 4.1) USNM 438619 (paratype B); height 14.3 mm.
Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.

46, 47. *Simnia (Neosimnia) puella* Dolin, n. sp. 41

46. (x 3.7) USNM 438620 (holotype); height 16.1 mm.
Locality: TU 458, Chipola River, Florida. Chipola Formation.

47. (x 4.7) USNM 438621 (paratype); height 12.3 mm.
Locality: TU 1196, Farley Creek, Florida. Chipola Formation.

mited by bulge of outer lip callosity, rounded in cross-section and forming nodules on right margin. Under ultra-violet light, an unbroken line of color extending from angulation between unicolored dorsal area and porcellanous lateral margin callus; a brown spot staining adapical extremity of exhalant channel.

Holotype: USNM 438622; height 20.6 mm, maximum diameter 7 mm, dorso/ventral diameter 5.2 mm; S. and R. Hoerle collectors (fig. 48; 48-f under ultra-violet light).

Paratype A: USNM 438623; height 16 mm, maximum diameter 4.8 mm, dorso/ventral diameter 3.7 mm; locality TU 555, E. and H. Vokes collectors (fig. 49; 49-b under ultra-violet light).

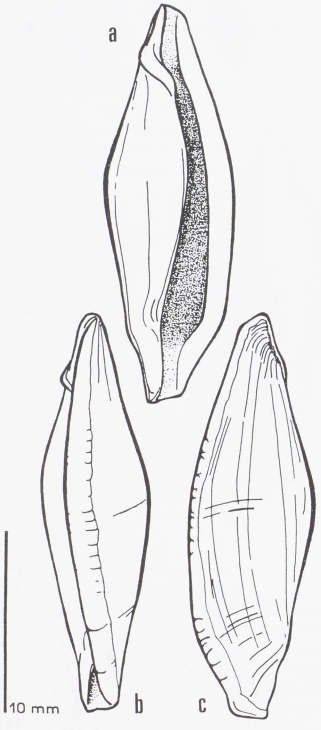


Figure 48a-c. *Simnia (Spiculata) terminatincta* Dolin, n. sp.; USNM 438622 (holotype).

Paratype B: USNM 438624; height 17 mm, maximum diameter 5 mm, dorso/ventral diameter 4.3 mm; locality TU 458, S. and R. Hoerle collectors (juvenile, fig. 50).

Paratype C: USNM 442670; height 23.2 mm (siphonal canal broken), maximum diameter 7 mm, dorso/ventral diameter 5.7 mm; locality TU 549, E. and H. Vokes collectors (fig. 51).

Type locality: TU 555; Chipola Formation, Chipola River, east bank, about 1000 ft. above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype and paratypes.

Discussion: Simnia (Spiculata) terminatincta differs totally from the few worldwide Miocene species described to date. It belongs to a lineage that is characterized by an elongate form and by a prolongation of the adapical rostration of the inner margin beyond the twisted adapical ridge. A similar undescribed form in the Langhian (Middle Miocene) of Touraine (France) has been confused with *S. (N.) semen*, but it is more stocky than *S. (S.) terminatincta.*

Simnia (Spiculata) pliomajor (Sacco, 1894) (see Ferrero Mortara *et al.*, 1984, p. 158, pl. 28, figs. 2 a-c), from the Astian (Pliocene) of Italy, is closely related and possesses a shorter siphonal canal, a thinner adapical ridge and a more twisted rostration of the inner margin.

Simnia (Spiculata) terminatincta resembles the Recent *S. (S.) vidleri* (Sowerby, 1881) and *S. (S.) loebbeckeana* (Weinkauff, 1881), both from California (see Cate, 1973, p. 82, figs. 182, 182 a). It presents, particularly, the elongation of the canals and the flattening of the posterior rostrum of the inner margin of the latter species; *S. (S.) loebbeckeana* is an even more acuminate species.

Simnia (Spiculata) terminatincta differs from the Recent species of the group by the unusual color pattern, which gives the species its name. Only certain species of *Phenacovolva* Iredale, 1930, from the Indo-Pacific are morphologically related, presenting a similar combination of chromatic characters.

Etymology: Latin *terminus* = end, *tinctus* = paint; named for the unusual color pattern in this species.

Subgenus SIMNIALENA Cate, 1973

Simnialena CATE, 1973, Veliger, v. 15, suppl., p. 75.

Type species: *Simnialena marferula* Cate, by original designation.

Description: "Shells of this genus are of medium size, oblong-ovate, usually thinly formed, with thinly-rolled outer lip edges; they possess a peculiar flatly-inflected, spiralling funicular cord, which distorts the adapical base, causing a suboblique angular ridge above the adapical terminal collar. The name is derived from the Greek *lenos*, a word for trough, trench." (Cate, 1973)

SIMNIA (SIMNIALENA) ORYZAGRANA Dolin, n. sp. Figure 52

Description: Shell small for the genus, broadly elongate, thin, cylindrical, with rounded abapical termination of neck and acuminated adapical termination; dorsum glossy, with very fine wavy incised transverse striae at either end, though unmarked centrally; numerous faint longitudinal growth lines visible; siphonal canal short; ventral area long, ovate, narrowing and thickening toward straight terminal ridge; fossula lacking, a long, low, short adaxial carinal wall on columellar area; adapical ridge forming an almost horizontal wrinkle, stout, completely crossing summit of shell and describing a very characteristic wide spiral ramp; appearing to be enrolled adapically around the particularly straight and sharp rostration of the inner margin; exhalant channel deep, almost sealed; outer lip smooth, thickened, slightly flattened basally. A dark color line underlying limit of ventral callus and dorsal area.

Holotype: USNM 442671; height 10.7 mm, maximum diameter 3.8 mm, dorso/ventral diameter 3 mm; S. and R. Hoerle collectors (fig. 52; 52-f under ultra-violet light).

Type locality: TU 458; Chipola Formation, Chipola River, east bank, about 1/3 mile above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype.

Discussion: This small species is described on the basis of a unique specimen. It belongs to a very characteristic and diversified lineage, of which it is the earliest member. Only two fossil species may be compared with it: *S. (S.) woodringi* Schilder, 1932 (for *Simnia immunita* of Woodring, 1928, p. 315, pl. 21, figs. 5, 6, *not* of Guppy), from the "Miocene" (= basal

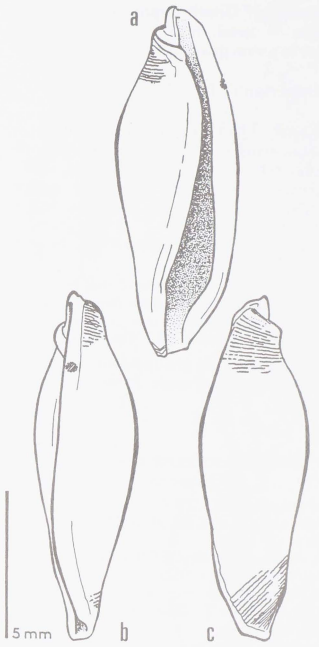


Figure 52a-c. *Simnia (Simnialena) oryzagrana* Dolin, n.sp.; USNM 442461 (holotype).

Pleistocene) of Jamaica, and *S. (S.)* cf. *uniplicata* (Sowerby, 1849) *sensu* Jung (1969, p. 479, pl. 48, figs. 11, 12), from the Pliocene of Trinidad. These species belong to the group of the Recent species *S. (S.) uniplicata* from Florida and *S. (S.) rufa* (Sowerby, 1832) from the Pacific coast of Mexico, which have an oblique adapical ridge and an elongate rostration of the inner margin.

Simnia (Simnialena) oryzagrana prefigures the minuscule *S. (S.) formicaria* (Sowerby, 1828) from the western Pacific. They are morphologically similar and of comparable size. The fossil species possesses a color line underlining the lateral margin callus, which does not exist in the Recent species.

