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REVIEW OF WESTERN ATLANTIC SPECIES OF
COCCULINID AND PSEUDOCOCCULINID LIMPETS,
WITH DESCRIPTIONS OF NEW SPECIES
(GASTROPODA: COCCULINIFORMIA)

JAMES H. McLEAN AND M. G. HARASEWYCH



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REVIEW OF WESTERN ATLANTIC SPECIES OF COCCULINID AND PSEUDOCOCCULINID LIMPETS, WITH DESCRIPTIONS OF NEW SPECIES (GASTROPODA: COCCULINIFORMIA)

JAMES H. McLEAN¹ AND M. G. HARASEWYCH²

CONTENTS

ABSTRACT	3
INTRODUCTION	3
MATERIALS AND METHODS	3
KEY TO WESTERN ATLANTIC COCCULINIDAE AND PSEUDOCOCCULINIDAE	4
SYSTEMATICS	6
Family Cocculinidae	6
Genus <i>Cocculina</i> Dall, 1882	8
<i>Cocculina rathbuni</i> Dall, 1882	8
<i>Cocculina messingi</i> , new species	11
<i>Cocculina emsoni</i> , new species	13
Genus <i>Coccopigya</i> Marshall, 1986	13
<i>Coccopigya spinigera</i> (Jeffreys, 1883)	13
<i>Coccopigya mikkelsenae</i> , new species	14
Genus <i>Cococrater</i> Haszprunar, 1987	16
<i>Cococrater pocillum</i> (Dall, 1890), new combination	16
<i>Cococrater portoricensis</i> (Dall & Simpson, 1901), new combination	17
Genus <i>Fedikovella</i> Moskalev, 1976	17
<i>Fedikovella caymanensis</i> Moskalev, 1976	17
<i>Fedikovella beanii</i> (Dall, 1882)	19
Family Pseudococculinidae	22
Genus <i>Notocrater</i> Finlay, 1926	24
<i>Notocrater houbricki</i> , new species	24
<i>Notocrater youngi</i> , new species	26
Genus <i>Tentaoculus</i> Moskalev, 1976	27
<i>Tentaoculus eritmeta</i> (Verrill, 1884), new combination	27
<i>Tentaoculus georgiana</i> (Dall, 1927), new combination	28
Genus <i>Caymanabyssia</i> Moskalev, 1986	28
<i>Caymanabyssia spina</i> Moskalev, 1976	28
Genus <i>Kaiparapelta</i> Marshall, 1986	28
<i>Kaiparapelta askewi</i> , new species	28
Genus <i>Copulabyssia</i> Haszprunar, 1988	29
<i>Copulabyssia leptalea</i> (Verrill, 1884)	29
Genus <i>Amphiplica</i> Haszprunar, 1988	29
<i>Amphiplica venezuelensis</i> McLean, 1988	29
REALLOCATED TAXA	30
“ <i>Cocculina</i> ” <i>conica</i> Verrill, 1884	30
“ <i>Cocculina</i> ” <i>dalli</i> Verrill, 1884	30
“ <i>Cocculina</i> ” <i>reticulata</i> Verrill, 1885	31

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“ <i>Cocculina</i> ” <i>lissocona</i> Dall, 1927	31
“ <i>Cocculina</i> ” <i>rotunda</i> Dall, 1927	32
“ <i>Cocculina</i> ” <i>superba</i> Clarke, 1960	32
ACKNOWLEDGMENTS	32
LITERATURE CITED	32

ABSTRACT. Western Atlantic members of the limpet families Cocculinidae and Pseudococculinidae are reviewed. Previously described species are allocated to current genera, and new species are described. A key to species is provided.

Family Cocculinidae: The genus *Cococrater* Haszprunar, 1987, is recognized in the western Atlantic. New species are *Cocculina messingi*, *Cocculina emsoni*, and *Coccopigya mikkelsenae*. New combinations are *Cococrater pocillum* (Dall, 1890) and *Cococrater portoricensis* (Dall & Simpson, 1901). Moskalev's (1976) assignment of *Fedikovella beanii* (Dall, 1882) is confirmed, and an English translation of the original description of *Fedikovella caymanensis* Moskalev, 1976, is given. Lectotypes are designated for *Cocculina rathbuni* Dall, 1882, *Cococrater pocillum* (Dall, 1890), and *Fedikovella beanii* (Dall, 1882).

Family Pseudococculinidae: The genera *Notocrater* Finlay, 1926, *Tentaoculus* Moskalev, 1976, and *Kaiparapelta* Marshall, 1986, are recognized in the western Atlantic. New species are *Notocrater houbrieki*, *N. youngi*, and *Kaiparapelta askewi*. New combinations are *Tentaoculus eritmeta* (Verrill, 1884) and *T. georgiana* (Dall, 1927). Waren's (1991) assignment of *Copulabyssia leptalea* is confirmed, and an English translation of *Caymanabyssia spina* Moskalev, 1976, is given. A lectotype is designated for *Tentaoculus georgiana* (Dall, 1927).

Six taxa originally proposed in *Cocculina* Dall, 1882, are removed from Cocculinidae or Pseudococculinidae and assigned to other families, although not confirmed as valid species.

INTRODUCTION

Limpets of the families Cocculinidae and Pseudococculinidae occur on biogenic substrates at bathyal and abyssal depths. The recent collection of a number of new species as well as fresh material of some previously described species has enabled us to reevaluate all the previously described taxa from the tropical western Atlantic and the northwestern Atlantic.

