

**Cocculinid and pseudococculinid limpets  
(Gastropoda: Cocculiniformia) from off the Caribbean coast  
of Colombia**

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*Abstract.*—The present paper reports on the occurrence of six species of Cocculinidae and three species of Pseudococculinidae off the Caribbean coast of Colombia. *Cocculina messingi* McLean & Harasewych, 1995, *Cocculina emsoni* McLean & Harasewych, 1995, *Notocrater houbricki* McLean & Harasewych, 1995 and *Notocrater youngi* McLean & Harasewych, 1995 were not previously known to occur within the of the Caribbean Sea, while *Fedikovella beanii* (Dall, 1882) had been reported only from the western margins of the Atlantic Ocean, including the lesser Antilles. New data are presented on the external anatomy and radular morphology of *Coccocrater portoricensis* (Dall & Simpson, 1901) that supports its placement in the genus *Coccocrater*. *Cocculina fenestrata* n. sp. (Cocculinidae) and *Copulabyssia colombia* n. sp. (Pseudococculinidae) are described from the upper continental slope of Caribbean Colombia.

Cocculiniform limpets comprise two groups of bathyal to hadal gastropods with global distribution that live primarily on biogenic substrates (e.g., wood, algal holdfasts, whale bone, cephalopod beaks, crab carapaces, or shark egg cases) that sink from shallow water into the aphotic zone (Haszprunar 1988, 1998; Lesicki 1998). Early records were assigned to the newly proposed families Cocculinidae Dall, 1882 and Lepetellidae Dall, 1882. Subsequent researchers discovered these gastropods to be both diverse and distinctive, apportioning the many newly collected deep sea species between two superfamilies, Cocculinoidea and Lepetelloidea, containing two and eight families respectively (see Haszprunar 1998, Lesicki 1998, Strong et al. 2003 and references therein). These limpets had been united in the superorder Cocculiniformia (Haszprunar 1987, 1998) but recent phylogenetic studies have shown Cocculiniformia to be

paraphyletic, with the Cocculinoidea related to Neomphalina and the Lepetelloidea included within Vetigastropoda (Ponder & Lindberg 1996, 1997; McArthur & Harasewych 2003).

Among the ten families of cocculiniform limpets, the best known and by far the most diverse are the Cocculinidae (Cocculinoidea) and the Pseudococculinidae (Lepetelloidea). Both are associated with sunken wood and plant material (Haszprunar 1988, Lesicki 1998), which tend to be encountered more often than other biogenic substrates (Leal & Harasewych 1999). Based on the primitive organization of the alimentary systems of the Cocculinidae and Pseudococculinidae, Haszprunar (1988:74) suggested that a diet of wood was likely the primitive condition, and that adaptations to other biogenic substrates were “probably the main driving force of the cocculiniform radiation.”

The western Atlantic fauna of cocculiniform limpets contains the first cocculinoidean and lepetelloidean species to be discovered (Dall 1882, Verrill 1880). While this fauna is widespread and diverse, published records from within the margins of the Caribbean tectonic plate are rare. Records of Cocculinidae are limited to reports of two species—*Cocculina rathbuni* Dall, 1882 and *Cococrater portoricensis* (Dall and Simpson, 1901)—from bathyal depths off the Caribbean coast of Colombia (Diaz & Puyana 1994). Among the Pseudococculinidae, *Notocrater pustulosa* Woodring, 1928 *non* Thiele, 1925, was described from the Miocene of Jamaica, whereas *Amphiplica venezuelensis* McLean, 1988 is known only from abyssal depths in the Venezuela Basin.

Recent explorations along the outer shelf and upper continental slope of the Caribbean coast of Colombia during cruises of INVEMAR-MACROFAUNA I and II in 1998–2001, resulted in the collection of a number of considerable range extensions and new species from the southwestern Caribbean Sea. The present paper reports on the members of the limpet families Cocculinidae and Pseudococculinidae that were collected as part of this survey. Range extensions and supplemental data are provided for previously known species, and one new species is described in each of the two families treated.

#### Materials and Methods

Samples were collected using a bottom trawl (9 × 1 m opening, 16 m in length) during cruises of INVEMAR-MACROFAUNA I and II, 1998–2001, aboard the R/V *Ancon*, working off the Caribbean coast of Colombia at depths of 20–500 m (Fig. 1). Specimens of Cocculinidae and Pseudococculinidae were sorted and stored in 70% ethanol, sometimes with fragments of wood on which they were collected. Subsequently, shells and radulae were dissected and examined using a scanning electron mi-

croscope (SEM). For specimens in which the preservation was adequate, bodies were critical-point dried, coated with carbon and gold, and the external anatomy examined with SEM.

The specimens on which this study is based are deposited in the Museo de Historia Natural Marina de Colombia-MHNMC (INV MOL), Santa Marta, and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

*Abbreviations.*—P = distance from anterior shell edge to apex; SH = shell height; SL = shell length; SW = shell width (see McLean & Harasewych 1995: fig. 1).

#### Systematics

Superfamily Cocculinoidea Dall, 1882

Family Cocculinidae Dall, 1882

Genus *Cocculina* Dall, 1882

*Cocculina rathbuni* Dall, 1882

Figs. 1, 2

*Cocculina rathbuni* Dall, 1882:402.—Dall, 1889:347, pl. 15, figs. 5, 7.—Pilsbry, 1890:132, pl. 25, figs. 5, 6 [copy of Dall].—Dall, 1908:340.—Thiele, 1909:6, pl. 2, figs. 1, 2.—Abbott, 1974:34, fig. 192.—McLean, 1987:325, figs. 1–4.—Haszprunar, 1987:321.—Díaz & Puyana, 1994:113, pl. 35, fig. 345 [copy of Dall].—McLean & Harasewych, 1995:8, figs. 2–11.—Lesicki, 1998:51.

*Material examined.*—INV MOL1672, 1 specimen (SL = 6.92, SW = 5.37, SH = 1.92 mm), Sta. 75, off Rosario Island (10°09'N, 76°00'W), in 296 m.

*Description.*—Shell (Fig. 2A) medium to large (SL ≈ 7 mm), thin, white, elliptically conical, low (SH/SL ≈ 0.30). Apex slightly posterior of center (P/SL ≈ 0.55). Protoconch (Fig. 2B, C) just below apex, 260 μm in length, with posteriormost portion enveloped by posterior slope of shell. Protoconch sculpture of raised cords forming irregular reticulate pattern that is aligned in rows, broader laterally. Surface within reticula-

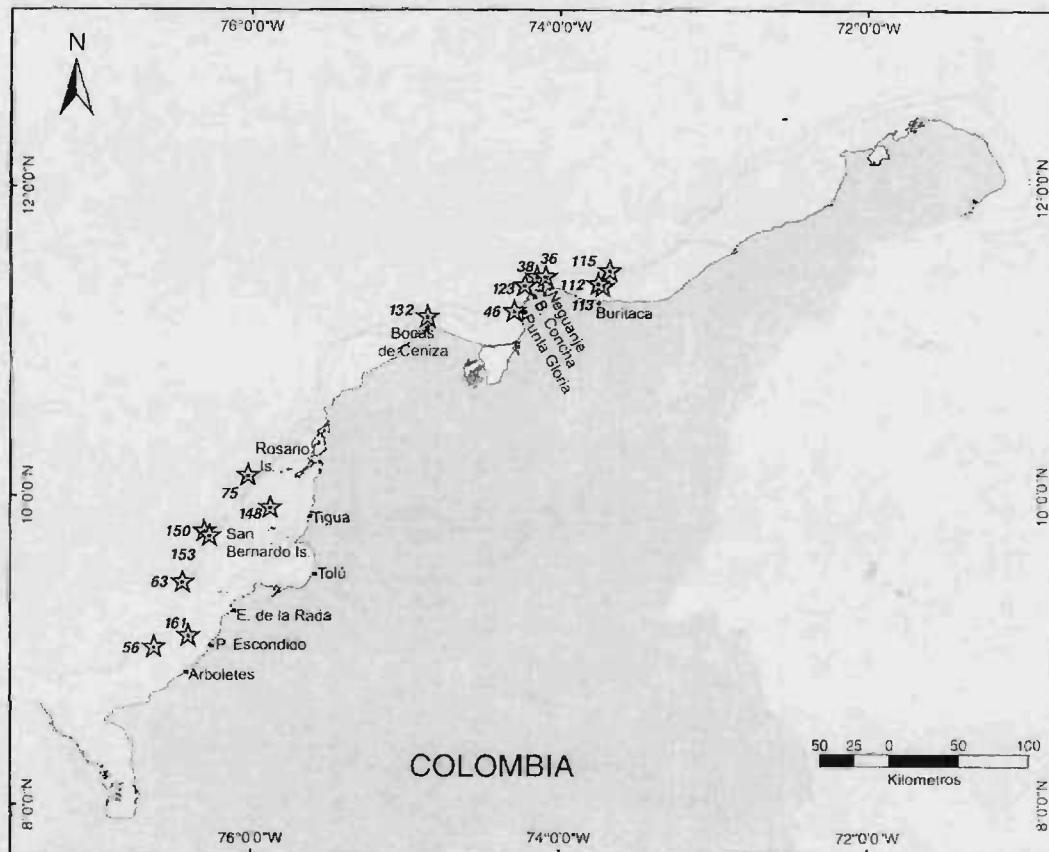


Fig. 1. Location of stations off the Caribbean coast of Colombia at which cocculiniform gastropods were collected during cruises of INVEMAR-MACROFAUNA I and II, 1998–2001, aboard the R/V *Ancon*. Stations range in depth from 70 to 516 m.

tions finely pitted (Fig. 2D). Teleoconch sculpture of prominent, raised concentric growth lines and weak, radial striae. Anterior and posterior slopes nearly straight. Aperture not planar, likely reflecting shape of substrate. Shell edge thin. Periostracum thin. Pigmented eyes absent.

*Range*.—Off Massachusetts, Florida, Bahamas, Martinique, St. Vincent, Barbados, Colombia (Dall 1889, Díaz & Puyana 1994, McLean 1987, McLean & Harasewych 1995) at depths of 124–1127 m.

*Remarks*.—A detailed synonymy, as well as illustrations of the shell, protoconch, external anatomy, and radular morphology of this species are provided by McLean & Harasewych (1995:8–11, figs. 2–11). Díaz & Puyana (1994:113) were the first to re-

port this species from the southwestern Caribbean Sea, off the coast of Colombia. Their records are from the same area off the Colombian coast but from greater depths (560–900 m).

*Cocculina messingi* McLean & Harasewych, 1995  
Figs. 1, 3, 4

*Cocculina messingi* McLean & Harasewych, 1995:11, figs. 12–24.—Lesicki, 1998:51.

*Cocculina* sp. 1 Ardila & Harasewych, 2002.