Etymology: Greek *oryza* = rice, Latin *granum* = seed; named for the resemblance to a rice grain.

Superfamily LAMELLARIOIDEA Orbigny, 1841
Family TRIVIIDAE Troschel, 1853
Subfamily ERATOINAE Gill, 1871
Genus HESPERERATO Schilder, 1932

Hespererato SCHILDER, 1932, *in* QUENSTEDT, Fossil. Catalogus (Berlin), v. 1/55, p. 83 (as *Erato* subgenus).

Type species: *Erato vitellina* Hinds, by original designation.

Description: "In the shells of this group the fossula seems to have become nearly obsolete, and there may be either one or two terminal ridges at the abapical canal." (Cate, 1977, p. 360)

Discussion: This group is limited to the Caribbean and Panamic Provinces in the Recent.

HESPERERATO CHIPOLANA (Maury)
Figures 53-55

Erato chipolana MAURY, 1910, Bulls. Amer. Paleontology, v. 4, no. 21, p. 27(145), pl. 6(23), fig. 9.

Erato chipolana Maury. SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 59.

Erato (Hespererato) chipolana Maury. GARDNER, 1947, U. S. Geol. Surv., Prof. Paper 142-H, p. 543.

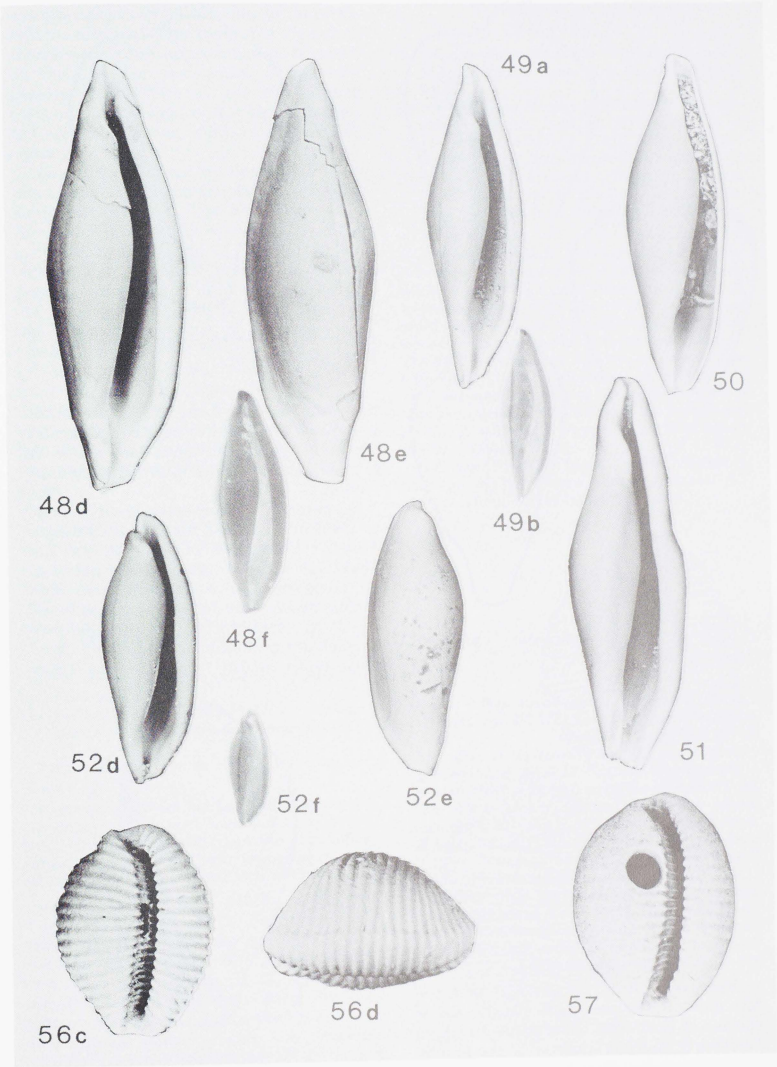
Hespererato chipolana chipolana (Maury). SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 15.

Description: "Shell small, rather heavy, ovate-conic. Spire short, broad, obtusely tapering. Body obtusely angulated at the periphery, somewhat obliquely constricted in front of the periphery, inclined to flare slightly at the anterior extremity. Conch and protoconch each including 2 1/2 volutions, the suture glazed, however, so that in unmutilated specimens it is entirely obscured. Protoconch revealed only by removing the surface enamel; smooth and very highly polished, somewhat naticoid; initial turn minute, inflated, partially immersed; remaining turn and a half increasing more rapidly in altitude than in diameter, flattening toward the close of the nucleus. Opening of conch marked by an abrupt change from the vitreous to the porcellanous texture. Surface smooth except for microscopically fine, irregular, blistered lines radiating from the apex to a little in front of the shoulder. Aperture sublinear, oblique. Outer lip sharply angulated at the shoulder, feebly contracted medially, much thickened and serrated along the inner margin by about 15 short, lirate ridges, longest medially and very short and heavy anteriorly, the foremost outlining the entrance to the incipient canal. Inner wall of aperture flattened; a series of irregular denticles developed along the inner margin of the aperture, the three in front produced into oblique and somewhat irregular ridges that simulate columellar folds. Fossula obsolete. Body constricted anteriorly into an ill-defined canal, squarely truncate or obscurely emarginate at its extremity." (Gardner, 1947)

Type material: PRI 3464 (holotype); height 4 mm, maximum diameter 3 mm, dorso/ventral diameter 2.4 mm (immature); PRI 3464a (paratype) (even more juvenile).

Type locality: "Bailey's Ferry, Florida." TU 555 (here restricted); Chipola Formation,

---


49a
48d
48e
50
49b
48f
51
52d
52e
52f
56c
56d
57

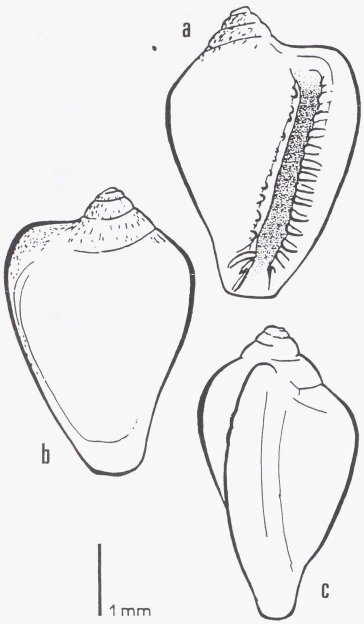


Figure 53a-c. *Hespererato chipolana* (Maury); USNM 442672.

Chipola River, east bank, about 1000 ft. above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Figured specimens: PRI 3464; holotype (fig. 54). PRI 3464a; paratype (fig. 55). USNM 442672; height 4.4 mm, maximum diameter 2.9 mm, dorso/ventral diameter 2.5 mm; 12 columellar teeth, 14 labral teeth; locality TU 555, S. and R. Hoerle collectors (fig. 53).

Material studied: In addition to the holotype and the paratype, the holotype of *H. domingensis* (Maury, 1917) was studied. In the Hoerle collection at the U. S. National Museum, 51 examples from the Chipola Formation (localities TU 555-41, TU 547-10) were examined.

Discussion: It is paradoxical that the Miocene of Florida yields only a single species of Eratoinae. In a single Burdigalian (Early Miocene) outcrop at the Moulin de Gamachot, Parish of Villandraut (Gironde, France), three species are found in strata interpreted to be a reefal lagoon (Dolin, in prep.). But there does not seem to be any other species in the Chipola Formation.

