PLIOCENE EPITONIIDAE OF THE ESMERALDAS BEDS NORTHWESTERN ECUADOR (MOLLUSCA: GASTROPODA)

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ABSTRACT

Four species of epitoniid gastropods that live today in the Panamic-Galapagan faunal province of the eastern Pacific are here reported from the Pliocene Esmeraldas beds of the Onzole Formation, near the village of Camarones, Esmeraldas Province, northwestern Ecuador.

INTRODUCTION

Four species of epitoniid gastropods [*Amaea (Scalina) ferminiana* (Dall, 1908), *Sthenorytis turbinus* (Dall, 1908), *Sthenorytis dianae* (Hinds, 1844), and *Cirsotrema togatum* (Hertlein and Strong, 1951)] are found in the Pliocene sediments of the Esmeraldas beds, along the northwestern coast of Ecuador (Figure 1). All four species are extant, and live today in the deep-water of the Panamic-Galapagan molluscan faunal province (Guaymas, Mexico, to Peru).

The Esmeraldas Formation was originally named by Olsson (1942, p. 260) for tuffaceous marine mudstones that are extensively exposed along the coast near Esmeraldas, as well as along the Rio Esmeraldas. Bristow (1976, p. 193) noted that several stratigraphic units (formations) are exposed in these areas and, because Olsson (1942) did not establish a type area or type section, he considered that the formation was inadequately defined. As a result of his work the Ecuadorian Geological map uses the name Onzole Formation for the strata. However, because of lithological differences, the name "Esmeraldas beds" will be used herein.

The fossiliferous Esmeraldas unit within the Onzole is Pliocene in age, with Haman and Kohl assigning it an earliest Pliocene age (about 5 million years) on the basis of contained planktic foraminifera and calcareous nannoplankton, and correlating it with Neogene planktic foraminiferal zone N18/19 (Haman and Kohl, 1986, p. 182; Kohl, *in* Vokes, this volume). Hasson and Fischer (1986, p. 36-37), however, concluded that the "Esmeraldas Formation" was largely Zanclian in age - 3.2 to 3.7 million years old - on the basis of its benthic foraminifera.

According to Olsson (1964, p. 7), the Esmeraldas mollusks are mainly species that have a deep-water aspect, and show relationships with Caribbean species, indicative of interoceanic exchanges between the Atlantic-Caribbean and Pacific that occurred during most of the Tertiary. Hasson and Fischer (1986, p. 36) noted that the Esmeraldas mollusks show a diversity of ecological requirements, as well as a wide bathymetric range, attributing this mixing, which would imply considerable downslope transport, to large mollusk-eating vertebrates that distributed their offal widely over the region. The fossiliferous units considered here (TU locs. 1397-1399) more likely represent gravity slides from shallow to deep-water (E. H. Vokes, pers. commun.). A depth range of greater than 700 m is implied by the microplankton, whereas the benthic foraminiferal faunas suggested depths in the 240-900 m range (upper bathyal) (Hasson and Fischer, 1986, p. 39). The known depth ranges for the four species of epitoniids discussed herein

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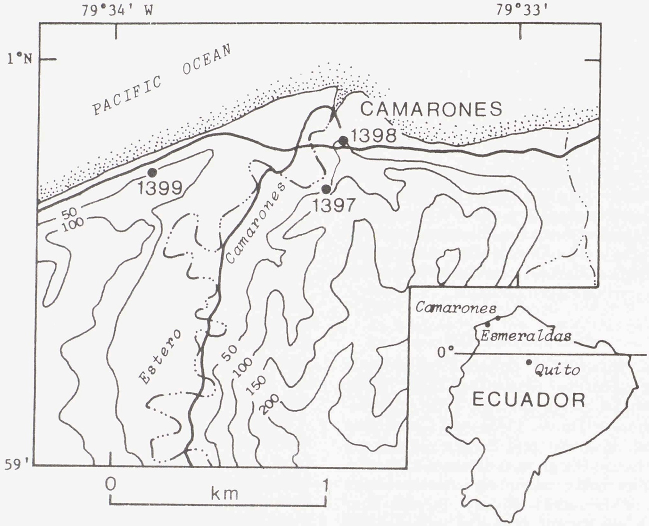


Figure 1. Index map showing position of fossil localities (TU locs. 1397, 1398, and 1399) in Pliocene Esmeraldas beds of the Onzole Formation, near village of Camarones, northwest coast of Ecuador. Contour interval 50 m.

are: 32-113 m, 36-275 m, 65-146 m, and 110-550 m.