Until recently these families were poorly known. A worldwide renaissance of interest in the group started with Moskalev (1976), followed by Hickman (1983), Marshall (1986), Haszprunar (1987, 1988a, 1988b), McLean (1987, 1988, 1991, 1992), and Dantart and Luque (1994). The number of genera has increased: currently there are 6 genera recognized in the family Cocculinidae and 12 in the family Pseudococculinidae.

During the 19th century there were nine taxa proposed in the genus *Cocculina* from the western Atlantic. Original descriptions and illustrations of the species described by Verrill and Dall were copied by Pilsbry (1890) and Thiele (1909). C.W. Johnson (1934) and Abbott (1974) listed 10 and 11 species, respectively, but no new information was added because few species were reported subsequent to their initial descriptions.

Although many of the previously described species have not been collected again, there is sufficient information in their original descriptions to allow most of them to be more precisely allocated to the genera that are now available. Of the 13 species originally described in *Cocculina*, only 5 now remain in the family Cocculinidae. Two are now placed in the Pseudococculinidae. Six other taxa proposed in *Cocculina* are removed to genera in other families but are not allocated at the specific level.

The four species of Cocculinidae and five species of Pseudococculinidae described from the western Atlantic over the last two decades bring the total to nine species of Cocculinidae and eight species of Pseudococculinidae, a total that greatly exceeds the number of species known from the eastern Pa-

cific. This number can be expected to increase as studies using research submersibles continue. All of the recently added new species and records have come to light from work with submersibles in both the western Atlantic and eastern Pacific, from either sampling of biogenic substrates or experimental work with larval settling.

MATERIALS AND METHODS

Species for which we have freshly collected material are treated here in detail; those known to us only from the type material are briefly treated. Revised English translations of the original Russian descriptions of two species described by Moskalev (1976) are also included.

Two species described in 1882 by Dall were based on material from widely separated localities, without designation of type localities. We have located only some of the original syntypes in the USNM collection, but we take this opportunity to designate lectotypes and corresponding type localities for *Cocculina rathbuni* Dall, 1882, and *Fedikovella beanii* (Dall, 1882), in order to facilitate comparison with the freshly collected material reported herein.

New material, collected using the research submersibles *Johnson-Sea-Link I* and *II* and *Clelia*, has come from several sources: three species were collected in the course of experimental work on larval settling conducted off New Providence Island, Bahamas, by Craig Young, Roland Emson, and Paul A. Tyler; two species were sampled during studies of stalked crinoids off Grand Bahama Island by Charles Messing; two species from off St. Vincent, Lesser Antilles, were found in the collections of the Harbor Branch Oceanographic Museum, and one species was collected off South Carolina by Harasewych.

Radulae were examined with scanning electron microscopy (SEM) after dissolution of tissues in NaOH, air-drying, and coating with carbon and gold-palladium. For specimens in which the preservation was adequate, bodies were critical-point dried and coated, and the external anatomy examined with SEM.

Parameters for shell measurements are shown in figure 1. The abbreviations for the measurements are used in the key to species that follows.

Abbreviations of museum repositories are LACM, Los Angeles County Museum of Natural History; HBOM, Harbor Branch Oceanographic Museum, Fort Pierce, Florida; and USNM, National Museum of Natural History, Washington, D.C.