*Material examined*.—INV MOL1661, 1 specimen (SL = 5.80, SW = 4.59, SH = 1.87 mm), Sta. 46, off Punta Gloria

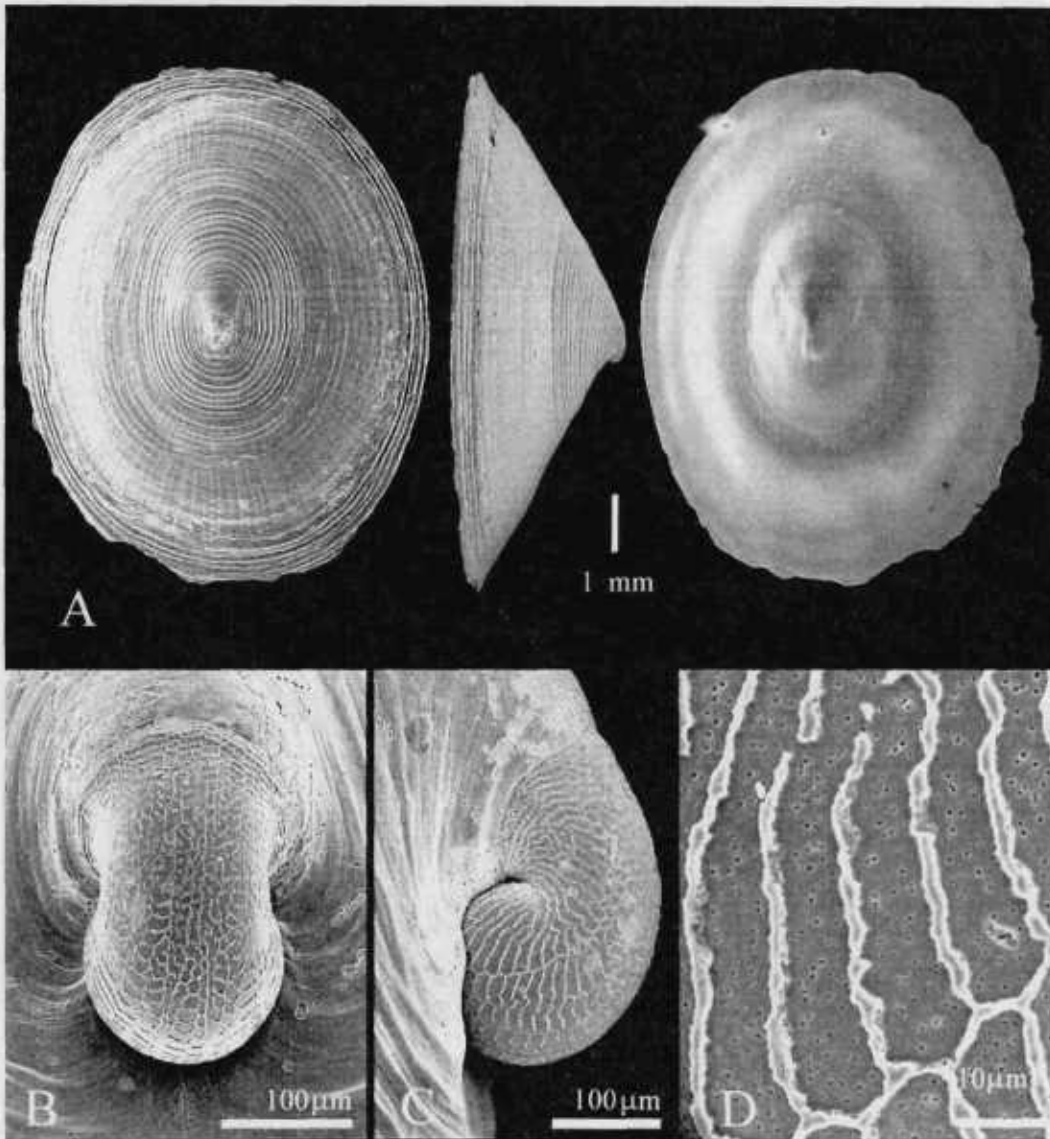


Fig. 2. *Cocculina rathbuni* Dall, 1882. INV MOL1672, Sta. 75, off Rosario Island (10°09'N, 76°00'W), in 296 m. Scanning electron micrographs (SEM) of shell. A. dorsal, left lateral, and ventral views of shell; B. dorsal and C. left lateral views of protoconch; D. detail of protoconch sculpture.

(11°11'N, 74°17'W), in 282 m. USNM 1008179, 3 specimens (SL = 10.9, SW = 8.9, SH = 3.3 mm), INV MOL1677, 1 specimen (SL = 10.36, SW = 8.64, SH = 3.23 mm), and INV MOL1678, 1 specimen (SL = 10.08, SW = 8.56, SH = 3.28 mm), Sta. 56, off Arboletes (9°02'N, 76°36'W), in 290 m. INV MOL1665, 1 specimen (SL = 6.20, SW = 4.78, SH = 1.87 mm), Sta.

75, off Rosario Island (10°09'N, 76°00'W), in 296 m. INV MOL3437 1 specimen (SL = 7.13, SW = 5.61, SH = 2.73 mm), Sta. 36, off Neguanje. (11°24'N, 74°09'W), in 296 m.

*Description.*—Shell (Figs. 3, 4A) medium to large (SL to 10.9 mm), thin, white, elliptically conical, low to moderate in height (SH/SL = 0.37–0.41). Apex slightly

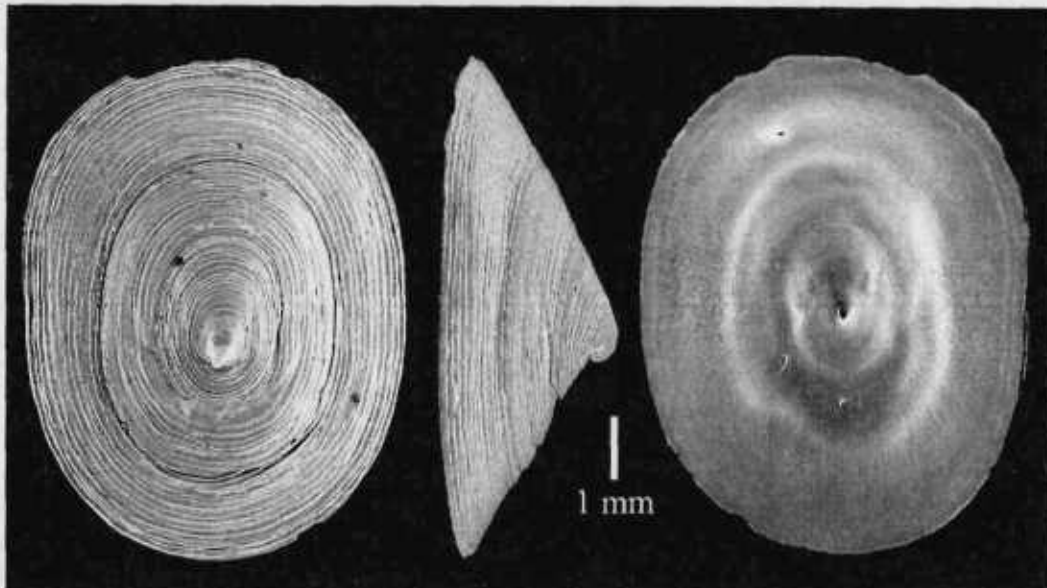


Fig. 3. *Cocculina messingi* McLean & Harasewych, 1995. INV MOL1665, Sta. 75, off Rosario Island (10°09'N, 76°00'W), in 296 m. SEM of shell. Dorsal, left lateral, and ventral views of shell.

anterior or slightly posterior of center ( $P/SL = 0.48-0.57$ ). Protoconch (Fig. 4B, C) below apex, 230  $\mu\text{m}$  in length, with posteriormost portion enveloped by posterior slope of shell. Protoconch sculpture (Fig. 4C, arrow, 4D) of raised cords forming honeycomb net pattern aligned longitudinally in rows. Surface within reticulations finely pitted. Teleoconch sculpture primarily of concentric growth lines, with radial striae weak or absent. Anterior and posterior slopes nearly straight. Aperture not planar, elliptical to roughly rectangular in outline, with anterior and posterior edges broadly rounded. Shell edge thin. Periostracum thin. Pigmented eyes present. Penis at tip of right oral lappet. Radula (Fig. 4E-G) with narrow rachidian tooth with short, raised tooth bearing single, triangular cusp; first lateral tooth with four cusps, second lateral tooth with three cusps, third lateral tooth with single cusp. Pluricuspid teeth with large central denticle, flanked by single, smaller denticles on outer and inner sides. Marginal teeth similar in size becoming progressively thinner, with more but fin-

er cusps along their distal margins towards the lateral edges of the radular ribbon.

*Range.*—This species was previously known only from the type locality, off Grand Bahama Island, in 412 m (McLean & Harasewych 1995). The present record extends the geographic range to off the Caribbean coast of Colombia, and the bathymetric range to 282 m.

*Remarks.*—We include under *C. messingi* several specimens that vary in shell height and position of shell apex. Some (Fig. 3) closely resemble the holotype of *C. messingi*, while others have a larger, proportionally higher shell in which the apex is situated slightly anterior of center (Fig. 4A). While these larger specimens may approach *Coccocrater portoricencis* (Dall & Simpson, 1901) (see below) in shell morphology, their radula are typical of *Cocculina*, with rachidian teeth that are comparatively narrow, with a raised, triangular, single cusp (see McLean & Harasewych 1995:figs. 20-22). These specimens have been identified as *C. messingi* based on their radular morphology and the presence of pigmented