ACKNOWLEDGMENTS

I gratefully acknowledge the kindness of Emily Vokes for allowing me the opportunity to work on the Esmeraldas epitoniids, and for providing the photographs of the fossils. William Pitt's contribution of a photograph of *Cirsotrema togatum* is appreciated. George Kennedy and Edward Wilson kindly read the manuscript and helped in manuscript preparation.

The following institutional abbreviations are used herein: CAS, California Academy of Sciences, San Francisco; LACMIP, Natural History Museum of Los Angeles County, Los Angeles; TU, Tulane University, New Orleans; and USMN, U.S. National Museum of Natural History, Washington (D.C.). Figured specimens are deposited in LACMIP (Vokes and Vokes collection), and CAS (Pitt collection).

SYSTEMATIC PALEONTOLOGY

Family EPITONIIDAE Lamarck, 1822 [?1812]

Genus AMAEA Adams and Adams, 1853

Type species: *Scalaria magnifica* Sowerby, 1844, by subsequent designation (Melvill, 1897).

Subgenus SCALINA Conrad, 1865

Type species: *Scalaria staminea* Conrad, 1865, by subsequent designation (Palmer, 1937); Eocene, Alabama. Synonyms: *Ferminoscala* Dall (1908, p. 315); *Elegantiscala* deBoury (1911, p. 216).

Discussion: There is a difference of opinion regarding the use of *Scalina* as a genus or as a subgenus of *Amaea*. There are distinct differences between *Amaea* and *Scalina*, so it seems wise to retain *Scalina* as a subgenus. The type of *Amaea* has a less distinct basal disk below which the sculpture is very different from that above, and is much larger than any known *Scalina*.

The northern limit of *Scalina* in the eastern Pacific is Isla Cedros, Baja California, Mexico; in the late Pleistocene it ranged as far north as the Los Angeles Basin, southern California [*A. (S.) effiae* (Willett, 1939); see DuShane, 1979].

AMAEA (SCALINA) FERMINIANA
(Dall, 1908)
Figures 2, 3

Epitonium (Ferminoscala) ferminiana DALL, 1908, p. 316, pl. 8, fig. 8.
Scala (Acrilla) wiegandi BÖSE, 1910, p. 228, pl. 12, fig. 8.
Epitonium (Ferminoscala) eleutherium PILSBRY and OLSSON, 1941, p. 38, pl. 2, fig. 7.
Amaea (Scala) ferminiana (Dall). KEEN, 1971, p. 438, fig. 672; DUSHANE, 1974, p. 55, figs. 65, 68.

Diagnosis: Shell large, acute, whorls 11 to 15, convex, closely adherent, nuclear whorls disintegrated, early whorls with one strong cord at periphery; subsequent whorls more rounded; suture moderately deep; costae 45 to 50, low, of varying widths; spiral cords intersected by the costae forming small, very unevenly spaced rhomboids within which there are fine axial and spiral threads; basal area defined by a small cord, sculpture the same as on the body whorl but fainter, with the costae more prominent than the spiral scupture; lip thin, patulous; peritreme incomplete.

Discussion: Pilsbry and Olsson (1941) described two new species of *Scalina* from the Pliocene of western Ecuador, as *Epitonium (Ferminoscala) eleutherium* and *E. (F.) manabianum*. Although worn, the specimen of *eleutherium* is considered to be synonymous with *Amaea (Scalina) ferminiana*, described from Point Fermin in the Gulf of California, Mexico (Recent).

