

A preliminary review of the Annulariidae (Gastropoda: Littorinoidea) of the Lesser Antilles

G. Thomas Watters

Museum of Biological Diversity
Ohio State University, 1315 Kinnear Road,
Columbus, OH 43212 USA

ABSTRACT

The Annulariidae of the Lesser Antilles, including the Virgin Islands, Isla de Vieques, and Isla Culebra, are reviewed. Eleven species are recognized in three genera. With rare exceptions, all occur in the Limestone Caribbees. One species, *Parachondria basicarinatus* (Pfeiffer, 1855), from St. Croix, may be extinct. All are believed to be related to Puerto Rican taxa.

Additional Keywords: Caribbean, operculate, land snails

INTRODUCTION

The Annulariidae are a speciose group (ca. 700 species) of calciphile land snails endemic to the Caribbean region (Watters, 2006). Although they have been extensively reviewed for Cuba (Torre and Bartsch, 1938; 1941), Hispaniola and the Bahamas (Bartsch, 1946), Puerto Rico (van der Schalie, 1948), Central America (Solem, 1961), and South America (Solem, 1960), no such review exists for the Lesser Antilles. As such, the systematics of this group in the Lesser Antilles was far from settled. This preliminary review examined >2200 specimens in >170 lots. Of the 19 nominal taxa described from the Lesser Antilles, the types are presumed lost for 13 (68%), the types have never been illustrated for seven (37%), and for five (26%) the types were both never illustrated and are presumed lost. The type locality for six (32%) does not mention any particular island.

The Virgin Islands, Isla de Vieques, and Isla Culebra are variously considered members of either the Greater or the Lesser Antilles. They are here included in the Lesser Antilles and are part of this report. The Netherlands Antilles (Aruba, Bonaire, and Curaçao) and Trinidad, also sometimes included in the Lesser Antilles, are not included here; their fauna does not seem to be related to the other Lesser Antillean annulariids discussed here.

Despite their abundance in the Greater Antilles, annulariids are not widely distributed in the Lesser Antilles. Their presence or absence on any island appears to be dictated by large-scale ecological constraints. These constraints are tied to the geological history of

the region. The largest part of the Lesser Antilles consists of a volcanic arc of islands on the eastern edge of the east-moving Caribbean Plate extending from Puerto Rico to South America. Many of these volcanoes remain active today and are dispersed along the arc from Saba to Grenada. At approximately half way on the arc, near Martinique, the arc splits to the north into two closely diverging secondary arcs. The eastern arc, the Limestone Caribbees, is the older (possible Eocene) and no longer has active volcanoes. The younger western arc (the Volcanic Caribbees, Miocene) has numerous volcanoes (Bouysse et al., 1990). Guadeloupe, near the split, is actually two islands, Basse-Terre in the western arc and Grand-Terre in the eastern arc, connected by an isthmus. Although the islands of the Lesser Antilles are largely igneous, the older islands of the eastern arc have been overlain with carbonate deposits. It is not surprising therefore that these calciphile snails occur almost exclusively on the islands of this eastern arc. With very rare exceptions, none occur in the western arc and none occur south of Martinique until Trinidad. These snails are therefore limited to non-actively volcanic, carbonate islands – the Limestone Caribbees and Trinidad. Although portions of St. Lucia and all of Barbados are sedimentary, no annulariids are recorded from there.

Northwest of these arcs, adjacent to Puerto Rico, are the Virgin Islands, Isla de Vieques, and Isla Culebra. Except for St. Croix, all are part of the Puerto Rico-Virgin Island Platform and are geologically separate from the rest of the Lesser Antilles. This limestone platform dates from the Oligocene (van Gestel et al., 1998). During the Last Glacial Maximum all were connected by dry land and all could have shared the same snail fauna. This division between the Virgin Islands and the rest of the Lesser Antilles is evident in the distributions of the species covered here as well. There is no overlap between the two groups.

St. Croix constitutes its own platform and may have moved from the forearc to the backarc in the Paleogene (Speed, 1989). It is separated from Puerto Rico and the remaining Virgin Islands by the Virgin Islands Basin (4500 m deep) and the Anegada Passage (1800 m deep) and was therefore never connected with them during

the Last Glacial Maximum. This island has the highest diversity of annulariids of the Lesser Antilles, but at least one species appears to be extinct and others may be confined to small areas of the island. Most species occur in the uplands in the northeastern part of the island. St. Croix is perhaps the most developed of the Lesser Antilles but the upland region has not been extensively altered.

Unlike Jamaica and portions of Hispaniola, the Lesser Antilles are not rafted portions of a proto-Central America but are volcanic islands that arose *de novo*. While the annulariid fauna of Jamaica and Hispaniola may have evolved in place, the fauna of the Lesser Antilles must have originated elsewhere. Two routes are available: from Puerto Rico or from South America (or a combination of both). Iturralde-Vinent and MacPhee (1999), in their GAARlandia theory, hypothesized that the biota of the Antilles in general had originated in South America and dispersed through the Lesser Antilles on a dry land bridge they termed the Aves Arch. If this is the case then, with the exception of offshore Trinidad, all annulariids have vanished from the Lesser Antilles from South America to Martinique leaving only taxa in the northern half of the arc. However, few (perhaps none) of the species in South America or Trinidad are congeneric with those in the Lesser Antilles. But all of the genera in the Lesser Antilles may be found in Puerto Rico (*Chondropoma*, *Diplopoma*, *Parachondria*). It is apparent that the dispersal pattern is from Puerto Rico to the adjacent Virgin Islands and from there to a few select islands in the northern Lesser Antilles, eventually dissipating in diversity by Martinique. Only three species occur south of the Virgin Islands to Trinidad. Only Trinidad appears to have derived its fauna from South America, only 11 km away.

Radiation within the Lesser Antilles probably has involved several mechanisms. Dispersal over land during lower ocean levels undoubtedly accounts for distributions in the Virgin Islands (except St. Croix) and between Antigua and Barbuda and between Anguilla and Saint Martin. But dispersal over water by either rafting or air borne must be invoked for radiations to St. Croix and Guadeloupe, both of which are separated from the next nearest source by distances of over 50 km and deep channels, the latter of which would preclude connections during the Last Glacial Maximum. Rafting might be most likely due to hurricanes dislodging vegetation containing the snails, which then drifted to other islands. Such dispersal has been recorded for iguanas rafted from Guadeloupe to Anguilla by Hurricane Luis, a distance of over 200 km (Censky et al., 1998). Annulariids, which can survive long periods behind nearly hermetically sealed opercula if not immersed, are good candidates for rafting. Rafting could also explain the patchy distribution of annulariids in the Lesser Antilles. Because rafting to islands of the western arc from the eastern arc would be just as probable as anywhere else, the absence of annulariids on those islands seems to be due to the ecological factors previously mentioned.

Shuttleworth (1858), Bland (1861), Mazé (1890), and Vernhout (1914) listed species records from localities that cannot be confirmed here. Some of their records seem out of the expected range of these species. Given the uncertainty of species identification at that time I view these records with skepticism until additional collections uphold them.

MATERIALS AND METHODS

Descriptions and measurements were made on shells oriented with the spire up and the aperture facing the viewer. Length was measured from the tip of the protoconch (or teleoconch of decollate specimens) to the opposite anterior-most extension of the outer lip, perpendicular to the coiling axis. Width was measured from the left edge of the adult whorl to the opposite maximum right extension of the outer lip. Subsets of specimens were measured to determine the minimum, maximum, and average lengths. The number of whorls was determined using the 1 D method of Van Osselaer (1999) in which the starting point is tangential to the suture. Numbers in parentheses in **Type Material** and **Other Material** refer to the number of specimens in the lot. **CHRESONYMIES** (all references) are given instead of synonymies (only primary changes); unless attributed to another author, synonyms are based on this review.

Abbreviations used in the text are: GTW: Collection of the author; MNHG: Muséum d'Histoire Naturelle, Genève, Switzerland; OSUM: Ohio State University Museum of Biological Diversity, Columbus, Ohio, USA; SMF: Naturmuseum Senckenberg, Frankfurt am Main, Germany; UF: Florida Museum of Natural History, Gainesville, Florida, USA; ZMB: Museum für Naturkunde Berlin, Germany.

SYSTEMATICS

Family Annulariidae Henderson and Bartsch, 1921
Subfamily Chondropomatinae Henderson and Bartsch, 1921

Genus *Chondropoma* Pfeiffer, 1847a

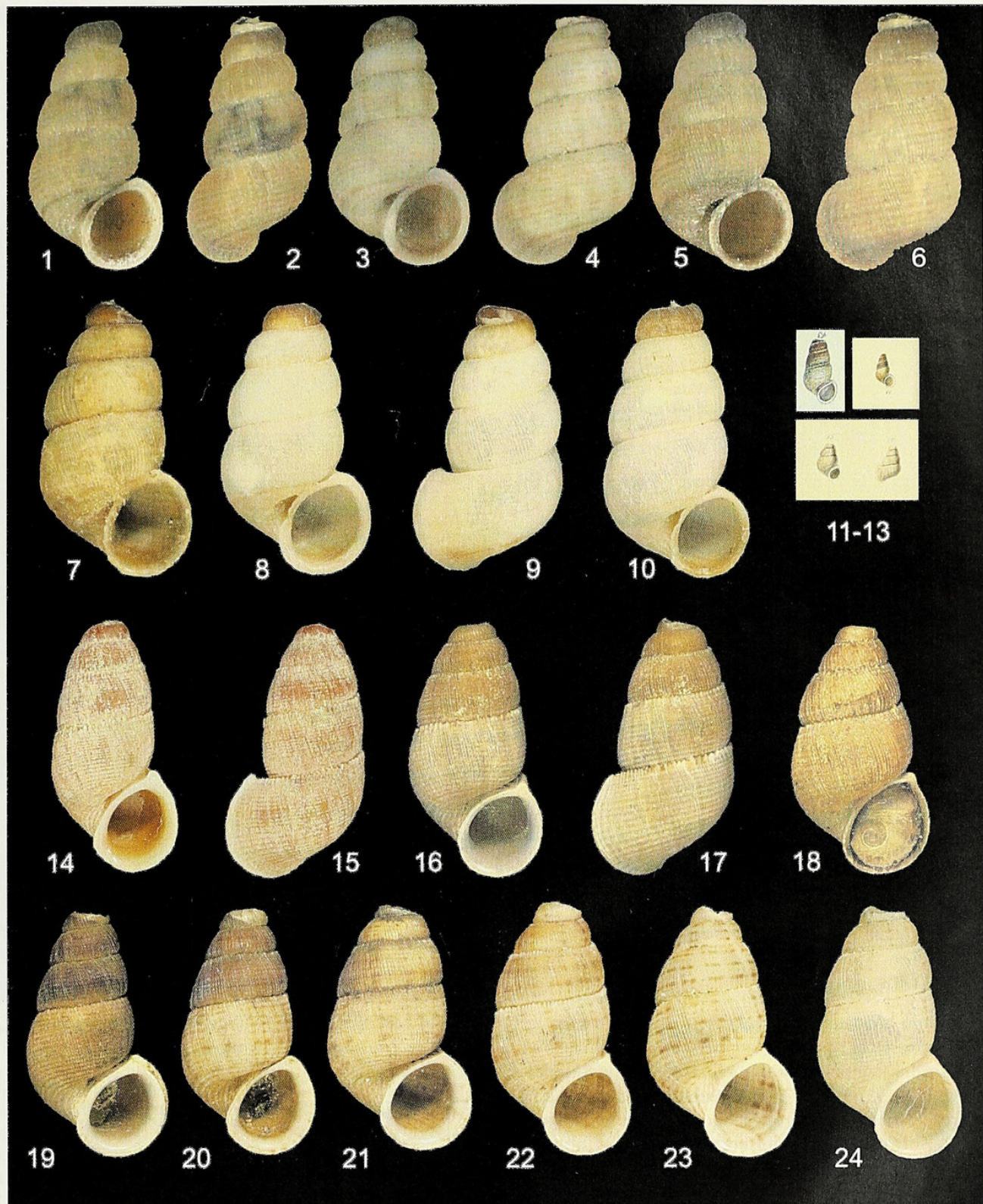
Subgenus *Chondropoma* Pfeiffer, 1847a

Type Species: *Cyclostoma sagra* d'Orbigny, 1842, by subsequent designation of Petit de la Saussaye, 1850.

Chondropoma (*Chondropoma*) *julieni* Pfeiffer, 1866
(Figures 1–10, 135)

CHRESONYMY

Chondropoma julieni Pfeiffer, 1866: 89; Pfeiffer, 1876a: 192; Mazé, 1890: 32; Vernhout, 1914: 183, 187; Coomans, 1967: 126; Watters, 2006: 319.
Choanopoma julieni (Pfeiffer, 1866). —Tryon, 1867: 99.
Chondropoma (*Chondropoma*) *julieni* Pfeiffer, 1866. —Henderson and Bartsch, 1921: 62; Watters, 2006: 28, 319.



Figures 1–24. *Chondropoma* species. 1–10. *Chondropoma julienei* Pfeiffer, 1866. 1–6. Probable syntypes of *Chondropoma julienei* Pfeiffer, 1866, Sombrero Island, ZMB 65674. 1–2. Ca. 10.5 mm. 3–4. Ca. 9 mm. 5–6. Ca. 7 mm. Photos courtesy Christine Zorn, ZMB. 7. Sombrero Island, UF 216657, 11.1 mm. 8–9. Sombrero Island, UF 216657, 10.9 mm. 10. Sombrero Island, UF 216656, 9.0 mm. 11–24. *Chondropoma pupiforme* (Sowerby, 1843). 11. Type figure of *Cyclostoma pupiforme* Sowerby, 1843: 102, pl. 24, fig. 43. 12. Type figure of *Chondropoma igneum* Reeve, 1863b: pl. 11, fig. 88. 13. *Cyclostoma pupiforme* Pfeiffer, 1847c: pl. 14, figs. 15, 16. 14–15. W of South Hill Village, Anguilla, UF 48725, 15.2 mm. 16–17. Anguilla, OSUM 4143, 13.0 mm. 18. Near Philipsburg, Sint Maarten, OSUM 4129, 10.3 mm. 19. Anguilla, GTW 14639a, 12.3 mm; 20. The Valley, Anguilla, UF 48727, 10.7 mm; 21. The Valley, Anguilla, UF 48727, 10.5 mm. 22. Katouche Bay Valley, Anguilla, UF 48714, 9.6 mm. 23. Isaac's Cove, Blackgarden Bay, Anguilla, UF 48715, 10.0 mm. 24. Isaac's Cove, Blackgarden Bay, Anguilla, UF 48715, 10.2 mm.



Figures 25–37. *Chondropoma rufilabre* (Potiez and Michaud, 1838). **25–26.** Type figure of *Cyclostoma rufilabrum* Potiez and Michaud, 1838: pl. 24, figs. 20, 21. **27.** *Chondropoma rufilabre* (“Beck”) in Reeve, 1863b: pl. 10, fig. 73a. **28–29.** St. Croix, OSUM 36197, 10.6 mm. **30.** St. Croix, OSUM 36212, 11.1 mm. **31.** St. Croix, UF 7597, 10.3 mm; **32.** St. Croix, UF 216802, 10.3 mm; **33.** Rust op Twist, St. Croix, UF 27962b, 11.8 mm; **34.** St. Croix, UF 7597, 13.2 mm. **35.** St. Croix, UF 118887, 9.9 mm. **36.** Rust op Twist, St. Croix, UF 27962b, 12.1 mm. **37.** Davis Bay, St. Croix, UF 27957, 9.2 mm.

Description: Shell small for genus (smallest=9 mm, largest=11.1, average=10.3, decollated), elongate conic, whorls adnate [attached to previous whorl] except for very short length just before lip. Umbilicus open but narrow, partially obscured by outer lip. Protoconch lost in all examples seen; Pfeiffer (1866) mentions “three obtuse whorls.” 3.75–4 decollated whorls remaining. Spiral sculpture of numerous, very fine threads (ca. 20), each separated by a space equal to width of thread. Subsutural and umbilical threads strongest but threads may be indistinct over most of whorl surface. Axial sculpture of numerous, very fine, closely spaced lamellae, best developed over spiral sculpture. Intersections of axial and spiral threads form a minutely scalloped, almost frosted, sculpture. Suture deeply incised, sutural tufts absent. Aperture composed of an inner and an outer lip, oval, barely adnate to previous whorl. Inner lip smooth, inconspicuous, flush with outer lip. Outer lip narrowly laterally expanded, narrowest toward umbilicus, slightly auriculate. Base color of shell white to tan. Most specimens patterned with faint, broken, brown spiral bands; usually one or two darker, unbroken bands occur half way between periphery and umbilicus. First remaining whorl dark brown to reddish. Lip white, unpatterned. Interior of aperture tan to a greater or lesser degree. Operculum, radula, and anatomy unknown.

