Groves, LT
1997

A REVIEW OF CYPRAEIFORM GASTROPODS FROM NEOGENE STRATA OF NORTHWESTERN ECUADOR, WITH THE DESCRIPTION OF TWO NEW SPECIES

LINDSEY T. GROVES*

MALACOLOGY AND INVERTEBRATE PALEONTOLOGY SECTIONS
NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY
LOS ANGELES, CALIFORNIA

I. ABSTRACT

Six cypraeacean species, two of them new, and one unidentified triviid specimen are reviewed from Neogene strata of northwestern Ecuador. New species of *Zonaria* s.s. and *Z. (Pseudozonaria)* are described from the lower Pliocene Esmeraldas beds of the Onzole Formation. These new species and *Jenneria (Jenneria) panamensis* (Olsson, 1967) are the first cypraeaceans reported from the Esmeraldas beds. The unidentified triviid is the first of its kind reported from the Neogene of Ecuador. Three previously described cypraeid species are also included in this review.

II. INTRODUCTION

Cypraeid, ovulid, and triviid gastropods are rare in the Neogene rock record of northwestern Ecuador. Herein are the first reports of these groups from the lower Pliocene Esmeraldas beds of the Onzole Formation and a review of the species from the upper Miocene Angostura and Guayacan formations and the lower Pliocene Jama Formation. All six of the species included here are extinct; however, all of the genera and/or subgenera are represented in the living fauna of either the tropical eastern Pacific Ocean or the Caribbean Sea.

Pilsbry and Olsson (1941) described *Cypraea cayapa* from the lower Pliocene Jama Formation, the first reported Neogene cypraeid from Ecuador. Marks (1951) identified poorly preserved single specimens from the "Blue siltstone" member of the upper Miocene Daule Formation [= Guayacan Formation] as *Cypraea* cf. *C. henekeni* and *Cypraea* sp. Unfortunately, these specimens are unavailable for examination. In 1964, Olsson described *Cypraea (Pseudozonaria) telembiensis* from the upper Miocene Angostura Formation near Telembi, Río Cayapas. From the same formation he reported two poorly preserved specimens of *Siphocypraea (Muracypraea) henekeni* from Cueva de Angostura, Río Santiago. Most recently Olsson (1967) described *Jenneria panamensis* from the upper Pliocene Charco Azul Formation, Río Blanco, Chiriquí Province, Panamá and it is herein reported from the Esmeraldas beds of the Onzole Formation at Quebrada Camarones. Two new species, *Zonaria (Zonaria) pittorum* and *Z. (Pseudozonaria) cathyae*, are the first cypraeids described from the Esmeraldas beds of the Onzole Formation (Text-figure 1). An incomplete specimen of *Pusula (Pusula)* sp. from these same beds is the first reported fossil triviid from Ecuador.

III. STRATIGRAPHIC NOMENCLATURE AND AGE

Because much has been published recently concerning the age of the Neogene formations of northwestern Ecuador (Haman and Kohl, 1986; Hasson and Fischer, 1986; DuShane, 1988; Vokes, 1988; 1989; 1990; Whittaker, 1988; Pitt and Pitt, 1989; 1992; 1997), only a brief overview of stratigraphic nomenclature and age will be discussed.