Woodring (1959, p. 188) reported three small specimens of *Scalina* cf. *brunneopicta* (Dall, 1908) from the upper part of the Gatun Formation, Canal Zone, Panama, and compared them with the Ecuadorian Pliocene *A. (S.) eleutheria*, believing them to be closely related species.

Amaea (Scalina) ferminiana was reported by Olsson (1942, p. 228) as a Pliocene fossil from the Burica Peninsula in Costa Rica, and again (1964, p. 199) as a Neogene fossil from northwestern Ecuador. *Scala (Acrilla) wiegandi* Böse, 1910, a late Tertiary fossil from Tehuantepec on the Caribbean side of the peninsula, was placed in the synonymy of *A. (S.) ferminiana* by DuShane (1974, p. 55). Böse's species came from strata now considered middle Pliocene in age (Neogene foraminiferal zone N20) (Akers, 1981, p. 146). Dall (1898, p. 652-653), referring to the early collection of Spencer (1897, p. 14, 24) from the same locality, noted that "the beds were deposited in deep water, probably between one hundred and fifty and four hundred fathoms in depth, judging by analogous recent species." *Scalina pseudoleroyi* (Maury, 1925) from Jamaica was considered to be a closely related species by Woodring (1959, p. 187). It may be that, with time, all of the fossil forms in this species group will be relegated to synonymy under *A. (S.) ferminiana*.

Occurrence: Pliocene; Esmeraldas beds, TU 1397 (four specimens). Recent; Gulf of California, Mexico south to Peru, dredged in 36 to 275 m depth.

Genus STHENORYTIS Conrad, 1862

Type species: *Scalaria expansa* Conrad, 1862, by subsequent designation (deBoury, 1889); Miocene, Maryland.

Discussion: Sthenorytis first appeared in the late Eocene in the Americas and Europe. The genus survives today in the western Atlantic and eastern Pacific Ocean.

STHENORYTIS TURBINUS (Dall, 1908)
Figures 4, 5

Epitonium (Sthenorhytis) turbinum DALL, 1908, p. 317, pl. 9, figs, 5, 6, 8; KEEN, 1971, p. 436, fig. 665.
Epitonium (Sthenorytis) toroense DALL, 1912, p. 6; DALL, 1925, p. 27, pl. 19, fig. 5.
Epitonium toroense var. *insigne* DALL, 1912, p. 7.
Sthenorytis toroensis toroensis (Dall). WOODRING, 1959, p. 184, pl. 37, figs. 2, 3, 11, 12.
Sthenorytis toroensis euthynta WOODRING, 1959, p. 185, pl. 37, figs. 1, 4, 5, 8.
Epitonium (Sthenorytis) turbinum Dall. DUSHANE, 1974, p. 45, figs. 113-117, 160.

Diagnosis: Shell large, thick, heavy, turbinate; nuclear whorls nearly always eroded; post-nuclear whorls nine, continuous, rapidly enlarging, showing incremental growth lines and a faint basal disk; interlamellar spaces with more or less distinct low, irregularly spaced spiral bands and microscopic spiral striae; costae 9 to 12, sharp edged, wider where they attach to the whorl, with a spine at the tip; each costa flattens as it approaches the suture, but adheres to the costa immediately above, with a spur that extends to the costa immediately to the left, leaving a pit at the suture, broadly reflected on the base, fusing with the lip; suture deep; aperture round, very oblique; lip heavy, reflected, continuous, with a spine on the shoulder.

Discussion: Woodring (1959, p. 184) placed *Sthenorytis toroensis* var. *insigne* (Dall, 1912) in synonymy with *S. pernobilis* (Fischer and Bernardi, 1857). Dall's type came from the Toro Limestone Member of the Chagres Sandstone at Toro Point on the Caribbean side of the Canal Zone and Woodring (1959, p. 184) subsequently obtained two fragments of a *Sthenorytis* from the same locality, basing his synonymy on these two specimens he deemed to be *S. pernobilis*. There is no figure of Dall's *S. toroensis* var. *insigne*; therefore, Woodring must have compared his two fragments with Dall's holotype (USMN 214346) and arrived at the conclusion that his and Dall's specimens represented the same taxon. With only the lower portion of the body whorl from which to make a judment, one can only take the Woodring assessment and accept his decision.