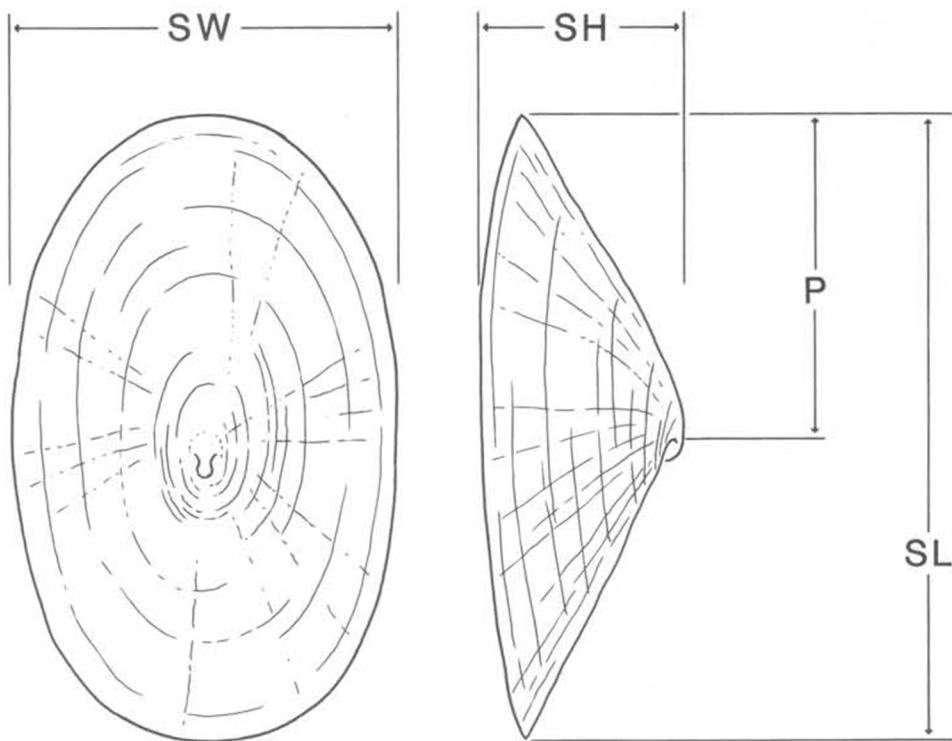
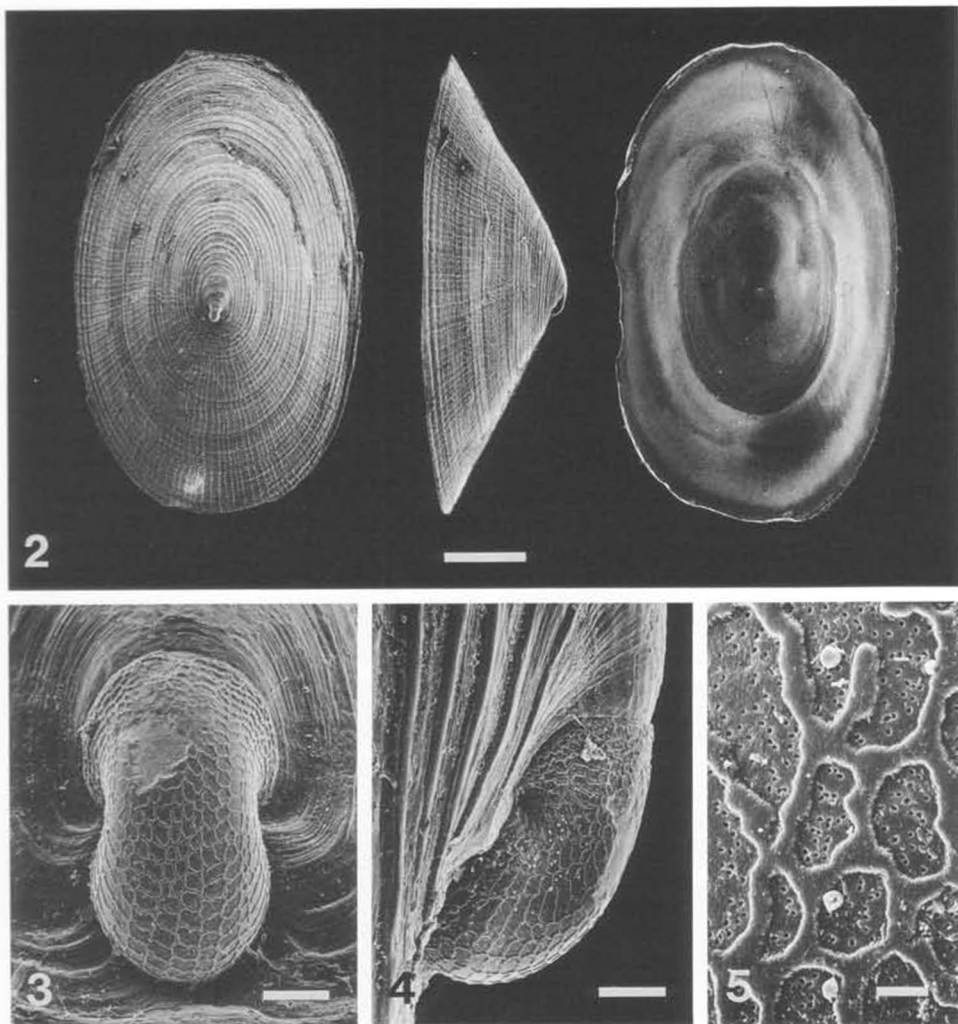


Figure 1. Shell measurements. P = apex position, measured from anterior margin of the shell to anterior margin of the protoconch; SH = shell height, maximum dorsoventral dimension measured perpendicular to the plane of the aperture; SL = shell length, measured from the anterior margin to the posterior margin of the aperture; SW = shell width, maximum lateral dimension of aperture measured perpendicular to the SL axis.

