

Middle Eocene Cypraeoideans from the San Juan Formation, Chiapas, southern Mexico

María del Carmen Perrilliat^{1,*}, Javier Avendaño², and Francisco J. Vega¹

¹Instituto de Geología, UNAM, Ciudad Universitaria, 04510, México, D. F., México.

²Instituto de Historia Natural del Estado de Chiapas, Calzada de los Hombres Ilustres S/N, Tuxtla Gutiérrez, Chiapas, 29000, México.

* mariacp@servidor.unam.mx

ABSTRACT

Four cypraeoid species one new, and six subspecies, two new from the middle Eocene San Juan Formation in central Chiapas, southern Mexico are described and illustrated. The new species *Macrocypraea veintensis* sp. nov., and two new subspecies *Bernaya (Bernaya) media chiapasensis* subsp. nov., and *Cypraeorbis alabamensis mexicana* subsp. nov. are established from well preserved specimens. Based on lithology and fossil content, a middle Eocene age for the San Juan Formation is confirmed.

Keywords: Cypraeoidean gastropods, middle Eocene, Chiapas.

RESUMEN

Se describen e ilustran diez especies de cipreas del Eoceno medio, provenientes de la Formación San Juan en la región central de Chiapas, sur de México. Una especie nueva *Macrocypraea veintensis* sp. nov., y dos nuevas subespecies *Bernaya (Bernaya) media chiapasensis* subsp. nov., y *Cypraeorbis alabamensis mexicana* subsp. nov. son descritas con base en especímenes bien preservados. Con base en la litología y contenido fósil, se confirma la edad de Eoceno medio para esta porción de la Formación San Juan.

Palabras clave: Cypraeoideos, Eoceno medio, Chiapas.

INTRODUCTION

Fossils of the San Juan Formation include foraminifera, corals, annelids, mollusks, crustaceans, echinoderms, sharks and wood. Previous works devoted to the description of foraminifera include Durham *et al.*, 1955; Licari, 1960; Frost and Langenheim, 1974; Pecheaux, 1984; Quezada-Muñetón, 1990; and Aguilar, 1993. Abundant corals were documented by Frost and

Langenheim (1974). Turrillid gastropods were reported by Allison (1967), and Allison and Adegoke (1969). A selachifauna from these outcrops were reported by Ferrusquía *et al.* (1999) and more recently (Vega *et al.*, 2001) documented crustaceans from the same locality as the gastropods.

The gastropods here reported were collected from locality IHN 1005, located 5 km north of Veinte de Noviembre town, which is about 40 km southeast of

Tuxtla Gutiérrez, on highway 190 between Tuxtla Gutiérrez and Angostura (Figure 1).

STRATIGRAPHY AND PALEOENVIRONMENT

The San Juan Formation has an areal extent of 135 km² and forms La Mesa de Copoya (Ferrusquía, 2000, p. 13). Licari (1960, p. 23) first proposed the name San Juan Shale for the foraminiferal shales, sandstones, pebble sandstone, and oyster shell beds that overlie and grade into the El Bosque Red beds. Allison (1967) introduced the name "San Juan Formation" and separated it into a lower siltstone and shale member, a more heterogeneous quartz-pebble conglomerate bearing middle member, and an upper sandstone-siltstone member.

In the studied area, the San Juan Formation is composed of light brown shales and yellowish brown fine grain calcarenite. Fossils from the calcarenite include the benthic foraminiferan species *Lepidocyclina (Polylepidina) antillea*, *Storrsella haasterisi*, *Sigmoilopsis centralamericana*, *Nummulites (Paleonummulites) panamensis*, and *Pellastispirella matleyi*, which confirm

a middle Eocene age for this locality (Frost and Langenheim, 1974; Ferrusquía-Villafranca, 1996; Vega et al., 2001). An open marine, shallow shelf paleoenvironment is interpreted for this locality, which is located in the middle part of the San Juan Formation (Figure 2).

Mollusks include diverse gastropods, bivalves, and nautiloids. Most nautiloid specimens display well preserved nacreous material.

EOCENE CYPRAEOIDEANS OF THE FLORIDIAN BASIN

The cypraeid species from Chiapas have affinities with species described from the middle Eocene of France, and Alabama and Mississippi in the East Coast of North America.

Four cypraeid and seventeen ovulid species are presently known from the Floridian Basin of Schilder and Schilder (1971) (Table 1). Gardner (1945) reported *Cypraedia* sp. from middle Eocene (Claibornian) and late Eocene (Jacksonian) strata of northeastern Mexico. The genus/subgenus *Bernaya (Protocypraea)* are herein