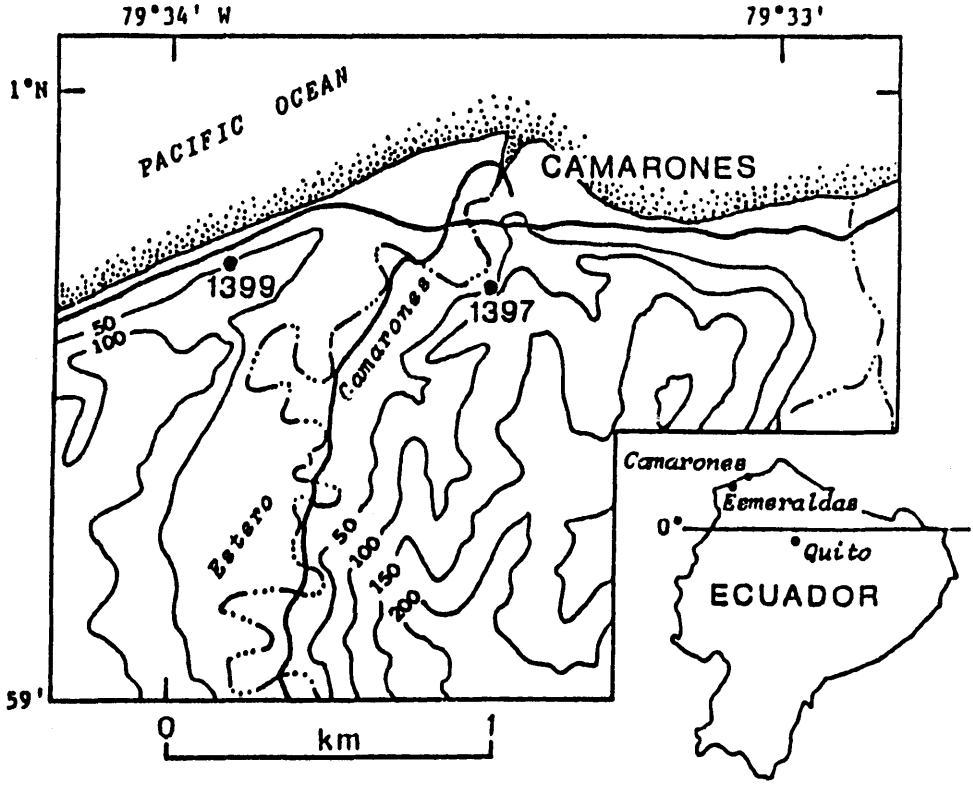
Miocene Units

The upper Miocene Angostura Formation of Stainforth (1948:142), named for outcrops along the Río Santiago, Esmeraldas Province, is the Ecuadorian equivalent of the Gatun Formation of Panamá (Pitt and Pitt, 1992). However,

* 900 Exposition Boulevard, Los Angeles, California 90007 USA, lgroves@nhm.org

EDITORIAL COMMITTEE FOR THIS PAPER:
JAMES H. MCLEAN, Natural History Museum, Los Angeles, California
RICHARD L. SQUIRES, California State University, Northridge

TULANE STUDIES IN GEOLOGY & PALEONTOLOGY 30(3): 1997



Text-figure 1. Index map of northwestern Ecuador showing type localities (TU 1397 and 1399 [=LACMIP localities 16944 and 16822 respectively]) of new species described herein [modified from DuShane, 1988]. Contour interval 50 m.

the uppermost part of the Gatun Formation may be of lower Pliocene age (Vokes, 1990). Olsson (1964:8) stated that this formation "is largely barren, but at a few places there are lenses or interbeds filled with finely preserved fossils." He also noted a close faunal relationship between the Angostura and Gatun formations.

Whittaker (1988) formally proposed the term Guayacan Formation [= the Blue Siltstone Member of the Daule Formation of Marks (1951)] for widespread upper Miocene strata in the Manabí Basin, as Mark's terminology did not conform to international guidelines for the naming of lithostratigraphic units (Hedberg, 1976). Additionally, the formational names of Bristow's (1976) Daule Group, which were derived from the Borbón Basin, were replaced by Whittaker's (1988) terminology based on Manabí Basin strata. The age of the Guayacan Formation is based on age-diagnostic planktic foraminifera.

Pliocene Units

Olsson (1942) proposed the name "Esmeraldas formation" for "the highly foraminiferal, tuffaceous shales so extensively exposed along the coast of Esmeraldas and along the Esmeraldas River itself" and thought it equivalent to the Borbón Formation. However, the Esmeraldas Formation is, in fact, correlative to the Onzole Formation of Stainforth (1948) (Pitt and Pitt, 1989). Bristow (1976) stated that the Esmeraldas Formation was improperly defined by Olsson (1942) and that the name Onzole Formation should be retained. Vokes (1988) suggested usage of "Esmeraldas beds" for "the mollusk-rich, shallow water

gravity flows" in the upper part of the Onzole Formation. This usage is retained herein. Haman and Kohl (1986) based the age of strata at Quebrada Camarones (= Esmeraldas beds of the Onzole Formation) on the presence of the benthic foraminiferal genus *Montfortella*. Micropaleontologic anaylses by Hasson and Fischer (1986) yielded a lower Pliocene (= Zanclian Stage of Seguenza, 1868) age for the Esmeraldas beds. Whittaker (1988) cited the age of the Onzole Formation as between upper Miocene and early Pliocene but considered the upper part of the Onzole, presumably including the Esmeraldas beds, to be entirely Pliocene as dated by benthic foraminifera.