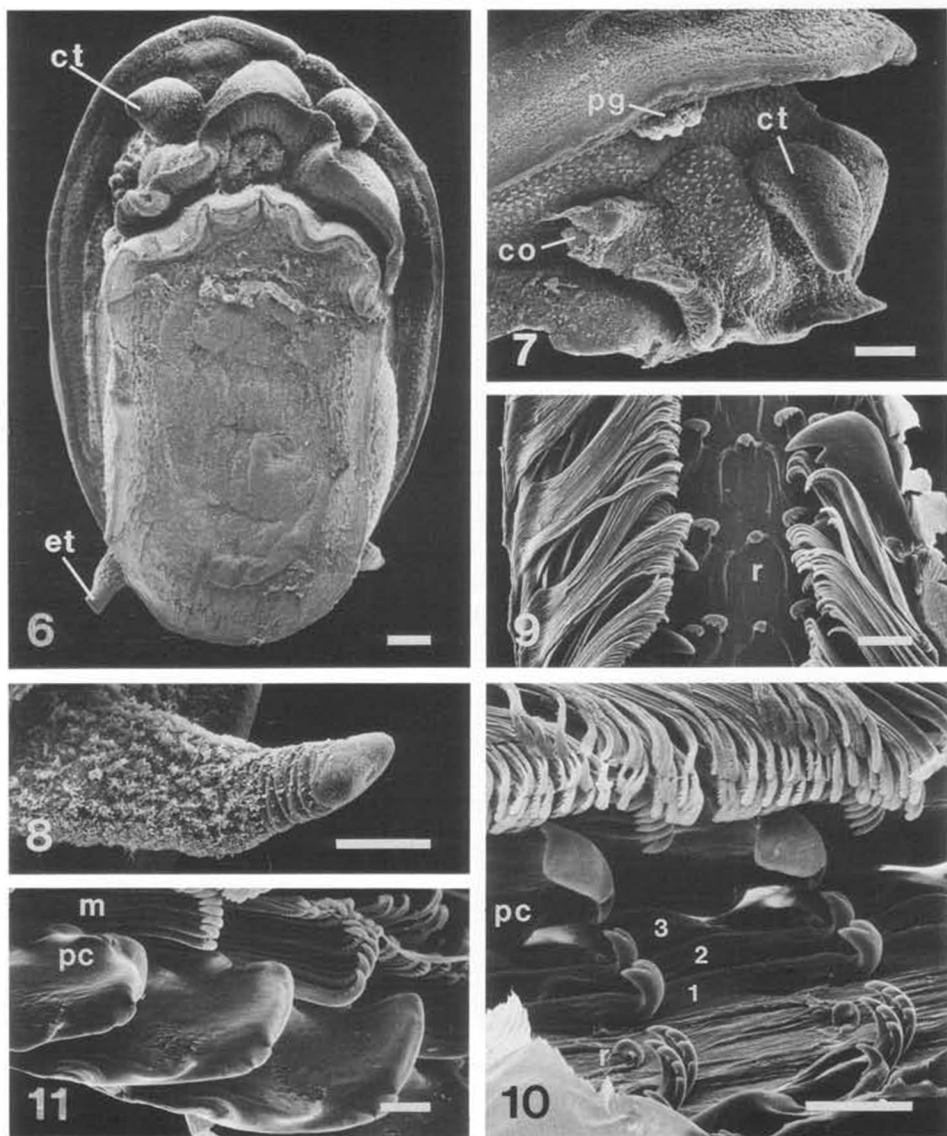
**KEY TO
WESTERN ATLANTIC COCCULINIDAE
AND PSEUDOCOCCULINIDAE**

- 1) Apical fold of protoconch short and broad; protoconch sculpture of reticulate or concentric net; radula slightly asymmetrical, 3 inner lateral teeth (Cocculinidae) 2
 - Apical fold of protoconch long and narrow; protoconch sculpture of pustulose crystals or anastomosing threads; radula strongly asymmetrical, 4 inner lateral teeth (Pseudococculinidae) 10
- 2) Protoconch with concentric sculpture (*Fedikovella*) 3
 - Protoconch with reticulate (honeycomb) sculpture 4
- 3) Apex overhanging posterior margin of shell ...
 - *Fedikovella caymanensis* Moskalev, 1976
 - Apex not overhanging posterior margin of shell *Fedikovella beanii* (Dall, 1882)
- 4) Shell with pits in radial rows; periostracum with raised hairs or spines (*Coccopygia*) 5
 - Shell without pits; periostracum smooth .. 6
- 5) Shell high (SH/SL > 0.35); apex near posterior margin of shell (P/SL > 0.8)
 - *Coccopygia spinigera* (Jeffreys, 1883)
 - Shell low (SH/SL > 0.30); apex nearly central (P/SL < 0.6)
 - *Coccopygia mikkelsenae*, new species
- 6) Copulatory organ at tip of right oral lapper (*Cocculina*) 7
 - Copulatory organ branched from right cephalic tentacle (*Cococrater*) 9
- 7) Shell high (SH/SL > 0.40), with 1 anterior and 2 posterior keels; apex posterior of center (P/SL > 0.6) ... *Cocculina emsoni*, new species
 - Shell low (SH/SL < 0.38), lacking keels; apex near center (P/SL < 0.6) 8
- 8) Shell with radial sculpture more prominent than concentric sculpture; pigmented eyes absent ...
 - *Cocculina rathbuni* Dall, 1882
 - Shell with concentric sculpture more prominent than axial sculpture; pigmented eyes present *Cocculina messingi*, new species
- 9) Shell high (SH/SL > 0.45); apex near posterior margin (P/SL > 0.7)
 - *Cococrater pocillum* (Dall, 1890)
 - Shell low (SH/SL < 0.45); apex anterior of center (P/SL < 0.5)
 - *Cococrater portoricensis* (Dall & Simpson, 1901)
- 10) Shell with interior septum; protoconch finely



Figures 2-5. *Cocculina rathbuni* Dall, 1882. 2. Dorsal, lateral, and ventral views of shell (USNM 860363). Scale bar = 1.0 mm. 3, 4. Dorsal and lateral views of protoconch of specimen in figure 1. Scale bars = 50 μ m. 5. Detail of protoconch sculpture in figure 3. Scale bar = 5 μ m.

- | | | | |
|--|----|--|--|
| pitted (<i>Tentaoculus</i>) | 11 | coarsely pustulose; eyes present; foot and mantle edge with fine brown spots | <i>Notocrater houbricki</i> , new species |
| - Shell lacking interior septum; protoconch without pits | 12 | - Protoconch coarsely pustulose; teleoconch finely pustulose; eyes absent; foot and mantle uniformly beige in color | <i>Notocrater youngi</i> , new species |
| 11) Shell low (SH/SL < 0.40); apex near center (P/SL < 0.6) | | 15) Shell without posterior ridges or indentations in margin; teleoconch with sharp conical granules forming diagonally reticulate pattern | <i>Caymanabyssia spina</i> Moskalev, 1976 |
| <i>Tentaoculus eritmeta</i> (Verrill, 1884) | | - Shell with 2 posterior ridges producing indentations in margin; teleoconch lacking diagonally oriented conical granules | <i>Kaiparapelta askewi</i> , new species |
| - Shell high (SH/SL > 0.40); apex near posterior margin (P/SL > 0.7) | | 16) Shell small, length < 4 mm | <i>Copulabyssia leptalea</i> (Verrill, 1884) |
| <i>Tentaoculus georgiana</i> (Dall, 1927) | | | |
| 12) Teleoconch sculpture granulate | 13 | | |
| - Teleoconch sculpture of raised concentric ridges | 16 | | |
| 13) Protoconch with anastomosing threads; teleoconch sculpture granulate (<i>Notocrater</i>) | 14 | | |
| - Protoconch with prismatic crystals; teleoconch sculpture of anastomosing network | 15 | | |
| 14) Protoconch finely pustulose; teleoconch | | | |