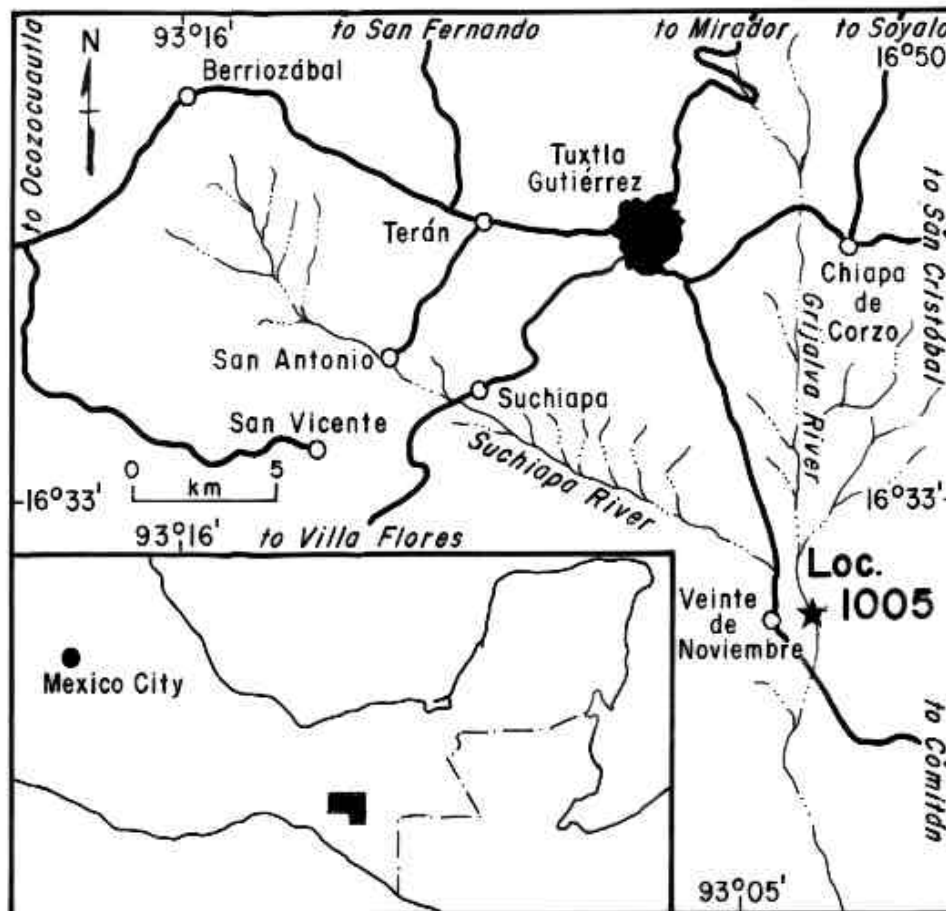


Figure 1. Location map of Veinte de Noviembre and locality IHN 1005, southeast of Tuxtla Gutiérrez, Chiapas.

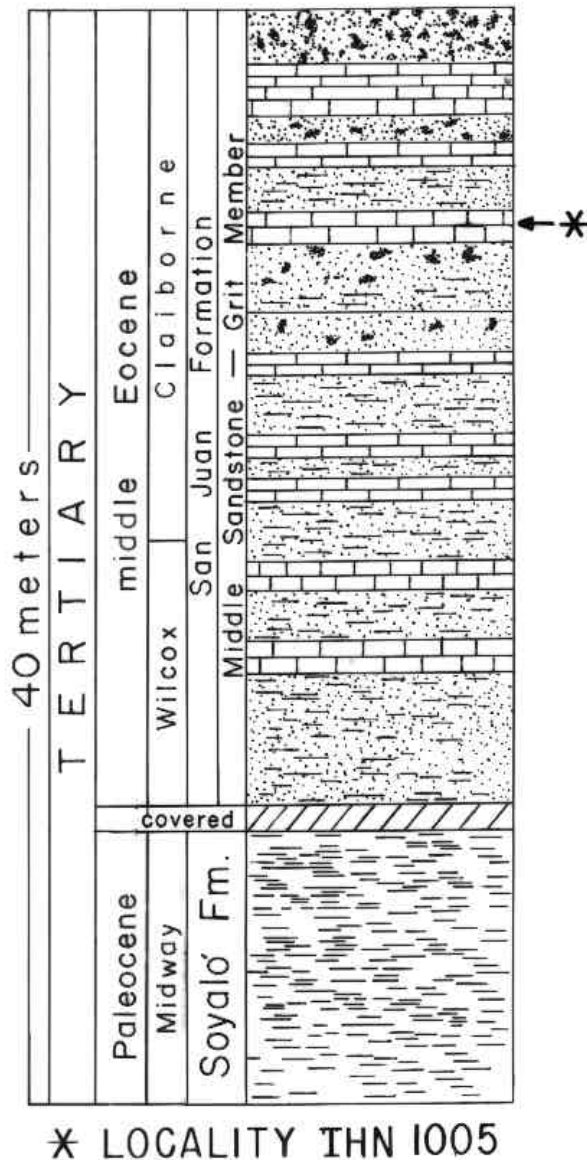


Figure 2. Composed stratigraphic section at Veinte de Noviembre, Chiapas, showing main stratigraphic units and precedence of material here described.

reported for the first time from the Eocene of the Floridian Basin. Additionally, the earliest report of the genus *Macrocypraea* is noted herein.

The studied material is deposited in the Instituto de Historia Natural y Ecología, Chiapas, and in the Colección de Paleontología of the Instituto de Geología, Universidad Nacional Autónoma de México. Types are included in the Type Collection and classified under the acronyms IHN and IGM respectively. The type locality is registered in the locality catalogue of the Instituto de Historia Natural y Ecología, Chiapas.

The classification herein follows that of Schilder and Schilder (1971).

SYSTEMATIC PALEONTOLOGY

Superfamily Cypraeoidea Gray, 1824

Family Cypraeidae Gray, 1824

Subfamily Bernayinae Schilder, 1927

Genus *Bernaya* Jousseau, 1884

Type species. *Cypraea media* Deshayes, 1835, by original designation. Upper Middle Eocene (Bartonian stage), Auvers-sur-Oise, Val-d'Oise (northwest of Paris).

Subgenus *Protocypraea* Schilder, 1927

Type species. *Eocypraea orbignyana* Vredenburg, 1920, by original designation. Upper Cretaceous (Turonian through Santonian), Trichinopoly Group, Kullygoody, southern India.

***Bernaya (Protocypraea) cf. angystoma* (Deshayes, 1835)**

Figures 3, 4

Discussion. This specimen is similar to *Bernaya (Protocypraea) angystoma angystoma* (Deshayes, 1835) (p. 723, pl. 95, figs. 39, 40) from the Lutetian of Chaumont, but differs from the latter in being wider, and anterior canal shallower.

Material. One specimen well preserved.

Hypotype. IHN 5456, measures 40.5 mm in length, and 30.9 mm in width.

Subgenus *Bernaya* s.s.

***Bernaya (Bernaya) obesa* (Deshayes, 1866)**

Figures 5, 6

Cypraea obesa Deshayes, 1866, p. 561, pl. 105, figs. 11, 12.

Cypraea (Bernaya) obesa Deshayes. Cossmann, 1889, p. 106; Cossmann and Pissarro, 1910-1913, pl. 32, fig. 162-1.

Bernaya (Bernaya) lata obesa Deshayes. Schilder and Schilder, 1971, p. 27.

Material. One specimen well preserved.