Type Material: Three specimens, ZMB 65674, collected by Alexis B. Julien from Sombrero Island, from the Pfeiffer collection, generally match Pfeiffer’s overall description (Figures 1–6). None are the stated size of 12 mm in length, the largest being approximately 10 mm. They probably are syntypes but this cannot be shown with certainty. Additionally, Pfeiffer’s material was not located by me at NHMUK in 2004.

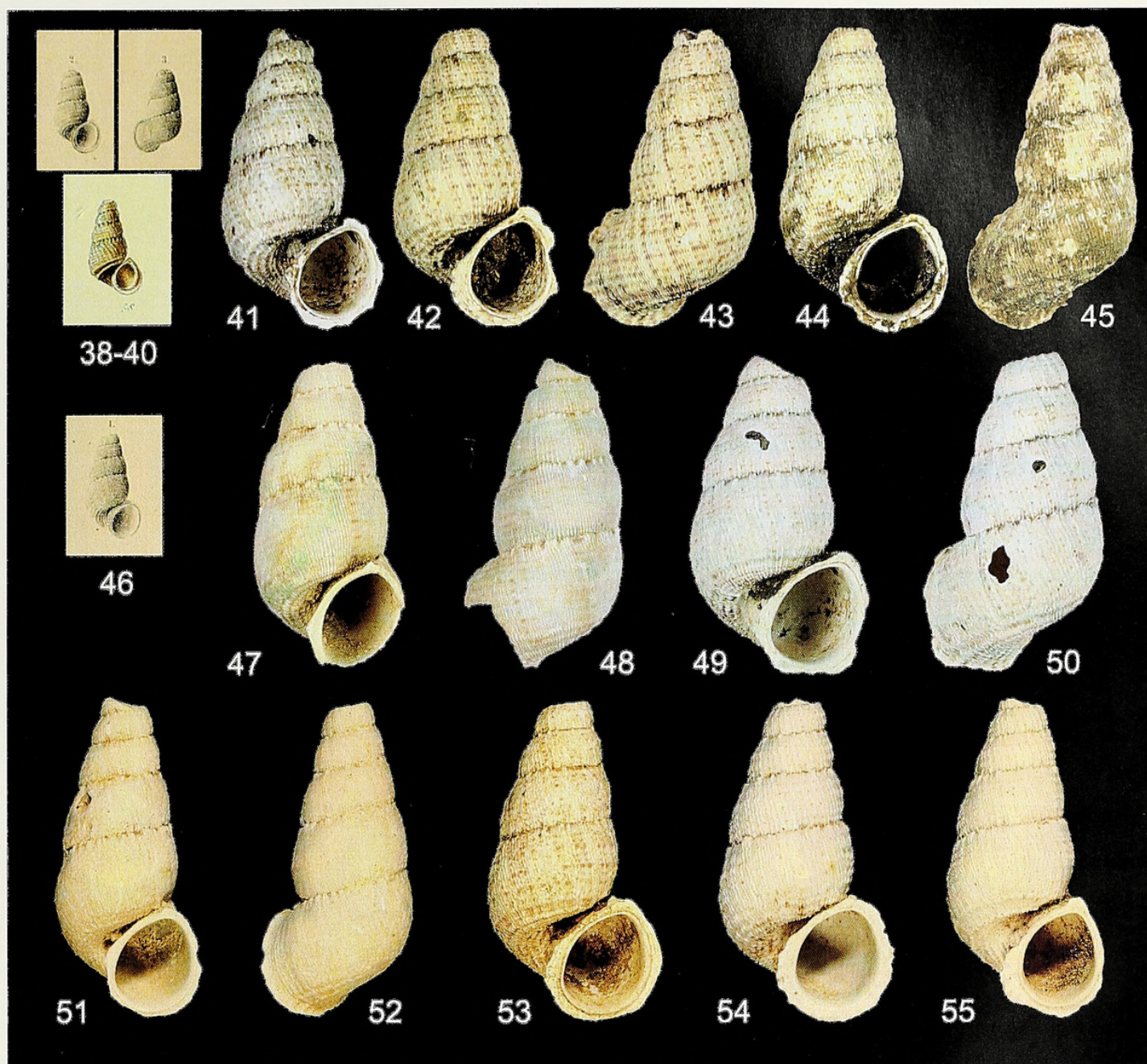
Type Locality: “in insulae Sombrero.”

Type Figure: Unfigured.

Other Material (Specimens Examined: 3): Sombrero Island, UF 216656 (1), UF 216657 (2).

Distribution: Sombrero Island: This species is probably endemic to the island. It was reported from Saint Martin by Vernhout (1914) and from Guadeloupe by Mazé (1890) but these are undoubtedly misidentifications for the superficially similar *Diplopoma crenulatum* recorded from both islands. Sombrero Island is now uninhabited but was intensively mined for guano prior to 1890. During hurricanes, waves may completely wash over the island, which is only 12 m above sea level.

Habitat: Not reported.

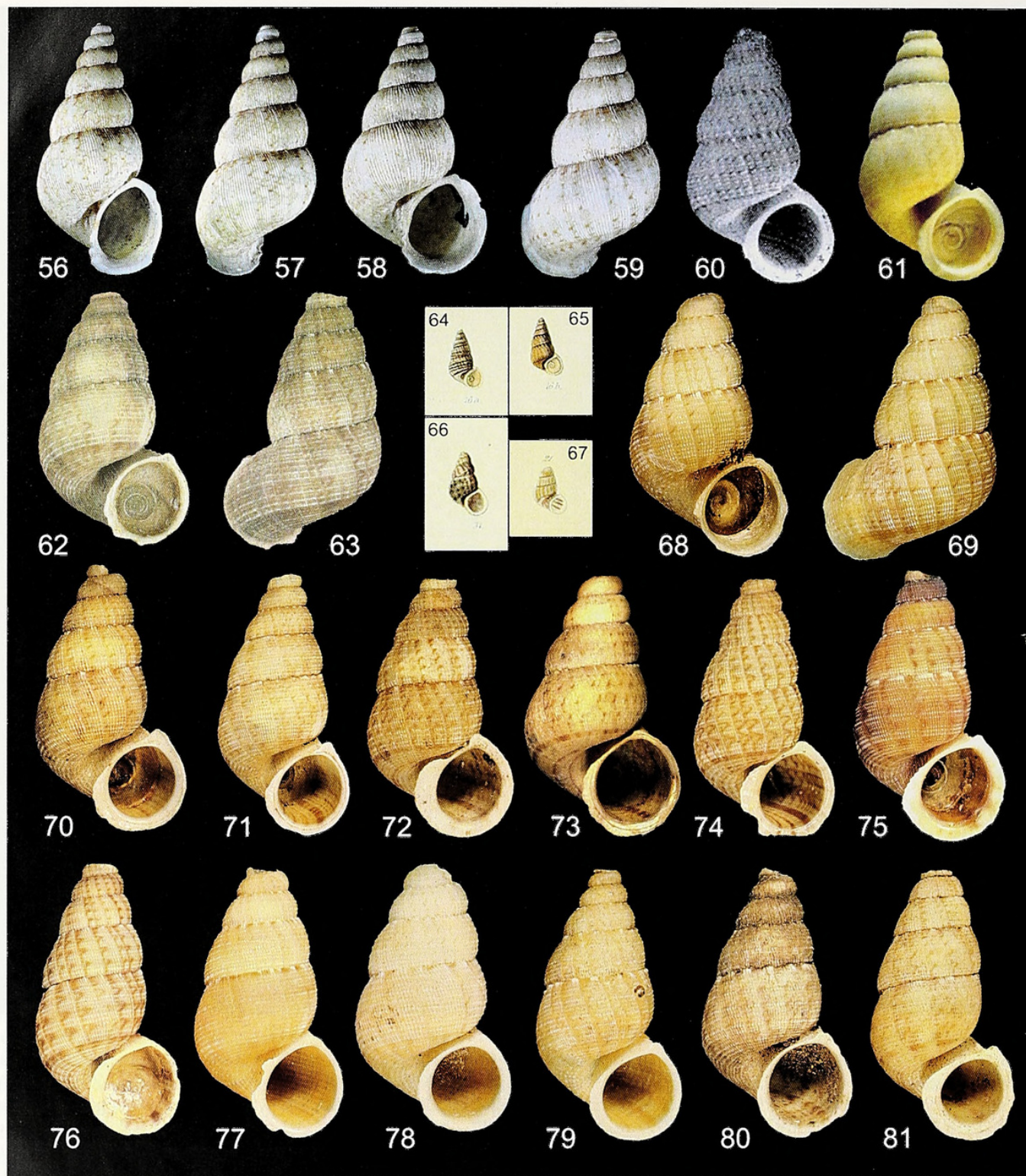


Figures 38–55. *Parachondria basicarinatus* (Pfeiffer, 1855). 38–39. Type figure of *Cyclostoma basicarinatum* Pfeiffer, 1855, in Pfeiffer, 1855: pl. 4, figs. 2, 3. 40. ?*Chondropoma basicarinatum* (Pfeiffer, 1855) in Reeve, 1863a: pl. 8, fig. 58. 41–45. Possible syntypes of *Cyclostoma basicarinatum* Pfeiffer, 1855, ZMB 96810, all ca. 19 mm, photos courtesy Christine Zorn, ZMB. 46. Type figure of *Cyclostoma chordiferum* Pfeiffer, 1855, in Pfeiffer, 1855: pl. 4, fig. 1. 47–50. Possible syntypes of *Cyclostoma chordiferum* Pfeiffer, 1855, ZMB 1231, photos courtesy Christine Zorn, ZMB. 47–48. ZMB 1231-1, 22 mm. 49–50. ZMB 1231-2, 17 mm. 51–52. St. Croix, UF 27927, 23 mm. 53. St. Croix, UF 18318, 19.6 mm. 54. Frederiksted, St. Croix, UF 27890, 16.4 mm. 55. St. Croix, UF 27922, 20.2 mm.

Variation Among Specimens: There was little variation in sculpture in the few specimens seen. The greatest variation was in color, which varied from a base color of tan to white, with or without spiral brown lines.

Comparison with Other Species: This species differs from all other Lesser Antillean annulariids by its small size, feeble sculpture, pale coloration, and lack of sutural tufts.

Original Description (translated from Latin): “Shell subperforated, oblong turret, truncate, solid, with obsolete (rarely distinct) spiral lirae and very dense longitudinal plicate sculpture, opaque, yellowish perhaps whitish, upper smoky, base sometimes lined with some red bands; spire gradually attenuated (lost apex of three obtuse whorls) truncated at top; suture impressed, rather simple; remaining four whorls moderately convex, front of last barely solute, base rounded; aperture subvertical,



Figures 56–81. *Parachondria lineolatus* (Lamarck, 1822). **56–59.** Syntypes of *Cyclostoma lineolata* Lamarck, 1822, MHNG 1093/31, now accessioned as MHNG-INVE-51228. Photos courtesy of Dr. Peter Schuchert (MNHG). **56–57.** ca. 17 mm. **58–59.** ca. 16 mm. **60.** Lectotype of *Cyclostoma newcombianum* Adams, 1849, MCZ 275708. Photo courtesy of A. Baldinger (MCZ), 12.6 mm. **61.** Possible syntype of *Cyclostomus fallax* Pfeiffer, 1851, NHMUK, unnumbered, 17 mm. **62–63.** Probable holotype of *Chondropoma tortolense* Pfeiffer, 1857, ZMB 65673, ca. 15 mm, photos courtesy Christine Zorn, ZMB. **64–65.** *Chondropoma newcombianum* (Adams, 1849) in Reeve, 1863a: pl. 3, figs. 16a, b. **66.** *Chondropoma tortolense* Pfeiffer, 1857, in Reeve, 1863a: pl. 4, fig. 31. **67.** Presumed type figure of *Cyclostomus fallax* Pfeiffer, 1851, from Pfeiffer, 1854d: pl. 45, figs. 21. **68–69.** Cinnamon Bay, St. John, GTW 7303b, 13.3 mm. **70.** Zion Hill, Tortola, UF 28691, 13.9 mm; **71.** Great Thatch Island, UF 202918, 17.5 mm. **72.** Guana Island, UF 210990, 14.8 mm. **73.** Tortola, OSUM 36864, 12.9 mm. **74.** Guana Island, UF 183233, 14.4 mm. **75.** Ginger Island, UF 202923, 13.8 mm. **76.** Grand Camanoe Island, UF 210981, 16.8 mm. **77.** Beef Island, UF 28703, 15.4 mm. **78.** Bahia Corcho, Isla de Vieques, UF 193999, 12.3 mm. **79.** Fish Bay Gut, St. John, UF 247114, 16.9 mm. **80.** Calvary Bay, St. John, UF 27958, 13.2 mm. **81.** Anegada, UF 202925, 17.9 mm.



Figures 82–93. *Parachondria (Parachondria) santacruzensis* (Pfeiffer, 1855). **82.** *Chondropoma santacruzense* (Pfeiffer, 1855), from Reeve, 1863a: pl. 7, fig. 50. **83.** Teague Point, St. Croix, UF 216876, 12.6 mm. **84.** St. Croix, UF 27923, 12.7 mm. **85–86.** St. Croix, UF 27923, 13.0 mm. **87.** St. Croix, UF 27923, 12.2 mm. **88.** Teague Point, St. Croix, UF 216876, 11.8 mm. **89.** Davis Bay, St. Croix, UF 27956, 10.7 mm. **90.** St. Croix, UF 158945, 13.6 mm. **91.** Bellevue, St. Croix, UF 27949, 12.5 mm. **92.** Estate Rattan, St. Croix, UF 426186, 11.7 mm. **93.** Virgin Islands, GTW 7303a, 12.2 mm.

subangulate oval; peristome simple (rarely somewhat double), continuous, everywhere narrowly expanded, upper angle narrowly produced." 12 mm length.

Discussion: None of the specimens examined of this rarely seen species have retained the operculum. Based solely on other shell characteristics, I have placed it in *Chondropoma*. It is not similar to any species from Puerto Rico, Hispaniola, or the Bahamas.

Etymology: Alexis A. Julien (1840–1919), geologist, chemist, natural historian, who studied Sombrero Island.

Chondropoma (Chondropoma) pupiforme (Sowerby, 1843) (Figures 11–24, 148–149)

CHRESONYMY

Cyclostoma pupiforme Sowerby, 1843: 102, pl. 24, figs. 43, 44; Pfeiffer, 1847a: 105; Pfeiffer, 1847c: pl. 14, figs. 15, 16; Pfeiffer, 1848: 121; Petit de la Saussaye, 1850: 46; Watters, 2006: 424–425.

Cyclostoma pupiniformes [sic] Sowerby, 1843. —Pfeiffer, 1846a: 43–44.

Cistula pupiformis (Sowerby, 1843). —Gray, 1850: 59–60; Guppy, 1864: 247.

Tudora pupaeformis [sic] (Sowerby, 1843). —Pfeiffer, 1851: 167; Pfeiffer, 1852a: 249–250; Pfeiffer, 1852b: 39; Pfeiffer, 1853: 174–175; Pfeiffer, 1858: 127; Bland, 1861: 355; Pfeiffer, 1865: 136; Bland, 1866: 141.

Cistula (Tudora) pupaeformis [sic] (Sowerby, 1843). —Adams and Adams, 1856: 294.

Chondropoma igneum Reeve, 1863b: pl. 11, fig. 88; Pfeiffer, 1865: 149; Pfeiffer, 1876a: 193; Vernhout, 1914: 187; Coomans, 1967: 126; Watters, 2006: 299.

Tudora pupiformis (Sowerby, 1843). —Pfeiffer, 1876a: 183; Kobelt, 1880: 277; Crosse, 1891: 177.

Tudora pupaeformis [sic] var. β (Sowerby, 1843). —Mazé, 1890: 31; Vernhout, 1914: 183, 187.