Figures 6-11. *Cocculina rathbuni* Dall, 1882. 6. Ventral view of critical-point-dried animal (shell in figures 2-5). Scale bar = 200 μ m. 7. Right lateral view of head. Scale bar = 200 μ m. 8. Right epipodial tentacle. Scale bar = 100 μ m. 9. Dorsal view of radular ribbon. Scale bar = 20 μ m. 10. Lateral view of longitudinally cut radula, revealing relative heights of tooth fields. Scale bar = 20 μ m. 11. Detail of pluricuspid and marginal teeth. Scale bar = 10 μ m.

co = copulatory organ; ct = cephalic tentacle; et = epipodial tentacle; m = marginal teeth; pc = pluricuspid tooth; pg = pseudoplicatid gill; r = rachidian tooth; 1 = first lateral tooth; 2 = second lateral tooth; 3 = third lateral tooth.

- Shell large, length > 7 mm
- *Amphiplica venezuelensis* McLean, 1988

SYSTEMATICS

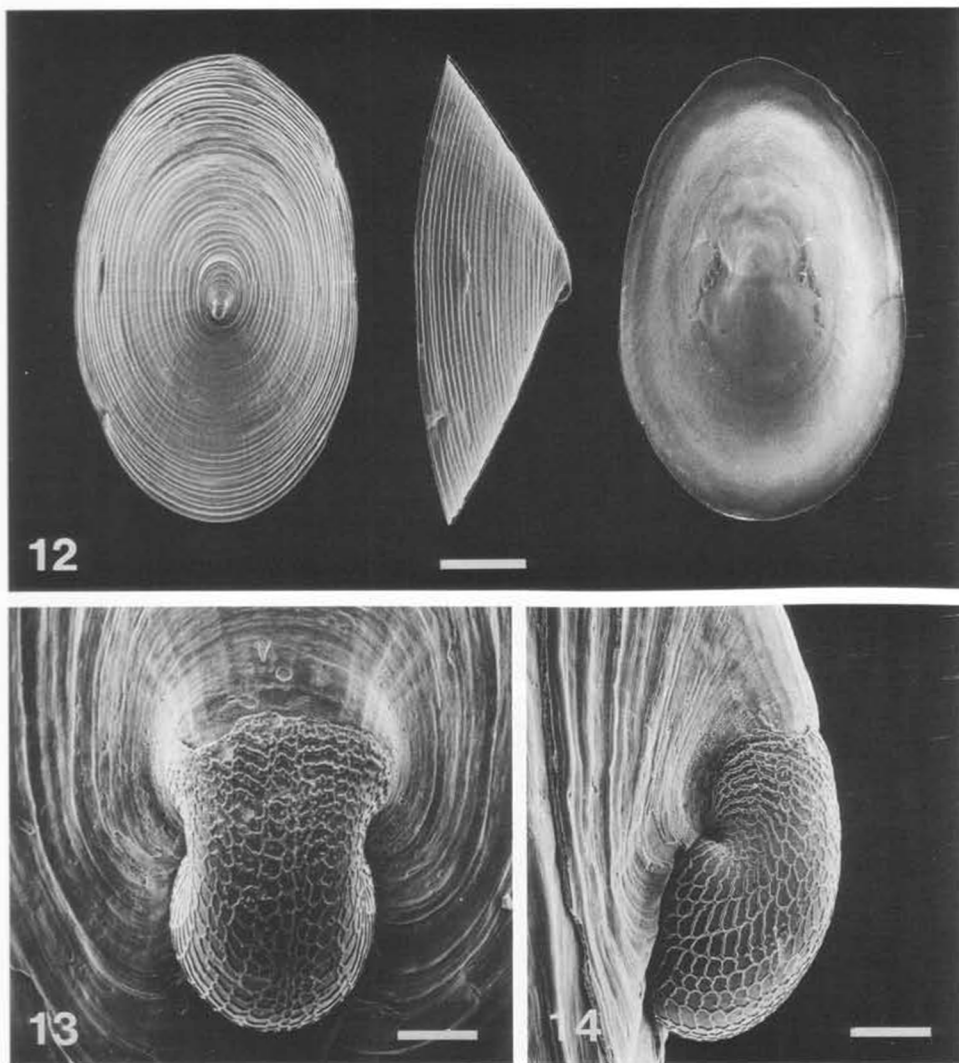
Family Cocculinidae Dall, 1882

DIAGNOSIS. Apical fold of protoconch short and broad; protoconch sculpture of reticulate net. Radula slightly asymmetrical, inner lateral teeth 3.

REMARKS. Marshall (1986) defined a number

of cocculinid genera on shell and radular characters; Haszprunar (1987, 1988b) treated anatomy of cocculinid genera and compared the group to other cocculiniform families. These works should be consulted for further details.