Hypotype. IHN 5457, measures 57.2 mm in length and 42.8 mm in width.

***Bernaya (Bernaya) media chiapasensis* subsp. nov.**

Figures 7-10

Diagnosis. A medium-sized *Bernaya*, with dorsum arched and maximum width slightly posterior of center.

Description. Shell inflated-pyriform, of medium

Table 1. Eocene Cypraeoidea of the Floridian Basin. Abbreviations used are: AL = Alabama; LA = Louisiana; MS = Mississippi; MX = Mexico; TX = Texas.

	AL	LA	MS	MX	TX
CYPRAEIDAE					
Early Eocene (Claibornian)					
<i>Cypraeorbis bulbosus</i> Garvie					X
Middle Eocene (Upper Claibornian)					
<i>Cypraeorbis alabamensis</i> (Gregorio)	X		X		
Late Eocene (Jacksonian)					
<i>Cypraeorbis ventripotens</i> Cossmann				X	X
<i>Proadusta blowi</i> (Dolin)		X			
OVULIDAE					
Early Eocene (Wilcoxian/Claibornian)					
<i>Eocypraea (Oxycypraea) eosmithi</i> (Aldrich)	X				
<i>Transovula regularoidea</i> (Aldrich)	X				X
Middle Eocene (upper Claibornian)					
<i>Cypraedia subcancellata</i> (Johnson)					X
<i>Cypropterina transovuloides</i> Schilder					
<i>Simnia subtruncata</i> (Johnson)		X			X
<i>Sulcocypraea kennedyi</i> (Harris)			X		X
<i>Sulcocypraea vaughani</i> (Johnson)		X	X		
<i>Transovula naviculae</i> Palmer					X
<i>Transovula texana</i> (Johnson)					X
Late Eocene (Jacksonian)					
<i>Cypraedia fenestralis</i> (Conrad, in Wailes)	X	X	X		
<i>Cypraedia pittsi</i> Dockery			X		
<i>Cypropterina ludoviciana</i> (Johnson)		X	X		
<i>Sphaerocypraea jacksonensis</i> (Johnson)		X	X		
<i>Sphaerocypraea towncreekensis</i> Dockery			X		
<i>Sulcocypraea conradi</i> (Schilder)			X		
<i>Sulcocypraea healey</i> (Aldrich)		X	X		
<i>Transovula producta</i> Dockery			X		

size; spire covered; dorsum arched, maximum height in the center; maximum width slightly posterior of center; aperture S-shaped, widening toward anterior end, narrowing toward posterior end forming a callous; denticulation coarse in inner lip with 15 small teeth separated by fine interstices, denticulation not preserved in outer lip; anterior terminal canal deep;

posterior terminal canal shallow; surface smooth.

Discussion. The Mexican specimens differ from *Bernaya (Bernaya) media media* (Deshayes, 1835) (p. 723, pl. 95, figs. 37, 38) from the Bartonian of Auvers, France in being smaller in size and also less inflated.