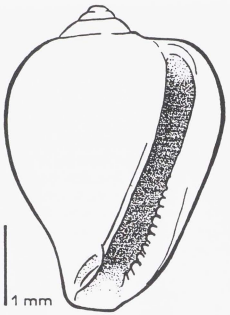


Figure 54. *Hespererato chipolana* (Maury); PRI 3464 (holotype).

Hespererato domingensis Maury (1917, p. 118[282], pl. 21[47], fig. 8) from the Late Miocene Cercado Formation on the Rio Mao (Dominican Republic), may prove to be conspecific with *H. chipolana*. The unique holotype is defective; the siphonal canal, the terminal ridge, and the protoconch are broken off. A projecting triangular tooth, which terminates the inner

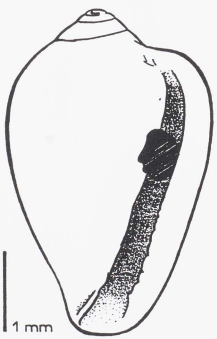


Figure 55. *Hespererato chipolana* (Maury); PRI 3464a (paratype).

margin adapically (unnoticed by Maury), and the terminal ridge place it in the genus *Hespererato*. The approximately 20 teeth on the outer lip are similar in the two species. The difference one can note is that, on the average, in *H. chipolana* they are more numerous, more close together adapically.

Related fossil forms are based on insufficient material, not permitting even the assignment to genus. The best example is furnished by *Erato* (s.s.) *venezuelana* Weisbord (1962, p. 224, pl. 18, figs. 6, 7), described from a unique juvenile specimen from the Pleistocene of Venezuela. Schilder and Schilder (1971, p. 15) considered this taxon a subspecies of *H. chipolana;* one may ask, on what grounds?

It is difficult to distinguish *H. chipolana* from the Recent species *H. maugeriae* (Sowerby, 1832), in the Gulf of Mexico, *H. martinicensis* Schilder, 1933, in the Antilles, and *H. columbella* (Menke, 1847), from west Panama (see Cate, 1977, figs. 42, 43, 44).

Subfamily TRIVIINAE Troschel, 1863
Genus TRIVIA Broderip, 1837

Trivia BRODERIP, 1837, *in* KNIGHT, Penny Cyclopaedia, v. 8, p. 256.

Type species: *Cypraea europaea* Montagu, by subsequent designation (Gray, 1847).

Trivea SWAINSON, 1840, Treatise on Malacology, p. 325.

Type species: *Cypraea coccinella* Lamarck, by original designation.

Coccinella HERRMANSEN, 1847, Index Genr. Malacoz., v. 1, p. 253 (not *Coccinella* Linné, 1758).

Type species: *Cypraea arctica* Pulteney, by original designation.

Description: "Shell marked with transverse, uninterrupted, elevated lines, uniting with the teeth; the aperture wide; and the extremities obtuse; inner lip with a thickened protuberance; pillar concave within." (Swainson, 1840)

Discussion: Schilder (1933, p. 19) introduced the subgenus *Sulcotrivia* in order to distinguish the species *S. dimidiata* (Bronn, 1837) (see Ferrero-Mortara *et al.*, 1984, p. 155, pl. 27, figs. 6 a-c) from the Astian (Pliocene) of Italy. But this species and related forms intergrade by their dorsal sulcus, with the Recent *Niveria pacifica* (Sowerby, 1832), from Pacific Panama. Herein the genus *Trivia* is not divided subgenerically.

TRIVIA CHIPOLANA Maury
Figures 56, 57

Trivia chipolana MAURY, 1910, Bulls. Amer. Paleontology, v. 4, no. 21, p. 26(144), pl. 6(23), fig. 8.

Trivia chipolana Maury. SCHILDER, 1927, Archiv Naturgesh., v. 91, no. A/10, p. 64.

Trivia chipolana Maury. GARDNER, 1947, U. S. Geol. Surv., Prof. Paper 142-H, p. 542.

Niveria (s.s.) *chipolana chipolana* Maury. SCHILDER and SCHILDER, 1971, Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) v. 85, p. 20.

Description: "Shell globose, inflated, rather thin, ribs fine, numerous, about twenty-five on the lip where they form a line of fine but sharply-defined teeth. The ribs extend uninterruptedly over the dorsal area of the shell and occasionally divaricate towards the lateral margins. The shell shows a very faint medial dorsal ridge with barely visible grooves on either side . . . very like small specimens of *T. europaea* Montagu from which it differs only in the faint dorsal groovings which are absent in the Europaean species." (Maury, 1910)

Holotype: PRI 3463; height 7.3 mm, maximum diameter 5.1 mm, dorso/ventral diameter 4.7 mm; 20 columellar teeth, 20 labral teeth.

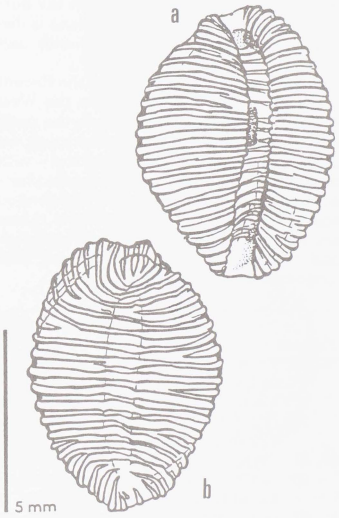


Figure 56a, b. *Trivia chipolana* Maury; PRI 3463 (holotype).

Type locality: "Bailey's Ferry, Florida." ? = TU 457, Chipola Formation, Chipola River, west bank, about one-half mile below mouth of Tenmile Creek (SW 1/4 Sec. 17, T1N, R10W), Calhoun Co., Florida. The holotype has the ocherous-yellow color of specimens from locality TU 457; however, no specimens have been collected recently in the "Bailey's Ferry" area. The shell Gardner (1947) cited from locality USGS 2213 [= TU 457] is *T. capillata*, n. sp., below.

Occurrence: Shoal River Formation, Chipola Formation; Florida.

Figured specimens: PRI 3463; holotype (fig. 56). USNM 442673; height 7.5 mm, maximum diameter 5.9 mm, dorso/ventral diameter 5 mm; 19 columellar teeth, 20 labral teeth; locality TU 546, E. and H. Vokes collectors (fig. 57).

Material studied: The holotype and the corroded specimen figured herein, the only other example known from the Chipola Formation, were both examined. In the collections of the U. S. National Museum, a third specimen from the Shoal River Formation (locality USGS 10603 – Whites Creek, Florida) was recognized.

Discussion: The last phrase of the Maury's description is ambiguous and Schilder and Schilder (1971) contend that it places the species in *Niveria*. The type shows a flat longitudinal zone on the dorsum but no sulcus. *Trivia chipolana* is distinct and cannot be confused with any other fossil species.

This species is very similar to the Recent *T. napolina* (Kiener, 1843) from the West African Province. They are both the same size, with a sharply projecting spire, an elongated form – slightly cylindrical – with distant ridges and an open exhalant channel that borders the heavy, very prolonged adapical ridge. In *T. napolina* the ridges are less numerous, heavier and rounded, and the exhalant channel is more prolonged, and more abaxially twisted.

TRIVIA JULIAE Dolin, n. sp.
Figures 58, 59

Description: Shell small with thickened test, subglobulose, with depressed outline, flattened and with spire projecting but covered; 17 or 18 heavy, rounded, spiral ridges, close to one another, crossing all of dorsal area without interruption; dorsal area greatly inflated, forming neither sulcus nor groove (a slight longitudinal depression visible under oblique light in TU 819 paratype); siphonal canal straight, somewhat deep; fossula and columellar areas deep, concave, strongly ribbed; exhalant channel not deep, poorly delimited and twisted abaxially; adapical ridge basally flat, obsolete, triangular, making a junction in continuity with outer margin; thus forming a rounded parietal pad, underlining adapical margin of exhalant channel. Outer lip calloused, crescent-shaped, wide in middle, high and margined exteriorly.