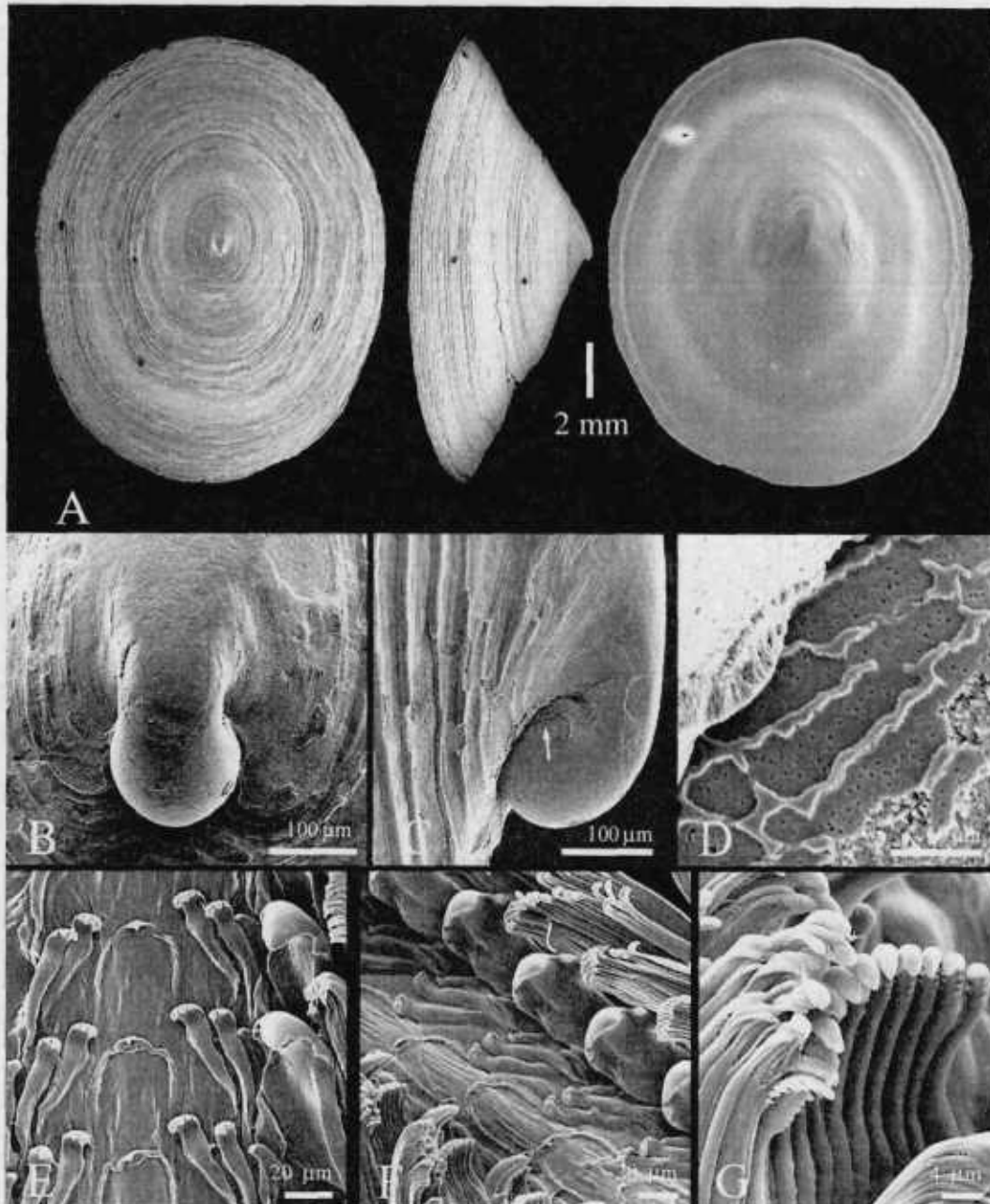


Fig. 4. *Cocculina messingi* McLean & Harasewych, 1995. USNM 1008179. Sta. 56, off Arboletes (9°02'N, 76°36'W), in 290 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Dorsal and C. left lateral views of protoconch. D. Detail of protoconch sculpture. E. Dorsal view of rachidian and lateral teeth. F. Oblique view of radular ribbon. G. Detail of marginal teeth.

eyes, which are absent in most other species of *Cocculina*.

*Cocculina messingi* occurs through most of the area sampled in this study (Fig. 1), but was collected over a very narrow bathymetric range (282–296 m).

*Cocculina emsoni* McLean & Harasewych, 1995

Figs. 1, 5

*Cocculina emsoni* McLean & Harasewych, 1995:13, figs. 25–35.—Lesicki, 1998:51.

*Material examined*.—INV MOL2377, 1 specimen (SL = 3.95, SW = 2.26, SH = 1.81 mm), INV MOL2379, 1 specimen (SL = 4.57, SW = 2.38, SH = 1.62 mm), Sta. 113, off Buratica (11°22'N, 73°44'W), in 300 m. INV MOL 2320, 1 specimen (SL = 3.88, SW = 1.95, SH = 1.27), Sta. 38, off Neguanje (11°24'N, 74°11'W), in 292 m.

*Description*.—Shell (Fig. 5A, E) small (SL = 3.95–4.57 mm), thin, white, lanceolate conical, medium (Fig. 5E) to high (Fig. 5A) in profile (SH/SL = 0.35–0.46). Apex well posterior of center (P/SL ≈ 0.74). Protoconch well below apex, 210 μm in length, with posteriormost portion enveloped by posterior slope of shell. Protoconch sculpture of raised cords forming even, hexagonal honeycomb pattern (Fig. 5C). Teleoconch sculpture dominated by 3 strong keels radiating from apex, 1 anteriorly directed keel situated along midline, 2 posteriorly directed keels each deviate from the midline by about 18°. Keels correspond to furrows along inner surface of shell. Numerous weaker radial cords present, concentric sculpture weak or indistinct. Anterior slope strongly convex, posterior slope straight, with concave trough between two posterior keels (Fig. 5B, F). Aperture with complex lanceolate outline, with convex areas flanking anterior keel. Shell edge thin. Periostracum thin, extending beyond shell edge, weakly hirsute along radial cords (Fig. 5D).

*Range*.—Previously known only from the type locality, off New Providence Is-

land, Bahamas, at a depth of 518 m (McLean & Harasewych 1995). The present records extend the range to off the Caribbean coast of Colombia, and the depth to 292 m.

*Remarks*.—The lanceolate morphology of the shell, the presence of three strong keels, and the hexagonal honeycomb sculpture of the protoconch of this species are diagnostic. The Colombian specimens are larger and more variable in terms of shell height and apex position than specimens in the type series.

*Cocculina fenestrata*, new species

Figs. 1, 6, 7

*Cocculina* sp. 2 Ardila & Harasewych, 2002.

*Type Material*.—Holotype, INV MOL2370 (SL = 3.3, SW = 2.2, SH = 1.2 mm). Paratype 1, INV MOL2371, (SL = 2.4, SW = 1.5, SH = 0.9 mm), Paratype 2, USNM 1008180, (SL = 2.3, SW = 1.5, SH = 0.8 mm), Sta. 115, off Buritaca, Palomino, Colombia (11°27'N, 73°40'W), in 504 m.

*Description*.—Shell (Fig. 6A) small (SL ≤ 3.3 mm), thin, white, ovately conical, of moderate height (SH/SL = 0.34). Apex just posterior of center (P/SL ≈ 0.53). Protoconch (Fig. 6B) slightly below apex, 210 μm in length, posteriormost portion enveloped by posterior slope of shell. Protoconch sculpture unknown, worn in all available specimens. Teleoconch sculpture of raised radial ribs, with two weak radial threads between adjacent ribs (Fig. 6A, C). Anterior slope weakly, evenly convex, posterior slope straight. Aperture ovate, slightly narrower anteriorly. Shell edge thin. Periostracum thin, finely tufted along radial ribs and threads (Fig. 6C), extending beyond shell edge.

External anatomy (Fig. 7A): Animal poorly preserved. Eyes lacking, epipodial tentacles present (Fig. 7C), oral lappet broad (Fig. 7B).

Radula (Fig. 7D, E): Rachidian tooth nar-

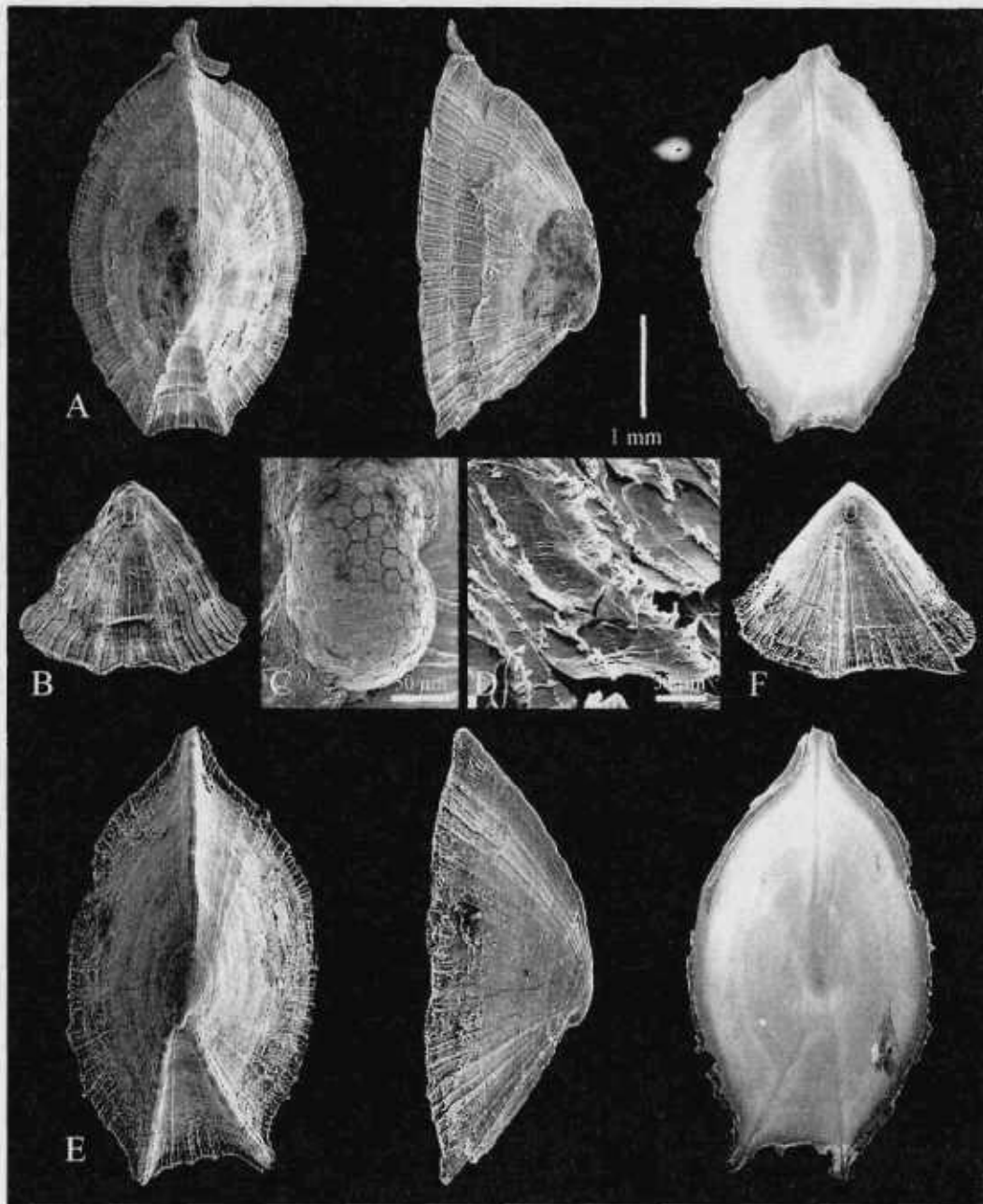


Fig. 5. *Cocculina emsoni* McLean & Harasewych, 1995. A-D. INV MOL2377. E-F. INV MOL2379. Both from Sta. 113, off Buratica (11°22'N, 73°44'W), in 300 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Posterior view of shell. C. Dorsal view of protoconch. D. Detail of periostracum. E. Dorsal, left lateral, and ventral views of shell. F. Posterior view of shell.