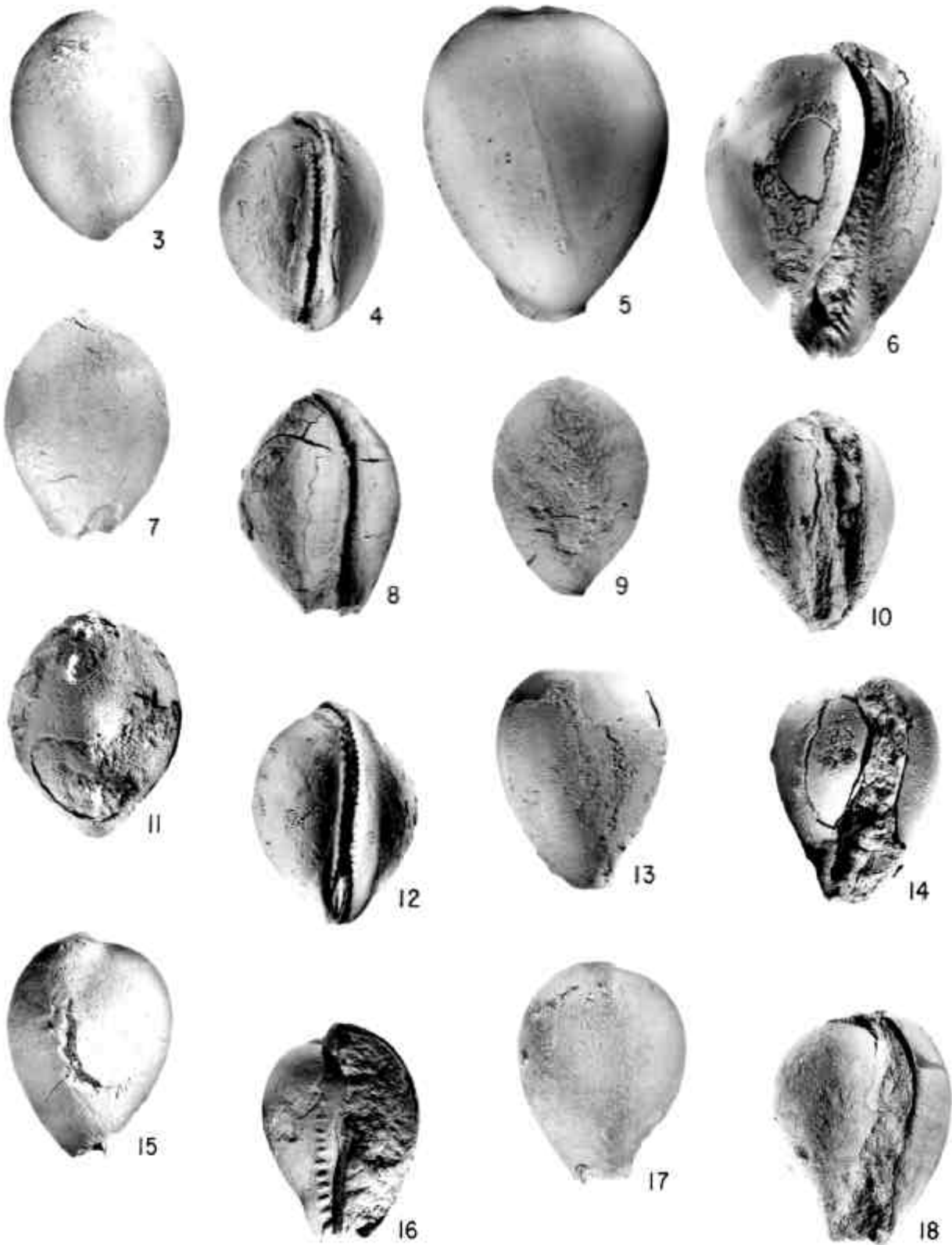


Plate 1. Figures 3 to 18. Figures 3, 4. *Bernaya (Protocypraea) cf. angustoma* (Deshayes, 1835), hypotype, IHN 5456, x 1.0. Figures 5, 6. *Bernaya (Bernaya) obesa* (Deshayes, 1866), hypotype, IHN 5457, x 1.0. Figures 7, 8. *Bernaya (Bernaya) media chiapasensis* subsp. nov., holotype, IHN 5459, x 1.1. Figures 9, 10. *Bernaya (Bernaya) media chiapasensis* subsp. nov., paratype, IGM 7599, x 1.0. Figures 11, 12. *Cypraeorbis alabamensis ventripotens* (Cossmann, 1903), hypotype, IHN 5461, x 1.3. Figures 13, 14. *Cypraeorbis alabamensis mexicana* subsp. nov., holotype, IHN 6712, x 1.25. Figures 15, 16. *Cypraeorbis alabamensis mexicana* subsp. nov., paratype, IGM 7600, x 1.3. Figures 17, 18. *Cypraeorbis* sp., hypotype IHN 6685, x 1.0.

Material. Two specimens well preserved.

Holotype. IHN 5459, measures 36.6 mm in length, and 26.2 mm in width; paratype: IGM 7599, measures 39.0 mm in length, and 28.0 mm in width.

Etymology. The name of the subspecies is dedicated to the State of Chiapas.

Genus *Cypraeorbis* Conrad, 1865

Type species. *Cypraea sphaeroides* Conrad, 1847, by original designation, Oligocene, Vicksburg, Mississippi.

***Cypraeorbis alabamensis ventripotens* (Cossmann, 1903)**

Figures 11, 12

Cypraea pinguis Conrad, 1854, p. 289, pl. 17, figs. 3a, 3b; Conrad, 1855, p. 262; Ingram, 1942, p. 15.

Cypraea (Luponia) ventripotens Cossmann, 1903, p. 161.

Cypraeorbis (C.) ventripotens (Cossmann). Schilder, 1927, p. 98; Schilder, 1932, p. 124.

Cypraeorbis ventripotens (Cossmann). Harris and Palmer, 1947, p. 318, pl. 40, figs. 11, 12, 15, 16.

Cypraeorbis alabamensis ventripotens Cossmann. Schilder and Schilder, 1971, p. 28.

Discussion. The Mexican specimen is well preserved and is a little more convex than the holotype.

Material. One well preserved specimen.

Hypotype. IHN 5461 measures 30.6 mm in length, and 23.5 mm in width.

***Cypraeorbis alabamensis mexicana* subsp. nov.**

Figures 13-16

Diagnosis. A medium sized *Cypraeorbis* inflated-pyriform, with maximum width posterior of center.

Description. Shell inflated-pyriform, of medium size; spire covered; dorsum arched; maximum width posterior of center; aperture S-shaped; denticulation coarse in inner lip with ten visible teeth separated by fine interstices; denticulation not preserved in outer lip; anterior terminal canal deep; posterior terminal canal not preserved; surface smooth.

Discussion. The specimens from Chiapas are wider than *Cypraeorbis alabamensis alabamensis* (Gregorio, 1890) (p. 59, pl. 9, figs. 8-10) from the Eocene of Alabama, and less inflated than *Cypraeorbis alabamensis nuculoides* (Aldrich, 1903) (p. 98, pl. 3, figs. 4-6) from the Claibornian Eocene of Mississippi and Alabama.

Material. Three specimens.

Holotype. IHN 6712, measures 31.4 mm in length, and 23.6 mm in width; paratype: IGM 7600, measures 30.2 mm in length, and 23.5 mm in width.

Etymology. The name of this subspecies is dedicated to Mexico.

***Cypraeorbis* sp.**

Figures 17, 18

Description. Shell inflated-pyriform, of medium size; spire covered; dorsum arched; maximum width posterior to center; aperture S-shaped covered not showing any denticulation in inner and outer lips; anterior terminal canal not preserved; posterior terminal canal shallow; surface smooth.

Discussion. This specimen is much wider than the ones described above and also is larger. With better preserved material this could be a new species.

Material. One specimen.

Hypotype. IHN 6685, measures 39.6 mm in length, and 30.2 mm in width.

Subfamily Cypraeinae Gray, 1824
Genus *Macrocypraea* Schilder, 1930

Type species. *Cypraea exanthema* Linnaeus, 1767, by original designation. Recent. North Carolina to Yucatan, West Indies.

***Macrocypraea veintensis* sp. nov.**

Figures 19-22

Diagnosis. Medium-sized shell, elongate. Spire with three inflated whorls.

Description. Shell elongate, of medium size; spire with three inflated whorls; aperture almost straight, widening toward anterior end; denticulation fine in both outer and inner lips; anterior terminal canal deep; posterior terminal canal shallow; surface smooth.

Discussion. It is the first time that this genus is going to be cited from the Eocene. This genus is represented in the Aquitanian Miocene by *Cypraea anguillana* Cooke (1919, p. 114, pl. 1, figs. 9a, b) from Anguilla and differs from the Mexican specimens in being smaller and also presents a different spire. In the Lower Miocene of Trinidad is known *Cypraea trinitatis* Mansfield (1925, p. 49, pl. 8, fig. 10) but the Mexican specimens are a little larger and broader.