Based upon a rich molluscan fauna, the lower Pliocene Jama Formation was proposed by Pilsbry and Olsson (1941) for exposures along Bahía Jama, Manabí Province. Benthic foraminifera within the formation indicate littoral to sublittoral depositional environments. Whittaker (1988) equated the Jama Formation with his lower Pliocene Bahía Formation [= Upper Calcareous member of Marks (1951)], both within the Manabí Basin, and he separated them on lithologic and faunal differences.

IV. ACKNOWLEDGMENTS

William D. and Lois J. Pitt, Sacramento, California, kindly donated personally collected specimens, provided stratigraphic and paleontologic information about the Onzole and Angostura formations, and reviewed an early version of the manuscript. Emily H. Vokes (TU), Elana Benamy and Gary Rosenberg (ANSP), Jean F. DeMouthe, Elizabeth Kools, and the late Tony Summers (CAS), Paul Jeffrey (BMNH), David R. Lindberg, Christopher P. Meyer, and Karen Wetmore-Grycewicz (UCMP), and Warren H. Blow, Jann Thompson, and Thomas R. Waller (USNM) granted numerous requests for specimen loans and locality information from their respective institutions. Librarians Donald W. McNamee and Mark Herbert (LACM Research Library) and Suzanne Henderson, Jean Crampon, and Melinda Hayes (Alan Hancock Foundation, University of Southern California) processed numerous interlibrary loan requests and aided in locating rare and obscure references. James H. McLean (Natural History Museum of Los Angeles County, Malacology) and Richard L. Squires (California State University, Northridge) reviewed the manuscript and offered helpful criticisms.

ABBREVIATIONS CITED

ANSP:	Academy of Natural Sciences of Philadelphia
BM(NH):	The Natural History Museum, London
CAS:	California Academy of Sciences, San Francisco
LACMIP:	Natural History Museum of Los Angeles County (Invertebrate Paleontology Section)
P:	Collecting locality numbers of W.D. and L.J. Pitt
TU:	Tulane University, New Orleans
UCMP:	University of California, Museum of Paleontology, Berkeley
USNM:	National Museum of Natural History, Smithsonian Institution, Washington, D.C.

V. SYSTEMATICS

For the most part, the classification scheme of Schilder and Schilder (1971) is utilized for generic and higher level taxonomy. The notable exception is that the *Siphocypraea (Muracypraea)* group is accepted as a full genus, as proposed by Kay (1995). Synonymy citations are limited to original descriptions, material examined, and all records of each species from Ecuador. Measurement parameters are defined as follows: length = greatest distance between anterior and posterior ends; width = greatest distance between lateral margins; and height = greatest distance between base and dorsum.

Superfamily VELUTINACEA Gray, 1840
Family TRIVIIDAE Troschel, 1863
Subfamily TRIVIINAE Troschel, 1863
Tribe PUSULINI Schilder, 1936

Genus PUSULA Jousseaume, 1884

Pusula JOUSSEAUME, 1884, Bull. Soc. Zool. France, v. 9, p. 99.

Type Species: *Cypraea radians* Lamarck, 1810, by original designation; Recent, Panamic Province.

Subgenus PUSULA Jousseaume, 1884

PUSULA (PUSULA) sp.

Plate 1, figure 1

Occurrence: Lower Pliocene Esmeraldas beds, Onzole Formation.

Figured Specimen: LACMIP hypotype 12429, TU locality 1399 (= locality P-101; LACMIP locality 16882), 16.8 mm length, 11.7 mm width, 10.4 mm height, H.E. and E.H. Vokes collectors (pl. 1, fig. 1).

Discussion: Only a single incomplete specimen of *Pusula (Pusula)* sp. is known from the Esmeraldas beds of the Onzole Formation. This fragment most closely resembles the Recent Panamic species *P. (P.) radians* (Lamarck, 1810) but has more numerous, finer ribs. This is the first published report of a fossil triviid from the Neogene of Ecuador.