Holotype: USNM 442674; height 7.1 mm, maximum diameter 5.5 mm, dorso/ventral diameter 4.8 mm, 20 columellar teeth, 21 labral teeth; S. and R. Hoerle collectors (fig. 58).

Paratype: USNM 442675; height 7.3 mm, maximum diameter 5.5 mm, dorso/ventral diameter 4.8 mm; 20 columellar teeth, 21 labral teeth; locality TU 820, S. and R. Hoerle collectors (fig. 59).

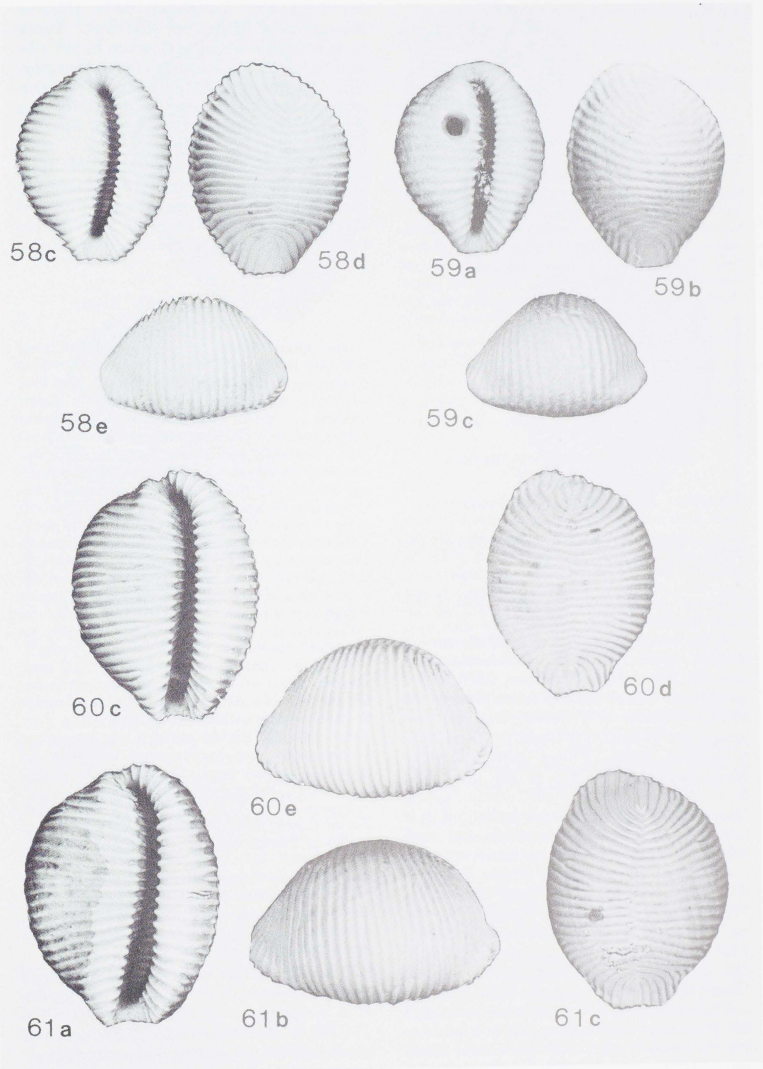
Type locality: TU 825; Chipola Formation, Farley Creek, at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: In addition to the figured type material, one other specimen from locality TU 819 was collected (paratype, MNHN) and at the U. S. National Museum there is a broken topotype (TU 825, S. and R. Hoerle collectors).

Discussion: This species is the smallest of the Triviinae in the Chipola Formation. It is distinguished from its congeners by the general outline, the heavy but numerous ridges, by the deep but poorly delimited exhalant channel, forming a heavy

---


58c
58d
59a
59b
58e
59c
60c
60d
60e
61a
61b
61c

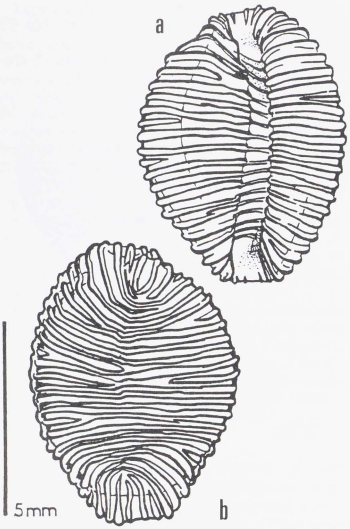


Figure 58a, b. *Trivia juliae* Dolin, n. sp.; USNM 442674 (holotype).

pad, and by the hemispheric callus of the outer lip, rising high.

Type material of *Trivia islahispaniolae* Maury, 1917, and *T. islahispaniolae petrela* Olsson and Harbison, 1953, were examined. These species have dorsal ribs similar to those of *T. juliae*, but they belong to the genus *Dolichupis*, having a non-projecting spire. *Trivia islahispaniolae* Maury *sensu* Jung (1971, p. 180, pl. 7, figs. 6, 7) from Grand Bay cliff (early Middle Miocene), Carriacou Island, is distinct. It is globular, with numerous thick but well separated ridges, which are interrupted to the level of the inner lip where they are thickened, as in *T. arctica* (Pulteney, 1799). The Carriacou fossil belongs to the same lineage as *T. antiquosphaera* Sacco, 1894 (see Ferrero Mortara *et al.*, 1984, p. 153, pl. 26, figs. 8 a-c) from the Burdigalian (Early Miocene) of the Turin Hills (Italy).

The only species that can be compared to *T. juliae* are either undescribed or poorly known, such as *T. grateloupi* Schilder, 1941 (see Cate, 1979, p. 30, pl. 7, fig. 26) from the Langhian beds (Middle Miocene) of Touraine (France). These form a lineage characterized by heavy ribs and strongly calloused lateral margins. They are ancestral to the Recent *T. leucosphaera* Schilder, 1931 (Cate, 1979, as *Pusula (Cleotrivia)*, p. 54, pl. 15, figs. 62, 62a) from the Gulf of Mexico.

Etymology: Named in honor of Julia Gardner, the first author in recent times to provide a revision of the Miocene fauna of Florida; if only for this reason, I owe to her the dedication of a species from these beds.

TRIVIA CAPILLATA Dolin, n. sp.
Figures 60, 61

Description: Shell large for the genus, oblong, with thin test; ventral area convex and general outline slightly cylindrical; protoconch and first whorls of teleoconch projecting under glaze, crossed by several ridges; about 20 thin, spiral ridges, pointed, close together, and for the most part uninterrupted, surmounting straight longitudinal dorsal groove, slightly incised; with exception of calloused ventral area, space between ribs dotted with fine incised lines, seemingly "pulled" from exterior glaze of shell; siphonal canal straight, well delimited; fossula and columellar area deep, concave, strongly ribbed; aperture rectilinear; exhalant channel abruptly twisted abaxially; overhung by strong elongate pad of adapical axial ridge; outer lip rather straight, weakly curved but abruptly incurved at extremities.

Holotype: USNM 442676; height 10.5 mm, maximum diameter 8 mm, dorso/ventral diameter 6.9 mm; 23 columellar teeth, 24 labral teeth; E. and H. Vokes collectors (fig. 60).

Paratype: MNHN; height 11.3 mm, maximum diameter 8.4 mm dorso/ventral diameter 7.2 mm; 24 columellar teeth, 23 labral teeth; locality TU 1196, D. Dockery collector (fig. 61).

Type locality: TU 1196; Chipola Formation, Farley Creek, north bank, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W).

Occurrence: Chipola Formation, Florida.

Material studied: In addition to the type material, a specimen cited by Gardner as *T. chipolana* (loc. USGS 2213, USNM 114106, F. Burns collector) was examined.