Woodring (1959, p. 184 pl. 37, figs. 2, 3, 11, 12) discussed and figured *S. toroensis toroensis* (Dall, 1912) from the Pliocene of the Canal Zone of Panama, and suggested that it might be a subspecies of *S. pernobilis*, a statement with which I do not concur. Even though the Dall species is from the Caribbean side of Panama, it is more like *S. turbinus* (Dall, 1908) from the eastern Pacific, with a turbinate outline and fewer costae (eight), than *S. pernobilis*, which has an acuminate outline and usually 12 costae. DuShane (1974, p. 47) placed *S. toroensis* in synonymy with *S. turbinus*.

Woodring (1959, p. 185) also described a new subspecies, *S. toroensis euthynta*, from the lower Pliocene Chagres Sandstone on the Caribbean coast between Rio Chagres and Pina, Canal Zone, and compared it with the nominate species. Woodring's two specimens were distinguished by their larger size and higher, narrower, less flattened lamellae, and fewer costae (eight). Woodring's (1959, pl. 37, figs. 1, 4, 5, 8) figures show *euthynta* to be conspecific with *S. turbinus*, even though the specimens are from the Caribbean. Nominal subspecies and varieties from the Pliocene of Panama and the Canal Zone exhibit a great deal of overlap in physical characteristics at different locations.

Sthenorytis toroensis euthynta does not compare well with *S. pernobilis* as the eight high costae are spaced farther apart, are bent backward with an erect shoulder hook, and have an entire aperture with a small hook.

Occurrence: Pliocene; Esmeraldas beds, TU 1397 (four specimens), TU 1398 (two specimens), and TU 1399 (two specimens). Recent; Cabo San Lucas, Baja California Sur, Mexico, to the Galápagos Islands, Ecuador, dredged in 110 to 550 m depth.

STHENORYTIS DIANAE (Hinds, 1844)
Figures 6-9

Scalaria Diana HINDS, 1844a, p. 125, figured; HINDS, 1844b, p. 125, figured; HINDS, 1844-45, p. 48, figured.

Sthenorytis paradisi HERTLEIN and STRONG, 1951, p. 90, pl. 3, fig. 5.

Sthenorytis hertleini OLSSON, 1964, p. 199, pl. 33, fig. 1, 1a, 1b.

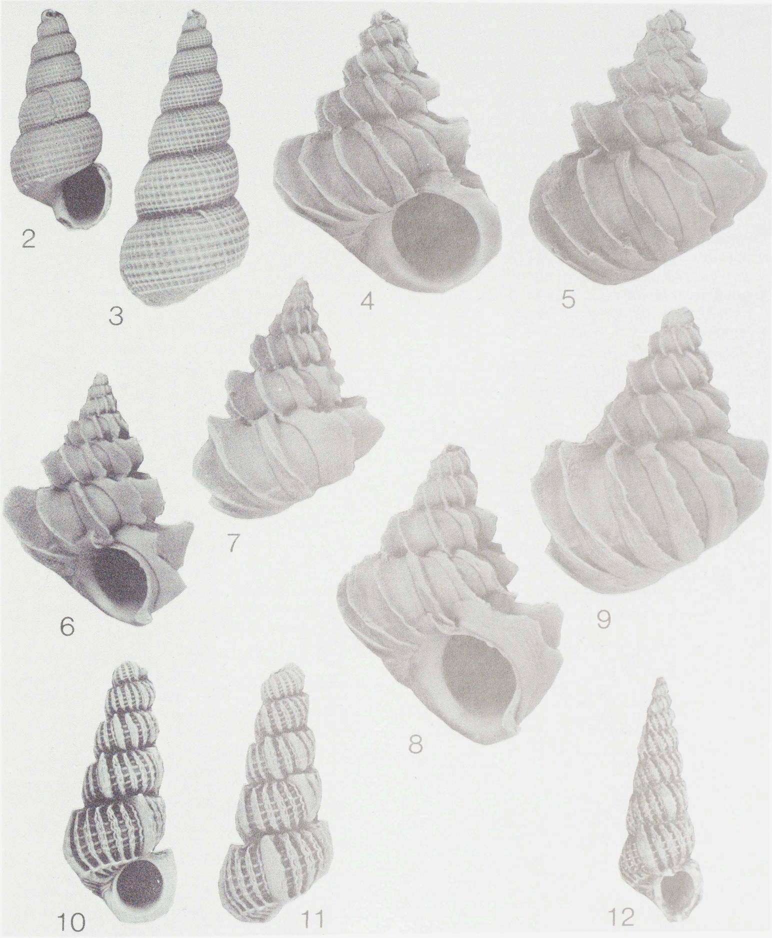
Epitonium (Sthenorytis) dianae (Hinds). KEEN, 1971, p. 434, fig. 664.