Superfamily CYPRAEACEA Rafinesque, 1815

Family CYPRAEIDAE Rafinesque, 1815

Subfamily BERNAYINAE Schilder, 1927

Tribe BERNAYINI Schilder, 1927

Genus MURACYPRAEA Woodring, 1957

Muracypraea WOODRING, 1957, The Nautilus, v. 70, p. 89 (subgenus of *Cypraea*).

Type Species: *Cypraea mus* Linnaeus, 1758, by original designation; Recent, Panamá, Colombia, and Venezuela.

MURACYPRAEA CAYAPA (Pilsbry and Olsson, 1941)

PLATE 1

Figures — Page

1. *Pusula (Pusula)* sp. 150
   LACMIP 12429 (hypotype); 16.8 mm length, 11.7 mm width, 10.4 mm height (x2.3).
   Locality: TU 1399 (= P-101; LACMIP 16882), Esmeraldas beds, Onzole Formation, Ecuador.
2,3. *Muracypraea cayapa* (Pilsbry and Olsson, 1941) 150
   ANSP 13665 (holotype); 64.3 mm length, 52.7 mm width, 42.4 mm height (x0.62).
   Jama Formation, Ecuador.
4-6. *Muracypraea "henekeni"* (Sowerby, 1850) 152
   4. LACMIP 12430 (hypotype); 50.5 mm length, 21.9 mm width, 31.2 mm height (x0.94).
   Locality: TU 1507 (= P-102; LACMIP 16943), Angostura Formation, Ecuador.
   5,6. LACMIP 12431 (hypotype); 42.1 mm length, 34.4 mm width, 23.2 mm height (x0.95).
   Locality: TU 1507 (= P-102; LACMIP 16943), Angostura Formation, Ecuador.
7,8. *Zonaria (Zonaria) pittorum* Groves, n.sp 153
   LACMIP 12432 (holotype); 40.1 mm length, 27.3 mm width, 20.9 mm height (x1.0).
   Locality: TU 1399 (= P-101; LACMIP 16882), Esmeraldas beds, Onzole Formation, Ecuador.
9,10. *Zonaria (Pseudozonaria) cathyae* Groves, n.sp. 154
   LACMIP 12433 (holotype); 22.3 mm length, 15.8 mm width, 12.8 mm height (x1.8).
   Locality: TU 1397 (= P-100; LACMIP 16944), Esmeraldas beds, Onzole Formation, Ecuador.
11,12. *Zonaria (Pseudozonaria) telembiensis* (Olsson, 1964) 154
   USNM 644048 (holotype); 19.5 mm length, 13.4 mm width, 10.1 mm height (x1.9)
   Locality: Angostura Formation, Ecuador.
13,14. *Jenneria (Jenneria) panamensis* (Olsson, 1967) 155
   LACMIP 12434 (hypotype); 25.8 mm length, 16.9 mm width, 11.8 mm height (x1.5)
   Locality: TU 1397 (= P-101; LACMIP 16944), Esmeraldas beds, Onzole Formation, Ecuador.