Discussion: This is the largest species of *Trivia* collected in the Miocene of Florida. It is a specimen of this species (USNM 114106) to which Gardner (1947, p. 542) made reference, when she erroneously wrote that *T. chipolana* "attains a length of

Figure 60a, b. *Trivia capillata* Dolin, n. sp.; USNM 442676 (holotype).

10.5 millimeters." *Trivia capillata* cannot be confused with any other species of this genus, with its narrow ribs and the longitudinal sulcus (visible under oblique light), which affects the dorsal area.

These characters are similar to those of *T. antiquosphaera* Sacco, 1894, *sensu* Glibert (1952, p. 265, pl. 3, figs. 6 a-d), from the Langhian (Middle Miocene) of France. In this line the shells are distinguished by the more oval outline and their more numerous and closely spaced ribs.

Etymology: Latin *capillatus* = hairy; in remembrance of the "Beatles" of my youth.

Genus DOLICHUPIS Iredale, 1930

Dolichupis IREDALE, 1930, Mem. Queensland Mus., v. 10, no. 1, p. 84.

Type species: *Cypraea producta* Gaskoin, by original designation.

Decoriatrivia CATE, 1979, San Diego Nat. Hist. Mus., Mem., v. 10, p. 95.

Type species: *Cypraea paucilirata* Sowerby, by original designation.

Description: Shell solid, ventral area lunate, flattened by development of heavy, rounded and marginate lateral margin calluses; latter conferring general form of a "colonial helmet;" protoconch not in dorsal sulcus; spiral ridges only incidentally interrupted dorsally; siphonal canal and exhalant channel somewhat deep but well delimited and prolonged by pointed, spatulate extensions of two lips; adapical ridge flattened, becoming confused with margin; fossula and columellar area deep, convex, and strongly ribbed; outer lip particularly wide.

Discussion: The Panamic and Pacific group *Dolichupis* merits separation from all others. One can easily divide it into two lineages: one with numerous thin spiral ridges, the other with thick sinuous ridges.

DOLICHUPIS CLYPEUS Dolin, n. sp.
Figures 62, 63

Description: Shell small, solid, somewhat roundly ovate; ventral area of inner and outer lip distinctly flattened; this impression reinforced by development of calloused lateral margins, thickening marginate extremities; dorsal area marked by longitudinal sulcus; heavy spiral ribs, blunt and sinuous, following on dorsal area, only being interrupted sporatically; glaze of shell notched by minuscule striae affecting wide intercostal zones; protoconch not projecting; siphonal canal rather elongate; exhalant channel sunken, widely open; fossula and columellar area deep, concave, strongly ribbed; outer lip very wide, weakly recurved.

Holotype: MNHN; height 7.8 mm, maximum diameter 6 mm, dorso/ventral diameter 5 mm, 18 columellar teeth, 19 labral teeth; L. Dolin collector (fig. 62).

Paratype: USNM 442677; height 6.9 mm, dorso/ventral diameter 4.5 mm (laterally broken), 17 columellar teeth, 19 labral teeth; locality TU 546, E. and H. Vokes collectors (fig. 63).

Type locality: TU 546; Chipola Formation, Tenmile Creek, about 1 1/2 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: For comparison, the holotype (USNM 371861) and the five paratypes (USNM 351482-351483, Vaughan and Nichols collectors) of *T. vaughani* Gardner, from the Shoal River Formation, were compared to the type material of *D. clypeus*.

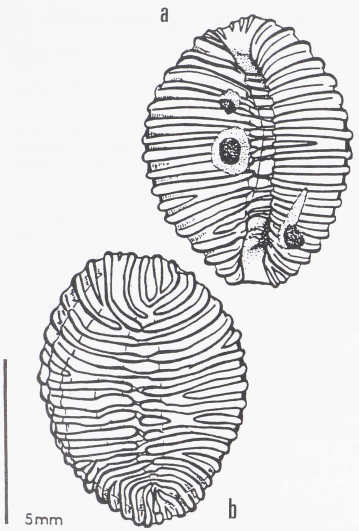


Figure 62a, b. *Dolichupis clypeus* Dolin, n. sp.; MNHN (holotype).

Discussion: Dolichupis clypeus n. sp., cannot be confused with any species from the Miocene of Florida, because of the character of its well delineated, widely open exhalant channel.

Trivia vaughani Gardner (1947, p. 542, pl. 54, figs. 9, 10), from the Shoal River Formation (Florida), has a circular ventral area. But it is allied to *Trivia burdigalensis excoccinella* Sacco, 1894, *sensu* Cossmann and Peyrot (1924, p. 384, pl. 10, figs. 31, 32) from the Early Miocene of Saucats (France). These forms are much more ovoid, broader posteriorly than anteriorly, are more inflated, they have a short siphonal canal and exhalant channel and their ridges are more slender and numerous.

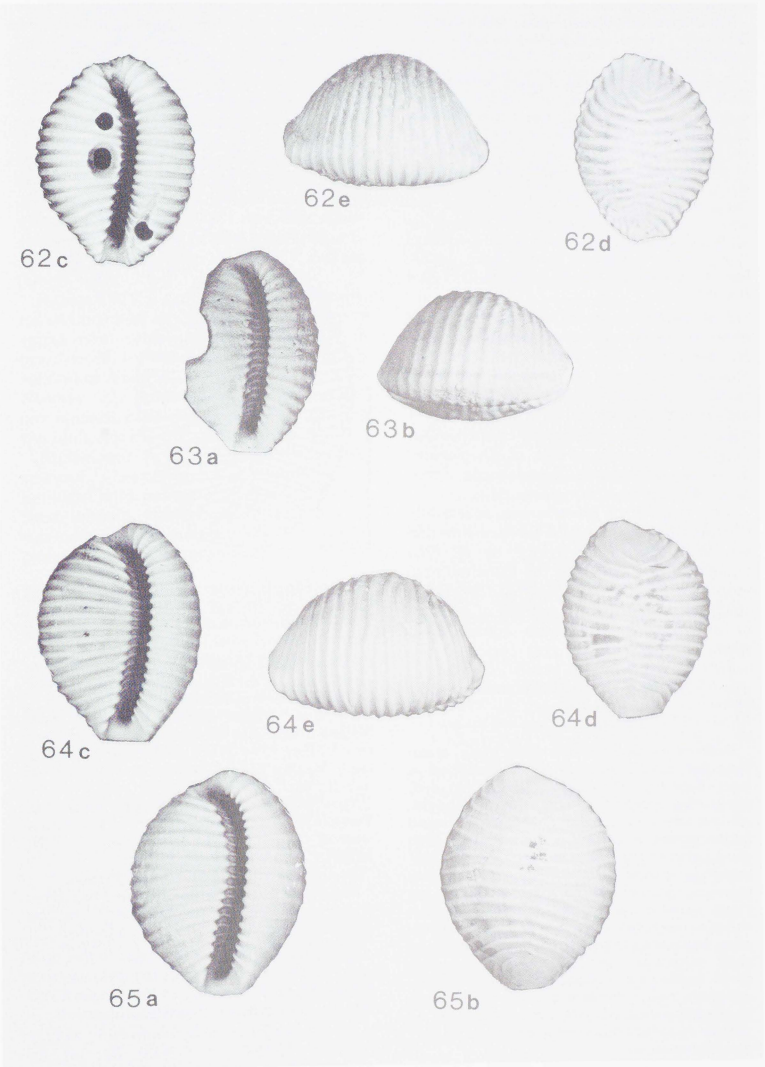
Dolichupis clypeus is one the earliest species of *Dolichupis*. The Late Miocene *D. islahispaniolae* (Maury, 1917, p. 117 [281], pl. 19[45], fig. 14) from the Cercado Formation (Dominican Republic) and the Plio-Pleistocene *D. islahispaniolae petrela* (Olsson and Harbison, 1953, p. 264, pl. 60, figs. 3-3d) from the Caloosahatchee Formation of St. Petersburg (Florida), are equally allied with this genus. These two subspecies are differentiated only by their size. However, they are much more sunken and flattened than *D. clypeus;* are more rotund, with their lateral margins developing a rounded and heavy pad; their siphonal canals and exhalant channels are raised, turned up dorsally; and the two lips are prolonged to the level of the latter. *Dolichupis islahispaniolae* is almost surely the ancestor of the Recent species *D. producta* (Gaskoin, 1836) and *D. sanguinea* (Sowerby, 1832).