Figures 2, 3. *Amaea (Scalina) ferminiana* (Dall), TU 1397. 2, LACMIP 7630, length (L), 16.2 mm, width (W), 7.5 mm; 3, LACMIP 7631, L 23.7 mm, W 11.2 mm.

Figures 4, 5. *Sthenorytis turbinus* (Dall), TU 1397. LACMIP 7582, L 31.1 mm, W 25.8 mm.

Figures 6, 7, 8, 9. *Sthenorytis dianae* (Hinds), TU 1399. 6, 7, LACMIP 7583, L 20.4 mm, W 16.0 mm; 8, 9, LACMIP 7584, L 24.5 mm, W 19.3 mm.

Figures 10, 11, 12. *Cirsotrema togatum* (Hertlein and Strong). 10, 11, LACMIP 7585, TU 1397, L 20.1 mm, W 9.3 mm; 12, CAS 611981.01 from Quebrada Camarones (W. D. Pitt collection), L 19.5 mm, W 7.0 mm.



FIGURES 2-12

Sthenorytis dianae (Hinds). DUSHANE, 1974, p. 44, figs. 118-121.

Diagnosis: Shell size normal for *Sthenorytis*, solid; nuclear whorls unknown; post-nuclear whorls six, well-rounded, rapidly enlarging; suture deep; costae six to ten, erect on early whorls, slighly reflected on later whorls, broadly expanded, forming coronating points, thick, heavy, with axial growth striations on the faces, confluent near the aperture; basal disk faintly developed; aperture round, not entire, produced at the shoulder into a large wing.

Discussion: Olsson (1964) reported four species of *Sthenorytis* from the Neogene of northwestern Ecuador: *S. turbina* (Dall), *S. dianae* (Hinds), *S. paradisi* (Hertlein and Strong), and *S. hertleini* Olsson. The last two were synonymized by DuShane (1974) under *S. dianae*, the only species of *Sthenorytis* with a long wing-like protuberance from the aperture; all three species synonymized by DuShane have this distinctive characteristic.

Occurrence: Pliocene; Esmeraldas beds, TU 1397 (six specimens), TU 1399 (one specimen). Recent; Cabo San Lucas, Baja California Sur, Mexico, to Costa Rica, and Ecuador, dredged in 65 to 146 m depth.

Genus CIRSOTREMA Mörch, 1852

Type species: *Scalaria varicosa* Lamarck, 1822, by monotypy. Recent, western Pacific Ocean.

CIRSOTREMA TOGATUM (Hertlein and Strong, 1951) Figures 10-12

Epitonium (Cirsotrema) togatum HERTLEIN and STRONG, 1951, p. 89, pl. 3, figs. 1-5; KEEN, 1971, p. 428, fig. 633.

Cirsotrema togatum (Hertlein and Strong). DUSHANE, 1974, p. 47, figs. 54-55; PITT, 1981, p. 155, figs. 2-3.