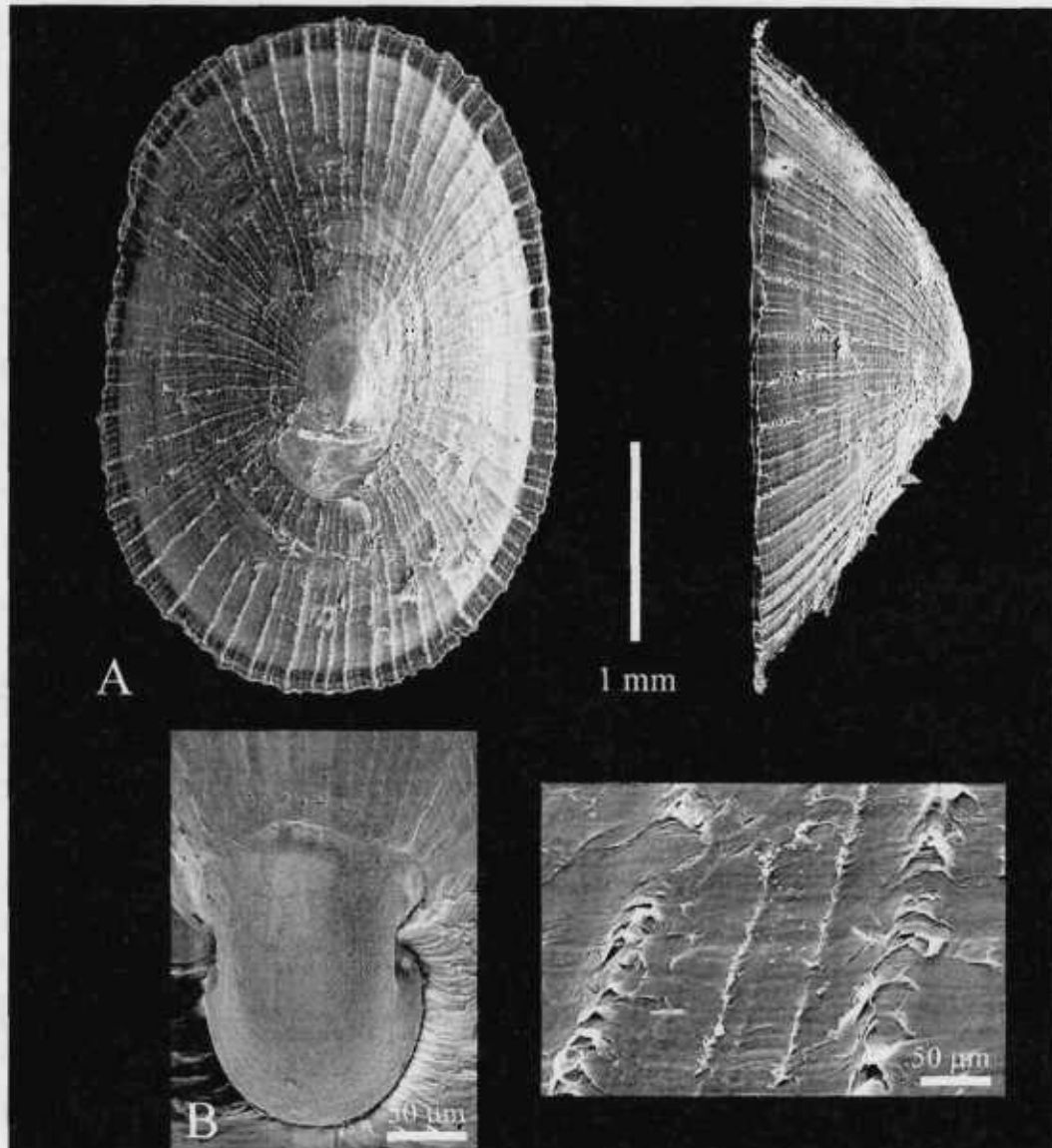


Fig. 6. *Cocculina fenestrata*. Holotype, INV MOL2370. Sta. 115, off Buritaca ( $11^{\circ}27'N$ ,  $73^{\circ}40'W$ ), in 504 m. SEM of shell. A. Dorsal and left lateral views of shell. B. Dorsal view of worn protoconch. C. Detail of periostracum.

row, with single triangular cusp on raised shaft. First and second lateral teeth each with four cusps, third lateral tooth with single cusp. Pluricuspid tooth with large central denticle, flanked by single denticle on outer edge, two weaker denticles on inner edge.

*Range*.—This species is presently known only from the type locality, off Buritaca, Palomino, Colombia, at a depth of 504 m.

*Remarks*.—Among the western Atlantic species, *Cocculina fenestrata* most closely resembles *C. emsoni*. While lacking the characteristic lanceolate outline and raised ridges of *C. emsoni*, *C. fenestrata* does share sculpture consisting of radial cords and threads, a periostracum that extends beyond the shell edge, and narrow rachidian teeth that have single cusps on a raised shaft.

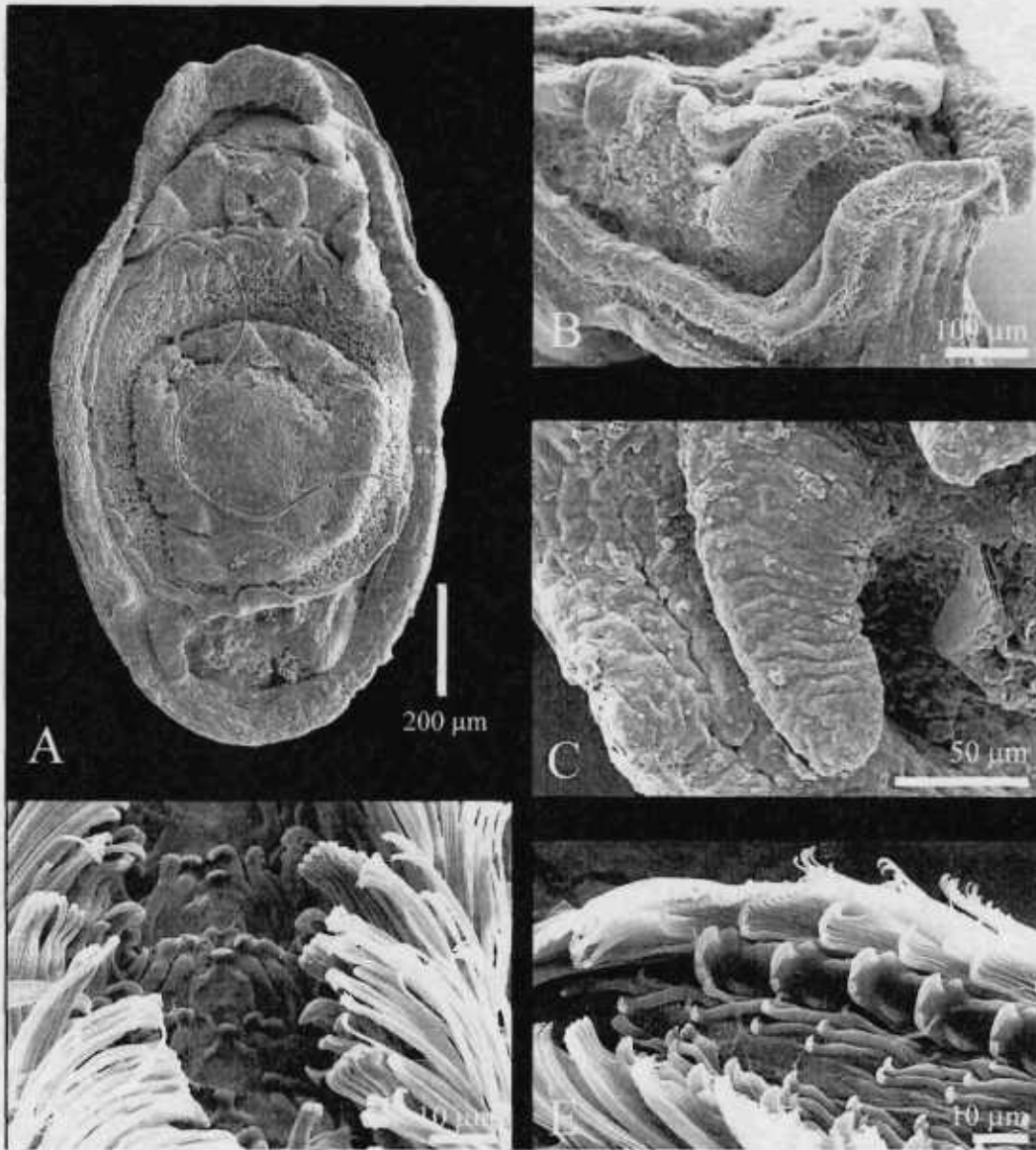


Fig. 7. *Cocculina fenestrata*. Paratype 1, INV MOL2371. Sta. 115, off Buritaca (11°27'N, 73°40'W), in 504 m. A. Ventral view of critical-point-dried animal. B. Left lateral view of head. C. Right epipodial tentacle. D. Dorsal view of radula. E. Lateral view of radula.

Genus *Cococrater* Haszprunar, 1987  
*Cococrater portoricensis* (Dall &  
 Simpson, 1901)  
 Figs. 1, 8, 9

*Cocculina portoricensis* Dall & Simpson,  
 1901:440, pl. 53, figs. 18, 19.—Thiele,  
 1909:10.—Abbott, 1974:35, fig. 202.—

Díaz & Puyana, 1994:113, pl. 35, fig.  
 344.

*Cococrater portoricensis*: McLean & Har-  
 asewych, 1995:17, fig. 50.—Lesicki,  
 1998:51.

*Material examined*.—INV MOL 1687, 1  
 specimen (SL = 11.62, SW = 8.59, SH =

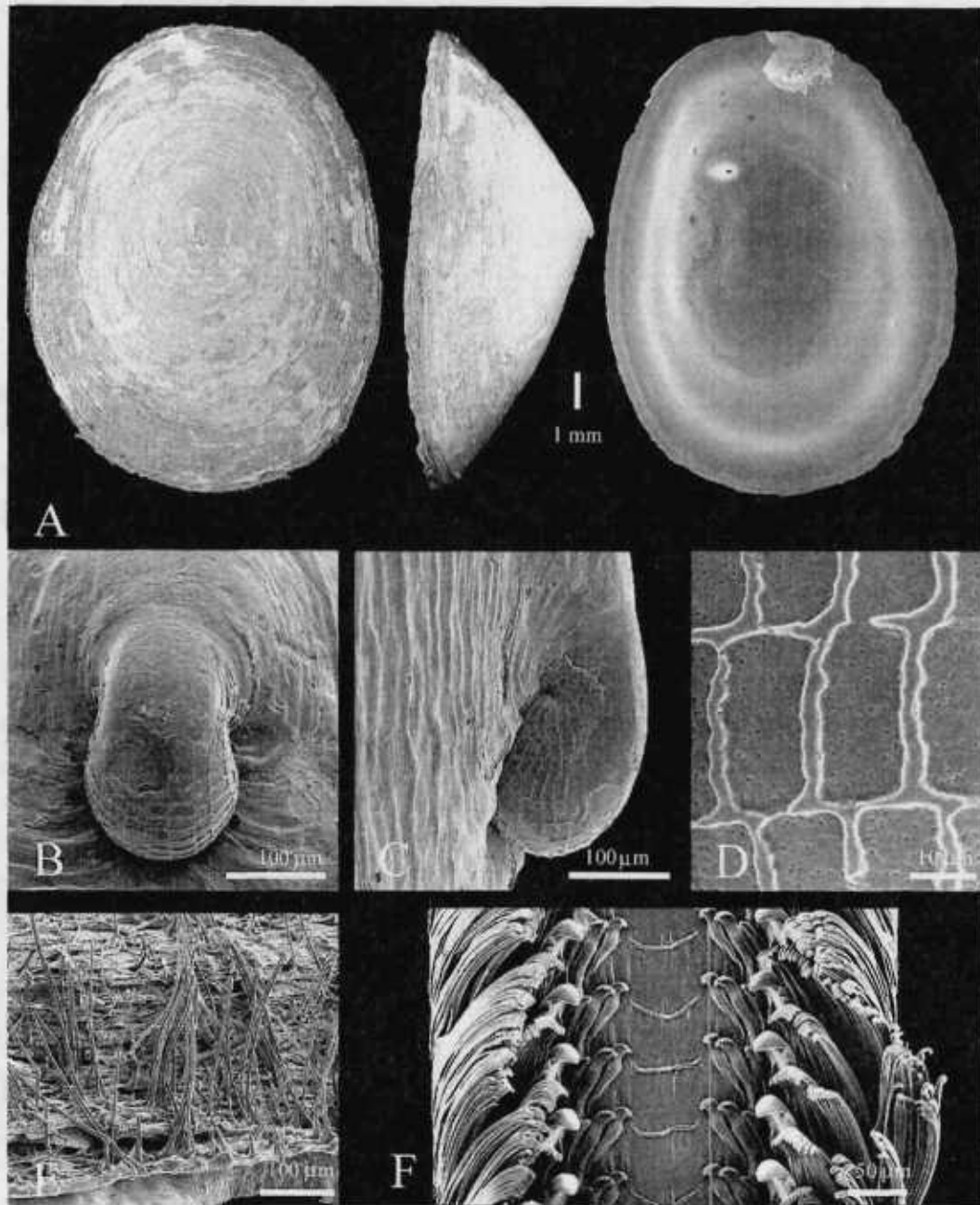


Fig. 8. *Coccocrater portoricensis* (Dall & Simpson, 1901). INV MOL1687. Sta. 63, off Ensenada de la Rada ( $9^{\circ}27'N$ ,  $76^{\circ}25'W$ ), in 272–310 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Dorsal and C. left lateral views of protoconch. D. Detail of protoconch sculpture. E. Detail of periostracum at shell edge. F. Dorsal view of radula.