Dolichipis clypeus certainly anticipates the Recent *D. paucilirata* (Sowerby, 1870) from the Panamic Province and *D. rubinicolor* (Gaskoin, 1836) from the Indian Ocean. It differs from the first in the more numerous ribs, and the more humped form; from the second it differs in lacking the rounded, heavy, close-set ribs and the semicircular outline.

Etymology: Latin *clypeus* = a large, round shield.

Genus NIVERIA Jousseaume, 1884
Subgenus NIVERIA Jousseaume, 1884

Niveria JOUSSEAUME, 1884, Bull. Soc. Zool.


62c
62e
62d
63a
63b
64c
64e
64d
65a
65b

France, v. 9, p. 100.

Type species: *Cypraea nivea* Sowerby *non* Dillwyn (= *Trivia nix* Schilder), by original designation.

Description: Shell solid, globose, ventral area more or less calloused; only point of spire weakly projecting; spiral ribs extending onto flanks; interrupted by deep, straight, longitudinal sulcus, amplifying development of pustules at dorsal extremities of ridges; siphonal canal short, even truncated in certain species; fossula deep, very concave and strongly ridged; columellar area reduced; angulation of inner lip slightly depressed; aperture expanded; adapical ridge recurved; exhalant channel deep, not delimited abaxially, outer lip outlining apex in a regular arc.

Discussion: Jousseaume (1884, p. 100) gives an awkward description of *Niveria*. No mention is made of the sulcus that is so characteristic and he wrongly evokes a rather projecting lamellar abapical termination to the inner lip, as in *Ipsa childreni* (Gray, 1825). This distinctive characteristic appears only in a group of deep-water Triviinae, the genus *Pseudotrivia* Schilder, 1936.

The species of *Niveria* are essentially Caribbean, but the genus is represented in the West African Province by *N. (N.) liltvedi* Gofas, 1983, and the Panamic Province, where *N. (N.) pacifica* (Sowerby, 1832) is sympatric with species of a genus or subgenus near *Pusula* Jousseaume, 1884.

Niveria (Niveria) carlottae
Dolin, n. sp.
Figures 64, 65

Description: Shell solid, roundly ovate; apical zone flat, sometimes very weakly reflected to level of protoconch; a dozen heavy, rounded, spiral ribs, meeting on both sides of straight, sunken longitudinal groove, sharply delimited by thickening into beads of extremities of ribs; glaze between ribs with a minuscule punctation, relatively sparce; neck and zone overhanging exhalant channel abnormally smooth, lacking cords usual in this zone in other species; siphonal canal short, sunken, and elevated dorsally; basal area regularly convex and inner lip short; columellar area flat, fossula weakly concave, denticulate; exhalant channel recurved, relatively well delimited, notably by lamellar, somewhat calloused, adapical ridge; outer lip slightly rounded, recurved adapically and very weakly margined.

Holotype: USNM 442678; height 8.4 mm, maximum diameter 6.3 mm, dorso/ventral diameter 5.5 mm; 16 columellar teeth, 20 labral teeth; S. and R. Hoerle collectors (fig. 64).

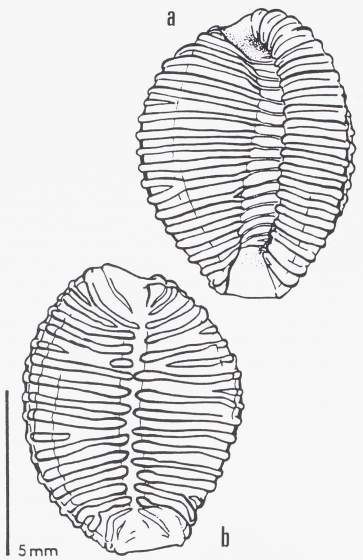


Figure 64a, b. *Niveria (Niveria) carlottae* Dolin, n. sp.; USNM 442678 (holotype).

Paratype: USNM 442679; height 8.6 mm, maximum diameter 6.8 mm, dorso/ventral diameter 5.7 mm; 15 (+ 1) columellar teeth, 19 labral teeth; locality TU 546, E. and H. Vokes collectors (fig. 65).

Type locality: TU 998; Chipola Formation, Tenmile Creek, north bank, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

Occurrence: Chipola Formation, Florida.

Material studied: The holotype and paratype. I also examined the holotype of *T. suffusa sanctidominici* Maury, 1917, for comparison.

Discussion: Niveria carlottae is the only species from the Chipola Formation with a genuine dorsal sulcus and interrupted spiral ribs, which form dorsal pustules.

Trivia suffusa sanctidominici Maury (1917, p. 117[281], pl. 19[45], fig. 15) appears at first glance to resemble *N. (N.)*

carlottae, but it is radically different. It has a weak dorsal sulcus, but this pertains to a different genus, that of *Trivirostra* Jousseaume, 1884. As in the Recent species from the Indo-Pacific, the siphonal canal is elongated and straight; the aperture is expanded in the anterior third by the hemispheric separation of the lips; the outer lip outlines the apical zone even more. At least two species from the Langhian (Middle Miocene) beds of Touraine (France) are comparable to *N. (N.) carlottae*. However, they are undescribed and belong to another lineage, that of *N. (N.) suffusa* (Gray, 1827).

Because of the similar but more cylindrical outline and the less numerous, heavy spiral ribs, which decrease laterally in number, *N. carlottae* appears most closely related to *Niveria (N.) nix* Schilder, 1922. *Niveria (N.) carlottae* is distinguished by two smooth, calloused flanks, surmounting the neck and the exhalant channel.

Etymology: I cannot close this study without honoring that outstanding geologist and paleontologist of the Caribbean domain, Carlotta Joaquina Maury. I dedicate to her memory this species so characteristic of the province.

V. LITERATURE CITED

AKERS, W. H., 1972, Planktonic foraminifera and biostratigraphy of some Neogene formations, northern Florida and Atlantic coastal plain: Tulane Stud. Geol. Paleont., vol. 9, nos. 1-4, p. 1-139, 4 text-figs., 60 pls.

BEETS, C., 1986, Neogene Mollusca from the Vogelkop (Bird's Head Peninsula), West Irian, New Guinea: Scripta Geol., vol. 82, p. 101-134.

BEU, A. G., and P. A. MAXWELL, 1990, Cenozoic Mollusca of New Zealand: New Zealand Geol. Surv., Pal. Bull. 58, 518 p., 57 pls.

BURGESS, C. M., 1983, Another new *Cypraea* in the *teres* complex (Gastropoda: Cypraeidae): Venus, vol. 42, no. 2, p. 183-191, 1 pl., 2 tables.

CATE, C. N., 1973, A systematic revision of the Recent Cypraeid family Ovulidae (Mollusca:Gastropoda): Veliger, vol. 15, Supplement, 116 p., 251 text-figs.

CATE, C. N., 1977, A review of the Eratoidae (Mollusca: Gastropoda): Veliger, vol. 19, no. 3, p. 341-366b, 53 text-figs.

CATE, C. N., 1979, A review of the Triviidae (Mollusca: Gastropoda): San Diego Soc. Nat. Hist., Memoir 10, 126 p., 39 pls.