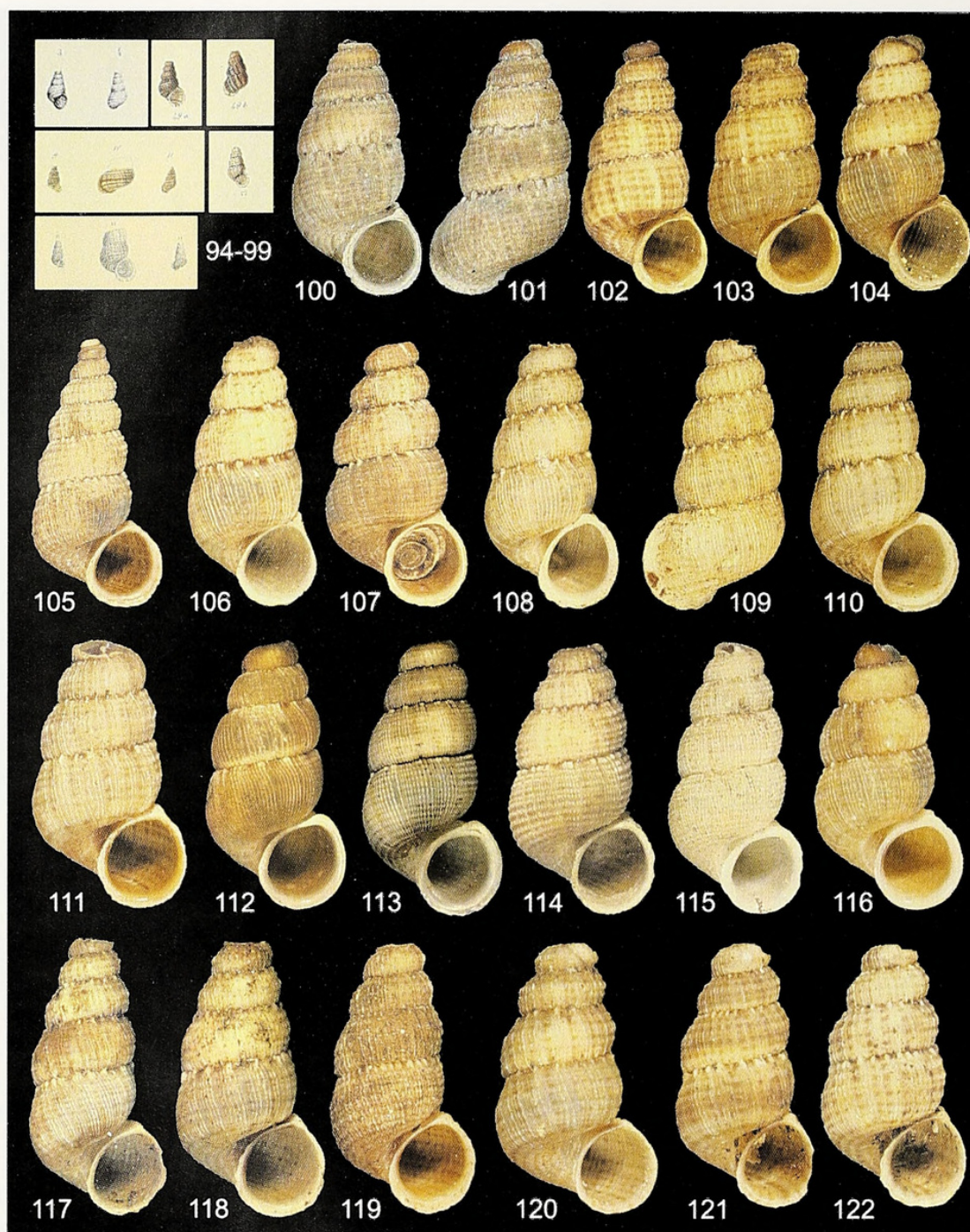
Chondropoma (Chondropoma) ignea Reeve, 1863. —Henderson and Bartsch, 1921: 62.

Parachondria (Parachondria) pupaeformis [sic] (Sowerby, 1843). —Henderson and Bartsch, 1921: 66; Watters, 2006: 44, 424–425.

Chondropoma (Chondropoma) pupiforme (Sowerby, 1843). —Clench and Aguayo, 1937: 66.

Chondropoma (Chondropomorus) ignaeum Reeve, 1863. —Bartsch, 1946: 199.

Chondropoma (Chondropomorus) pupaeforme [sic] (Sowerby, 1843). —Bartsch, 1946: 199.



Figures 94–122. *Diplopoma crenulatum* (Potiez and Michaud, 1838). **94.** Type figures of *Cyclostoma crenulatum* Potiez and Michaud, 1844, pl. 24, figs. 3, 4. **95.** *Chondropoma guadeloupense* Pfeiffer, 1847, from Reeve, 1863a: pl. 7, figs. 49a, b. **96.** *Chondropoma antiguense* (Pfeiffer, 1858) from Reeve, 1863b: pl. 10, fig. 72. **97.** Presumed type figures of *Chondropoma guadeloupense* Pfeiffer, 1847, from Pfeiffer, 1849: 176, pl. 28, figs. 9–11. **98.** *Chondropoma antiguense* (Pfeiffer, 1858) from Reeve, 1863b: pl. 10, fig. 72. **99.** Type figures of *Choanopoma occidentale* Pfeiffer, 1861: 216, pl. 3, figs. 11–13. **100–101.** Holotype of *Adamsiella (Adamsiellops) crenulata martinensis* Coomans, 1967, 12.0 mm, photo courtesy of U.S. National Museum of Natural History. **102.** Grands Fonds, Guadeloupe, UF 259784, 10.1 mm. **103.** Morne-à-l'Eau, Guadeloupe, UF 260049, 11.3 mm. **104.** 5 km SE of Grand-Bourg, Marie-Galante, UF 259937, 9.6 mm. **105.** Presqu'île de la Caravelle, 3 km W of Tartane, Martinique, UF 258449, 13.4 mm. **106.** 3 km NW of Grelin, Marie-Galante, UF 259938, 11.4 mm. **107.** Guadeloupe, UF 216565, 11.3 mm. **108–109.** Presqu'île de la Caravelle, 3 km W of Tartane, Martinique, UF 258449, 13.1 mm. **110.** Presqu'île de la Caravelle, 3 km W of Tartane, Martinique, UF 258449, 12.0 mm. **111.** 2.5 km E of Trois-Rivières, Guadeloupe, UF 258460, 8.6 mm. **112.** Rubbish Bay, Barbuda, OSUM 36916, 10.2 mm. **113.** Bull Hole, Barbuda, OSUM 36917, 12.1 mm. **114.** St. Mary Parish, Antigua, OSUM 4155, 10.5 mm. **115.** 9.7 km NNE of St. Johns, Antigua, UF 258450, 12.0. **116.** between Codrington and The Caves, Barbuda, UF 211003, 8.3 mm. **117.** Sainte-Anne, Guadeloupe, GTW 11473a, 11.0 mm. **118.** Le Moule, Guadeloupe, GTW 7064b, 10.5 mm. **119.** Baie de Nord Ouest, 2.5 km W of Le Moule, Guadeloupe, UF 259940, 9.2 mm. **120.** 6 km SE of Anse-Bertrand, Guadeloupe, UF 258455, 9.3 mm. **121.** 3 km NE of Port-Louis, Guadeloupe, UF 258454, 7.8 mm. **122.** 3 km NE of Port-Louis, Guadeloupe, UF 258454, 7.7 mm.



Figures 123–134. *Parachondria* sp. St. Croix, GTW 10099a, 15.9 mm [operculum glued into aperture backwards by collector]. **125.** *Parachondria* cf. *salleanus* (Pfeiffer, 1850). Sombrero Island, UF 119118, 14.3 mm. **126–130.** *Diplopoma decussatum* (Lamarck, 1822). **126.** Monte Pirata, Isle de Vieques, UF 28647, 14.0 mm. **127.** Cayo Luis Peña, UF 23271, 14.0 mm. **128.** Monte Pirata, Isle de Vieques, UF 28668, 13.7 mm. **129–130.** Playa Caracas, Isle de Vieques, UF 28670, 13.6 mm. **131–134.** *Diplopoma sulculosum* (Pfeiffer, 1852). **131.** NHMUK, unnumbered, possible syntype, 15.0 mm. **132–133.** Isaac's Cliff, Blackgarden's Bay, GTW 11473b, 10.7 mm. **134.** E edge of Katouche Bay Valley, UF 48713, 9.6 mm.

Chondropoma pupiforme (Sowerby, 1843). —Clench, 1950: 271.

Chondropoma pupaeformis [sic] (Sowerby, 1843). —Coomans, 1967: 126.

Parachondria (*Parachondria*) *igneus* (Reeve, 1863). —Watters, 2006: 44, 299.

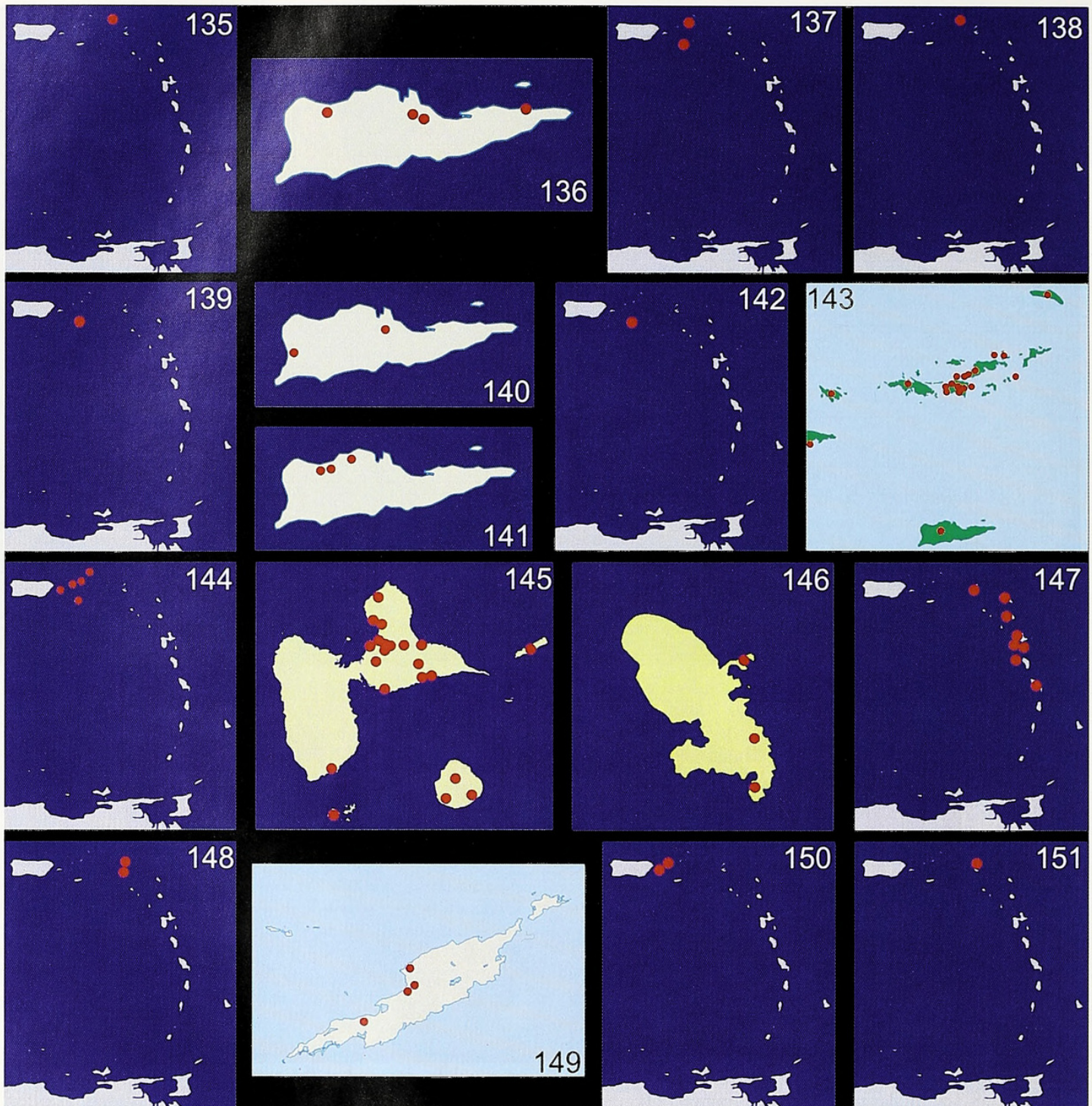
Parachondria (*Parachondria*) *pupiformis* (Sowerby, 1843). —Watters, 2006: 44, 424–425.

Description: Shell medium sized for genus (smallest=8.3 mm, largest=15.8, average=12.0, decollated). Elongate conic to bullet-shaped, whorls solute [not attached to previous whorl] for last 1/8th of last whorl. Umbilicus open but narrow, compressed. Protoconch of 1.5 smooth, rounded, yellowish whorls, rather prominent. 3.5–4.5 decollated whorls remaining; most specimens are decollated. Spiral sculpture of numerous, widely spaced, fine threads or cords (ca. 19 on final whorl). Umbilical cords somewhat stronger than those elsewhere. Axial sculpture of numerous, very fine, closely spaced lamellae, best developed over spiral sculpture where it has a scalloped appearance. Intersections of axial and spiral sculpture form a minute scalloped, almost frosted, sculpture. In a few specimens (Figures 14, 15) scalloped edges

appear to have a periostracum that is easily worn away. Suture deeply channeled, bounded by minute sutural tufts. Tufts composed of 1–2 individually, non-fused, expanded axial lamellae, separated by 2–5 non-expanded lamellae, usually forming a regular pattern of tufts/no tufts at suture. Aperture composed of an inner and an outer lip, teardrop-shaped, solute from previous whorl. Inner lip smooth, barely erect from outer lip. Outer lip very narrowly expanded, narrowest toward umbilicus, sharply auriculate, somewhat thickened. Base color of shell pale tan to red or dark brown on final 1–2 whorls. Earliest remaining whorls usually darker. Most specimens patterned with faint, broken, brown spiral bands. Lip white, faintly or not patterned with spiral markings on adapertural side. Interior of aperture tan, orange, or white; spiral markings may show through. Operculum paucispiral with a granulose covering. Radula and anatomy unknown.

Type Material: *Cyclostoma pupiforme* Sowerby, 1843: ?NHMUK – not located; *Chondropoma igneum* Reeve, 1863: ?NHMUK – not located.

Type Localities: *Cyclostoma pupiforme* Sowerby, 1843: Not given; *Chondropoma igneum* Reeve, 1863: Unknown.



Figures 135–151. Distributions. **135.** *Chondropoma julienei* Pfeiffer, 1866, Lesser Antilles. **136–137.** *Parachondria santacruzensis* (Pfeiffer, 1855). **136.** St. Croix. **137.** Lesser Antilles. **138.** *Parachondria* cf. *salleanus* (Pfeiffer, 1850). Lesser Antilles. **139–140.** *Parachondria basicarinatus* (Pfeiffer, 1855). **139.** Lesser Antilles. **140.** St. Croix. **141–142.** *Chondropoma rufilabre* (Potiez and Michaud, 1838). **141.** St. Croix. **142.** Lesser Antilles. **143–144.** *Parachondria lineolatus* (Lamarck, 1822). **143.** Spanish and Virgin islands, St. Croix and Anegada points are generic; **144.** Lesser Antilles. **145–147.** *Diplopoma crenulatum* (Potiez and Michaud, 1838). **145.** Guadeloupe, Marie-Galante, Îles des Saintes, and La Désirade (generic point). **146.** Martinique. **147.** Lesser Antilles. **148–149.** *Chondropoma pupiforme* (Sowerby, 1843). **148.** Lesser Antilles. **149.** Anguilla. **150.** *Diplopoma decussatum* (Lamarck, 1822). Lesser Antilles (also in Puerto Rico). **151.** *Diplopoma sulculosum* (Pfeiffer, 1852). Lesser Antilles.

Type Figures: *Cyclostoma pupiforme* Sowerby, 1843: Sowerby, 1843: pl. 24, figs. 43, 44 (Figure 11); *Chondropoma igneum* Reeve, 1863: Reeve, 1863b: pl. 11, fig. 88 (Figure 12).

Other Material (Specimens Examined: 138): Sint Maarten, OSUM 4129 (2), near Philipsburg; Anguilla, GTW 14639a (2); OSUM 4143 (45); UF 48714 (33), Katouche Bay Valley; UF 48718 (8), E edge of Katouche

Bay Valley; UF 48707 (10), Isaac's Cliff, Blackgarden Bay; UF 48715 (14), Isaac's Cave, Blackgarden Bay; UF 48725 (13), 4 km W of South Hill Village; UF 48727 (11), The Valley [town].

Distribution: Saint Martin/Sint Maartin. Coomans (1967) regarded this species as extirpated from this island. However, fresh specimens collected near Philipsburg in the 1950s (OSUM 4129) suggest this may not be the case. Anguilla. Most records are from the Katouche Bay Valley rain forest on the north-central coast and surrounding areas.

Habitat: In rain forests, probably under rocks and logs. One lot from a cave.

Variation among Specimens: Populations range from dark, un-patterned specimens (Figure 19) to nearly white, almost un-patterned specimens (Figure 24). However, intermediate forms (Figures 20–23) clearly connect the two extremes. Pale specimens occur at Blackgarden Bay and elsewhere and seem to be the form illustrated by Pfeiffer (1847c) as *C. pupiforme* on his plate 14, figures 15 and 16 (Figure 13). The types of *C. pupiforme* and *C. igneum* were based on the dark, un-patterned forms. In other regards, populations vary somewhat in average size. Sculpture is constant.

Comparison with Other Species: The dark brown or red, bicolored forms are unmistakable; the lighter, patterned forms differ in having serrate, non-fused tufts at the suture.

ORIGINAL DESCRIPTIONS

Cyclostoma pupiforme Sowerby, 1843: "Shell nearly cylindrical, very slightly acuminate, its apex truncated or decollated; spire consisting of 4 turgid, very finely decussated volutions; suture strongly marked; aperture nearly round, angular at the upper part, peritreme very slightly reflected; umbilicus very small."