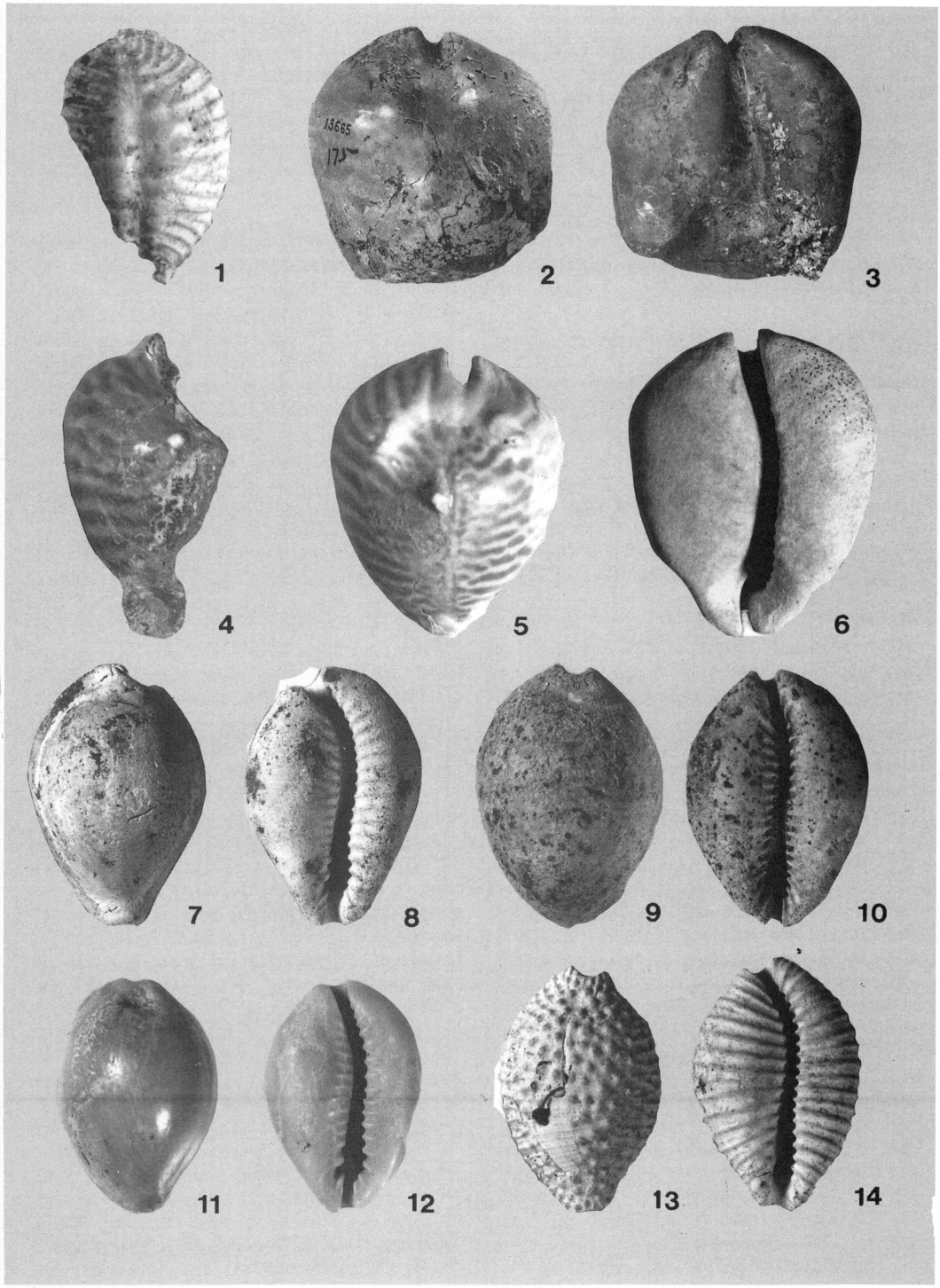


PLATE 1

Plate 1, figures 2, 3

Cypraea cayapa PILSBRY and OLSSON, 1941, Proc. Acad. Nat. Sci. Philadelphia, v. 93, p. 41-42, pl. 7, fig. 4; INGRAM, 1947, Bulls. Amer. Paleontology, v. 31, no. 120, p. 60-61, 89-90; INGRAM, 1947, Bulls. Amer. Paleontology, v. 31, no. 122, p. 145; WOODRING, 1959, U.S. Geol. Surv. Prof. Paper 306-B, p. 194; RICHARDS, 1968, Spec. Pub. Acad. Nat. Sci. Philadelphia, v. 8, p. 113.

Siphocypraea cayapa (Pilsbry and Olsson). SCHILDER, 1961, Arch. Moll., v. 90, no. 4/6, p. 148; PETUCH, 1979, Bull. Mar. Sci., v. 29, no. 2, p. 217; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 100.

Siphocypraea (Muracypraea) cayapa (Pilsbry and Olsson). SCHILDER and SCHILDER, 1971, Inst. Roy. Sci. Nat. Belgique, Mem. 85, p. 29, 104.

Barycypraea (Muracypraea) cayapa (Pilsbry and Olsson). GROVES, 1993, West. Soc. Malac., Ann. Rept., v. 25, p. 12.