CERNOHORSKY, W. O., 1965, Genera of living Cypraeidae: The Cowrey, vol. 1, no. 8, p. 115-128.

COSSMANN, A. E. M., and A. PEYROT, 1924, Conchologie néogénique de l'Aquitaine, pt. 4: Actes Soc. Linn. Bordeaux, vol. 74, p. 363-610, pls. 8-18.

DALL, W. H., 1890-1903, Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci., Trans., vol. 3 (in 6 pts.), 1654 p., 60 pls.

DALL, W. H., 1915, A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida: U. S. Natl. Mus., Bull. 90, 173 p., 27 pls.

DEY, A. K., 1962, The Miocene Mollusca from Quilon, Kerala (India): Geol. Surv. India, Mem., Palaeontologica Indica, (N.S.) vol. 36, p. 1-129, pls. 1-10, 2 text-figs.

DOCKERY, D. T., III, 1977, Mollusca of the Moodys Branch formation, Mississippi: Mississippi Geol. Survey, Bull. 120, 212 p., 28 pls., 23 text-figs.

DOLIN, L., 1987, Cypraeidae infralittorales de l'Angola: Xenophora, vol. 36-37, p. 21-27, 2 pls., 18 text-figs.

DOLIN, C., L. DOLIN, and P. LOZOUET, 1985, Paleoecology of some classic Tertiary localities in Aquitaine and Paris basins of France: Mississippi Geology, vol. 5, no. 4, p. 4-13, 1 pl., 1 text-fig.

FERRERO MORTARA, E., L. MONTEFAMEGLIO, M. NOVELLI, G. OPESSO, G. PAVIA, and R. TAMPIERI, 1984, Catalogo dei tipi e degli esemplari figurati della collezione Bellardi e Sacco: Cataloghi Mus. Reg. Sci. Nat. Torino, vol. 7, no. 2, 484 p., 56 pls.

GABB, W. M., 1873, On the topography and geology of Santo Domingo: Amer. Philos. Soc., Trans., (N.S.) vol. 15, p. 49-259, 2 maps.

GARDNER, J. A., 1926-1950, The molluscan fauna of the Alum Bluff Group of Florida: U. S. Geol. Surv., Prof. Paper 142, 709 p., 62 pls., 1 map.

GLIBERT, M., 1952, Gastropodes du Miocène moyen du bassin de la Loire: Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) vol. 46, 450 p., 15 pls.

GOSLINER, T. M., and W. R. LILTVED, 1985, Aspects of the morphology of the endemic South African Cypraeidae with a discussion of the evolution of the Cypraeacea and Lamellariacea: Ann. South African Mus., vol. 96, no. 4, p. 67-122, 35 text-figs., 1 table.

GRAY, J. E., 1847, A list of the genera of Recent Mollusca, their synonyma and types: Zool. Soc. London, Proc., vol. 15, p. 129-219.

HEILPRIN, A., 1886-1887, Explorations on the west coast of Florida and in the Okeechobee wilderness: Wagner Free Inst. Sci., Trans., vol. 1, p. 1-134, pls. 1-19 [p. 65-127 published in 1886, remainder in 1887; see Petit and Wil-

son, 1986, Tulane Stud. Geol. Paleont., vol. 19, no. 2, p. 96-96].

INGRAM, W. M., 1939a, Notes on *Cypraea heilprini* Dall and *Cypraea chilona* Dall with new species from the Pliocene of Costa Rica: Bulls. Amer. Paleontology, vol. 24, no. 84, p. 319-326, pl. 21.

INGRAM, W. M., 1939b, New fossil Cypraeidae from Miocene of the Dominican Republic and Panama, with a survey of the Miocene species of the Dominican Republic: Bulls. Amer. Paleontology, vol. 24, no. 85, p. 327-340, pl. 22.

INGRAM, W. M., 1942, Type fossil Cypraeidae of North America: Bulls Amer. Paleontology, vol. 27, no. 104, p. 91-122, pls. 8-11.

INGRAM, W. M., 1947, New fossil Cypraeidae from Venezuela and Colombia: Bulls. Amer. Paleontology, vol. 31, no. 121, p. 126-136, pls. 8-9.

INGRAM, W. M., 1948, New fossil Cypraeidae from the Miocene of Florida and Colombia: California Acad. Sci., Proc., (Ser. 4) vol. 26, no. 6, p. 125-133, pl. 2, 12 text-figs.

JOUSSEAUME, F., 1884, Étude sur la famille des Cypraeidae: Soc. Zool. France, Bull., vol. 9, p. 81-100.

JUNG, P., 1969, Miocene and Pliocene mollusks from Trinidad: Bulls. Amer. Paleontology, vol. 55, no. 247, p. 289-657, 60 pls., 4 text-figs.

JUNG, P., 1971, Fossil mollusks from Carriacou, West Indies: Bulls. Amer. Paleontology, vol. 61, no. 269, p. 143-262, 21 pls., 1 map, 2 tables.

KAY, E. A., 1960, Generic revision of the Cypraeidae: Malac. Soc. London, Proc., vol. 33, no. 6, p. 278-287, 8 text-figs., 1 table.

KAY, E. A., 1963, Anatomical notes on *Cypraea aurantium* Gmelin and other cowries, and an examination of the genus *Lyncina* Troschel: Malac. Soc. Australia, Jour., vol. 7, p. 47-61, 1 pl., 12 text-figs.

LILTVED, W. R., and F. G. LE ROUX, 1988, A new fossil *Cypraea* (Gastropoda: Prosobranchia) from southern Africa with notes on the Alexandria Formation: Veliger, vol. 30, no. 4, p. 400-407, 8 text-figs.

MACNEIL, F. Ś., and D. T. DOCKERY, III, 1984, Lower Oligocene Gastropoda, Scaphopoda and Cephalopoda of the Vicksburg Group in Mississippi: Mississippi Bureau Geol., Bull. 124, 415 p., 72 pls., 16 figs.

MAGNE, J., Y. GOURINARD, and M. J. WALLEZ, 1987, Comparaison des étages du Miocene inférieur définis par Stratotypes ou par zones paléontologiques: Strata, vol. 3, no. 1, p. 95-107, 2 tables.

MARTIN, K., 1891-1906, Die fossilen von Java: Sammlung. Geol. Reichs-Mus. Leiden, (N.S.) vol. 1, 332 p., 45 pls.

MAURY, C. J., 1910, New Oligocene shells from Florida: Bulls. Amer. Paleontology, vol. 4, no. 21, p. 119-164, pls. 18-26.

MAURY, C. J., 1917, Santo Domingo type sections and fossils. Pt. 1: Bulls. Amer. Paleontology, vol. 5, no. 29, p. 165-415, pls. 29-65.

MOORE, R. C., 1960, Treatise on Invertebrate Paleontology: Part I, Mollusca 1; p. i-xxiii, I1-I351, 261 text-figs.

OLSSON, A. A., 1967, Some mollusks from south Florida and the Caribbean: Paleontological Research Inst., Ithaca, New York, 161 p., 9 pls.

OLSSON, A. A., and A. HARBISON, 1953, Pliocene Mollusca of southern Florida, with special reference to those from North Saint Petersburg: Acad. Nat. Sci. Philadelphia, Mon. 8, 458 p., 65 pls., 2 text-figs., 2 maps.

OLSSON, A. A., and R. E. PETIT, 1968, Notes on *Siphocypraea:* Bulls. Amer. Paleontology, vol. 54, no. 242, p. 277-289, pl. 18.

PETUCH, E. J., 1979, A new species of *Siphocypraea* (Gastropoda:Cypraeidae) from northern South America, with notes on the genus in the Caribbean: Bull. Marine Sci., vol. 29, no. 2, p. 215-225, 2 pls.