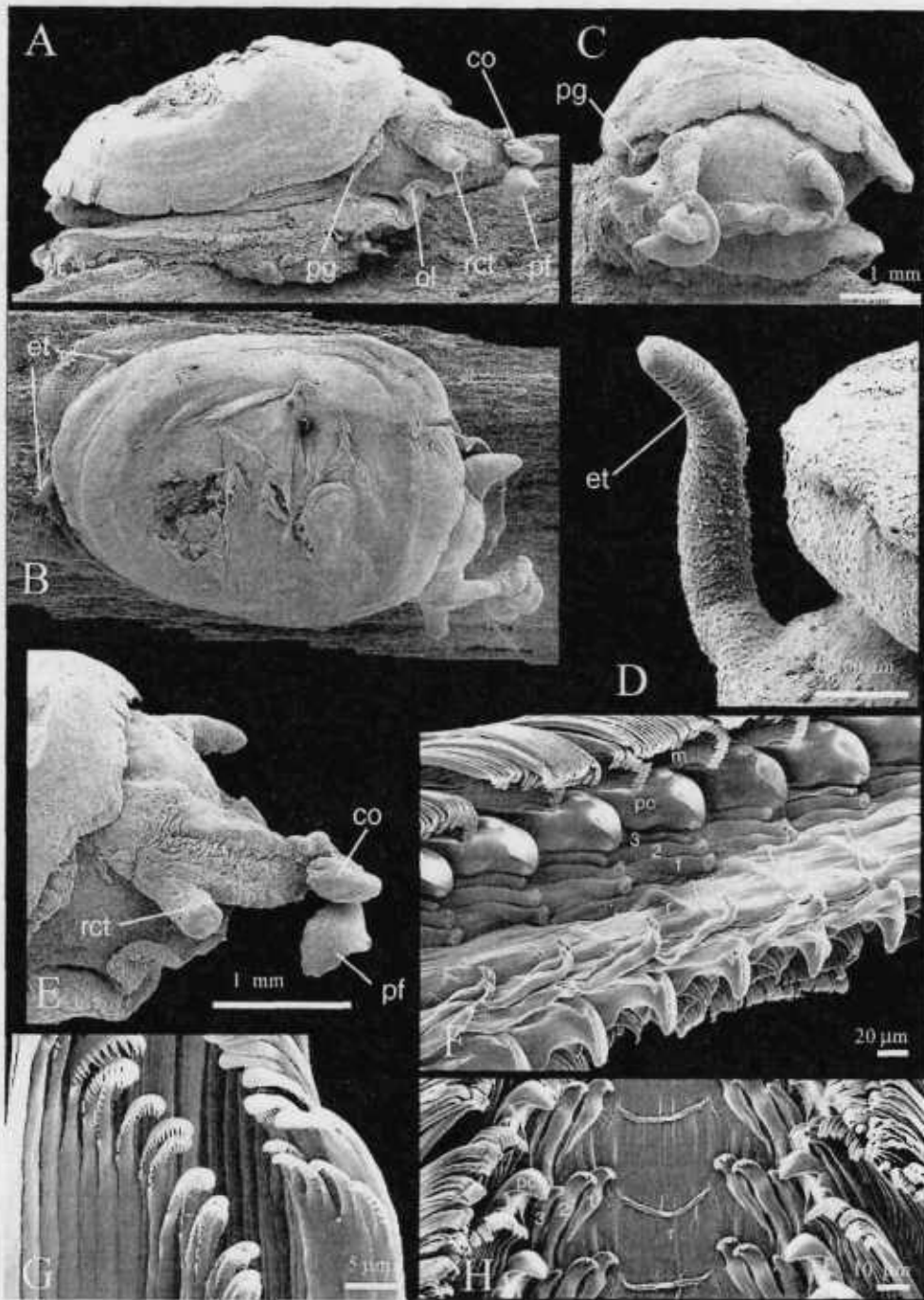


Fig. 9. *Coccocrater portoricensis* (Dall & Simpson, 1901). INV MOL1687. Sta. 63, off Ensenada de la Rada (9°27'N, 76°25'W), in 272–310 m. A. Right lateral view of critical-point-dried animal. B. Dorsal view of critical-point-dried animal. C. Frontal view of animal. D. Right epipodial tentacle. E. Detail of right cephalic tentacle and copulatory organ. F. Lateral view of radula. G. Detail of marginal teeth. H. Detail of rachidian and lateral teeth. co—copulatory organ, et—epipodial tentacle, ol—oral lappet, pc—pleurocuspid tooth, pf—penial flap, pg—pseudoplicatid gill, r—rachidian tooth, rct—right cephalic tentacle, 1—1<sup>st</sup> lateral tooth, 2—2<sup>nd</sup> lateral tooth, 3—3<sup>rd</sup> lateral tooth.

3.71 mm); INV MOL 1685, 2 specimens (SL = 10.60, SW = 7.52, SH = 3.47 mm); INV MOL 1686, 2 specimens (SL = 11.38, SW = 8.44, SH = 3.59 mm); USNM 1024534, 1 specimen (SL = 11.72, SW = 8.06, SH = 3.85) Sta. 63, off Ensenada de la Rada (9°27'N, 76°25'W), in 272–310 m.

*Description.*—Shell (Fig. 8A) large for family (reaching 12 mm), moderately thick, white, inflated, ovately conical, high (SH/SL = 0.41–0.46). Apex anterior of center (P/SL = 0.44–0.46). Protoconch (Fig. 8B, C) forming apex, 250  $\mu$ m in length, with posterior ventral margin embedded in posterior slope of shell. Protoconch sculpture of raised cords forming reticulate pattern aligned longitudinally in rows. Surface within reticulations finely pitted (Fig. 8D). Teleoconch sculpture of weak, irregular growth lines, and feeble radial cords and intervening threads, most clearly discerned along posterior slope. Anterior and posterior slope weakly, evenly convex. Aperture nearly planar, weakly ovate, narrower anteriorly. Shell edge thick. Periostracum thin, strongly hirsute (Fig. 8E) but hairs confined to shell margin, worn or absent nearer to apex. Periostracal hairs follow radial cords and threads.

External anatomy (Fig. 9A–E): Animals lacking pigmented eyes. Penis emerging from right cephalic tentacle (Fig. 9A, E, rct), Y-shaped, with inner, shorter branch comprising copulatory organ (Fig. 9A, E, co) and longer, flatter, outer branch forming penial fold (Fig. 9A, E, pf). Pseudoplicatid gill (Fig. 9A, C, E, pg) on right side dorsal to oral lappet (Fig. 9A, ol). Pair of posterior epipodial tentacles (Fig. 9B, D, et).

Radula (Figs. 8F, 9F–H): Rachidian teeth (Fig. 9F, H, r) with broad attachment area, broad, thickened anterior edge without discernible cusps; first lateral teeth (Fig. 9F, H, 1) with 1–3 cusps, second lateral teeth (Fig. 9F, H, 2) with 5 cusps, third lateral teeth (Fig. 9F, H, 3) with single cusp. Pluricuspid teeth (Fig. 9F, H, pc) broad, with large main cusp and single, inner and outer secondary

cusps. Marginal teeth (Fig. 9F–H, m) similar in size.

*Range.*—This species was known from a unique holotype taken in 566 m off San Juan Harbor, Puerto Rico, until Díaz & Puyana (1994:113) reported it from an area slightly to the north of the present record (Díaz & Puyana 1994:fig. 15, sector 2), at depths ranging from 40 to 600 m. The specimens we illustrate came from a depth of 272–310 m, substantially shallower than the holotype. Since cocculinids inhabit primarily bathyal depths, the published 40 m record will require confirmation.

*Remarks.*—Dall & Simpson (1901) described this species in the genus *Cocculina* Dall, 1882, commenting on its conchological similarities to *C. rathbuni*, and noted its lack of eyes and the presence of a large penis projecting from the right cephalic tentacle, a pseudoplicatid gill, and long, paired, epipodial tentacles. McLean & Harasewych (1995:17) transferred *C. portoricensis* to the genus *Cococrater* Haszprunar, 1987, recognizing that the combination of anatomical features and the absence of a hirsute periostracum were diagnostic of that genus.

The newly collected and well preserved specimens of *C. portoricensis* clearly have a hirsute periostracum (Fig. 8E), at least near the shell edge. However, these periostracal hairs are worn and absent over most of the shell surface, which closely resembles that of the holotype of *C. portoricensis*. The periostracum of *C. portoricensis* is similar to but has longer hairs than does *Coccopigya mikkelsenae* McLean & Harasewych, 1995. The radulae of these two species are also very similar, although *C. mikkelsenae* has rachidian teeth with a thickened anterior edge and one or more distinct cusps (see McLean & Harasewych 1995:fig. 45). The penis of *C. portoricensis* is bifid, while that of *C. mikkelsenae* consists of a single, tapering lobe. Despite the similarity to *Coccopigya mikkelsenae*, we provisionally retain *C. portoricensis* in *Cococrater* because the genus *Coccopigya*