Chondropoma igneum Reeve, 1863: "Shell compressly umbilicated, cylindrically conical, rather solid, whitish, tinged with fiery rose, whorls convex, very minutely lamellarly decussated, finely denticulated in the sutures, aperture pyriformly circular, lip scarcely reflected."

Discussion: The type locality of *Cyclostoma pupiforme* Sowerby, 1843, was not given in the original description. Pfeiffer (1848: 121) was uncertain of its origin as well and cautioned: "Remains uncertain. My example is said to come from Mexico, others originate from Haiti" [translated]. Pfeiffer (1852b), Bland (1861), and Henderson and Bartsch (1921) also listed it from Haiti. But Clench and Aguayo (1937: 66) stated "It is questionable whether the species occurs in Hispaniola at all" and Bartsch (1946), in his review of Hispaniolan annulariids, placed it in Saint Martin.

Although *Chondropoma igneum* Reeve, 1863, like *Cyclostoma pupiforme*, was described without locality and the type cannot be located, it seems obvious

from the illustration that it is the same species (Figure 12).

Etymology: *Cyclostoma pupiforme* Sowerby, 1843: *L. pupa*, girl or doll, but used in entomological sense of a pupa, *L. forma*, shape; shaped like a pupa; *Chondropoma igneum* Reeve, 1863: *L. ignis*, fire; colored like fire.

***Chondropoma (Chondropoma) rufilabre* (Potiez and Michaud, 1838)**
(Figures 25–37, 141–142)

CHRESONOMY

Cyclostoma rufilabrum "Beck, monente" Potiez and Michaud, 1838: 241, pl. 24, figs. 20, 21; Mörch, 1854: 10; Pfeiffer, 1855: 101; Watters, 2006: 449–450.

Cyclostoma rufilabrum "Beck." —Sowerby, 1843: 106, pl. 24, fig. 61; Pfeiffer, 1846a: 34; Pfeiffer, 1847a: 106; Pfeiffer, 1852b: 42 [in synonymy of *Cyclostoma bilabre* Menke, 1843]; Pfeiffer, 1853: 188 [in synonymy of *Cyclostoma bilabre* Menke, 1843]; Bland, 1858: 154.

Cyclostoma rufilabre "Michaud." —Petit de la Saussaye, 1850: 46.

Cistula rufilabrum "Beck" Sowerby, 1843. —Gray, 1850: 59.

Cyclostoma bilabre Menke, 1843: 8; Petit de la Saussaye, 1850: 46; Gray, 1850: 59; Pfeiffer, 1855: 101; Bland, 1858: 154; Pfeiffer, 1858: 133; Shuttleworth, 1858: 154; Reeve, 1863b: text to pl. 10; Jacobson, 1968: 21; Watters, 2006: 175 [all, except for Menke, 1843, and Petit, 1850, in synonymy of *Cyclostoma rufilabrum* Potiez and Michaud, 1838].

Cyclostoma rufilabrum "Beck" Sowerby, 1843. —Pfeiffer, 1851: 170 [in possible synonymy of *Cyclostoma bilabre* Menke, 1843]; Pfeiffer, 1852a: 268 [in synonymy of *Cyclostoma bilabre* Menke, 1843].

Cistula bilabre (Menke, 1843). —Pfeiffer, 1853: 188 [in synonymy of *Cyclostoma rufilabrum* Potiez and Michaud, 1838].

Cistula rufilabris ("Beck"). —Pfeiffer, 1851: 170; Pfeiffer, 1852a: 268; Pfeiffer, 1858: 133; Bland, 1861: 359; Pfeiffer, 1865: 143; Pfeiffer, 1876a: 188; Kobelt, 1880: 281; Hinkley, 1885: 21.

Cistula ? bilabris (Menke, 1843). —Pfeiffer, 1852b: 42.

Cistula bilabris (Menke, 1843). —Pfeiffer, 1853: 188; Adams and Adams, 1856: 293.

Tudora rufilabrum ("Beck"). —Mörch, 1860: 12.

Chondropoma rufilabre ("Beck"). —Reeve, 1863b: pl. 10, figs. 73a, b.

Chondropoma (Chondropoma) rufilabre ("Beck" Potiez and Michaud, 1838). —Henderson and Bartsch, 1921: 62; Watters, 2006: 28, 449–450.

Cistula rufilabris ("Pfeiffer"). —Baker, 1956: 31.

Chondropoma rufilabrum ("Beck" Potiez and Michaud, 1838). —Jacobson, 1968: 21.

non Cyclostoma bilabre "Menke" Pfeiffer, 1846b: pl. 6, figs. 22, 23 *fide* Pfeiffer, 1847d: 52 [= ?].

Description: Shell small-medium sized for genus (smallest=6 mm, largest= 13.8, average=10.8, decollated). Short, compact, bullet-shaped, whorls adnate. Umbilicus closed or nearly so by outer lip. Protoconch of 1.5 smooth, inflated whorls, barely demarcated from teleoconch. 3.5–4.5 decollated whorls, most specimens are decollated. Spiral sculpture of numerous, widely spaced, rounded cords (ca. 15–19 on final whorl). Umbilical cords somewhat stronger than those elsewhere. Axial sculpture of numerous, very fine, closely spaced lamellae, best developed over spiral sculpture where it has a scalloped or granulose appearance; slightly stronger at suture in some specimens. Suture narrowly channeled or sealed, rendered serrate by axial sculpture; tufts absent. Aperture composed of an inner and an outer lip, oval, adnate to previous whorl. Inner lip smooth, erect from outer lip, thickened. Outer lip expanded, narrowest toward umbilicus, auriculate at 12 and 7 o'clock positions, thickened, composed of numerous lamellae, edge slightly scalloped. Base color of shell pale tan to straw-colored. Occasional pale specimens patterned with faint, broken or continuous, brown spiral bands (Figure 31) but most specimens un-patterned. Lip yellow, orange, red, or dark purple, inner lip often more darkly colored than outer lip. Interior of aperture orange or tan, colored at margin with color of lip. Operculum paucispiral with a granulose covering. Radula and anatomy unknown. Rarely specimens seem to have a remnant of a periostracum (Figure 36).

Type Material: *Cyclostoma rufilabrum* Potiez and Michaud, 1838: Douai Museum. According to the website of the Musée de la Chartreuse Douai, the "natural sciences collection [was] completely destroyed" during WW II; specimens also in the Férussac collection were subsequently incorporated into the general collection of the Muséum national d'Histoire naturelle, Paris (Dance, 1966); *Cyclostoma bilabre* Menke, 1843: Menke collection dispersed (Kohn, 1992).

Type Localities: *Cyclostoma rufilabrum* Potiez and Michaud, 1838: "Les Indes? les Antilles" [Orient, *fide* Gray (1850). St. Croix, *fide* Sowerby (1843) and Bland (1861). St. Croix and St. Thomas, *fide* Shuttleworth (1858)]; *Cyclostoma bilabre* Menke, 1843: "in ora orientali" [Ostküste von Neuholland, *fide* Pfeiffer (1846b). Orient, *fide* Gray (1850). Corrected to Virgin Islands, Menke in Shuttleworth (1858)].

Type Figures: *Cyclostoma rufilabrum* Potiez and Michaud, 1838: pl. 24, figs. 20, 21 (Figures 25, 26); *Cyclostoma bilabre* Menke, 1843: Unfigured.

Other Material (Specimens Examined: 583): U.S. Virgin Islands, OSUM 22088 (2); OSUM 36198 (3); St. Croix, GTW 8270a (1); OSUM 36197 (7); OSUM 36212 (2); OSUM 36213 (2); UF 7597 (131); UF 18317 (1); UF 118887 (50); UF 158946 (6); UF 195527 (2); UF 195528 (7); UF 216802 (3); UF 216803 (6); GTW 8270b

(1), north shore; UF 27954 (33), North Star; UF 27957 (43), Davis Bay; UF 27962a,b (283), Rust op Twist.

Distribution: U.S. Virgin Islands: This species is probably endemic to St. Croix. Shuttleworth (1858) listed St. Thomas for *C. bilabre* Menke, 1843, but I have not seen any specimens from there and given the uncertainty of that taxon the record is regarded as questionable. The majority of lots are labeled only "St. Croix" without further information. The few localized lots are from a 6 km expanse on the northern coast from Davis Bay to Rust op Twist, but the actual extent of the species on the island is unknown.

Habitat: No habitat information found but apparently limited to the hills on the north side of the island, where it is locally abundant.

Variation among Specimens: Populations vary in the number of spiral cords (15–19) and color of the aperture and lip but generally are quite uniform in other shell characteristics.

Comparison with Other Species: No other annulariid, in the Lesser Antilles or elsewhere, has the combination of a small, compact shell, uniformly decussate sculpture, and (usually) brightly colored aperture and peristome. It most closely resembles *Chondropoma schalei* Baker, 1950, from Puerto Rico, with which it may have a common ancestor.

ORIGINAL DESCRIPTIONS

Cyclostoma rufilabrum Potiez and Michaud, 1838 (translated from French): "Shell oval-conic, perforated or subperforated, yellowish-white and latticed; spire composed of four convex whorls; suture fairly well indicated, especially in the variety A; lip reddish, but the same color as in the cavity of the shell; aperture oblique ovoid; summit truncated. We do not know the operculum." Variety A "larger, perforated, lacking striae, suture deep, lip yellow-white."

Cyclostoma bilabre Menke, 1843 (translated from Latin): "Shell ovate-conic, apex decollated, imperforate, solid; five convex whorls, sides with a longitudinally traverse, dense, elegant weave; peristome double: externally reflexed."

Discussion: *Cyclostoma bilabre* Menke, 1843, has been considered a junior synonym of *C. rufilabrum* by most authors, despite a lack of illustration or adequate original description (which makes no reference to the distinctly colored peristome of this species). There is no indication that any subsequent author had seen the type specimen or series. Given that the type is apparently lost and was never illustrated, and the species cannot be identified from the original description, it is best to consider this taxon a *nomen dubium*.

Etymology: *Cyclostoma rufilabrum* Potiez and Michaud, 1838: *L. rufus*, red + *L. labrum*, lip; red lipped;

Cyclostoma bilabre Menke, 1843: *L. bi*, two + *L. labrum*, lip; two lipped.

Genus *Parachondria* Dall, 1905

Subgenus *Parachondria* Dall, 1905

Type Species: *Turbo fascia* Wood, 1828, by original designation.

***Parachondria (Parachondria) basicarinatus* (Pfeiffer, 1855)**
(Figures 38–55, 139–140)

CHRESONYMY

Cyclostoma basicarinatum Pfeiffer, 1855: 101–102, pl. 4, figs. 2, 3; Weinland, 1876: 174; Pfeiffer, 1876b: 234; Weinland, 1880: 349.

Cyclostoma chordiferum Pfeiffer, 1855: 102, pl. 4, fig. 1; Weinland, 1876: 174; Weinland, 1880: 349; Watters, 2006: 204–205.

Chondropoma basicarinatum (Pfeiffer, 1855). —Mörch, 1860: 12; Jacobson, 1968: 20 [in synonymy of *Cyclostoma santacruzense* Pfeiffer, 1855].

Cyclostomus chordiferum Pfeiffer, 1855. —Bland, 1861: 361; Bland, 1866: 139.

? *Chondropoma basicarinatum* (Pfeiffer, 1855). —Reeve, 1863a: pl. 8, fig. 58.

Chondropoma (Chondropomorus) basicarinatum (Pfeiffer, 1855). —Henderson and Bartsch, 1921: 61.

Chondropoma chordiferum (Pfeiffer, 1855). —Jacobson, 1968: 20 [in synonymy of *Cyclostoma santacruzense* Pfeiffer, 1855].

Parachondria (Parachondria) basicarinatus (Pfeiffer, 1855). —Watters, 2006: 44, 166.

Parachondria (Parachondria) chordiferus (Pfeiffer, 1855). —Watters, 2006: 44, 204–205.

Description: Shell large for genus (smallest=16.4 mm, largest=23.0, average=19.3, decollated). Elongate conic, whorls rarely adnate, more commonly solute for last ¼ of last whorl. Umbilicus open, narrow. Protoconch lost in all examples seen. 4.5–4.75 decollated remaining whorls. Spiral sculpture of numerous, closely spaced threads (ca. 17–19 on final whorl). Those within umbilicus and just before it are much stronger and more widely separated, forming a basal carinae in some specimens. Axial sculpture of numerous, very fine, closely spaced lamellae, best developed over spiral sculpture where it has a scalloped appearance; slightly stronger on basal cords. Intersections of axial and spiral sculpture form a minute scalloped sculpture. Suture deeply channeled to sealed, rendered serrate by tufts. Tufts of 2–4 barely fused, expanded axial lamellae separated by 1–8 unfused lamellae. Aperture composed of an inner and an outer lip, teardrop-shaped, solute from previous whorl. Inner lip smooth, erect laterally and anteriorly from outer lip. Outer lip narrowly expanded, narrowest toward umbilicus, auriculate at 12 and 7 o'clock positions, thickened, composed of numerous lamellae, anterior-medial edge scalloped. All examples seen are faded, heavily weathered specimens. Specimens

patterned with broken, brown spiral bands that form a regular checkerboard pattern. Lip and aperture color unknown. Operculum, radula, and anatomy unknown.

Type Material: *Cyclostoma basicarinatum* Pfeiffer, 1855: Three specimens, ZMB 96810(1)–96810(3), from the Dunker collection might represent Pfeiffer's material and are labeled "*Choanopoma basicarinatum* Pfr." (Figures 41–45). Although clearly the same species, none closely match Pfeiffer's 1855 plate 4, figures 2 and 3 of *Cyclostoma basicarinatum*, presumably the figured type. They probably are syntypes but this cannot be shown with certainty. Additionally, Pfeiffer's material was not located by me at NHMUK in 2004; *Cyclostoma chordiferum* Pfeiffer, 1855: Two specimens at ZMB, with an original number of 1231(1), 1231(2) from Pfeiffer's collection, are only labeled with "St. Croix" with no mention of "Bulows Minde" (Figures 47–50). Neither closely matches the presumed type figure. Although Pfeiffer clearly had more than one specimen (he gave a range of sizes), none at the ZMB can be associated with the type lot with certainty although they probably are syntypes. Additionally, Pfeiffer's material was not located by me at NHMUK in 2004.

Type Localities: *Cyclostoma basicarinatum* Pfeiffer, 1855: "*La Grange prope Frederiksted insulae St. Croix*"; *Cyclostoma chordiferum* Pfeiffer, 1855: "*Bulows Minde insulae St. Croix*."

Type Figures: *Cyclostoma basicarinatum* Pfeiffer, 1855: Pfeiffer, 1855: pl. 4, figs. 2, 3 (Figures 38–39); *Cyclostoma chordiferum* Pfeiffer, 1855: Pfeiffer, 1855: pl. 4, fig. 1 (Figure 46).

Other Material (Specimens Examined: 14): U.S. Virgin Islands, St. Croix, UF 18318 (2), UF 27922 (2), UF 27927 (3), UF 195459 (2); UF 27885 (2), Bellevue; UF 27890 (3), Frederiksted.

Distribution: U.S. Virgin Islands: This species is endemic to St. Croix, where it is possibly extinct. Specimens, including the type, have been recorded from Frederiksted on the west coast and Bellevue/Bulows Minde just west of Christiansted.

Habitat: Unknown. The type locality of *C. basicarinatum*, near Frederiksted, is adjacent to a remnant patch of rain forest and it is likely that this species once occurred in similar habitat across the island. All of the known sites for this species are in hill country.

Variation Among Specimens: Specimens vary in the strength of spiral sculpture and degree of separation of the outer lip from the previous whorl.

Comparison with Other Species: *Parachondria basicarinatus* is very similar to the extant *P. santacruzensis*. They differ primarily in size: *P. basicarinatus* averages 19.3 mm in length, *P. santacruzensis* averages 12.2 mm.

Parachondria basicarinatus has more spiral threads on the final whorl (17–19) than does *P. santacruzensis* (12–15).

ORIGINAL DESCRIPTIONS

Cyclostoma basicarinatum Pfeiffer, 1855 (translated from Latin): "Shell barely perforated, oblong turret, truncate, spiral lirae, sculpture densely ribbed, somewhat interrupted (3–4 bundles formed), discolored, faint interrupted brown bands evident; spire rather regularly attenuated; suture densely denticulated; remaining five whorls slightly convex, front of last barely solute, base with 2–3 strong, well-developed carinae; aperture subvertical, angulate oval; peristome double: inner barely expanded, external expanded, upper and left margin narrow." 18–19 mm length.

Cyclostoma chordiferum Pfeiffer, 1855 (translated from Latin): "Shell very narrowly perforated, oblong-turret, truncate, obsolete spiral lirae and crowded ribs, discolored; spire rather regularly attenuated; suture with crowded denticles; 4.5 remaining whorls, slightly convex, front of last briefly solute, base with 6–7 elevated, strong lirae; aperture angulate-oval; peristome double: inner expanded, barely projecting, outer subequally expanded everywhere." 19–23 mm length.