Muracypraea cayapa (Pilsbry and Olsson). GROVES, 1997, West. Soc. Malac., Ann. Rept., v. 29, p. 8.

Type Material: Holotype ANSP 13665; 64.3 mm length (incomplete), 51.7 mm width, 42.4 mm height, A.A. Olsson collector (pl. 1, figs. 2, 3).

Type Locality: Puerto Jama, Manabí Province, Ecuador; lower Pliocene, Jama Formation.

Occurrence: Known only from a single incomplete specimen from the type locality (Pilsbry and Olsson, 1941).

Discussion: Although approximately one-third of the anterior of this large specimen is missing, it unlikely to be confused with any other cypraeid species from Ecuador. Similar large *Muracypraea* specimens from Venezuela, Baja California Sur, Mexico, and Imperial County, California, were compared to *M. cayapa* and together might represent a separate lineage based on their shared prominent pair of posterior dorsal tubercules, highly angular shape, and highly arched dorsum.

MURACYPRAEA "HENEKENI"
(Sowerby, 1850)
Plate 1, figures 4, 5, and 6

Cypraea henikeri SOWERBY, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 45, pl. 9, fig. 3 [error for *henekeni*].

Cypraea cf. *C. henekeni* Sowerby. MARKS, 1951, Bulls. Amer. Paleontology, v. 33, no. 139, p. 376.

Siphocypraea (Muracypraea) henekeni (Sowerby). OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 176-177, pl. 31, figs. 3-3a.

Type Material: Lectotype (designated by Pflug, 1961:21) BM(NH) G83940; paralectotypes, here recognized, BM(NH) GG20023, GG20024, GG20025, GG20026 and GG20027.

Type Locality: Río Yaque, northern Dominican Republic (Woodring, 1959); late Miocene, presumably Cercado or Gurabo Formation.

Occurrence: PANAMÁ: Gatun Formation (Woodring, 1959; Pit and Pitt, 1993); ECUADOR: Angostura Formation (Olsson, 1964); Blue Siltstone Member, Daule Formation [= Guayacan Formation] (Marks, 1951); COLOMBIA: Nariño Department (herein).

Figured Specimens: LACMIP 12430, TU locality 1507 (= P-102; LACMIP locality 16943), 50.5 mm length, 21.9 mm width, 31.2 mm height [incomplete] (pl. 1, fig. 4), H.E. and E.H. Vokes collectors; LACMIP 12431, TU locality 1507 (= LACMIP locality 16945), 42.1 mm length, 34.4 mm width, 23.2 mm height (pl. 1, figs. 5, 6), H.E. and E.H. Vokes collectors.

Material Examined: ECUADOR: 1 partial specimen, locality P-102, Angostura Formation, Punta Verde, Esmeraldas Province (Coll. W.D. and L.J. Pitt); 1 specimen, TU locality 1507, Angostura Formation, Río Verde, Esmeraldas Province (Coll. H.E. and E.H. Vokes); 1 specimen, USNM 644046, Angostura Formation, Río Santiago, Esmeraldas Province; and 1 specimen, USNM 644047, Angostura Formation, Río Santiago, Esmeraldas Province; PANAMÁ: 1 specimen, locality P-95, Gatun Formation, Cativa, Colón Province (Coll. W.D. and L.J. Pitt); 1 specimen, ANSP 315087, Gatun Formation, Cativa, Colón Province (Coll. W.C. Gruff); 3 specimens, TU locality 1432, Gatun Formation, Cativa, Colón Province (Coll. H.E. and E.H. Vokes); 2 specimens, TU locality 960 [= locality 139E of Woodring (1959)], Gatun Formation, Isla Payardi, Colón Province (Coll. H.E. and E.H. Vokes); 5 specimens, TU locality 958, Gatun Formation, east of Cativa, Colón Province (Coll. H.E. and E.H. Vokes); 5 specimens, TU locality 757, Gatun Formation, east of Cativa, Colón Province (Coll. H.E. and E.H. Vokes); 1 specimen, TU locality 1433, Gatun

Formation (Coll. H.E. and E.H. Vokes); 1 specimen, LACMIP locality 16936, Gatun Formation (Coll. T. Bratcher); and COLOMBIA: 1 partial specimen, UCMP locality C-14311, Nariño Department (Coll. Tropical Oil Company).