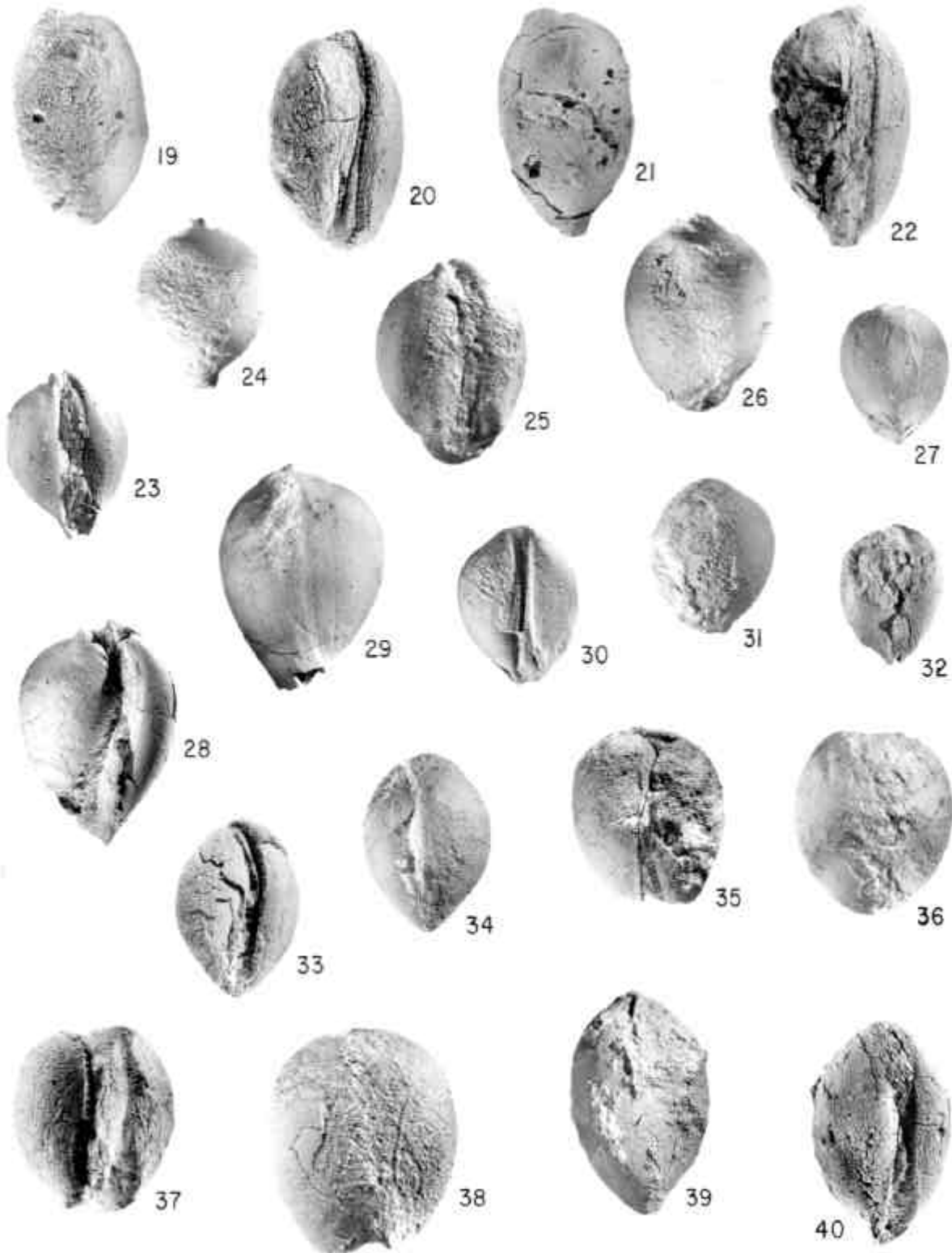


Plate 2. Figures 19 to 40. Figures 19, 20. *Macrocypraea veintensis* sp. nov., holotype, IHN 6682, x 1.0. Figures 21, 22. *Macrocypraea veintensis* sp. nov., paratype, IGM 7601, x 1.0. Figures 23, 24. *Proadusta subrostrata bartonensis* (Edwards, 1854), hypotype, IGM 7602, x 1.5. Figures 25, 26. *Proadusta subrostrata bartonensis* (Edwards, 1854), hypotype, IHN 5419, x 1.6. Figures 27, 32. *Proadusta* sp., hypotype, IHN 5425, x 1.5. Figures 28, 29. *Proadusta acyensis* (De Raincourt, 1876), hypotype, IHN 6703, x 1.3. Figures 30, 31. *Proadusta* sp., hypotype, IGM 7603, x 1.5. Figures 33, 34. *Eocypraea (Eocypraea) inflata* (Lamarck, 1802), hypotype, IHN 6736, x 1.5. Figures 35, 36. *Eocypraea (Eocypraea)* sp., hypotype, IHN 6715, x 1.5. Figures 37, 38. *Eocypraea (Eocypraea)* sp., hypotype, IGM 7604, x 1.5. Figures 39, 40. *Eocypraea (Eocypraea)* cf. *E. castacensis* (Stewart, 1926), hypotype, IHN 5458, x 1.2.

Material. Three specimens.

Holotype. IHN 6682, measures 39.9 mm in length, and 22.6 mm in width; paratype: IGM 7601, measures 42.0 mm in length and 22.0 mm in width.

Etymology. The name of the species is dedicated to the town Veinte de Noviembre where the material was collected.

Genus *Proadusta* Sacco, 1894

Type species. *Proadusta denticulina* Sacco, 1894, by original designation, Oligocene (Tongrian), Italy.

***Proadusta subrostrata bartonensis* (Edwards, 1854)**

Figures 23-26

Cypraea bartonensis Edwards, 1854, p. 130, pl. 17, fig. 6; Cossmann, 1889, p. 103, pl. 3, figs. 20, 21; Cossmann, 1897, p. 337, pl. 8, figs. 1, 2.

Cypraea (Bernayia) bartonensis Edwards. Vasseur, 1881, pl. 1, figs. 30, 31; Cossmann and Pissarro, 1910-1913, pl. 32, figs. 162-3.