Six genera of Cocculinidae are currently recognized: *Cocculina* Dall, 1882, *Coccopigya* Marshall, 1986, *Cococrater* Haszprunar, 1987, *Paracocculina* Haszprunar, 1987, *Fedikovella* Moskalev, 1976, and *Teuthirostria* Moskalev, 1976. No species of



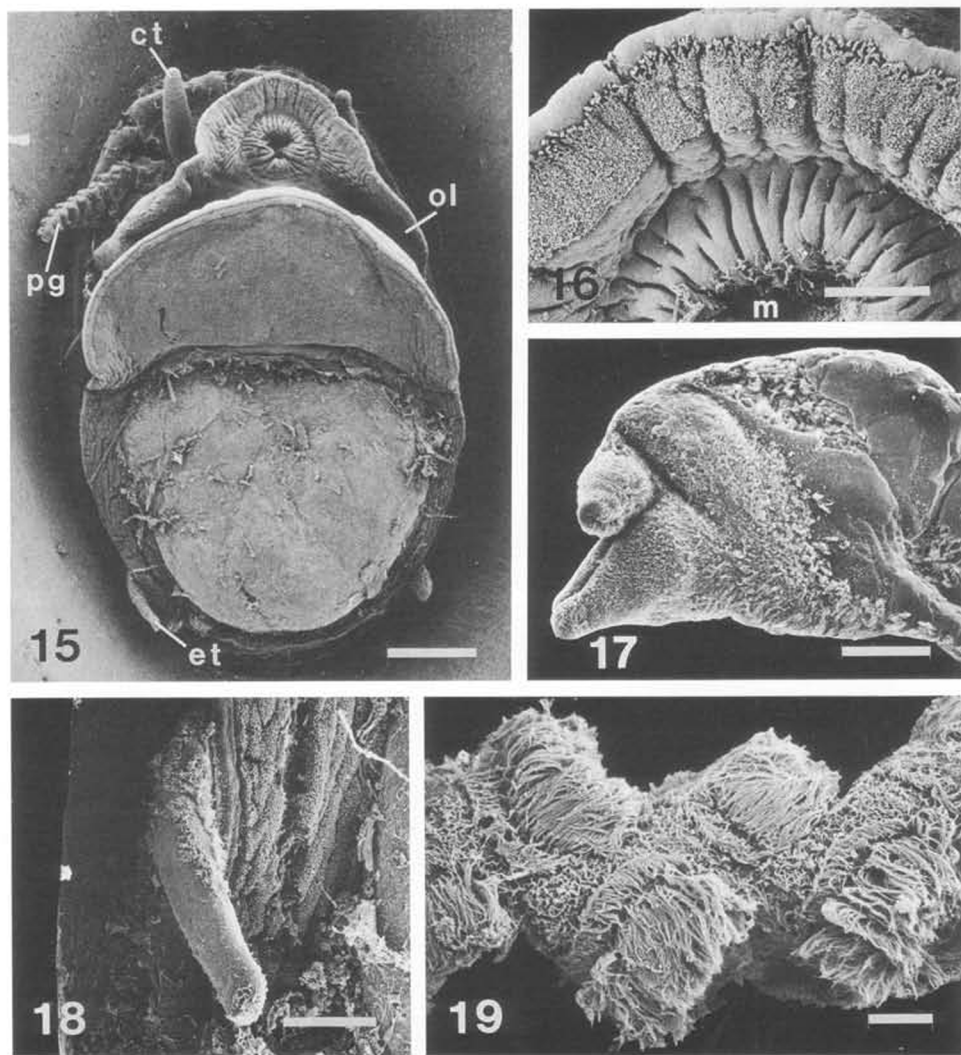
Figures 12-14. *Cocculina messingi*, new species. 12. Dorsal, lateral, and ventral views of holotype. Scale bar = 1.0 mm. 13, 14. Dorsal and lateral views of protoconch of holotype. Scale bars = 50 μ m.

Paracocculina and *Teuthirostria* are known from the western Atlantic or eastern Pacific.

Four of the genera (excepting *Fedikovella* and *Teuthirostria*) have protoconch sculpture of a raised honeycomb network aligned in longitudinal rows. The most significant character for separation of genera is the position of the copulatory organ in these simultaneous hermaphrodites: modified tip of right oral lappet in *Cocculina*, branched from the base of right cephalic tentacle in *Coccopigya* and *Cococrater*, from right side of foot in *Paracocculina*, but yet unknown in *Fedikovella* and *Teuthirostria*. The genus *Coccopigya* can be recognized by its hirsute periostracum, but no clear separation of *Cocculina*, *Cococrater*, and *Paracocculina* can be defined on shell or radular characters.

Species in most genera have a pair of posterior epipodial tentacles (figures 5, 8) and a pseudoplicatid gill (figures 15, 19), as defined by Haszprunar (1987), on the right side.

Marshall considered the ridges on the edge of the rachidian tooth to represent vestiges of the first laterals, numbering the further laterals as 2-4. However, to avoid ambiguity, we number the slender lateral teeth that have cusps as 1-3 (figure 10, 1-3). The large multicuspoid tooth that separates the laterals from the marginals is here called the pluricuspid tooth (figures 10, 11, pc) rather than lateral tooth 4, as it has no features in common with the other lateral teeth. The pluricuspid teeth are the largest teeth and are clearly the most effective teeth in the row.



Figures 15–19. *Cocculina messingi*, new species. 15. Ventral view of critical-point-dried animal of holotype. Scale bar = 200 μm . 16. Anterior margin of oral lappet. Scale bar = 100 μm . 17. Copulatory organ. Scale bar = 100 μm . 18. Right epipodial tentacle. Scale bar = 100 μm . 19. Detail of pseudoplicatid gill. Scale bar = 20 μm .
 ct = cephalic tentacle; et = epipodial tentacle; m = mouth; ol = oral lappet; pg = pseudoplicatid gill.

Genus *Cocculina* Dall, 1882

Type species (subsequent designation, Dall, 1908: 340): *Cocculina rathbuni* Dall, 1882.

DIAGNOSIS. Protoconch with honeycomb sculpture, periostracum smooth; teleoconch sculpture of fine radial ribs and growth lines; copulatory organ at tip of right oral lappet.