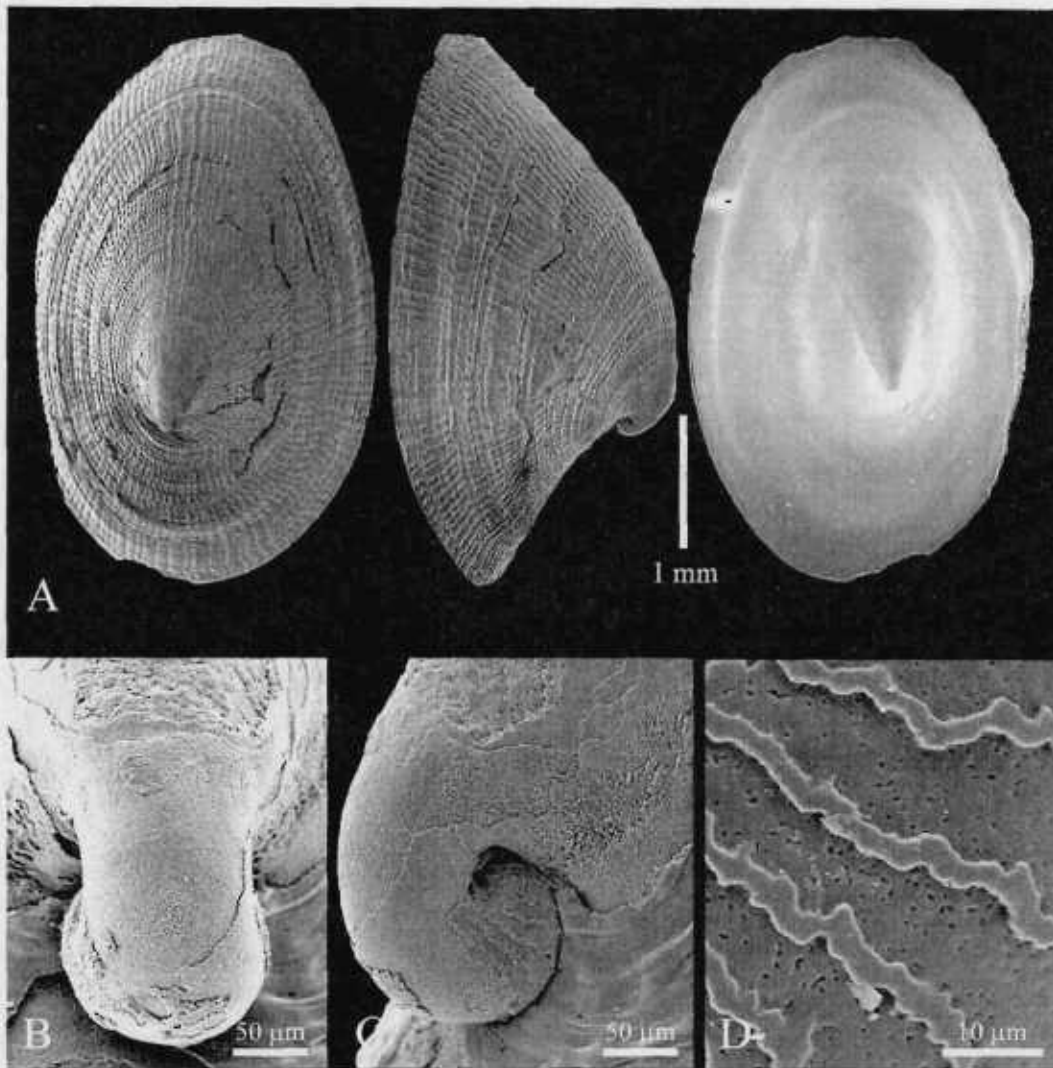


Fig. 10. *Fedikovella beanii* (Dall, 1882). INV MOL2372. Sta. 150, Off San Bernardo Island (9°46'N, 76°17'W), in 500–516 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Dorsal, and C. right lateral views of protoconch. D. Detail of protoconch sculpture.

is characterized by the absence of epipodial tentacles, which are prominent in *C. portoricensis* (Fig. 9B, D, et).

Genus *Fedikovella* Moskalev, 1976

*Fedikovella beanii* (Dall, 1882)

Figs. 1, 10

*Cocculina beanii* Dall, 1882:403.—Dall, 1889:347, pl. 25, figs. 2, 4, 8.—Pilsbry, 1890:132, pl. 25, figs. 23, 24.—Thiele,

1909:6, pl. 2, figs. 3, 4.—Abbott, 1974: 34, fig. 194.

*Fedikovella beanii*: Moskalev, 1976:64 [as *beanii*].—McLean & Harasewych, 1995: 19, figs. 51–57.—Lesicki, 1998:52.

*Material examined*.—INV MOL2372, 2 specimens (SL = 4.2, SW = 2.5, SH = 2.2 mm), Sta. 150, Off San Bernardo Island, Colombia. (9°46'N, 76°17'W), in 500–516 m.

*Description*.—Shell (Fig. 10A) small

(4.2 mm), moderately thick, white, arched, high (SH/SL = 0.52). Apex well posterior of center (P/SL = 0.60). Protoconch (Fig. 10B, C) well below apex, 220  $\mu$ m in length, with posterior margin embedded in posterior slope of shell. Protoconch sculpture of irregular, roughly parallel, raised cords perpendicular to the long axis of the shell, confined to bulbous portion of protoconch. Surface between ridges pitted (Fig. 10D). Teleoconch sculpture of radial ribs dominating concentric ridges. Anterior slope strongly convex, posterior slope weakly concave. Aperture not planar, weakly ovate, narrower anteriorly. Shell edge moderately thin. Periostracum thin.

*Range*.—Massachusetts, New Jersey, Guadalupe, Martinique, St. Vincent, Barbados (Dall 1889, McLean & Harasewych 1995) at depths of 210–1049 m. The new records from Colombia extend the species range to the southwestern Caribbean.

*Remarks*.—The Colombian specimens closely resemble *Fedikovella beanii* taken in the eastern Caribbean (see McLean & Harasewych 1995:figs. 51–53) in general morphology and in having a characteristic sculpture along the early portion of the protoconch. However, radial sculpture is dominant in the Colombian specimens, whereas concentric sculpture predominates in the Atlantic specimens. Leal & Harasewych (1999:123) reported differences in protoconch sculpture and reproductive anatomy between the abyssal type species of *Fedikovella* (*F. caymanensis* Moskalev, 1976) and the bathyal *F. beanii*, and suggested that a reassessment of the relationship of *F. beanii* may be in order.

Superfamily Lepetelloidea Dall, 1882  
Family Pseudococculinidae Hickman,  
1983

Genus *Notocrater* Finlay, 1926  
*Notocrater houbricki* McLean &  
Harasewych, 1995

Figs. 1, 11

*Notocrater houbricki* McLean & Harasewych, 1995:24, figs. 58–65.—Lesicki, 1998:57.

*Material examined*.—INV MOL 2364, 1 specimen (SL = 1.8, SW = 1.3, SH = 0.8 mm), INV MOL 2603, 1 specimen (SW = 1.3, SW = 1.0 mm, apex broken) Sta. 153, off Tolú (9°45'N, 76°15'W), in 270 m. INV MOL3584, 11 specimens (to SL = 2.4, SW = 1.8, SH = 1.1 mm) Sta. 123, off Bahia Concha (11°22'N, 74°10'W) in 154 m. INV MOL3585, 17 specimens (to SL = 3.3, SW = 2.3, SH = 1.5 mm) Sta. 132, off Bocas de Ceniza (11°08'N, 74°53'W) in 153 m. INV MOL3587, 1 specimen (SL = 1.8, SW = 1.3, SH = 0.8 mm) Sta. 148, off Tigua (9°59'N, 75°46'W) in 89 m.

*Description*.—Shell (Fig. 11A) small (3.3 mm), thin, white, arched, high (SH/SL = 0.45). Apex well posterior of center (P/SL = 0.89). Protoconch (Fig. 11B, C) well below apex, 172  $\mu$ m in length, with posterior margin embedded in posterior slope of shell. Protoconch smooth, with densely but irregularly scattered fine crystals. Teleoconch sculpture of raised concentric bands that, with increasing shell size, become irregular, then interrupted into beads or pustules (Fig. 11D) that align to form regularly curved rows. Radial sculpture of very fine, irregular, threads and beads that abut but do not cross concentric bands. Anterior slope strongly convex, posterior slope weakly concave. Aperture roughly planar, broadly elliptical. Shell edge thin, sharp. Periostracum thin.

*Range*.—Previously known only from the type locality, off Grand Bahama Island, Bahama Islands at a depth of 412 m (McLean & Harasewych 1995). The present record extends the range to off the Caribbean coast of Colombia, and the depth range to 89 m.

*Remarks*.—The posterior position of the apex, the distinctive arched shell, and the distinctive sculpture of the protoconch and teleoconch readily identify this species.

*Notocrater youngi* McLean &  
Harasewych, 1995  
Figs. 1, 12

*Notocrater youngi* McLean & Harasewych, 1995:26, figs. 66–75.—Lesicki, 1998:57.

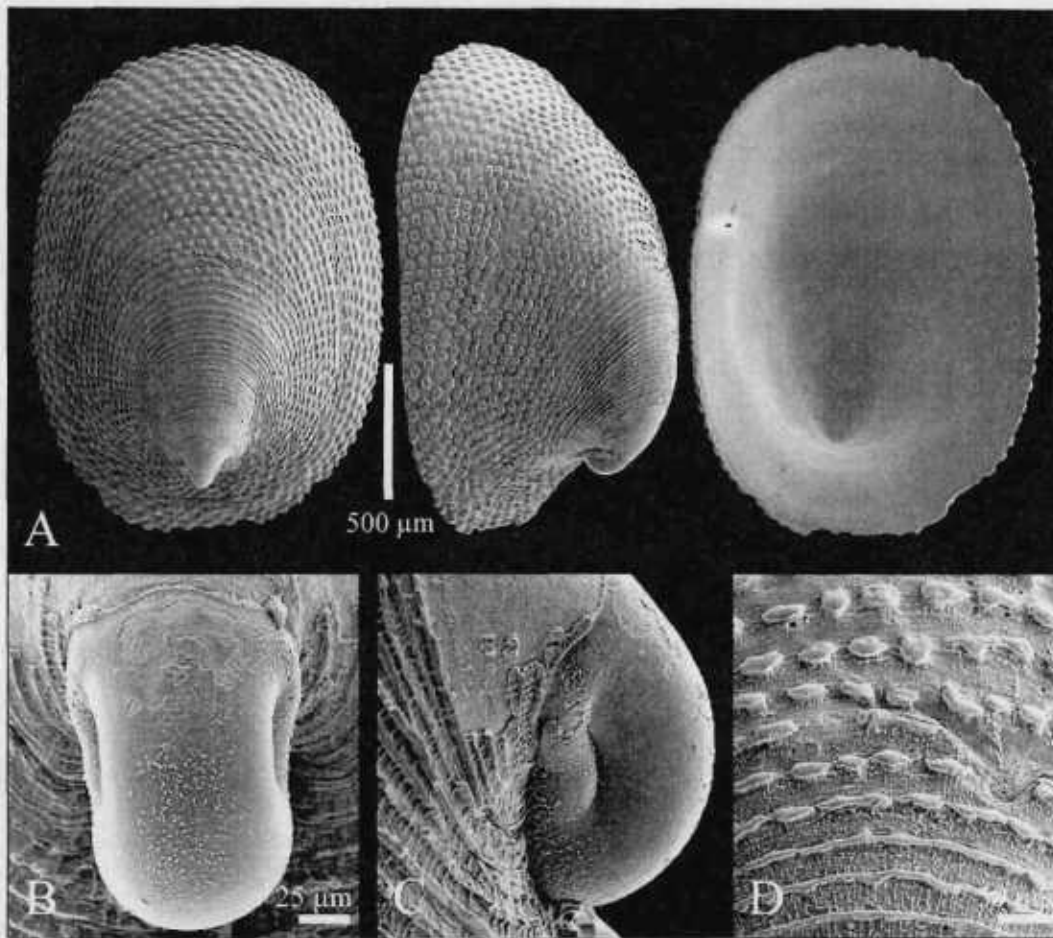


Fig. 11. *Nojocrater houbricki* McLean & Harasewych, 1995. INV MOL2364. Sta. 153, off Tolú (9°45'N, 76°15'W), in 270 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Dorsal, and C. left lateral views of protoconch. D. Detail of teleoconch sculpture.