Discussion: Both *C. basicarinatum* and its synonymous taxon *C. chordiferum* were described from heavily weathered specimens. Reeve's figured specimen, collected by 1863, appears recent (Figure 40). However, this figure may actually represent the extant *P. santacruzensis*, but it is not sufficiently detailed to determine to which taxon it applies and Reeve does not indicate its size. No more recent specimens are known.

Although no examples retain an operculum, the close similarity of this species with *Parachondria santacruzensis* indicates that it is a *Parachondria* as well.

Etymology: *Cyclostoma basicarinatum* Pfeiffer, 1855: *L. basis*, base + *L. carina*, keel; keeled on the base; *Cyclostoma chordiferum* Pfeiffer, 1855: *L. chorda*, cord + *L. -fer*, carry; bearing cords.

***Parachondria (Parachondria) lineolatus* (Lamarck, 1822)** (Figure 56–81, 143–144)

CHRESONYMY

Cyclostoma lineolata Lamarck, 1822: 147; Deshayes and Milne Edwards, 1838: 358–359; Delessert, 1841: pl. 29, figs. 8a,b,c; Pfeiffer, 1852a: 418; Shuttleworth, 1854b: 91; Mermoud, 1952: 49–51, figs. 114a–c; Watters, 2006: 335.

Cyclostoma lineolatum Lamarck, 1822. —Pfeiffer, 1847a: 105; Petit de la Saussaye, 1850: 46.

Cyclostoma swiftianum "Newcomb MMS, 1845" Adams, 1849a: 8 [*nomen nudum*].

Cyclostoma newcombianum Adams, 1849a: 8; Adams, 1849b: 15; Adams, 1851a: 2; Adams and Chitty, 1851a: 177; Adams and Chitty, 1851b: 101; Adams, 1851b: 180; Adams, 1854: 104; Adams, 1851c: 203;

Bland, 1852: 216; Bland, 1854: 74; Pfeiffer, 1854c: 278, pl. 37, figs. 25, 26; Jacobson and Boss, 1973: 390–391, pl. 59, fig. 1; Watters, 2006: 372.

Cyclostoma troscheli Pfeiffer, 1850a: 64; Pfeiffer, 1851: 173 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Adams, 1851c: 203; Pfeiffer, 1852a: 288–289 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Bland, 1852: 216 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Pfeiffer, 1852b: 45 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Reeve, 1863a: text to pl. 3 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Arango y Molina, 1865: 89; Arango y Molina, 1867: 76; Arango y Molina, 1878: 11 [as Pfeiffer, 1864]; Kobelt, 1880: 261; Jacobson and Boss, 1973: 390–391; Watters, 2006: 521–522.

Cistula lineolata (Lamarck, 1822). —Gray, 1850: 58; Adams and Adams, 1856: 294; Pfeiffer, 1858: 134; Bland, 1861: 358; Pfeiffer, 1862: 154; Pfeiffer, 1876a: 188; Gundlach, 1878: 14–15; Crosse, 1891: 169; Dall and Simpson, 1901: 435.

Cistula? lineolata (Lamarck, 1822). —Pfeiffer, 1851: 170; Pfeiffer, 1852a: 270, 418; Pfeiffer, 1852b: 42; Pfeiffer, 1853: 188–189.

Cyclostomus fallax Pfeiffer, 1851: 171 [*nomen nudum*]; Pfeiffer, 1852c: 68; Pfeiffer, 1858: 126; Bland, 1861: 359; Pfeiffer, 1865: 134; Pfeiffer, 1876a: 182; Kobelt, 1880: 281; Watters, 2006: 260.

Chondropoma newcombianum (Adams, 1849). —Pfeiffer, 1851: 173; Pfeiffer, 1852a: 288–289; Pfeiffer, 1852b: 45; Adams and Adams, 1856: 295; Pfeiffer, 1857: 158; Bland, 1861: 358–359, table 2; Reeve, 1863a: pl. 3, figs. 16a, b; Pfeiffer, 1865: 152; Pfeiffer, 1876a: 194; Gundlach, 1878: 15–16; Kobelt, 1879: 198, pl. 62, fig. 39; Kobelt, 1880: 279, 281; Fischer and Crosse, 1890: 203.

Chondropoma swiftianum "Newcomb" Pfeiffer, 1851: 173 [introduced in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Pfeiffer, 1852a: 288–289 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Bland, 1852: 216 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Pfeiffer, 1852b: 45 [in synonymy of *Cyclostoma newcombianum* Adams, 1849]; Reeve, 1863a: text to pl. 3 [in synonymy of *Cyclostoma newcombianum* Adams, 1849].

Cistula? fallax (Pfeiffer, 1852). —Pfeiffer, 1852a: 273; Pfeiffer, 1853: 192–193.

Cistula fallax (Pfeiffer, 1852). —Pfeiffer, 1852b: 43; Adams and Adams, 1856: 294.

Cyclostoma (Cistula?) fallax (Pfeiffer, 1852). —Pfeiffer, 1854a: 65–66.

Cyclostoma fallax (Pfeiffer, 1852). —Pfeiffer, 1854d: pl. 45, figs. 21, 22; Pfeiffer, 1854e: 369; Reeve, 1861b: pl. 12, fig. 71.

Cyclostoma (Chondropoma) newcombianum Adams, 1849. Shuttleworth, 1854a: 71.

Cyclostoma (Chondropoma?) newcombianum Adams, 1849. Shuttleworth, 1854b: 92.

Chondropoma tortolense Pfeiffer, 1857: 158; Bland, 1861: 359; Reeve, 1863a: pl. 4, fig. 31; Pfeiffer, 1865: 152; Pfeiffer, 1876a: 195; Kobelt, 1880: 281; Martens, 1882: 370–371; Clench, 1939: 288; van der Schalie, 1948: 35; Watters, 2006: 516.

Chondropoma lineolatum (Lamarck, 1822). —Mörch, 1860: 12.

Cistula lineolata ("Pfeiffer"). —Kobelt, 1880: 279.

Chondropoma (*Chondropomorus*) *newcombianum* (Adams, 1849). —Henderson and Bartsch, 1921: 61.

Chondropoma (*Chondropomorus*) *tortolense* Pfeiffer, 1857. —Henderson and Bartsch, 1921: 61.

Cyclostoma lineatum [sic] Lamarck, 1822. —Mermod, 1952: 50.

Licina decussata "Lamarck" Parkinson, 1987: 62, fig. 53, bottom middle [misidentification].

Parachondria (*Parachondria*) *fallax* (Pfeiffer, 1852). —Watters, 2006: 44, 260.

Parachondria (*Parachondria*) *lineolatus* (Lamarck, 1822). —Watters, 2006: 44, 335.

Parachondria (*Paracondria*) *newcombianus* (Adams, 1849). —Watters, 2006: 44, 372.

Parachondria (*Parachondria*) *tortolensis* (Pfeiffer, 1857). —Watters, 2006: 44, 516.

non *Choanopoma troscheli* Pfeiffer, 1864. —Watters, 2006: 522 [in synonymy of *Cyclostoma newcombianum* Adams, 1849, in error].

non *Cyclostoma lineolatum* "Lamarck" Pfeiffer, 1847d: 49, pl. 6, figs. 27, 28 [pl. 1846]; [= ?; *fide* Mermod, 1952: 50].

Description: Shell medium-sized for genus (smallest=10.1 mm, largest=17.5, average=14.2, decollated). Elongate conic, last whorl nearly adnate to openly solute for last ¼ turn. Umbilicus open, narrow. Protoconch of 1.5 rounded, smooth whorls. 3.5–5 decollated remaining whorls. Spiral sculpture of numerous threads (ca. 27–30 on final whorl). Threads widely separated below suture but become less so as they progress toward umbilicus. Axial sculpture of numerous, very fine, closely spaced lamellae, best developed over spiral sculpture where it has a scalloped or slightly fenestrate appearance. In addition, some specimens have very regular, peculiar, raised axial ridges reminiscent of "varices" that divide whorl into axial sections. Suture deeply channeled, bounded by very regularly spaced, well-developed tufts. Tufts composed of 2–5 fused or barely fused axial lamellae; tufts begin just after raised axial ridges and individual lamellae within tuft decrease in height as shell enlarges. Aperture composed of an inner and an outer lip, oval to teardrop-shaped, solute from previous whorl. Inner lip smooth, inconspicuous. Outer lip narrowly expanded, narrowest toward umbilicus, auriculate posteriorly, thickened, composed of numerous lamellae, anterior-medial edge scalloped in some specimens. Base color pale tan to reddish brown overlain with a complex color pattern. Dark brown axial markings may be solid scallops (Figure 74), undulating lines (Figure 75), broken diagonal lines (Figure 72), or absent (Figure 77). Dark spiral bands

may be present on base. Tufts and intersections of axial and spiral sculpture may be white. Lip white, rarely banded. Outer color pattern may show through within aperture. Operculum paucispiral with a granulose deposit. Radula and anatomy unknown.

Type Material: *Cyclostoma lineolata* Lamarck, 1822: Syntypes: MHNG 1093/31 (11), now accessioned as MHNG-INVE-51228 (Figures 56–59); *Cyclostoma newcombianum* Adams, 1849: Lectotype: MCZ 275708, by subsequent designation of Jacobson and Boss (1973) (Figure 60); ? Paralectotype: SMF unnumbered; *Cyclostoma troscheli* Pfeiffer, 1850: Not located and presumed lost; *Cyclostomus fallax* Pfeiffer, 1851: Three specimens at NHMUK, unnumbered, from the Cuming collection bearing Pfeiffer's handwriting may be syntypes (Figure 61); *Chondropoma tortolense* Pfeiffer, 1857: One specimen, ZMB 65673, from the Pfeiffer collection, collected at Tortola by Riise, matches the description and size of the specimen in Pfeiffer's original description (Figures 62–63). Pfeiffer described the operculum, which is also present in the ZMB specimen. I regard this ZMB specimen as the holotype.

Type Localities: *Cyclostoma lineolata* Lamarck, 1822: "dans les Antilles." Restricted here to St. John, U.S. Virgin Islands [see remarks]; *Cyclostoma newcombianum* Adams, 1849: "Jamaica." Originally believed to be from Jamaica, but later corrected to St. Thomas by Adams and Chitty (1851a); *Cyclostoma troscheli* Pfeiffer, 1850: "in ins. St. Thomas"; *Cyclostomus fallax* Pfeiffer, 1851: "hab.?"; *Chondropoma tortolense* Pfeiffer, 1857: "in insulae Tortola" collected by Riise.

Type Figures: *Cyclostoma lineolata* Lamarck, 1822: Mermod, 1952: figs. 114a,b,c; *Cyclostoma newcombianum* Adams, 1849: Jacobson and Boss, 1973: pl. 59, fig. 1; *Cyclostoma troscheli* Pfeiffer, 1850: Unfigured; *Cyclostomus fallax* Pfeiffer, 1851: Pfeiffer, 1854d: pl. 45, figs. 21, 22 (Figure 67); *Chondropoma tortolense* Pfeiffer, 1857: Unfigured.

Other Material (Specimens Examined: 325): Spanish Virgin Islands, Isla Culebra, UF 23261 (1), S slope Cerro Resaca; UF 23250 (6), UF 23252 (1), Cerro Resaca. Isla de Vieques, UF 28670 (9), UF 193999 (3), Playa Caracas, Fort Garcia; UF 28647 (11), UF 28668 (10), Monte Pirata, near summit. British Virgin Islands, Anegada, UF 202925 (7), Beef Island, UF 28703 (2), Ginger Island, UF 202923 (3), Grand Camanoe Island, UF 210981 (18), Guana Island, UF 183244 (1), UF 210990 (11); UF 210993 (5), ridge along NE end. Great Thatch Island, UF 202918 (4), UF 202919 (7), Tortola, UF 119182 (2); OSUM 36864 (5), GTW 7063a (1), 488 m, Sage Mountain; UF 27947 (2), UF 28696 (1), UF 28699 (5), Sage Mountain; UF 28676 (16), UF 28683 (11), UF 28691 (15), Zion Hill; UF 183244 (1), West End, Belmont Pond. U.S. Virgin Islands. St. Croix, GTW 10099b (1). St. John, UF 259948 (3); UF 27975 (13), Bordeaux Mountain; UF 48872 (1), Calabash Bay; UF 27958 (2), Calvary Bay; UF

197916 (4), Caneel Bay; UF 197923 (1), Catherineberg Sugar Mill; UF 27963 (2), Chocolate Hole; GTW 7303b (3), UF 27979 (28), along Cinnamon Bay Trail, Cinnamon Bay; UF 48862 (1), Butler's Gut, Coral Bay; UF 48759 (1), Coral Bay; UF 247114 (2), UF 247115 (2), Fish Bay Gut; UF 197945 (18), Josie Gut Sugar Estate ruins; UF 247126 (1), Great Lameshur Bay; UF 27968 (28), UF 247135 (2), UF 247136 (2), Reef Bay; UF 27980 (74), Wahoe Bay; UF 48851 (1), UF 259947 (2), Windberg Gut, St. Thomas. UF 119180 (1), UF 119181 (2), UF 119183 (5), UF 216686 (1), UF 216687 (2); UF 113836 (1), W slope of mountain top, N of intersection of hwy. 33/40.

Distribution: Isla Culebra, Isla de Vieques, British and U.S. Virgin Islands. Pfeiffer (1851) reported *Cyclostoma lineolata* from St. Vincent but Mermod (1952) could not verify this locality. It is highly unlikely that this record is correct; no annulariids are known from St. Vincent.

Habitat: Under rocks, logs.

Variation among Specimens: As may be expected from a widespread species occurring on isolated islands, there is significant variation. Color patterns vary greatly but all have the same common elements and intermediates occur for any two extremes. Sculpture varies from scalloped to fenestrate depending on the strength of the axial lamellae. The degree of "soluteness" of the outer lip also varies, from the very solute form characterized by *Cyclostomus fallax* Pfeiffer, 1851, to the nearly adnate *Cyclostoma lineolata* Lamarck, 1822. The types of *Cyclostoma lineolata* Lamarck, 1822, are unusual in retaining the protoconch.

Comparison with Other Species: The distinct and regular color pattern and tufts of this species separate it from most other Lesser Antillean taxa. The raised axial ridges ("varices") of some specimens are unique.

Diplopoma decussatum, with which this species co-occurs in the Spanish Virgin Islands, is easily discerned by its operculum (multispiral and lamellate in *D. decussatum* and paucispiral without a lamella in *P. lineolatus*). However, lacking the operculum the two are nearly inseparable based solely on shell characteristics. *Diplopoma decussatum* never has the "varices" of *P. lineolatus* and the individual lamella of each sutural tuft do not decrease in size within the tuft. Nevertheless specimens may be very difficult to separate (e.g., the probable holotype of *Chondropoma tortolense* Pfeiffer, 1857, (Figures 62, 63) would have been assigned to *D. decussatum* if not for the operculum).

ORIGINAL DESCRIPTIONS

Cyclostoma lineolata Lamarck, 1822 (translated from Latin): "Shell ventricose-conic, somewhat perforated, with thin longitudinal striations, yellowish-brown, banded with interrupted white lines; with wavy longitudinal reddish-brown little lines; seven remaining, convex; margin of lip white, reflexed."

Cyclostoma newcombianum Adams, 1849: "Shell much elongated, conic; very pale orange, elegantly decorated with several spiral series of small brown oblique spots which have white shadows, the spots being in transverse series; with numerous small but strong transverse whitish raised lines, which are mostly in groups of three to five and at the summits are developed into minute sutural crenulations; spire with slightly convex outlines; apex truncate with the loss of two or three whorls; five whorls remaining, with a well impressed suture; last whorl detached from the penult whorl near the aperture; aperture suborbicular, quite angular above; inner peritreme slightly produced; outer peritreme moderately expanding, shining, reflected exactly into the plane of the aperture, rather thick, nearly wanting opposite to the penultimate whorl, moderately produced above into a sharply angular concave wing; umbilicus very small."

Cyclostoma troscheli Pfeiffer, 1850 (translated from Latin): "Shell slightly perforate, oblong turret, thin, sculpture of elevated concentric lines and crossed over by crowded longitudinal plications, delicate, somewhat shiny, yellowish brown, spire elongate, barely truncate; suture denticulate; 5.5 slightly convex whorls, top smooth, forward narrowly solute, base with distinct spiral striations, crowded; aperture vertical, angulate-rounded; peristome thin, somewhat double, narrow and horizontally expanded, top somewhat tongue-shaped, angled. Operculum membranous, four-whorled, flat." 15 mm length.