Cypraea (Bernayia) bartoniensis Edwards. Cossmann, 1905, p. 94, pl. 15, figs. 18-20.

Proadusta subrostrata bartonensis Edwards. Schilder and Schilder, 1971, p. 58.

Discussion. The Mexican specimens are a little broader than the ones from France.

Material. Three specimens well preserved.

Hypotype. IGM 7602, measures 23.0 mm in length, 16.2 mm in width; hypotype : IHN 5419, measures 20.0 mm in length, 14.0 mm in width.

***Proadusta acyensis* (Raincourt, 1876)**

Figures 28, 29

Cypraea acyensis de Raincourt, 1876, p. 293, pl. 5, figs. 8, 8a.

Discussion. A specimen little more convex than the specimen from France.

Material. One specimen well preserved.

Hypotype. IHN 6703, measures 30.2 mm in length, and 18.4 mm in width.

***Proadusta* sp.**
Figures 27, 30-32

Description. Shell inflated-pyriform, of small size; spire covered; dorsum arched; maximum width slightly posterior of center; aperture almost straight; denticulation

covered in both outer and inner lips; anterior and posterior terminal canals shallow; surface smooth.

Discussion. These specimens differ from *Proadusta subrostrata bartonensis* Edwards (1854, p. 130, pl. 17, fig. 6) from the Eocene of France that they are smaller in size and the posterior terminal canal is shallower.

Material. Six specimens.

Hypotype. IHN 5425, measures 18.6 mm in length, 14.5 mm in width; hypotype: IGM 7603, measures 16.6 mm in length, and 13.1 mm in width.

Family Oculidae Fleming, 1828
Subfamily Eocypraeinae Schilder, 1924
Genus *Eocypraea* Cossmann, 1903

Type species. *Cypraea inflata* Lamarck, 1802, by original designation. Middle Eocene (Lutetian-Bartonian Stages), Paris Basin, France.

Subgenus *Eocypraea* s.s.

***Eocypraea (Eocypraea) inflata* (Lamarck, 1802)**

Figures 33, 34

Cypraea inflata Lamarck, 1802, p. 389, vélin n° 2, fig. 6.
Cypraea (Eocypraea) inflata Lamarck. Cossmann, 1903, p. 162, pl. 9, figs. 18, 19.

Discussion. The Mexican specimen is a little wider than the one from France. The teeth are not preserved in the inner and outer lips.

Material. One specimen not well preserved.

Hypotype. IHN 6736, measures 21.2 mm in length, and 13.0 mm in width.

Eocypraea (Eocypraea) sp.
Figures 35-38

Description. Shell inflated-globose, of small size; spire covered; dorsum arched; maximum width in the center; aperture almost straight; denticulation fine with smooth interstices; anterior and posterior terminal canals shallow; surface smooth.

Discussion. These specimens are not well preserved, although they are internal molds some features can be seen; the inner and outer lips are partially preserved. They can be assigned to *Eocypraea*.

Material. Two specimens.

Hypotype. IHN 6715, measures 21.8 mm in length, and

19.6 mm in width; hypotype: IGM 7604, measures 22.1 mm in length, and 19.3 mm in width.

Eocypraea (Eocypraea) cf. castacensis (Stewart, 1926)
Figures 39, 40

Discussion. The Mexican specimen is similar to *Cypraea castacensis* Stewart (1926, p. 370, pl. 28, fig. 10) from the Eocene of Tejón, California in general aspect, but it is a little larger and wider. The outer and inner lips are covered with sediment but it can be seen in the anterior part of the inner lip a fine denticulation.

Cypraea sabuloviridis Whitfield (1892, p. 223, pl. 33, figs. 20-22) of Shark River and at Farmingdale, New Jersey is the only reported Eocene species from eastern North America, but it is a cast strongly ovate and obtusely pointed and sulcated at the extremity, is different from the Mexican specimen.

Material. One well preserved specimen.

Hypotype. IHN 5458, measures 32.7 mm in length, and 20.5 mm in width.

Eocypraea? sp.
Figures 41, 42

Description. Shell inflated-globose, of medium size; spire with four whorls; maximum width in the center; aperture almost straight, the same width; no teeth preserved; anterior terminal canal shallow; surface smooth.

Discussion. An internal mold that are not preserved all

features, maybe with a complete specimen can be assigned correctly to this genus and a species. Cannot be compared with any described Eocene species.

Material. One internal mold.

Hypotype. IHN 6686, measures 43.8 mm in length, and 30.0 mm in width.

Cypraeidae indet.
Figures 43-46

Discussion. Several specimens not well preserved. Small-pyriform molds; inner and outer lips without teeth; anterior and posterior terminal canals shallow.

Material. Seven specimens.

Hypotype. IHN 6705, measures 22.8 mm in length, and 17.6 mm in width; hypotype: IGM 7605, measures 20.7 mm in length, and 16.2 mm in width.

ACKNOWLEDGMENTS

We are grateful to Lindsey T. Groves and Warren G. Allmon for their critical revision to the manuscript. Antonio Altamira of the Laboratorio de Fotografía helped with the illustrations of the specimens. This research was supported by the Consejo Nacional de Ciencia y Tecnología, project CONACYT – NSF Otoño 2000, “Paleobiogeografía y evolución de crustáceos y moluscos del Eoceno - Oligoceno de Baja California Sur y Chiapas, México”.