*Material examined.*—INV MOL1660, 1 specimen (SL = 3.14, SW = 2.57, SH = 1.33 mm), Sta. 56, off Arboletes (9°02'N, 76°36'W), in 290–309 m. INV MOL3597, 3 specimens (SL = 2.8, SW = 2.1, SH = 1.0 mm) Sta. E161, off Puerto Escondido (9°14'N, 76°26'W) in 70 m.

*Description.*—Shell (Fig. 12) of moderate size (3.1 mm), thin, white, elliptically conical, high (SH/SL = 0.41). Apex posterior of center (P/SL = 0.64). Protoconch barely below apex, broken, sculpture unknown. Teleoconch sculpture of raised concentric bands that become irregular, then interrupted into beads or pustules that align

to form regularly curved rows. Radial sculpture of very fine, irregular, threads and beads that abut but do not cross concentric bands. Anterior slope weakly convex to straight, posterior slope straight. Aperture planar, broadly elliptical. Shell edge thin, sharp. Periostracum thin.

*Range.*—Previously known only from the type locality, off Grand Bahama Island, Bahama Islands at a depth of 518 m (McLean & Harasewych 1995). The present record extends the range to off the Caribbean coast of Colombia, and the depth range to 70 m.

*Remarks.*—The single specimen from



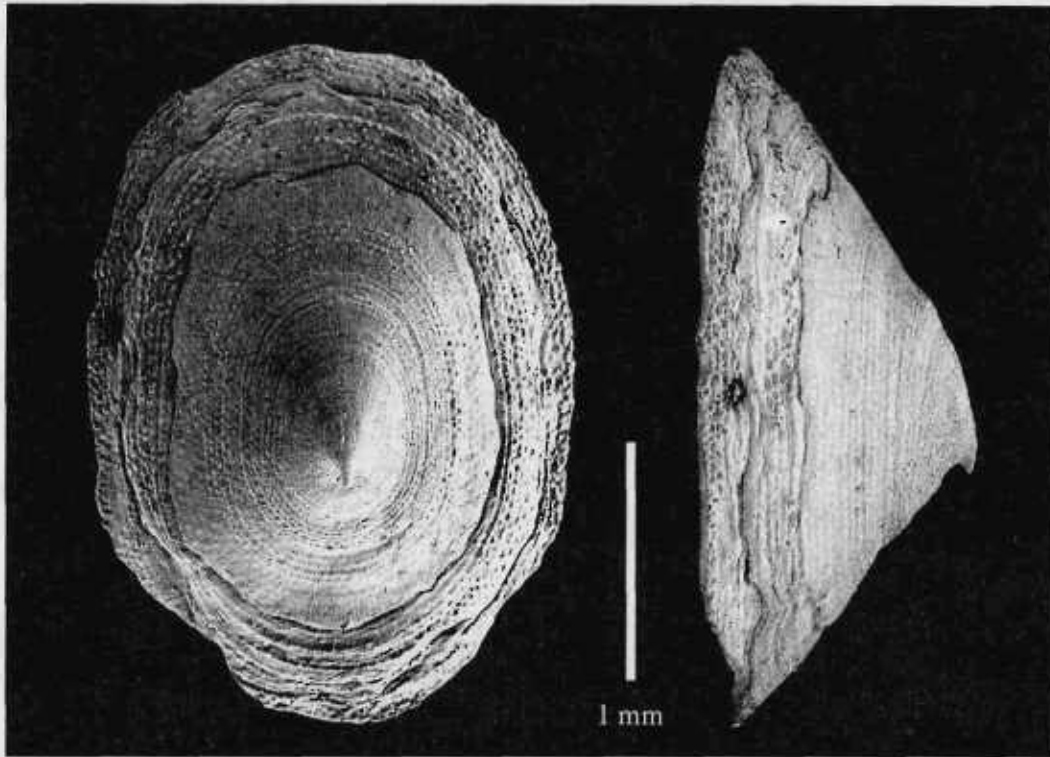


Fig. 12. *Notocrater youngi* McLean & Harasewych, 1995. INV MOLI660. Sta. 56, off Arboletes (9°02'N, 76°36'W), in 290–309 m. SEM of dorsal and left lateral views of shell.

Colombia, although worn, is readily identified on the basis of its conical shell shape, nearly apical protoconch, and characteristic teleoconch sculpture.

Genus *Copulabyssia* Haszprunar, 1988

*Copulabyssia colombia*, new species

Figs. 1, 13, 14, 15

*Type material*.—Holotype INV MOL2366 (SL = 3.6, SW = 2.6 SH = 1.7 mm), Paratype 1, INV MOL 2367 (SL. 3.5, SW. 2.6 SH. 1.3 mm), Paratype 2, USNM 1008181 (SL = 2.9, SW = 2.1, SH = 1.0), Sta. 112, off Buritaca, Palomino (11°22'N, 73°43'W), in 300 m.

*Description*.—Shell (Figs. 13A, 14A) large for genus (SL to 3.6 mm), thin, white, weakly arched, of moderately low (SH/SL  $\approx$  0.32). Apex well posterior of center (P/SL  $\approx$  0.75). Protoconch (Figs. 13B, 14B, C) well below shell apex, 190  $\mu$ m in length,

with ventral portion enveloped by posterior slope of shell. Protoconch smooth, not pitted, with densely scattered fine crystals confined to the lateral sides of earliest portion of protoconch (Fig. 14D). Teleoconch sculpture of strong, concentric cords (about 40  $\mu$ m apart), with fine, irregular striae that abut one or both bounding concentric cords but do not cross them (Fig. 13C). Anterior slope moderately, evenly convex, posterior slope weakly concave to straight. Aperture nearly planar, roughly elliptical. Shell edge, thin, sharp. Periostracum thin.

External anatomy (Fig. 15A): head large, with large mouth (Fig. 15A, mo) within prominent oral lappet. Eyes absent. Right cephalic tentacle (Fig. 15A, rct) much larger and longer than left (Fig. 15A, lct), modified as copulatory organ. Gill (Fig. 15A, g) long, tapering, distal end emerges from mantle cavity posterior to right cephalic

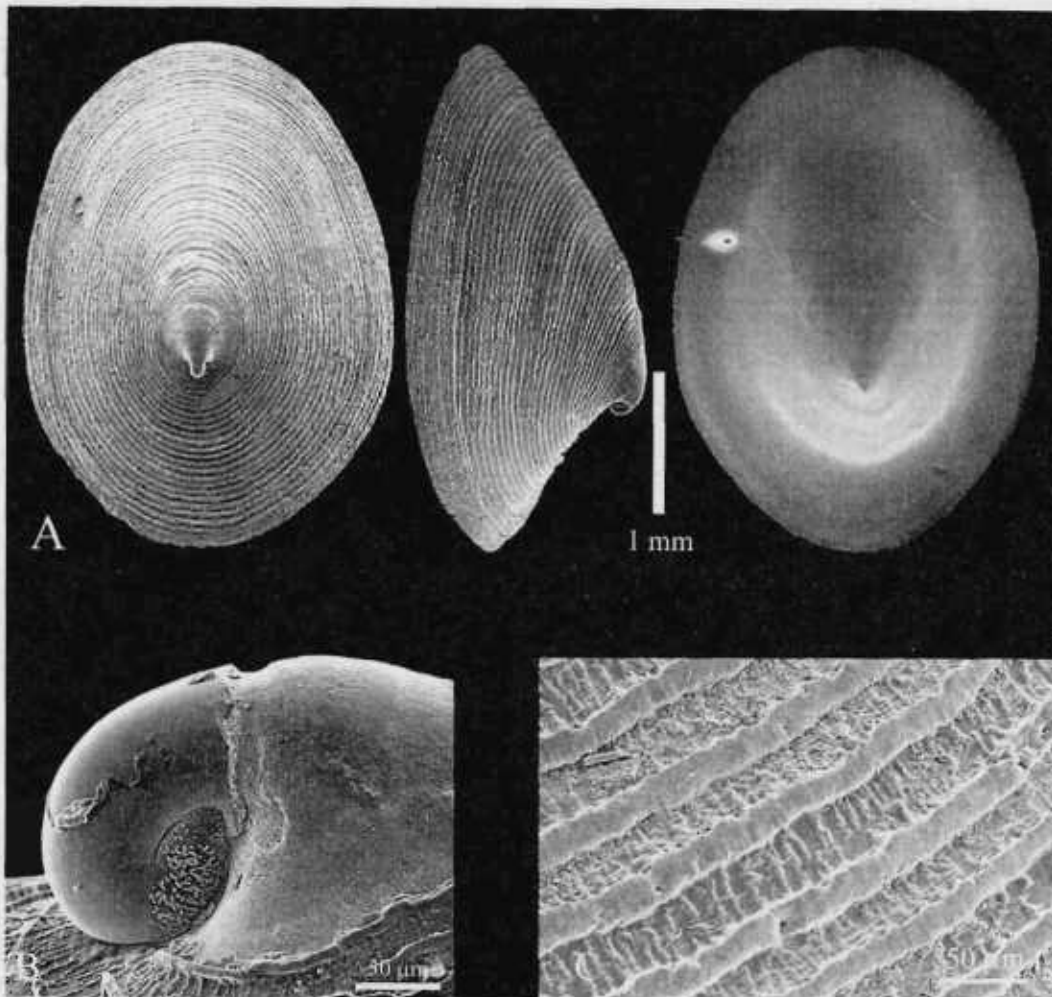


Fig. 13. *Copulabyssia colombia*. Holotype, INV MOL2366. Sta. 112, off Buritaca, Palomino ( $11^{\circ}22'N$ ,  $73^{\circ}43'W$ ), in 300 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Right lateral view of Protoconch. C. Detail of teleoconch sculpture of paratype 2.

tentacle. Epipodial tentacles (Fig. 15A, et) moderately long, cylindrical.

Radula: Asymmetrical, narrow ( $145\ \mu\text{m}$ ). Rachidian tooth (Fig. 15B, r) broadly rhomboidal, without cusps. First lateral tooth (Fig. 15B, 1) triangular, anterior edge may be raised to form cusp. Second, third, and fourth lateral teeth (Fig. 15B, 2–4) sinuate, with anterior end strongly recurved, forming hook-like cusp. Pleurocuspid tooth (Fig. 15B, pc) with 2–3 subterminal cusps. Marginal teeth (Fig. 15B, m) numerous, second

the largest, with 5–6 cusps confined to distal end.

*Range*.—This species is known from the type locality, off Buritaca, Palomino, Colombia, in 300 m.