Diagnosis: Shell large in size; nuclear whorls one and one half, showing early sculpture; third whorl post-nuclear with strong axial ribs and evenly spaced spiral sculpture; four whorls showing sufficient expansion of the ribs to join the expansion of the neighboring ribs, leaving small openings through which the regular shell surface may be seen; lamination of the ribs extending above and below to give a three-dimensional quality to the intricate sculpture; this pattern continues on all later whorls, increasing in strength with each whorl; whorls 9.5 to 10.5; suture very deep; umbilicus lacking; with a basal ridge, above and below which there are rather deep pits; aperture circular; lip slightly patulous, crenulated, thickened by the last rib.

Discussion: Pitt (1981, p. 155) reported the first fossil specimen of *Cirsotrema togatum* from the Esmeraldas Formation at Quebrada Camarones, *i.e.*, the canyon of Estero Camarones (Figure 1). A single specimen (Figure 12) was taken at that time, but more specimens have been collected subsequently (W. D. Pitt, pers. commun.).

Occurrence: Pliocene; Esmeraldas beds, TU 1397 (four specimens). Recent; Guaymas, Sonora, Mexico, throughout the Gulf of California, to Costa Rica, and the Galápagos Islands, Ecuador, dredged in 32 to 113 m depth.

LOCALITY DATA

The following Tulane University (TU) fossil localities are all from the Pliocene Esmeraldas beds exposed in Esmeraldas Province on the northwestern coast of Ecuador (see Figure 1 for index map), collected by E. H. Vokes and H. E. Vokes, January 1981.

TU 1397. Quebrada Camarones, cut bank on east side of canyon at east edge of village of Camarones, 20 km (by road) east of bridge over Rio Esmeraldas, and approximately 10 km east of mouth of Rio Esmeraldas. The exposure represents a shallow-water gravity flow into deep water.

TU 1398. Roadcut at mouth of Quebrada Camarones, east side of bridge over Estero Camarones, village of Camarones. The exposure represents mixed deep-water and shallow-water gravity flows.

TU 1399. Roadcut along sea cliff approximately 0.5 km west of Estero Camarones on west side of village of Camarones. Exposure represents a shallow-water gravity slide with gravel and wood, into deep-water clays.

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July 20, 1988

REVIEWS

THE UTILITY OF REGIONAL GRAVITY AND MAGNETIC ANOMALY MAPS, edited by W. J. Hinze. Published by the Society of Exploration Geophysicists, Tulsa, Oklahoma, 1985, xiv + 454 pp., color illustrations, index, $75.00

This volume presents thirty-three papers by more than fifty authors representing the remarkable body of scientific information gained from recent compilation of gravity and magnetic anomaly maps. The subjects included range from map preparation to the multitudinous uses of regional maps illustrated with actual examples from mineral and geothermal exploration, earthquake-hazard evaluation, general geologic mapping, and the exploration for petroleum. Digital processing, digital filtering, and data-enhancement techniques applied to gravity and magnetic data are extensively treated. The application of geophysical techniques to determine the nature of the basement rock beneath the cover of sedimentary and surficial deposits is stressed to provide an improved knowledge of the Earth's crust. The volume begins with five large composite magnetic and gravity anomaly maps of the United States and Canada in full color. Throughout the work the map coverage ranges from regional to national; most maps are of North America but global maps and maps of other continents are included. This volume will constitute a major reference source for gravity and magnetic maps of the Earth for many years to come.

THE FACTS ON FILE DICTIONARY OF GEOLOGY AND GEOPHYSICS, by Dorothy Farris Lapidus and Donald R. Coates, scientific adviser. Published by Facts On File Publications, New York and Oxford, 1987, iv + 347 pp., $24.95

This is an alphabetical self-indexing reference tool to the basic terminology of geology and geophysics for the student, the amateur, and professional scientists in related fields. It is clear and concise and quite useful. The more than three thousand terms and phrases included appear to provide thorough and comprehensive coverage. The listings are enhanced by about seventy-five explanatory line drawings. This volume extends the Facts On File series; previously dictionaries on Biology, Botany, Chemistry, Mathematics, Physics, and Science have been published. The Geology and Geophysics volume is recommended as a general reference for students and nonspecialists.

—H.C.S.