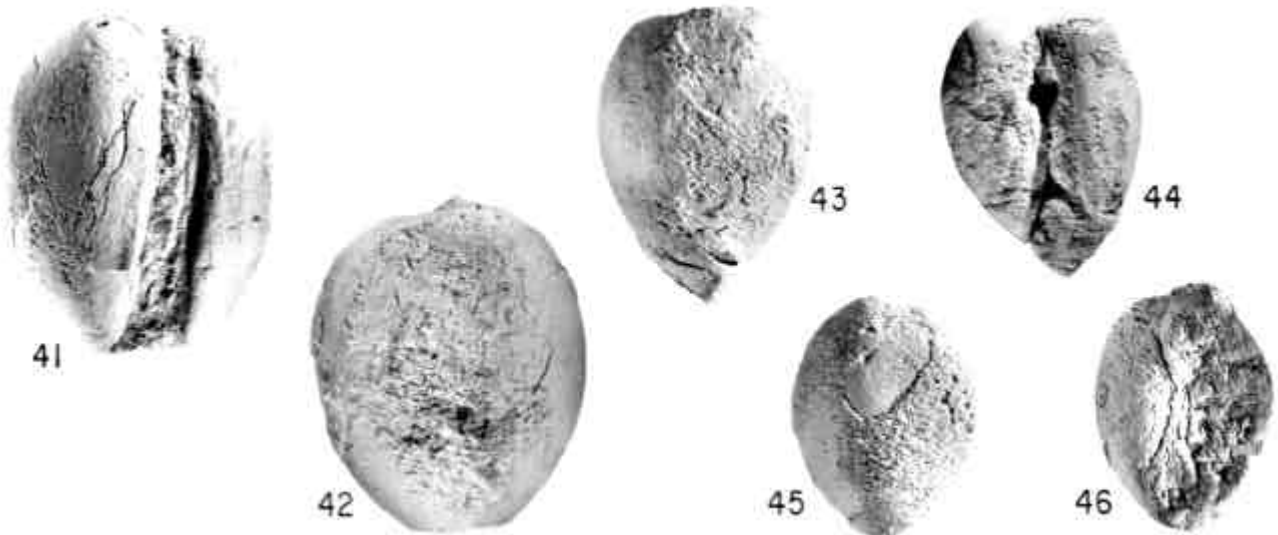


Plate 3. Figures 41 to 46. Figures 41, 42. *Eocypraea? sp.*, hypotype, IHN 6686, x 1.0. Figures 43, 44. *Cypraeidae indet.*, hypotype, IHN 6705, x 1.6.