Cyclostomus fallax Pfeiffer, 1851 (translated from Latin, from Pfeiffer, 1852a): "Shell umbilicate, oblong-turret, truncate, thin, with obtuse spiral lirae, with crowded decussate longitudinal lines (eight sometimes ten more or less well-developed), not scaly, barely shining, white, with wavy lines; marked with interrupted yellowish-brown; spire subconvex-turret; suture minutely fasciculated-crenulated; 4-4.5 remaining whorls slightly convex, last rounded, ornated below with medium yellowish-brown bands, front solute for a long way, around open umbilicus slightly spirally sulcate; aperture subvertical, oval; peristome white, double: inner a little expanded, appressed, outer short, more or less equally expanded in all directions, top angulated. Operculum?" 14 mm length.

Chondropoma tortolense Pfeiffer, 1857 (translated from Latin): "Shell narrowly perforate, ovate-turret, truncate, unequal spiral lirae, crowded ribs that cross, irregular varices simulating decussations, white-corneous, striped with red angular lines; spire rather regularly attenuated; suture with white bundles of crenulations; 4.5 remaining whorls moderately convex, front of last solute, carinate on back, marked between with medium red bands; aperture vertical, angulate-oval; peristome nearly double, outer top angulate, undulating." 15 mm length. (German translation): "Closely related with *Ch. Newcombianum* Ad., however by the notched peristome and the operculum, whose nucleus is more eccentric, it is distinguished."

Discussion: This species varies considerably in size, coloration, development of the outer lip, and prominence

of sutural tufts. This variability has led to several synonyms. Specimens vary not only by island but by populations within an island.

Cyclostoma lineolata Lamarck, 1822 was described from “les Antilles.” A second label accompanying the syntypes reads “Portorico.” Mermod (1952) never mentioned this second label but, somewhat incongruously, commented that van der Schalie (1948) had not found this species in Puerto Rico. Mermod also illustrated a specimen (his figs. 114a, b), which he stated was the largest of the lot. As pointed out by Dr. Peter Schuchert (in litt., Nov. 2013, MHNG) it is not. The type seems conspecific with specimens from St. John and the type locality is herein restricted to St. John, U.S. Virgin Islands.

Chondropoma tortolense variety “major” was listed from Puerto Rico by Martens (1882) but was not mentioned in the review of Puerto Rican annulariids by van der Schalie (1948). However, van der Schalie (1948) did suggest that *C. tortolense* might be only a form or subspecies of the Puerto Rican *Parachondria conseptus* (Martens, 1883), a conclusion with which I cannot concur. *Parachondria conseptus* (Martens, 1883) has much coarser sculpture and a more solute final whorl than does *P. lineolatus*.

Cyclostomus fallax was described from an unknown locality. It closely resembles specimens from Anegada.

Etymology: *Cyclostoma lineolata* Lamarck, 1822: *L. lineola*, small line; with small lines; *Cyclostoma newcombianum* Adams, 1849: Wesley Newcomb (1808–1892), American physician, conchologist, Hawaiian temperance leader; *Chondropoma swiftianum* Pfeiffer, 1851: Robert Swift (~1795–1872), collector in St. Thomas, Virgin Islands; *Cyclostoma troscheli* Pfeiffer, 1850: Franz Hermann Troschel (1810–1882), German conchologist, ichthyologist at Universität Bonn and Curator at Zoologisches Museum Berlin; *Cyclostomus fallax* Pfeiffer, 1851: *L. fallax* – deceptive; derivation unclear; *Chondropoma tortolense* Pfeiffer, 1857: Tortola + *L. -ensis*, from; from Tortola.

Parachondria (Parachondria) species
(Figures 123–124)

A specimen from St. Croix (GTW 10099a) is closely related to *P. lineolatus*. It differs in the adnate final whorl, the attached outer lip to the previous whorl, the patterned outer lip, as well as having a broad, dark band within the umbilicus and a higher, narrower spire with one additional whorl. All of these characteristics are outside the range of variation seen in *P. lineolatus*. Annulariids are known for their highly endemic taxa and this specimen seems to represent an undescribed species. But because it is known from a single specimen lacking more precise locality data, it is not described here.

Parachondria (Parachondria) cf. salleanus (Pfeiffer, 1850b)
(Figures 125, 138)

A single specimen from Sombrero Island (UF 119118) appears to belong to this Hispaniolan species. It seems

unlikely that this species would naturally occur >525 km away from the Dominican Republic, bypassing Puerto Rico and the Virgin Islands. Sombrero Island was mined for guano and was visited on a regular basis by ships and workers; this record may be an anthropogenic introduction or a mislabeled specimen. I do not regard it as a natural part of the Lesser Antillean fauna.

Parachondria (Parachondria) santacruzensis (Pfeiffer, 1855)
(Figures 82–93, 136–137)

CHRESOONYMY

Cyclostoma santacruzense Pfeiffer, 1855: 101; Watters, 2006: 461.

Chondropoma santacruzensis (Pfeiffer, 1855). —Mörch, 1860: 12.

Chondropoma santacruzense (Pfeiffer, 1855). —Bland, 1861: 359, table 2; Reeve, 1863a: pl. 7, fig. 50; Pfeiffer, 1865: 154; Pfeiffer, 1876a: 196; Kobelt, 1880: 281; Weinland, 1880: 349; Jacobson, 1968: 20–21.

Chondropoma (Chondropomorus) santacruzense (Pfeiffer, 1855). —Henderson and Bartsch, 1921: 61.

Cyclostoma chordiferum Pfeiffer, 1855. —Jacobson, 1968: 20 [in synonymy of *Cyclostoma santacruzense* Pfeiffer, 1855].

Cyclostoma basicarinatum Pfeiffer, 1855. —Jacobson, 1968: 20 [in synonymy of *Cyclostoma santacruzense* Pfeiffer, 1855].

Cyclostoma kazika Weinland, 1876. —Jacobson, 1968: 20 [in synonymy of *Cyclostoma santacruzense* Pfeiffer, 1855]; Watters, 2006: 319 [as *nomen dubium*].

Parachondria (Parachondria) ? santacruzensis (Pfeiffer, 1855). —Watters, 2006: 44, 461.

Description: Shell medium-sized for genus (smallest=10.7 mm, largest=14.5, average=12.2, decollated). Elongate conic, last whorl adnate or very narrowly solute for last ¼ turn. Umbilicus open, narrow. Protoconch of 1.5 rounded, smooth whorls. 3.5–5 decollated remaining whorls. Spiral sculpture of numerous rounded or flattened cords (ca. 12–15 on final whorl). Several cords on base are more prominent and widely spaced than elsewhere. Axial sculpture of numerous, coarse, closely spaced, erect lamellae, best developed over spiral sculpture where it has a scalloped appearance. Suture deeply indented, bounded by irregular, widely spaced, well-developed tufts. Tufts composed of 1–2 expanded but unfused lamellae with 2–5 much smaller, unexpanded lamellae between them. Aperture composed of an inner and an outer lip, teardrop-shaped, adnate or nearly so with previous whorl. Inner lip smooth, usually erect. Outer lip narrowly expanded, narrowest toward umbilicus, auriculate posteriorly, thickened, composed of numerous lamellae, anterior-medial edge scalloped in some specimens. Base color pale tan to reddish brown. Patterned with spiral rows of darker reddish or brown dots and dashes, neatly aligned vertically. Tufts and intersections of axial and spiral sculpture may be white. Lip white, often with color pattern continuing onto front of lips.

Outer color pattern may show through within aperture. Operculum paucispiral with a granulose deposit. Radula and anatomy unknown. Specimens often are covered in a very fine adherent sand or grit.

Type Material: ? Syntype: ZMB 65692, not located (Christine Zorn, in litt., Dec. 2013, ZMB). Additionally, Pfeiffer's material was not located by me at NHMUK in 2004.

Type Locality: "Spring Gutt prope Christiansted insulae St. Croix."

Type Figure: Unfigured.

Other Material (Specimens Examined: 107): U.S. Virgin Islands, St. Croix, GTW 7303a (1), UF 27923 (8), UF 119184 (16), UF 158945 (5), UF 195541 (2); UF 27949 (55), Bellevue; UF 27956 (10), Davis Bay; UF 426186 (7), Estate Rattan, 166 m; UF 216876 (24), Teague Point; UF 216877 (2), "Santa Cruz Island, Solomons." British Virgin Islands, Tortola, UF 119182 (1).

Distribution: U.S. Virgin Islands, St. Croix; British Virgin Islands, Tortola, single record. One specimen, UF 216878, is labeled only "Puerto Rico." While it is not impossible that this species also occurs in Puerto Rico, van der Schalie (1948) did not include it in his revision of the annulariids of that island. It may be a mislabeled specimen.

Habitat: Under leaf litter, logs, stones. Known sites for this species in St. Croix are all in the northern hills of the island.

Variation among Specimens: Specimens vary primarily in the strength of the color pattern and the strength of the sutural tufts.

Comparison with Other Species: This species is obviously closely related to *P. basicarinatus*: both have a similar color pattern and enlarged basal cords. They differ primarily in size (*P. basicarinatus* averages 19.3 mm in length, *P. santacruzensis* averages 12.2 mm) and in the number of spiral threads on the final whorl (17–19 in *P. basicarinatus*, 12–15 in *P. santacruzensis*).

ORIGINAL DESCRIPTION

(Translated from Latin): "Shell perforate, oblong-turret, narrow, longitudinal membranous ribs, undulating, sculpture dense, not shiny, reddish horn, colored with rows of reddish spots and one basal band; spire rather regularly attenuated, truncate; suture with unequally distant crenulated denticles; 4.5 remaining whorls moderately convex, front of last briefly solute; aperture vertical, oval, top subangulate; peristome double: inner slightly expanded, outer expanded, from penultimate whorl slightly detached, above and below narrowly perforated. Operculum flat, corneous." 11.5–12 mm length.

Discussion: Both *P. santacruzensis* and *P. basicarinatus* are similar to *P. conseptus* (Martens, 1882). That species is

known only from the Aguas Buenas region in east-central Puerto Rico. *Parachondria conseptus* is a large species like *P. basicarinatus* and the two may have a common ancestor. *Parachondria santacruzensis* appears to be a miniature relative of the two.

Jacobson (1968) synonymized *Cyclostoma kazika* Weinland, 1876 with *P. santacruzensis*. *Cyclostoma kazika* was described with doubt from Haiti. The figures by Pfeiffer in 1876b are unrecognizable and the type is presumed lost. The specific name itself is enigmatic and gives no clue as to its provenance (*kazika* is Latin for goat). Watters (2006) regarded this taxon as a *nomen dubium*.

Etymology: *L. santacruzense*, Santa Cruz + *L. -ense*, from; from St. Croix.

Genus *Diplopoma* Pfeiffer, 1859

Subgenus *Diplopoma* Pfeiffer, 1859

Type Species: *Diplopoma architectonicum* Pfeiffer, 1859, by original designation.

***Diplopoma (Diplopoma) crenulatum* (Potiez and Michaud, 1838)**
(Figures 94–122, 145–146)

CHRESONYMY

Cyclostoma crenulatum "Férussac *ex fide ipsa*" Potiez and Michaud, 1838: 235, Atlas [1844] pl. 24, figs. 3, 4; Watters, 2006: 220–221.

Chondropoma guadeloupense Pfeiffer, 1847b: 124; Reeve, 1863a: pl. 7, figs. 49a, b [in synonymy of *Cyclostoma crenulatum* Potiez and Michaud, 1838].

Cyclostoma guadeloupense (Pfeiffer, 1847). —Pfeiffer, 1849: 176, pl. 28, figs. 9–11 [pl. 1848?]; Petit de la Saussaye, 1850: 47; Pfeiffer, 1851: 173; Beau, 1852: 427; Pfeiffer, 1852a: 289–290; Pfeiffer, 1852b: 45; Reeve, 1863a: text to pl. 7; Watters, 2006: 283 [all, except for Pfeiffer, 1849, in synonymy of *Cyclostoma crenulatum* Potiez and Michaud, 1838].

Cyclostoma crenulatum "Michaud." —Petit de la Saussaye, 1850: 47; Beau, 1852: 427.

Chondropoma crenulatum ("Férussac" Potiez and Michaud, 1838). Pfeiffer, 1851: 173.

Chondropoma crenulatum ("Férussac") Pfeiffer, 1852a: 289–290; Pfeiffer, 1852b: 45; Adams and Adams, 1856: 295; Bland, 1861: 354; Reeve, 1863a: pl. 7, figs. 49a, b; Kobelt, 1880: 283; Vernhout, 1914: 183.

Cistula antiguensis "Shuttleworth" Pfeiffer, 1858: 131; Watters, 2006: 142–143.

Choanopoma occidentale Pfeiffer, 1861: 216, pl. 3, figs. 11–13; Bland, 1861: 358; Pfeiffer, 1865: 104–105; Pfeiffer, 1876a: 157; Kobelt, 1880: 282; Mazé, 1890: 32; Vernhout, 1914: 183; Watters, 2006: 384.

Cistula antiguensis "Shuttleworth." —Bland, 1861: 351; Pfeiffer, 1865: 142; Pfeiffer, 1876a: 187; Kobelt, 1880: 282.

Chondropoma antiguense (Pfeiffer, 1858). —Reeve, 1863b: pl. 10, fig. 72.

- Chondroma* [sic] *crenulatum* ("Férussac"). —Mazé, 1890: 32.
- Chondropoma* (*Chondropomorus*) *crenulata* ("Férussac"). —Henderson and Bartsch, 1921: 61.
- Adamsiella* (*Adamsiellops*) *antiguense* ("Shuttleworth"). —Henderson and Bartsch, 1921: 71.
- Adamsiella* (*Adamsiellops*) *occidentale* (Pfeiffer, 1861). —Henderson and Bartsch, 1921: 71.
- Adamsiella antiguensis* (Pfeiffer, 1858). Baker, 1928: 48.
- Licina* (*Choanopomops*) *antiguensis* ("Shuttleworth"). —Baker, 1928: 48.
- Chondropoma* (*Chondropomorus*) *antiguensis* ("Shuttleworth" Pfeiffer, 1858). —Bartsch, 1946: 199.
- Adamsiella antiguensis* ("Shuttleworth"). —Clench, 1956: 69.
- Adamsiella* (*Adamsiellops*) *crenulata* ("Férussac"). —Coomans, 1967: 126.
- Adamsiella* (*Adamsiellops*) *crenulata martinensis* "Bartsch MSS" Coomans, 1967: 126–128, figs. 39–41; Watters, 2006: 219–220.
- Annularia* (*Annularia*) *occidentale* (Pfeiffer, 1861). —Coomans, 1967: 128.
- Diplopoma* (*Diplopoma*) *crenulata martinense* (Coomans, 1967). —Watters, 2006: 35, 219–220.
- Diplopoma* (*Diplopoma*) *crenulatum crenulatum* (Potiez and Michaud, 1838). —Watters, 2006: 35, 220–221.
- Diplopoma* (*Diplopoma*) sp. Watters, 2006: 35.
- Parachondria* (*Parachondria*) *antiguensis* (Pfeiffer, 1858). —Watters, 2006: 44, 142–143.
- Parachondria* (*Parachondria*) *occidentalis* (Pfeiffer, 1861). —Watters, 2006: 44, 384.
- Diplopoma* sp. Robinson et al., 2009: 625–625, figs. 80, 9A.

Description: Shell small to medium-sized for genus (smallest=8.1 mm, largest=15.8, average=11.3, decollated). Elongate conic, last whorl barely adnate or more commonly very narrowly solute for last ¼ turn. Umbilicus open, narrow. Protoconch of 1.5 rounded, smooth, tan whorls. 3.5–5 decollated remaining whorls, most specimens are decollate. Spiral sculpture of numerous rounded threads, often weakly developed or indistinguishable, but more prominent in some populations (up to 19 on final whorl). Several cords on base are more prominent and widely spaced than elsewhere. Axial sculpture of numerous, fine, closely spaced, erect lamellae, best developed over spiral sculpture. Where spiral sculpture is better developed, surface has a scalloped appearance (Figure 114). In specimens where spiral sculpture is less developed or absent, surface has only sinuous, axial lamellae (Figure 112). Suture deeply indented to narrowly channeled, bounded by irregular groups of tufts. Tufts composed of 1–5 expanded and loosely fused lamellae with varying numbers of unexpanded lamellae between them. Tufts may be quite prominent (Figure 100) or nearly absent (Figure 115). Aperture composed of an inner and an outer lip, oval or teardrop-shaped, usually narrowly solute with previous whorl. Inner lip smooth, narrowly erect. Outer lip very

narrowly expanded, narrowest toward umbilicus, narrowly auriculate posteriorly. Base color white to pale tan. Un-patterned or with vague pale tan spiral spots and bands; these are rarely prominent. Tufts and intersections of axial and spiral sculpture may be white. Lip white, rarely with color pattern continuing onto front of lips. Aperture white or tan; outer color pattern may show through within aperture. Operculum multispiral with an oblique, erect calcareous lamella. Radula and anatomy unknown.