PFLUG, H. D., 1961, Mollusken aus dem Tertiär von Santo Domingo: Acta Humboldtiana, Ser. Geol. Paleont., vol. 1, p. i-vi + 1-107, 26 pls., 1 map.

PILSBRY, H. A., 1922, Revision of W. M. Gabb's Tertiary Mollusca of Santo Domingo: Acad. Nat. Sci. Philadelphia, Proc., vol. 73, p. 305-435, pls. 16-47, 48 text-figs.

RICHTER, G., and G. THORSON, 1975, Pelagische Prosobranchier-Larven des Golfes von Neapel: Opelia, vol. 18, p. 109-185.

SAUNDERS, J. B., P. JUNG, and B. BIJUDUVAL, 1986, Neogene Paleontology in the northern Dominican Republic. 1. Field surveys, lithology, environment and age: Bulls. Amer. Paleontology, vol. 89, no. 323, 79 p., 39 text-figs., 4 tables.

SCHILDER, F. A., 1924, Kritisches Verzeichnis der rezenten und fossilen Cypraeen: Abhandl. Arch. Mollusk., vol. 1, no. 2, p. 117-308.

SCHILDER, F. A., 1927, Revision der Cypraeacea (Mollusca, Gastropoda): Archiv Naturgesh., vol. 91, no. A/10, 165 p.

SCHILDER, F. A., 1931, The living species of Amphiperatinae: Malac. Soc. London, Proc., vol. 20, p. 46-63, pls. 3-5.

SCHILDER, F. A., 1933, Die Cypraeacea des Pliocaen und Wemmelien von Belgien: Mus. Roy. Hist. Nat. Belgique, Bull., vol. 9, no. 9, p. 1-28, 11 text-figs.

SCHILDER, F. A., 1935, Revision of the Tertiary Cypraeacea of Australia and Tasmania: Malac. Soc. London, Proc., vol. 21, p. 325-

355, 50 text-figs.
SCHILDER, F. A., 1936, Anatomical characters of the Cypraeacea which confirm the conchological classification: Malac. Soc. London, Proc., vol. 22, p. 75-112, pls. 11, 12.
SCHILDER, F. A., 1939, Cypraecea aus dem Tertiär von Trinidad, Venezuela und den Antillen: Abhandl. Schweizer. Palaeont. Gesell., vol. 62, p. 1-35, 32 text-figs.
SCHILDER, F. A., 1941, Verwandtschaft und Verbreitung des Cypraeacea: Arch. Mollusk., vol. 73, p. 57-120, 2 pls.
SCHILDER, F. A., and M. SCHILDER, 1938-1939, Prodrome of a Monograph of living Cypraeidae: Malac. Soc. London, Proc., vol. 22-23, p. 119-231, 1 text-fig., 9 maps.
SCHILDER, M., and F. A. SCHILDER, 1971, A catalogue of living and fossil cowries. Taxonomy and bibliography of Triviacea and Cypraeacea (Gastropoda Prosobranchia): Mém. Inst. Roy. Sci. Nat. Belgique, (Ser. 2) vol. 85, 240 p.
SWAINSON, W., 1840, A treatise on malacology. London, 419 p., 130 figs.
TRYON, G. W., 1885, Manual of Conchology; structural and systematic, vol. 7, p. 153-240, 23 pls.
VOKES, E. H., 1979, The age of the Baitoa Formation, Dominican Republic, using Mollusca for correlation: Tulane Stud. Geol. Paleont., vol. 15, no. 4, p. 105-116, 2 pls., 3 text-figs.
VOKES, E. H., 1986, Notes on the fauna of the Chipola formation – XXX. On the presence of *Eudolium (Galeodolium) subfasciatum* Sacco (Gastropoda: Tonnidae): Tulane Stud. Geol. Paleont., vol. 19, no. 4, p. 177-180, 1 text-fig.
WEISBORD, N. W., 1962, Late Cenozoic gastropods from northern Venezuela: Bulls. Amer. Paleontology, vol. 42, no. 193, p. 1-672, pls. 1-48.
WILSON, B. R., 1985, Direct development in southern Australian Cowries (Gastropoda: Cypraeidae): Australian Jour. Mar. Freshw. Resh., vol. 36, p. 267-280, 7 text-figs., 1 table.
WILSON, B. R., and J. A. MCCOMB, 1967, The Genus *Cypraea* (Subgenus *Zoila* Jousseaume): Indo-Pacific Mollusca, vol. 1, no. 8, p. 457-488, pls. 329-344.
WOODRING, W. P., 1928, Miocene mollusks from Bowden, Jamaica; Pt. 2. Gastropods and discussion of results. Carnegie Inst. Washington, Publ. 385, 564 p., 40 pls., 3 text-figs.
WOODRING, W. P., 1959, Geology and paleontology of Canal Zone and adjoining parts of Panama. Description of Tertiary mollusks (Gastropods: Vermetidae to Thaididae): U. S. Geol. Surv., Prof. Paper 306-B, p. 147-239, pls. 24-38.

VI. LOCALITY REGISTER

The following are Tulane University fossil locality numbers. All are in Calhoun County, Florida, and may be located on either the Altha West or Clarksville Quadrangles.

196. Tenmile Creek, north bank, about 1/4 mile west of bridge of Florida Highway 73 (NE 1/4 Sec. 12, T1N, R10W).
456. Tenmile Creek, north bank, about 1/4 mile east of bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W).
457. Chipola River, west bank, about 1/2 mile below mouth of Tenmile Creek (SW 1/4 Sec. 17, T1N, R9W).
458. Chipola River, east bank, about 1/3 mile above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W).
459. Chipola River, east bank, about 1500 feet above mouth of Taylor Lake Branch (NW 1/4 Sec. 29, T1N, R9W).
546. Tenmile Creek, north bank, about 1 1/2 miles west of Chipola River (NW 1/4 Sec. 12, T1N, R10W).
547. Chipola River, west bank, about 2000 feet above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W).
548. Chipola River, west bank, at bend about 1800 feet below mouth of Farley Creek (NW 1/4 Sec. 29, T1N, R9W).
549. Chipola River, east bank, about 1/4 mile below mouth of Farley Creek (NE 1/4 Sec. 32, T1N, R9W).
550. Chipola River, east bank, 1 1/4 miles below mouth of Tenmile Creek (NE 1/4 Sec. 20, T1N, R9W).
551. Chipola River, east bank, about 1/4 mile below mouth of Fourmile Creek (NE 1/4 Sec. 32, T1N, R9W).
553. Chipola River, east bank, at mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W).
554. Chipola River, east bank, immediately below powerline crossing (SW 1/4 Sec. 17, T1N, R9W).
555. Chipola River, east bank, about 1000 feet above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W).
818. Farley Creek, south bank, 0.1 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
819. Farley Creek, south bank, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
820. Farley Creek, north bank, just east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
821. Farley Creek, north bank, 0.1 mile east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).

825. Farley Creek, north bank, at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
828. Farley Creek, south bank, about 3/4 mile west of bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W).
830. Tenmile Creek, north bank, at powerline crossing about 1.3 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).
950. Chipola River, west bank, about 2000 feet above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W).
951. Tenmile Creek, south bank, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).
998. Tenmile Creek, north bank, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).
999. Farley Creek, south bank, about 900 feet west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
1048. Farley Creek, south bank, about 0.6 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W).
1050. Chipola River, west bank, just below powerline crossing (SW 1/4 Sec. 17, T1N, R9W).
1196. Farley Creek, north bank, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W).

The following localities are in the Dominican Republic:

1226. Baitoa Formation, Río Yaque del Norte, east bank, below the village of Baitoa, and above the confluence of the Río Yaque and the Río Bao.
1443. Unnamed formation, Río Yaque del Norte, east bank, at López, just upstream from mouth of Arroyo López.