REMARKS. *Cocculina* is represented in the western Atlantic by the type species and two new species here described: *C. messingi* and *C. emsoni*. Other western Atlantic taxa described in this genus are herein reallocated to other genera or enumerated under a heading of species for which the generic affinity or synonymy has not been established.

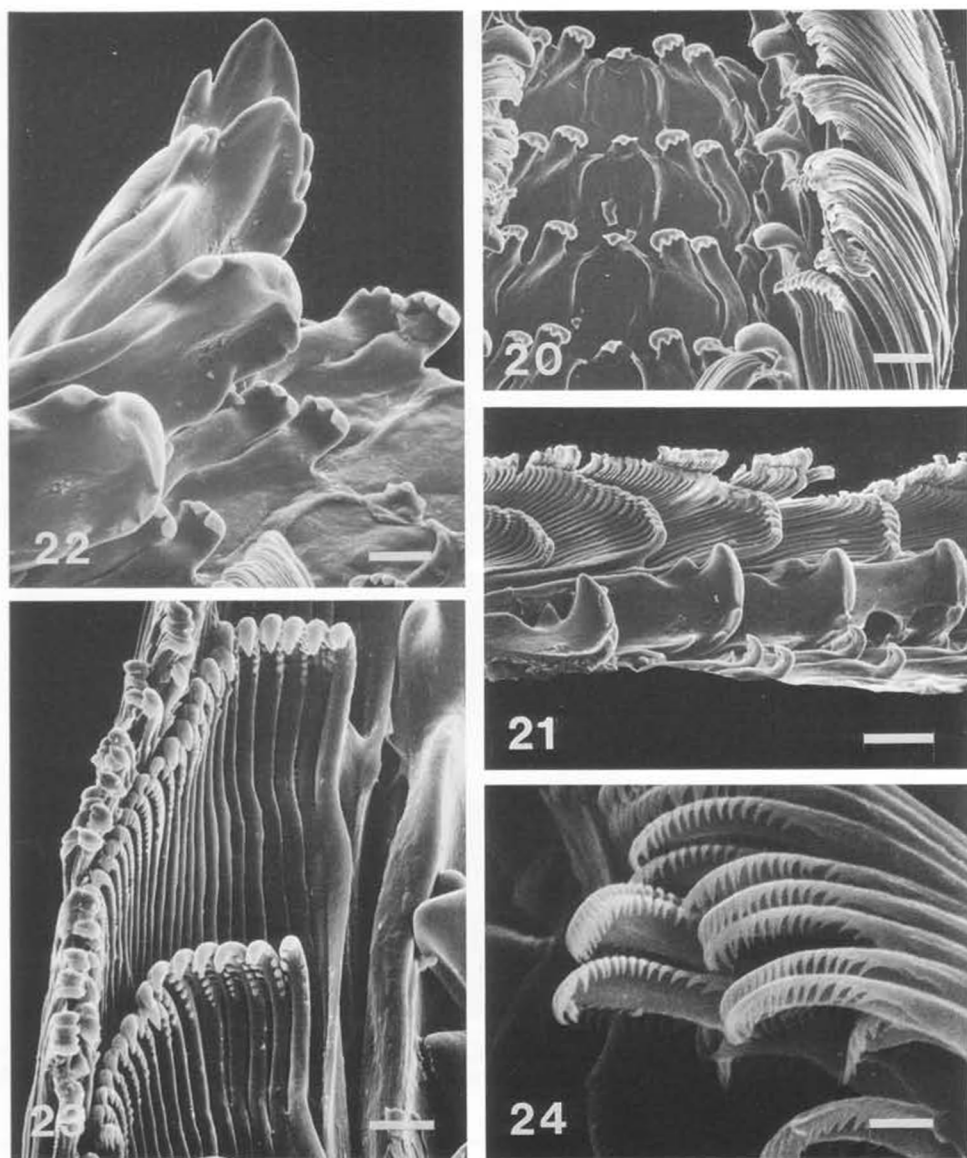
In the eastern Pacific, the genus is represented by *C. baxteri* McLean, 1987, *C. cowani* McLean, 1987, and *C. craigsmitthi* McLean, 1992, the last unique in the family for its occurrence on whale bone.

Cocculina rathbuni Dall, 1882

Figures 2–11

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 [type designation]; Thiele, 1909:6, pl. 2, figs. 1, 2; C.W. Johnson, 1934:66 [checklist only]; Abbott, 1974:34, fig. 192; McLean, 1987:325, figs. 1–4.