Two of Woodring's (1959) hypotypes [USNM 562581 and 562582] from the Gatun Formation of Panamá and a single specimen from the San Ignacio area, Baja California Sur, Mexico [USNM collection], may also represent *M. "henekeni."*

Discussion: Numerous forms and/or varieties identified as *M. henekeni* were synonymized by Woodring (1959). However, specimens from Panamá and Ecuador (and a single partial specimen from southwestern Colombia) differ significantly enough to justify splitting from the nominal species. They are generally smaller, have a distinct triangular or arrowhead shape, possess prominent pairs of dorsal tubercules, and in some instances have a central "spike-like" dorsal tubercule. Many of the specimens also display original color striping and blotching of dull reddish brown and yellowish orange uncommonly found in the nominal species. Woodring (1959) acknowledged the variability of *M. henekeni* and the excess of names applied to this species, and he stated that "some of the names in the synonymy may prove to be useful for local populations when adequate samples are available." Groves and Arnold (in preparation) will provide further justification in splitting the western Caribbean and Ecuadorian specimens from *M. henekeni* of the Dominican Republic, Trinidad, Venezuela, and northern Colombia. Specimens herein therefore are referred to *M. "henekeni"* in the interim. Pilsbry and Olsson (1941:42) mentioned that "a smaller, undescribed species occurs in the Miocene of the Río Santiago, northern Ecuador, but none are known in the present west coast fauna." This form might represent *M. "henekeni"* of this present study, however, their whereabouts are unknown.

Subfamily ERRONEINAE Schilder, 1927
Tribe ZONARIINI Schilder, 1932
Genus ZONARIA Jousseaume, 1884

Zonaria JOUSSEAUME 1884, Bull. Soc. Zool. France, v. 9, p. 92-93.

Type Species: *Cypraea zonata* Lamarck, 1810 (not Chemnitz, 1788) [= *Cypraea zonaria* Gmelin, 1791], by original designation; Recent, West Africa.

Subgenus ZONARIA Jousseaume, 1884

ZONARIA (ZONARIA) PITTORUM Groves, n.sp.

Plate 1, figures 7, 8

Zonaria (Zonaria) n.sp. GROVES, 1997, West. Soc. Malac., Ann. Rept., v. 29, p. 8.

Diagnosis: A *Zonaria* s.s. with lengthened anterior, weak teeth on anterior canal, and smooth narrow fossula.

Description: Shell shape pyriform, medium in size; spire covered; dorsum prominently arched; maximum height slightly posterior of midpoint; aperture slightly curved posteriorly toward columella; denticulation strong with smooth interstices; labial lip with 19 teeth; columellar lip with 17 teeth; strong anterior canal teeth, weak posterior canal teeth; fossula smooth and narrow; basal marginal callus moderate to prominent; deep and well developed terminal canals.

Type Material: Holotype LACMIP 12432; length 40.1 mm, width 27.3 mm, height 20.9 mm, H.E. and E.H. Vokes collectors (pl. 1, figs. 7, 8).

Type Locality: TU locality 1399 (= P-101; LACMIP locality 16882), lower Pliocene Esmeraldas beds, Onzole Formation; roadcut on west side of village of Camarones, 20 km east of bridge over Río Esmeraldas, Esmeraldas Province, Ecuador.

Occurrence: Esmeraldas beds, Onzole Formation, Ecuador; TU locality 1399 [= P-101; LACMIP locality 16882] (1 specimen).

Discussion: The new species is most similar to *Zonaria (Zonaria) porcellus cocconii* (Mayer, 1875) from the middle to upper Pliocene (= Piacenzian Stage of Mayer-Eymar, 1857) rocks of northern Italy. *Zonaria (Z.) pittorum*, n.sp., has a more sinuous aperture and fewer, stronger apertural teeth that extend further onto the labial and columellar surfaces than in *Z. (Z.) porcellus cocconii.* Both species differ from *Z. (Z.) porcellus* (Brocchi, 1814), also from the middle to upper Pliocene rocks of northern Italy, by having a more inflated columella, a higher arched dor-