Type Material: *Cyclostoma crenulatum* Potiez and Michaud, 1838: Douai Museum. According to the website of the Musée de la Chartreuse Douai, the "natural sciences collection [was] completely destroyed" during WW II; *Chondropoma guadeloupense* Pfeiffer, 1847: Not located and presumed lost; *Cistula antiguensis* Pfeiffer, 1858: Not located and presumed lost; *Choanopoma occidentale* Pfeiffer, 1861: ? Syntype: ZMB 65671, not located (Christine Zorn, in litt., Dec. 2013, ZMB). Additionally, Pfeiffer's material was not located by me at NHMUK in 2004.

Adamsiella (*Adamsiellops*) *crenulata martinensis* Coomans, 1967: Holotype: USNM 389964 (Figures 100–101); paratypes: USNM 389961 (26); USNM 652968 (23); USNM 636106 (31); "some paratypes have been donated to the Zoological Museum in Amsterdam."

Type Localities: *Cyclostoma crenulatum* Potiez and Michaud, 1838: "La Guadeloupe, sur la palmiste"; *Chondropoma guadeloupense* Pfeiffer, 1847: "Guadeloupe"; *Cistula antiguensis* Pfeiffer, 1858: "in insula Antigua"; *Choanopoma occidentale* Pfeiffer, 1861: "in insulae Martinique"; *Adamsiella* (*Adamsiellops*) *crenulata martinensis* Coomans, 1967: "Hill top east of Grande Case Bay, St. Martin."

Type Figures: *Cyclostoma crenulatum* Potiez and Michaud, 1838: pl. 24, figs. 3, 4 (Figure 94); *Chondropoma guadeloupense* Pfeiffer, 1847: Pfeiffer, 1849: pl. 28, figs. 9–11 [1848?] (Figure 97); *Cistula antiguensis* Pfeiffer, 1858: Unfigured; *Choanopoma occidentale* Pfeiffer, 1861: Pfeiffer, 1861: pl. 3, figs. 11–13 (Figure 99); *Adamsiella* (*Adamsiellops*) *crenulata martinensis* Coomans, 1967: Coomans, 1967, figs. 39–41.

Other Material (Specimens Examined: 967):

Antigua, UF 212344 (6); OSUM 4155 (19), Saint Mary Parish; GTW 7064d (30), S of Veranda Resort, Saint Philip Parish; GTW 7064e (27), Half Moon Bay, Saint Philip Parish; UF 211008 (10), Willikies; Barbuda, UF 79058 (14), GTW 7064c (3); OSUM 36916 (22), GTW 7062a (2), Rubbish Bay; OSUM 36917 (66), GTW 7064a (3), Bull Hole; UF 258450 (35), 9.7 km NNE of St. Johns, between Codrington and The Caves; UF 211003 (21), UF 259949 (2), Codrington; Guadeloupe, UF 119152 (2), UF 216565 (2), UF 216566 (4); (Basse-Terre) UF 258460 (49), 2.5 km E of Trois-Rivières; (Grand-Terre) UF 258452 (53), 2 km SW of Château-Gaillard; UF 258455 (31), 6 km SE of Anse-Bertrand;

UF 258458 (19), 2 km E of Petit-Canal; UF 258459 (22), 2 km S of Le Moule; GTW 7064b (5), Le Moule; UF 258451 (58), 258461 (17), 1 km SE of Vieux Bourg; UF 258466 (8), 2 km SE of Vieux Bourg; UF 258463 (12), 0.8 km S of Sauvia; UF 258465 (6), 1 km N of Châteaubrun; UF 260040 (10), Plage de Babin, ca. 5 km W of Vieux Bourg, 200 m from sea; UF 258456 (49), 7 km NE of Les Abymes; UF 258469 (10), 8 km ENE of Les Abymes; UF 259784 (5), Grands Fonds; UF 260037 (26), near Bessons on SE outskirts of Pointe-à-Pitre; UF 260049 (6), Morne-à-l'Eau, 3 km S of Chasseau on rd. to Jabrun-St. Cyr, 500 m; UF 258457 (21), 2 km W of Morne-à-l'Eau; UF 258453 (28), 3 km NW of Gosier; UF 258464 (15), 6 km E of Gosier; UF 259942 (1), Gosier; UF 258462 (19), 5 km WSW of Sainte-Anne; UF 258468 (8), 4 km WSW of Sainte-Anne; UF 259941 (2), 1 km E of Sainte-Anne; GTW 7064 (2), GTW 11473a (3), Sainte-Anne; Marie-Galante, UF 259936 (7), Le Trou à Diable, 7 km NW of Capesterre-de-Marie-Galante; UF 259937 (2), 5 km SE of Grand-Bourg; UF 259938 (17), UF 259939 (7), 3 km NW of Grelin; GTW 7064g (2), 10 km N of St. Louis; Îles des Saintes, GTW 7064h (1), Terre-de-Bas; Martinique, UF 119137 (40), Sainte-Anne; UF 258446 (16), UF 259946 (2), 1 km SE of Sainte-Anne; UF 258448 (47), 1 km N of Sainte-Anne; UF 248447 (84), 7 km S of Le Vauclin; UF 258449 (15), Presqu'île de la Caravelle, 3 km W of Tartane.

Distribution: Antigua: Widespread and often abundant; Barbuda: Widespread and often abundant; St. Martin/Sint Maartin: Recorded from St. Martin by Vernhout (1914) but this may apply to the Sint Maartin portion of the island as well. Coomans (1967) described *Adamsiella* (*Adamsiellops*) *crenulata martinensis* from Grande Case Bay, St. Martin; Guadeloupe: widely distributed on Grand-Terre, very rare on Basse-Terre; of the 43 lots from Guadeloupe, only one was from Basse-Terre; Marie-Galante: Apparently widely distributed; La Désirade, *vide* Robinson et al. (2009); Îles des Saintes; Terre-de-Bas; Dominica: reported from the battlements of Fort Shirley at Cabrit's Point by Robinson et al. (2009; see remarks below); Martinique: coastal localities along the eastern shore away from the mountains of the northwest.

Habitat: Potiez and Michaud (1838) mentioned that this species occurred on palm trees. The author has found it under coral debris, rocks, logs, and leaf litter in sandy soil under shrubs and trees in xeric conditions. In contrast to many other Lesser Antillean annulariids, this species prefers the lowlands, sometimes occurring within meters of the shore.

Variation among Specimens: Specimens vary not only among islands but among populations on a single, often small, island as well. Shells from Guadeloupe (Figures 107, 111, 120) tend to be wider and less attenuate than those from smaller islands (Figures 105, 115). The strength and numbers of spiral threads are often more developed on smaller islands. However, this is not always the case. On the small island of Barbuda, spiral

sculpture may vary from coarse (Figure 113) to absent (Figure 112) between populations separated from each other by only a few kilometers.

Comparison with Other Species: This species superficially resembles *P. santacruzensis* in shell shape and sculpture. *Parachondria santacruzensis* is often much more colorful, with better defined sculpture. That species has a chondropomine operculum (paucispiral in a single plane) whereas *D. crenulatum* has an annularine operculum (multispiral with an erect lamella). There does not appear to be any overlap in the distributions of the two species as well.

ORIGINAL DESCRIPTIONS

Cyclostoma crenulatum Potiez and Michaud, 1838 (translated from French): "Shell subcylindrical, umbilicate, of the color of bright horn, transparent, and covered on the surface with longitudinal grooves joined in bundles of three and three, or of four and four, these which form the crenulations on the upper part of the spire; in some individuals the transverse grooves cut others, and render the shell latticed; spire composed of seven rather convex whorls; suture deep; opening nearly round and detached from the second whorl; summit nearly always truncate. Operculum forms a concentric spiral, and the detached part is an elevated, projecting lamella which produces a very attractive outward effect." 12–15 mm length.

Chondropoma guadeloupense Pfeiffer, 1847, was described in a footnote to an unrelated paper by Philippi in the *Zeitschrift für Malakozoologie* and not in 1849 in the *Systematisches Conchylien-Cabinet* as given by Watters (2006) (translated from Latin): "Shell narrowly perforate, oblong turret, decollate, solid, with transverse, acute, elevated longitudinal ribs, sculptured with transverse lirae above, cinnamon; suture with well-developed rather distant white denticles; four convex whorls; aperture vertical, oval; peristome red, continuous, double, inner a little expanded, appressed, outer narrowly expanded, slightly separated in proximity to penultimate whorl. Operculum thin, cartilaginous. Related to *C. xanthostomo* Sow., and certainly to *C. crenulato* M., from both distinguished without trouble by sculpture." 11 mm length.

Cistula antiguensis Pfeiffer, 1858 (translated from Latin): "Shell somewhat perforate, turret-oblong, truncate, sculpture with obtuse spiral lirae, crossed over by crowded longitudinal plications, somewhat bundled, white, banded with interrupted obsolete red lines; suture irregularly nodulose-crenulated; five remaining whorls moderately convex, last not solute; aperture vertical, oval; peristome simple, hardly adnate, top angulate, narrowly expanded on all sides. Operculum typical." 12 mm length.

Choanopoma occidentale Pfeiffer, 1861 (translated from Latin): "Shell nearly perforated, oblong turret, solid, truncate, sculpture of obsolete bands of lirae and rope-like longitudinal ribs nearly bundled, not shining,

yellowish, sometimes with indistinct marks of interrupted red bands; spire regularly attenuated; suture irregular and strongly dentate; five remaining whorls convex, front of last solute; aperture subvertical, oval; peristome simple, narrowly expanded. Operculum with three whorls, elevated margins produced." 12.5–13 mm length.

Adamsiella (*Adamsiellops*) *crenulata martinensis* Coomans, 1967: "Shell like *crenulata*, but smaller, maximum size 13 mm. The adult has four to five whorls, the apical whorls being decollated. The color is pale light brown, the four spiral rows of reddish spots are hardly visible in the subspecies."

Discussion: This is by far the most widespread of the Lesser Antillean annulariids. The variation of this species among islands has resulted in the creation of several synonyms. Its abundance in Guadeloupe on Grand-Terre, in comparison to its great rarity on Basse-Terre, highlights this species' apparent habitat needs that are furnished only in the Limestone Caribbees, but not in the Volcanic Caribbees. Robinson et al. (2009) reported it (as *Diplopoma* sp.) from Cabrit's Point in Dominica and suggested it may have been introduced by anthropogenic means at the end of the 18th century. However, given this species' preference for the coastal plain on other islands, it is also possible that this species naturally occurs on Dominica and that Cabrit's Point represents one of the very few such habitats in mountainous Dominica; *D. crenulatum* may be naturally eking out its existence on an inhospitable island at this location.

Potiez and Michaud's (1844) figure of *Cyclostoma crenulatum* is a small and stylized rendition that does not match their description (Figure 94). It clearly does not have the seven whorls mentioned in the description or any indication of the sutural crenulations formed by three or four fused ribs. In the original description (1847b) Pfeiffer compared his *C. guadeloupense* to *C. crenulatum* but asserted that it was "distinguished without trouble by sculpture" [translated]; nevertheless, by 1851 he regarded the two species as synonymous. However, the description of *C. crenulatum* clearly describes a multispiral operculum with an elevated lamella, whereas Pfeiffer described the operculum of *C. guadeloupense* as thin and cartilaginous, a difference that cannot be reconciled at this time.

Adamsiella (*Adamsiellops*) *crenulata martinensis* Coomans, 1967, was distinguished primarily by its smaller size. However, the holotype is actually larger (12.0 mm) than the average size of the species across its range (11.3 mm). This subspecies falls within the range of variation in size and sculpture and is not here considered distinct.

Etymology: *Cyclostoma crenulatum* Potiez and Michaud, 1838: *L. crenulatus*, minutely crenulate; *Chondropoma guadeloupense* Pfeiffer, 1847: *L. Guadeloupe* + *L. -ensis*, from; from Guadeloupe; *Cistula antiguensis* Pfeiffer, 1858: Antigua + *L. -ensis*, from; from Antigua; *Choanopoma occidentale* Pfeiffer, 1861: *L. occidentalis*,

western; derivation unclear (this species is one of the eastern-most in the family); *Adamsiella* (*Adamsiellops*) *crenulata martinensis* Coomans, 1967: [St.] Martin + *L. -ensis*, from; from St. Martin.

***Diplopoma* (*Diplopoma*) *decussatum* (Lamarck, 1822)**
(Figures 126–130, 150)

CHRESOONYMY

Cyclostoma decussata Lamarck, 1822: 147; Deshayes and Milne Edwards, 1838: 358; Delessert, 1841: pl. 29, figs. 6a,b,c; Pfeiffer, 1852a: 417; Baker, 1924: 91; Baker, 1928: 48; Mermod, 1952: 48–49, fig. 113.

Cyclostoma decussatum Lamarck, 1822. —Menke, 1830: 40; Sowerby, 1831: unpaginated; Reeve, 1862: pl. 22, fig. 148.

Cyclostoma decussatum "Pfeiffer." —Adams, 1847: 23; Pfeiffer, 1847a: 106; Pfeiffer, 1864: 159.

Cistula? decussata (Lamarck, 1822). Gray, 1850: 58.

Choanopoma decussatum (Lamarck, 1822). —Pfeiffer, 1851: 153; Pfeiffer, 1852a: 155; Pfeiffer, 1852b: 25; Adams and Adams, 1856: 296; Pfeiffer, 1858: 99; Bland, 1861: 358, 360; Pfeiffer, 1865: 100; Pfeiffer, 1876a: 156; Gundlach, 1878: 13; Kobelt, 1880: 279, 280; Fischer, 1885: 748; Aguayo, 1966: 14.

Choanopoma decussatum (Lamarck, 1822). —Pfeiffer, 1853: 109.

Cyclostoma (*Choanopoma*) *decussatum* Lamarck, 1822. —Shuttleworth, 1854b: 90.

Chondropoma decussatum (Lamarck, 1822). —Mörch, 1860: 12.

Choanopoma decussata (Lamarck, 1822). —Dall and Simpson, 1901: 435.

Annularia (*Annularia*) *decussatum* (Lamarck, 1822). —Henderson and Bartsch, 1921: 73.

Licina (*Choanopomops*) *decussata* (Lamarck, 1822). —Baker, 1924b: 2; Baker, 1962: 19.

Licina decussata (Lamarck, 1822). van der Schalie, 1948: 31, pl. 2, fig. 3, map 10.

Cyclostoma (*Choanopoma*) *senticosum* Shuttleworth, 1854. —van der Schalie, 1948: 31 [in possible synonymy].

non *Cyclostoma decussatum* "Lamarck" Sowerby, 1843: 165a, pl. 31A, figs. 300, 301 [= *Licina reeveana* Pfeiffer, 1852b, *fide* Bartsch, 1946: 175].

non *Cyclostoma decussatum* "Pfeiffer" Pfeiffer, 1849: 178–179, pl. 29, figs. 10–13 [pl. 1848?]; Pfeiffer, 1854c: pl. 38, figs. 38, 39 [= ?; *fide* Mermod, 1852: 48].

non *Licina decussata* "Lamarck" Parkinson, 1987: 62, fig. 53, below middle [= *Parachondria lineolatus* (Lamarck, 1822)].

Description: Shell medium-sized for genus (smallest=12.4 mm, largest=15.0, average=13.6, decollated). Elongate conic, last whorl narrowly solute for last ¼ turn. Umbilicus open, narrow. Protoconch of 1.5 rounded, smooth, tan whorls. 4–4.5 decollated remaining whorls, most specimens are decollate. Spiral sculpture of ca. 30 faint threads, widely spaced, particularly below

suture, slightly stronger in umbilicus. Axial sculpture of numerous, fine, closely spaced, erect lamellae. At intersections of spiral and axial sculpture, surface has a scalloped or finely beaded appearance. Suture shallow, not channeled, bounded by irregular groups of tufts. Tufts composed of one (rarely two fused) slightly expanded lamella. Aperture composed of an inner and an outer lip, oval, narrowly solute with previous whorl. Inner lip smooth, barely erect, inconspicuous. Outer lip narrowly expanded, much narrower toward umbilicus, scalloped on umbilical side in some specimens, with a small but prominent, concave auricle posteriorly. Base color tan to yellowish, with vague, brown spiral bands (most commonly at base), and axial, brown zig-zags. Tufts and intersections of axial and spiral sculpture white. Lip white, rarely with color pattern continuing onto front of lip. Aperture tan; outer color pattern prominent within aperture. Operculum multispiral with an oblique, erect calcareous lamella, often eroded off. Radula and anatomy unknown.

Type Material: Syntype MNHG., unnumbered.

Type Locality: "dans l'Île de Porto-Ricco."

Type Figure: Mermod, 1952: fig. 113.

Other Material (Specimens Examined: 59): Spanish Virgin Islands, Isla de Vieques, UF 28647 (11), UF 28668 (10), Monte Pirata, near summit, 260 m; UF 28670 (9), Playa Caracas; Cayo Luis Peña, UF 23271 (29).

Distribution: Puerto Rico: Widely distributed, particularly in the northeastern part of the island (van der Schalie, 1948); Spanish Virgin Islands: Isla de Vieques, Cayo Luis Peña, and probably Isla de Culebra.