DESCRIPTION. Shell (figure 2) medium to large-

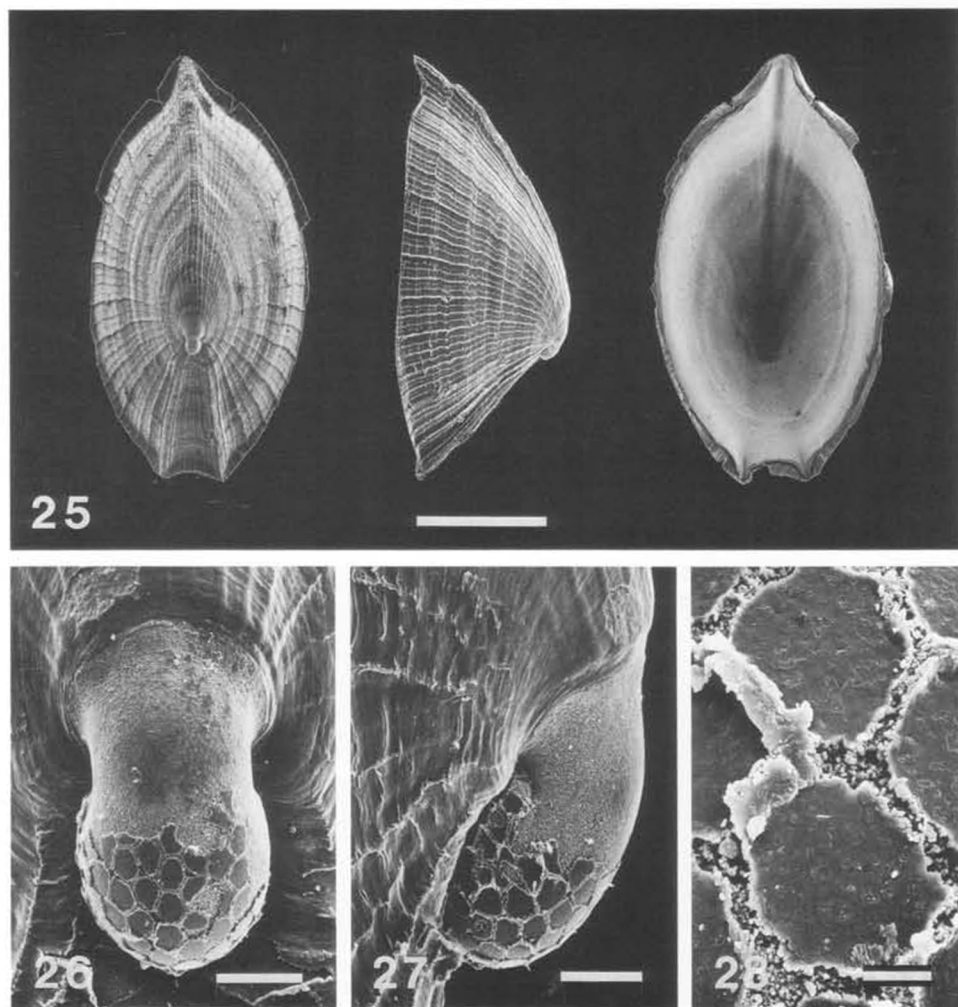


Figures 20–24. *Cocculina messingi*, new species. 20. Dorsal view of radular ribbon. Scale bar = 20 μm . 21. Lateral view of longitudinally cut radula revealing relative heights of tooth fields. Scale bar = 20 μm . 22. Detail of rachidian, lateral, and pluricuspid teeth. Scale bar = 10 μm . 23. Detail of marginal teeth. Scale bar = 6 μm . 24. Detail of distal ends of outer marginal teeth. Scale bar = 2 μm .

sized for family (maximum length 11 mm), thin, not eroded, white, periostracum thin. Shell height moderate, that of illustrated specimen 0.35 times length. Anterior and posterior slopes nearly straight, lateral slopes slightly convex. Outline in dorsal view elongate-oval, anterior end slightly narrower than posterior end; aperture not planar, ends raised relative to sides of shell. Apex slightly posterior to center, protoconch slightly below highest point of shell, extending posteriorly. Protoconch length 240 μm , protoconch sculpture of honeycomb net pat-

tern, aligned longitudinally in rows (figures 3, 4). Surface within netted area of protoconch finely pitted (figure 5). Tip of protoconch immersed in posterior slope of shell. Teleoconch sculpture of raised concentric growth lines and fine radial striae; concentric sculpture more prominent than radial sculpture, not raised at intersections with radial striae. Shell edge thin and sharp.

Dimensions. Length 11, width 6.5, height 2.75 mm (original description); length 5.7, width 3.9, height 2.0 mm (figure 2).



Figures 25-28. *Cocculina emsoni*, new species. 25. Dorsal, lateral, and ventral views of holotype. Scale bar = 1.0 mm. 26, 27. Dorsal and lateral views of protoconch of holotype. Scale bars = 50 μ m. 28. Detail of protoconch sculpture in figure 26. Scale bar = 5 μ m.

External Anatomy (figures 6-8). Eyes lacking, copulatory organ at tip of right oral lappet, basal portion enlarged, producing bilobed effect; pseudoplicatid gill on right side dorsal to oral lappet; pair of posterior epipodial tentacles (figures 6, 8), with tufts of cilia under high magnification (figure 8); area at side of head with tufts of cilia like those of epipodial tentacles (figure 7).

Radula (figures 9-11). Rachidian broad, outer edges weakly defined, tip with single small overhanging cusp; first lateral with four cusps on outer edge, second with three, third singly cusped; pluricuspid long and broad, with inner and outer cusps. Marginals similar in size.

NEW RECORD. Off Southwest Reef, New Providence Island, Bahamas ($24^{\circ}54'04''$ N, $77^{\circ}33'14''$ W), 518 m, *Johnson-Sea-Link II*, dive 2317, 9 May 1992. Disposition of specimens: USNM

860363, LACM 151187, HBOM 065:03884. On palmetto (*Sabal palmetto*) fronds deployed earlier for sampling of invertebrate settling. According to R. Emson (pers. comm.), this species along with *C. emsoni* is frequently recruited on palmetto substrates at this locality. Further details will be provided in a forthcoming paper by C.M. Young, P.A. Tyler, and R.H. Emson.

REMARKS. Dall mentioned material of *Cocculina rathbuni* from three stations [Massachusetts, Barbados, and Martinique] in the original description, without designation of a holotype or type locality. Although the 11 mm specimen (from Massachusetts?) has not been located, the other two syntypes are present in the USNM. The Barbados specimen (Blake sta. 288, USNM 333750) is a partially dissected, dried animal with no shell. The Martinique specimen (Blake sta. 195, USNM