REFERENCES

- Aguilar, M., 1993, Bioestratigrafía general del Terciario (Paleogeno) de la localidad El Jobo, Tuxtla Gutiérrez, Chiapas: México, Universidad Nacional Autónoma de México, Facultad de Ciencias, Tesis profesional, 59 p. (Unpublished)
- Aldrich, T.H., 1903, New species of Tertiary fossils from Alabama, Mississippi and Florida: *The Nautilus*, 16 (9), 97-101.
- Allison, R.C., 1967, The Cenozoic Stratigraphy of Chiapas, Mexico, with Discussions of the Classification of the Turritellidae Selected Mexican Representatives: Berkeley, University of California, Tesis doctoral, 225 p. (Unpublished)
- Allison, R.C., Adegoke, O.S., 1969, The *Turritella rina* group (Gastropoda) and its relationship to *Torcula* Gray: *Journal of Paleontology*, 43 (5), 1248-1266.
- Conrad, T.A., 1847, Observations on the Eocene formation, and descriptions of one hundred and five new fossils of that period, from the vicinity of Vicksburg, Mississippi; with an appendix: *Proceedings of the Academy of Natural Sciences of Philadelphia*, 3, 280-299.
- Conrad, T.A., 1854, Fossil Testacea of the Tertiary Green-sand Marbled of Jackson, Miss. p. 289, pls. 14-17. Reprint *Bulletins of American Paleontology*, 24 (8)6, 350-359, in Wailes, B.L.C., Report on the Agriculture and Geology of Mississippi: Jackson, Mississippi, 371 p.
- Conrad, T.A., 1855, Observations on the Eocene deposit of Jackson, Mississippi, with descriptions of thirty-four new species of shells and corals: *Proceedings of the Academy of Natural Sciences of Philadelphia*, 7, 257-263.
- Conrad, T.A., 1865, Catalogue of the Eocene and Oligocene testacea of the United States: *American Journal of Conchology*, 1 (1), 1-35.
- Cooke, C.W., 1919, Tertiary mollusks from the Leeward Islands and Cuba: Washington, Carnegie Institution, Publication, 291, 103-156.
- Cossmann, M., 1889, Catalogue Illustré des Coquilles fossiles de l'Éocène des environs de Paris: *Annales de la Société Royale Malacologique de Belgique*, 24 (4), 3-385.
- Cossmann, M., 1897, Mollusques éocéniques de la Loire-inférieure: Troisième fascicule: *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France*, 7 (4), 297-358.
- Cossmann, M., 1903, *Essais de Paléoconchologie Comparée*: Paris, Privately Published, Cinquième Livraison, 215 p.
- Cossmann, M., 1905, Faune Éocénique du Cotentin: *Bulletin de la Société Géologique de Normandie*, 24, 51-122.
- Cossmann, M., Pissarro, G., 1910-1913, *Iconographie complète des Coquilles fossiles de l'Éocène des environs de Paris*: Paris, Tome 2, 20 p., 65 pls.
- Deshayes, G.P., 1824-1837, *Description des coquilles fossiles des environs de Paris*: Paris, Privately Published, 2, 499-814.
- Deshayes, G.P., 1866, *Description des animaux sans Vertèbres découvertes dans le bassin de Paris pour servir de supplément à la description des coquilles fossiles des environs de Paris, comprenant une revue générale de toutes les espèces actuellement connues*: Paris, v. 3, Text, 628 p., v. 2, Atlas, 107 pls.
- Durham, J.W., Arellano, A.R.V., Peck, J.H., 1955, Evidence for no Cenozoic Isthmus of Tehuantepec seaways: *Bulletin Geological Society of America*, 66, 977-992.
- Edwards, F.E., 1849-1877, *A Monograph of the Eocene Cephalopoda and Univalves of England*: London, Palaeontographical Society of London, 1, 361 p.
- Ferrusquía-Villafranca, I., 1996, Contribución al Conocimiento Geológico de Chiapas—el Área de Ixtapa-Soyaló: Universidad Nacional Autónoma de México, Instituto de Geología, *Boletín*, 109, 130 p., 22 pls.
- Ferrusquía-Villafranca, I., Applegate, S.P., Espinosa-Arrubarrena, L., 1999, First Paleogene selachifauna of the middle American-Caribbean-Antillean region, La Mesa de Copoya, west-central Chiapas, Mexico; systematics and paleontological significance: *Revista Mexicana de Ciencias Geológicas*, 16 (2), 155-174.
- Ferrusquía-Villafranca, I., Applegate, S.P., Espinosa-Arrubarrena, L., 2000, First Paleogene Selachifauna of the middle American-Caribbean-Antillean region, La Mesa de Copoya, west-central Chiapas; geologic setting: *Revista Mexicana de Ciencias Geológicas*, 17 (1), 1-23.
- Fleming, J., 1828, *A History of British Animals Exhibiting the Descriptive Characters and Systematical Arrangement of the Genera and Species Including the Indigenous, Extirpa, and Extinct Kinds, together with Periodical and Occasional Visitors*: Philadelphia, Bell and Bradfute, xxiii, 565 p.
- Frost, S.H., Langenheim, R.L., 1974, Cenozoic Reef Biofacies; Tertiary Larger Foraminifera and Scleractinian Corals from Chiapas, Mexico: De Kalb, Illinois, Northern Illinois University Press, 388 p.
- Gardner, J., 1945, Mollusca of the Tertiary Formations of Northeastern Mexico: *Geological Society of America, Memoir* 11, 322 p., 27 pls.
- Gray, J.E., 1824, *Monograph on the Cypraeidae, a family of testaceous Mollusca*: *Zoological Journal*, 1, 1-71.
- Gregorio, A. de., 1890, *Monographie de la Faune Éocénique de l'Alabama et Surtout de Celle de Claiborne de l'étage Parisien (Horizon à Venericardia planicosta Lamk.)*: Palermo, Librairie Internationale L. Pedone Lauri et de Charles Clausen, *Annales de Géologie et de Paléontologie*, 7, 156 p., 8, 157-316.
- Harris, G.D., Palmer, K.V.W., 1947, The Mollusca of the Jackson Eocene of the Mississippi embayment (Sabine River to the Alabama River): *Bulletins of American Paleontology*, 30 (117), 207-563.
- Ingram, W.M., 1942, Type fossil Cypraeidae of North America: *Bulletins of American Paleontology*, 27 (104), 1-32.
- Jousseume, F.P., 1884, Étude sur la famille des Cypraeidae: *Bulletin de la Société Zoologique de France*, 9, 81-100.
- Lamarck, J.B.P.A. de M. de., 1802, *Mémoires sur les fossiles des environs de Paris comprenant la détermination des espèces qui appartiennent aux animaux marins sans vertèbres, et dont la plupart sont figurés dans la collection des vélins du Muséum*: *Annales du Muséum National d'Histoire Naturelle*, 1, 383-391 [reprinted by Paleontological Research Institution: Ithaca, New York, 1978].
- Licari, G.R., 1960, Geology and amber deposits of the Simojovel area, Chiapas, Mexico: Berkeley, University of California, Tesis de maestría, 142 p.
- Linnaeus, C., 1767, *Systema naturae per regna tria naturae*: Stockholm, Editio duodecima, reformata, v. 1. Regnum Animale, Pt. 1, p. 1-532 (1766); pt. 2, p. 533-1327 (1767).
- Mansfield, W.C., 1925, Miocene gastropods and scaphopods from Trinidad, British West Indies: *Proceedings of the United States National Museum*, 66 (22), 1-65.
- Pecheaux, J.F., 1984, Le Senonien supérieur-Tertiaire de Chiapas (SE du Mexique) et ses macroforaminifères: Nice, Université de Nice, These de 3 Cycle, Doctorado, 154 p.
- Quezada-Muñeton, F., 1990, El Cretácico medio-superior y el límite Cretácico superior-Terciario inferior en la Sierra de Chiapas: *Boletín de la Asociación Mexicana de Geólogos Petroleros*, 39, 3-98.
- Raincourt, M. de., 1876, Description d'espèces nouvelles du bassin de Paris: *Bulletin de la Société Géologique de France*, 3 (4), 290-203.
- Sacco, F., 1894, I molluschi dei Terreni terziari del Piemonte e della Liguria. Parte XV. (Cypraeidae, et Amphiperasidae): Torino, Carlo Clausen, 74 p.
- Schilder, F.A., 1924, Systematischer Index der rezenten Cypraeidae: *Archiv für Naturgeschichte*, 90A (4), 179-214.
- Schilder, F.A., 1927, Revision der cypraeacea (Moll., Gastr.): *Archiv für Naturgeschichte*, 91A (10), 1-171.
- Schilder, F.A., 1932, *Fossilium Catalogus. I. Animalia. Pars 55; Cypraeacea*: Berlin, W. Junk, 276 p.
- Schilder, M., Schilder, F.A., 1971, A Catalogue of Living and Fossil Cowries; Taxonomy and Bibliography of Triviacea and Cypraeacea (Gastropoda prosobranchia): Institut Royal des Sciences Naturelles de Belgique, *Mémoires*, 85, 246 p.
- Stewart, R.B., 1926, Gabb's California fossil type gastropods: *Proceed-*

- ings of the Academy of Natural Sciences of Philadelphia, 78, 287-447.
- Vasseur, G., 1881, Éocène de Bretagne. Faune de Bois-Gouët. Atlas Paléontologique. Preface et Légendes par M. Cossmann: Paris, A. Herrmann & Fils, 19 pls.
- Vega, F.J., Cosma, T., Coutiño, M.A., Feldmann, R.M., Nyborg, T.G., Schweitzer, C.E., Waugh, D., 2001. New Middle Eocene decapods from Chiapas, Mexico: *Journal of Paleontology*, 75 (5), 929-946.
- Vredenburg, E., 1920, Classification of the recent and fossil Cypraeidae: *Records of the Geological Survey of India*, 51 (2), 65-152.
- Whitfield, R.P., 1892, Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey: United States Geological Survey, Monographs, 18, 402 p.
- Manuscript received: September 11, 2001
Corrected manuscript received: April 23, 2002
Manuscript accepted: June 21, 2002