*Remarks*.—*Copulabyssia colombia* most closely resembles the western Atlantic species *C. riosi* (Leal & Simone, 2000) from  $\sim 1000$  m depths of southeastern Brazil. It may be distinguished from *C. riosi* by: its more centrally placed apex; its lower shell, with more widely spaced concentric ribs

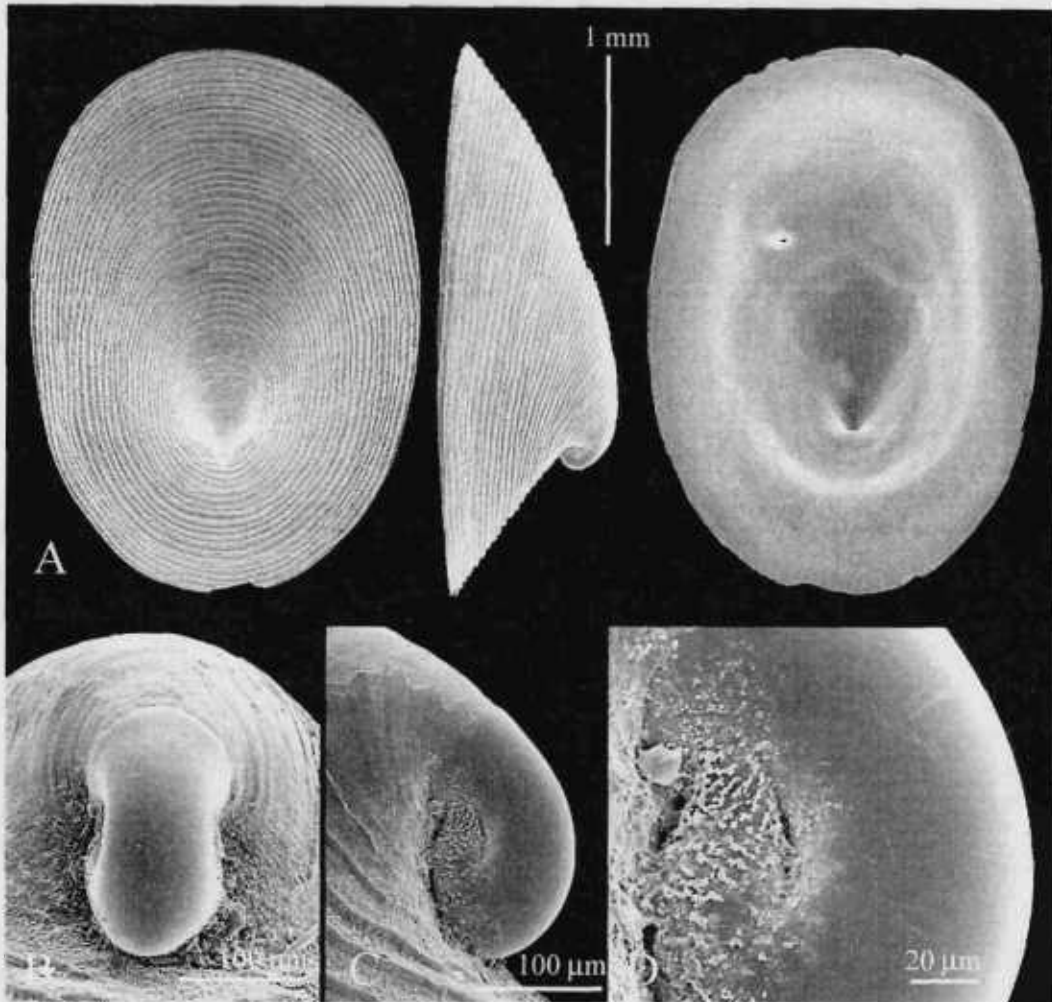


Fig. 14. *Copulabyssia colombia*. Paratype 2, USNM 1008181. Sta. 112, off Buritaca, Palomino (11°22'N, 73°43'W), in 300 m. SEM of shell. A. Dorsal, left lateral, and ventral views of shell. B. Dorsal, and C. left lateral views of protoconch. D. Detail of protoconch sculpture.

(~40  $\mu\text{m}$ ); having a greatly reduced or absent apical septum; its cusplless rachidian teeth; and its simple, stout, single epipodial tentacles.

#### Discussion

Although the known diversities of the cocculinid and pseudococculinid faunas of the western Atlantic Ocean are second only to those of the western Pacific (Lesicki 1998), both are still thought to be in a stage of rapid growth through discovery. Roughly half of the described species of western

Atlantic Cocculinidae (5 of 11) and Pseudococculinidae (8 of 12) have been published within the past decade (Table 1). This study reports the presence of six species of Cocculinidae along the upper continental slope off the Caribbean coast of Colombia, more than half the total number of species reported from the western Atlantic Ocean (Table 1). Five of the six species of Cocculinoidea reported from the Bahamas and/or the Antilles from depths less than 1000 m were collected during this study. While *Coccolpigya mikkelsenae*, known only from

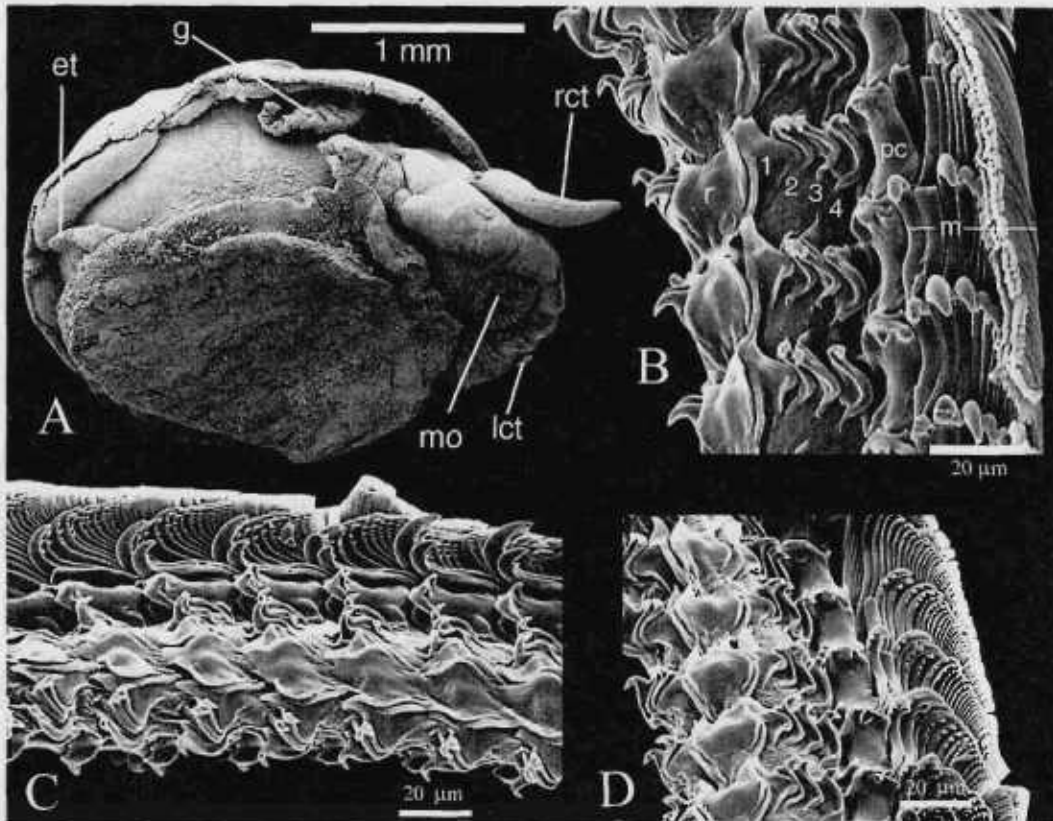


Fig. 15. *Copulabyssia colombia*. Paratype 2, USNM 1008181. Sta. 112, off Buritaca, Palomino (11°22'N, 73°43'W), in 300 m. Scanning electron micrographs of A. Right lateral view of critical-point-dried animal. B. dorsal view of right side of radula. C. lateral view of radula. D. Oblique view of radula. et—epipodial tentacle, g—gill, lct—left cephalic tentacle, m—marginal teeth, mo—mouth, pc—pleurocuspid tooth, r—rachidian tooth, rct—right cephalic tentacle, 1—1<sup>st</sup> lateral tooth, 2—2<sup>nd</sup> lateral tooth, 3—3<sup>rd</sup> lateral tooth, 4—4<sup>th</sup> lateral tooth.

its type locality in St. Vincent, has not been collected off Colombia, *Fedikovella beanii*, which co-occurs with *C. mikkelsenae*, was represented in these collections by two specimens. Similarly, only a single new species, *Cocculina fenestrata*, was discovered in our samples. When the composition and diversity of the upper slope cocculinid fauna of the Bahamas and Antilles and that of the southwestern Caribbean are compared, each contains 83% of the species of the other.

Only three of 12 described species of western Atlantic Pseudococculinidae were recovered from our samples. Comparison of only upper continental slope faunas of the

Bahamas and Antilles reveals that both previously described species also occur off the Caribbean coast of Colombia, but at substantially shallower depths. The new species, *Copulabyssia colombia*, was collected in 300 m, substantially shallower than the other two species of *Copulabyssia* currently known from the temperate and tropical western Atlantic (Leal & Simone 2000). The shallower occurrences of cocculiniform limpets off the coast of Colombia, in some cases extending onto the outer continental shelf, may be the consequence of seasonal upwelling bringing larvae into shallower waters where they metamorphose onto submerged wood.

Table 1.—Bathymetric and geographic ranges of western Atlantic Cocculinidae and Pseudococculinidae. Data from McLean & Harasewych 1995, Lesicki 1998, Leal & Harasewych 1999, Leal & Simone 2000, and Simone & Da Cunha 2003. ANT = Greater & Lesser Antilles; BAH = Bahamas; NAm = North America; SAm = South America; SCA = Southern Caribbean.

	Depth (m) Colombian records	Depth (m) published studies	SCA	ANT	BAH	NAm	SAm
<b>COCCULINIDAE</b>							
<i>Cocculina rathbuni</i> Dall, 1882	296	124–1127	*	*	*	*	
<i>C. messingi</i> McLean & Harasewych, 1995	282–296	412	*		*		
<i>C. emsoni</i> McLean & Harasewych, 1995	292–300	518	*		*		
<i>C. fenestrata</i> Ardila & Harasewych, herein	504		*				
<i>Coccopigyra spinigera</i> (Jeffreys, 1883)		613–1534				*	
<i>C. mikkelsenae</i> McLean & Harasewych, 1995		421		*			
<i>Cococrater pocillum</i> (Dall, 1890)		1600		*			
<i>C. portoricensis</i> (Dall & Simpson, 1901)	272–310	566	*	*			
<i>Fedikovella caymanensis</i> Moskalev, 1976		6740–724		*			
<i>F. beanii</i> (Dall, 1882)	500–516	183–1846	*	*		*	
<i>Macleaniella moskalevi</i> Leal & Harasewych, 1999		5179–8595		*			
<b>PSEUDOCOCCULINIDAE</b>							
<i>Pseudococculina rimula</i> Simone & da Cunha, 2003		350–400					*
<i>Notocrater houbricki</i> McLean & Harasewych, 1995	89–270	412	*		*		
<i>N. youngi</i> McLean & Harasewych, 1995	70–309	518	*		*		
<i>Tentaculus erimeta</i> (Verrill, 1884)		2653				*	
<i>T. georgiana</i> (Dall, 1927)		805				*	
<i>Caymanabyssia spina</i> Moskalev, 1976		6740–7247		*			
<i>Kaiparapelta askewi</i> McLean & Harasewych, 1995		194				*	
<i>Copulabyssia leptalea</i> (Verrill, 1884)		3080–3700				*	
<i>C. riosi</i> Leal & Simone, 2000		960–1320					*
<i>C. colombia</i> Ardila & Harasewych, herein	300		*				
<i>Amphipluca venezuelensis</i> McLean, 1988		3476–5057	*				
<i>A. plutonica</i> Leal & Harasewych, 1999		6466–7247		*			

This study reveals an unexpected homogeneity in the upper slope cocculinid and pseudococculinid faunas of the Bahamas, Antilles and southwestern Caribbean Sea, and indicates that these animals have larvae capable of long range dispersal. It would seem that a substantial portion of the diversity of these faunas has already been sampled, at least for common species occurring at bathyal depths.

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