Habitat: In the Spanish Virgin Islands this species is widely distributed from sea level to the summit of Monte Pirata at 260 m, the highest point on Isla de Vieques. Its specific habitat is not recorded. Most of Isla de Vieques is a National Wildlife Refuge or a U.S. Naval restricted area; Cayo Luis Peña is a wildlife sanctuary.

Variation among Specimens: Specimens vary in the intensity of the color pattern and the strength of the suture sculpture but are otherwise quite uniform in the Lesser Antilles.

Comparison with Other Species: See under *Parachondria lineolatus*.

ORIGINAL DESCRIPTION

(Translated from Latin) "Shell swollen-conic, barely perforate, decussate striations, yellowish-red; wavy longitudinal brown lines; six convex whorls; margin of lip white, reflected. 7 lignes" [ca. 15.8 mm].

Etymology: *L. decussatus*, with crossed-lines.

***Diplopoma (Diplopoma) sulculosum* (Pfeiffer, 1852)**
(Figures 131–134, 151)

CHRESONOMY

Cyclostomus sulculosus "Férussac" Pfeiffer, 1851: 166 [nomen nudum]; Pfeiffer, 1852a: 242; Pfeiffer, 1854b: 94; Watters, 2006: 497.

Cyclostomus suturale "Férussac" Pfeiffer, 1851: 166 [introduced in synonymy of *Cyclostomus sulculosus* Pfeiffer, 1851]; Pfeiffer, 1852b: 38 [in synonymy of *Cyclostomus sulculosus* Pfeiffer, 1851]; Reeve, 1861: pl. 16, fig. 105 [in synonymy of *Cyclostomus sulculosus* Pfeiffer, 1851]; Watters, 2006: 498 [in synonymy of *Cyclostomus sulculosus* Pfeiffer, 1851].

Cyclophorus sulculosus ("Férussac" Pfeiffer, 1852). — Pfeiffer, 1852b: 38.

Cyclostomus? *sulculosus* "Férussac" Pfeiffer, 1852. — Pfeiffer, 1853: 169.

Cistula sulculosa "Férussac." — Pfeiffer, 1854b: 95.

Cyclostoma sulculosum "Férussac" Pfeiffer, 1854d: pl. 41, figs. 15, 17, 22, 23; Pfeiffer, 1854e: 318.

Cyclostomus sulculosus "Férussac." Adams and Adams, 1856: 291.

Choanopoma sulculosum ("Férussac"). — Pfeiffer, 1858: 101; Bland, 1861: 358, 360, table 2; Pfeiffer, 1865: 103; Bland, 1866: 142; Pfeiffer, 1876a: 157; Kobelt, 1880: 280; Horst and Shepman, 1908: 356.

Cyclostoma sulculosum "Férussac." — Reeve, 1861: pl. 16, fig. 105.

Choanopoma sulculosum (Pfeiffer, 1852). — Kobelt, 1880: 282; Dall and Simpson, 1901: 435.

Annularia (Annularia) sulculosum ("Férussac"). — Henderson and Bartsch, 1921: 73.

Juannularia? *sulculosa* (Pfeiffer, 1852). — Watters, 2006: 91, 497.

Description: Shell small for genus (smallest=9.6 mm, largest=15.0, average=11.8, decollated). Short conic, compact, solid, last whorl narrowly solute for last 1/8th turn. Umbilicus open, narrow, occluded by outer lip. Protoconch unknown. 3.75–4 decollate remaining whorls. Spiral sculpture of ca. 14 rounded, prominent chords, of equal strength. Axial sculpture of numerous, fine, closely spaced, erect lamellae. Suture deep, channeled, largely concealed by sutural tufts. Prominent tufts composed of irregular groups of erect, weakly fused lamellae, strongly concave adaperturally, often broken off. Aperture composed of an inner and an outer lip, oval, very narrowly solute with previous whorl. Inner lip smooth, barely erect, inconspicuous. Outer lip widely expanded, thickened, lamellate, much narrower toward umbilicus, scalloped on umbilical side in some specimens, with a prominent auricle posteriorly. Base color pinkish but overlain with white axial and spiral sculpture; bands absent. First remaining whorl dark reddish-brown. Lip white. Aperture tan to chestnut. Operculum, radula, and anatomy unknown.

Type Material: Six specimens at NHMUK, unnumbered, labeled with Pfeiffer's handwriting, from the Cuming collection, are probably syntypes (Figure 131).

Type Locality: "in insula Guadeloupe."

Type Figure: Pfeiffer, 1854c: pl. 41, figs. 15, 17, 22, 23.

Other Material (Specimens Examined: 3): Anguilla, GTW 11473b (1); UF 48708 (1), Isaac's Cliff, Blackgarden's Bay; UF 48713 (1), E edge of Katouche Bay Valley.

Distribution: Anguilla: Eastern Katouche Bay Valley and Blackgarden's Bay. Isla de Vieques, Guadeloupe, Saint Bartélemy, *vide* Bland (1861, 1866); however, I have not seen specimens from these islands. It is unlikely that it occurs at Isla de Vieques. This appears to be a rare species.

Habitat: Not recorded.

Variation among Specimens: The few specimens seen vary in the degree to which the sutural tufts are developed or worn away.

Comparison with Other Species: The heavy spiral cords and unusual scalloped sutural tufts are unique.

ORIGINAL DESCRIPTION

(Translated from Latin) "Shell barely umbilicate, oblong, solid, with elevated lirae, sculpture with crowded longitudinal lines, with crossed lirae (four to five may be strong), not shining, yellowish-red; spire gradually attenuated, truncate; suture somewhat channeled, with irregular and distant thickened crenulations; 4 remaining whorls slightly convex, front of last slightly solute; aperture vertical, oval, brown inside; peristome white, double: inner a little expanded, appressed, outer narrowly expanded, top of lip a triangular elevation, to penultimate whorl very narrow, left margin narrow. Operculum ?" 14 mm length.

Discussion: This peculiar species is placed in *Diplopoma* with reservations. I have not seen the operculum but Henderson and Bartsch (1921) placed it in *Annularia* suggesting a multispiral, lamellate operculum. It strongly resembles the Cuban *Juannularia* but no intervening forms occur between Cuba and the Lesser Antilles. It does not seem closely related to any other Lesser Antillean form and may deserve its own genus.

Etymology: *L. sulcus*, wrinkled or furrowed.

ACKNOWLEDGMENTS

I am indebted to the following institutions and personnel for the images and the loan of specimens: G. Paulay, J. Slapsinsky, F. Thompson, (UF); P. Schuchert (MNHG); C. Zorn (ZMB); K. Way (NHMUK); A. Baldinger (MCZ). The manuscript greatly benefited from comments by T. Pearce (Carnegie Museum of Natural History, Pittsburgh, Pennsylvania).

LITERATURE CITED

- Adams, C.B. 1847. Catalogue of the genera and species of recent shells in the collection of C.B. Adams. Justus Cobb, Middlebury, Vermont, 32 pp.
- Adams, C.B. [Sept.] 1849a. Descriptions of forty-four supposed new species and varieties of operculated land shells from Jamaica. Contributions to Conchology (1): 1–14.
- Adams, C.B. [Sept.] 1849b. Catalogue of operculated land shells which inhabit Jamaica. Contributions to Conchology (1): 15–16.
- Adams, C.B. [April] 1851a. Catalogue of the land shells which inhabit Jamaica. Privately printed. 9 pp.
- Adams, C.B. [April] 1851b. Catalogue of the land shells which inhabit Jamaica. Contributions to Conchology (9): 179–186.
- Adams, C.B. [Nov.] 1851c. Notes on... Contributions to Conchology (10): 203–204.
- Adams, C.B. 1855. Catalogue of the land shells which inhabit Jamaica. Annals of the Lyceum of Natural History of New York 5: 103–111.
- Adams, C.B. and E. Chitty. [April] 1851a. Remarks on the habitats of certain species of land shells. Contributions to Conchology (9): 176–177.
- Adams, C.B. and E. Chitty. [May] 1851b. Remarks on the habitats of certain species of land shells. Annals of the Lyceum of Natural History of New York 5: 100–101.
- Adams, H. and A. Adams. 1856. The genera of Recent Mollusca, arranged according to their organization, 2. J. Van Voorst, London. Parts 25–28: pp. 285–412, pls. 97–112.
- Aguayo, C.G. 1966. Una lista de los moluscos terrestres y fluviales de Puerto Rico. *Stahlia* (5): 1–17.
- Arango y Molina, R. 1865. Catalogo de los moluscos terrestres i fluviales de la Isla de Cuba. Privately printed, Havana, pp. 71–149 + errata + addenda.
- Arango y Molina, R. 1867. In: P. y A. Poey, *Conspectus familiarum et index molluscorum terrestrium et aquarum dulcium insulae Cubae*. Repertorio Físico-Natural de la Isla de Cuba 2(4): 73–88.
- Arango y Molina, R. 1878. Contribucion a la fauna malacologica Cubana. G. Montiel y Comp., Habana, 280 + 35 pp.
- Baker, H.B. 1924. Land and freshwater molluscs of the Dutch Leeward Islands. Occasional Papers of the Museum of Zoology, University of Michigan (152): 1–159.
- Baker, H.B. 1928. Mexican mollusks collected for Dr. Bryant Walker in 1926, I. Occasional Papers of the Museum of Zoology, University of Michigan (193): 1–65.
- Baker, H.B. 1956. Familial names for land operculates. *The Nautilus* 70: 28–31.
- Baker, H.B. 1962. Puerto Rican land operculates. *The Nautilus* 76: 16–22, text figures.
- Bartsch, P. 1946. The operculate land mollusks of the family Annulariidae of the island of Hispaniola and the Bahama Archipelago. Bulletin of the U.S. National Museum 192: 264 pp., 38 pls.
- Beau, M. 1852. Catalogue des coquilles trouvées à l'île de la Guadeloupe. *Journal de Conchyliologie* 2: 422–431.
- Bland, T. 1852. Catalogue of the terrestrial shells of St. Thomas, West Indies. Contributions to Conchology (11): 215–224.
- Bland, T. 1854. Note on the geographical distribution of the terrestrial mollusks which inhabit the island of St. Thomas, W.I. Annals of the Lyceum of Natural History of New York 5: 74–75.
- Bland, T. 1858. Corrections and additional facts, especially as to the habitat of sundry species. Annals of the Lyceum of Natural History of New York 6: 151–154.

- Bland, T. 1861. On the geographical distribution of the genera and species of land shells of the West India Islands; with a catalogue of the species of each island. *Annals of the Lyceum of Natural History of New York* 7: 335–361.
- Bland, T. 1866. Remarks on the origin and distribution of the operculated land shells which inhabit the continent of America and the West Indies, with a catalogue of the American species. *American Journal of Conchology* 2: 54–63, 136–143, 349–370.
- Bouysse, P., D. Westercamp, and P. Andreieff. 1990. The Lesser Antilles island arc. In: Moore, J.C., Mascle, A., et al. (eds.), *Proceedings of the Ocean Drilling Program, Scientific Results* 110: 29–44.
- Censky, E.J., Hodge, K. and J. Dudley. 1998. Over-water dispersal of lizards due to hurricanes. *Nature* 395: 556.
- Clench, W.J. 1939. Land shells of Guana Island, Virgin Islands, West Indies. *Memorias de la Sociedad Cubana de Historia Natural "Felipe Poey"* 13(4): 287–288, pl. 36.
- Clench, W.J. 1950. Land shells of Mona Island, Puerto Rico. *Journal de Conchyliologie* 90: 269–276, 1 pl.
- Clench, W.J. 1956. Land shells of Barbuda Island, Lesser Antilles. *The Nautilus* 70: 69–70.
- Clench, W.J. and C.G. Aguayo. 1937. Notes and descriptions of some new land and freshwater mollusks from Hispaniola. *Memorias de la Sociedad Cubana de Historia Natural "Felipe Poey"* 11(2): 61–76, pl. 7.
- Coomans, H.E. 1967. The non-marine Mollusca of St. Martin (Lesser Antilles). *Studies on the fauna of Curaçao and other Caribbean Islands* 24: 118–145.
- Crosse, H. 1890. Faune malacologique terrestre et fluviatile de l'île de la Trinité (Antilles). *Journal de Conchyliologie* 38: 35–65.
- Crosse, H. 1891. Faune malacologique terrestre et fluviatile de l'île de Saint-Domingue. *Journal de Conchyliologie* 39: 73–210.
- Dall, W.H. and C.T. Simpson. 1901. The Mollusca of Porto Rico. *Bulletin of the U.S. Fish Commission* 20: 351–524.
- Delessert, B. 1841. *Recueil de coquilles décrites par Lamarck dans son Histoire Naturelle des animaux sans vertèbres, et non encore figurées*. Fortin, Masson et Cie, Libraires, Paris, 100 pp., 40 pls.
- Deshayes, G.-P. and H. Milne Edwards. 1838. *Histoire naturelle des animaux sans vertèbres*, 8. J.B. Baillière, Paris. 660 pp.
- Fischer, P. 1880–1887. *Manuel de conchyliologie et de paléontologie conchyliologique ou histoire naturelle des mollusques vivants et fossiles*. Librairie F. Savy, Paris, xxiv + 1369 pp., 23 pls. [p. 748, 1885].
- Gray, J.E. 1850. Nomenclature of molluscan animals and shells in the collection of the British Museum. Part I. Cyclophoridae. *British Museum*, London, 69 pp. + index.
- Guppy, R.J.L. 1864. Descriptions of new species of fluviatile and terrestrial operculate Mollusca from Trinidad. *Annals and Magazine of Natural History* (3)14(82): 243–248.
- Gundlach, J. 1878. *Apuntes para la fauna Puerto-Riqueña* (part 4). Privately printed, 54 pp.
- Henderson, J.B. and P. Bartsch. 1921. A classification of the American operculate land mollusks of the family Annulariidae. *Proceedings of the U.S. National Museum* 58: 49–82.
- Hinkley, A.A. 1885. *Catalogue of land and fresh water shells in the cabinets of A.A. Hinkley*. Privately printed, DuBois, Illinois. 27 pp.
- Horst, R. and M.M. Shepman. 1908. *Muséum d'histoire naturelle des Pays-Bas*. 13. Catalogue systématique des mollusques (gastropodes prosobranches et polyplacophores). E.J. Brill, Leiden, xii + 572 pp.
- Iturralde-Vinent, M.A. and R.D.E. MacPhee. 1999. Paleogeography of the Caribbean region: implications for Cenozoic biogeography. *Bulletin of the American Museum of Natural History* 238: 1–95.
- Jacobson, M.K. 1968. Land Mollusca of St. Croix, Virgin Islands. *Sterkiana* (32): 18–28.
- Jacobson, M.K. and K.J. Boss. 1973. The Jamaican land shells described by C.B. Adams. *Occasional Papers on Mollusks* 3(47): 305–519.
- Kobelt, W. 1879. *Illustriertes Conchylienbuch* 2, part 6: pp. 145–176, pls. 51–60.
- Kobelt, W. 1880. *Illustriertes Conchylienbuch* 2, part 9: pp. 265–312, pls. 81–90.
- Kohn, A.J. 1992. A chronological taxonomy of *Conus*, 1758–1840. *Smithsonian Institution Press*, Washington D.C. 315 pp.
- Lamarck, J.B.P.A. de M. de. 1822. *Histoire naturelle des animaux sans vertèbres, présentant les caractères généraux et particuliers de ces animaux, leur distribution, leurs classes, leurs familles, leurs genres, et la citation des principales espèces qui s'y rapportent; précédée d'une introduction offrant la détermination des caractères essentiels de l'animal, sa distinction du végétal et des autres corps naturels; enfin, l'exposition des principes fondamentaux de la zoologie*. Tome sixième. Deuxième partie. Chez l'auteur, au jardin du Roi, 232 pp.
- Martens, K.E. von. 1882. Descriptions of two species of land shells from Porto Rico, W.I. *Annals of the New York Academy of Sciences* 2: 370–371.
- Mazé, H. 1890. Supplément au catalogue révisé des mollusques terrestres et fluviatiles de la Guadeloupe et de ses dépendances. 1. Guadeloupe proprement dite et Grande-Terre. *Journal de Conchyliologie* 38: 19–34.
- Menke, C.T. 1830. *Synopsis methodica molluscorum generum omnium et specierum earum, etc.*, 2nd ed. G. Uslar, Pymont, 168 pp.
- Mermod, G. 1952. Les types de la collection Lamarck au Muséum de Genève. Mollusques vivants, III. *Revue Suisse de Zoologie* 59(2): 24–97.
- Mörch, O.A.L. 1854. Fortegnelse over Prof. R. af D. C.F.L. hencks efterladte Conchyliensamling. Kjøbenhavn, C.F. Graebese, 34 pp.
- Mörch, O.A.L. 1860. Catalogue d'une collection de coquilles dont la vente doit commencer le 4 Decbr. 1860. Copenhague, C.F. Graebese. 26 pp.
- Parkinson, B. 1987. *Tropical landshells of the world*. Verlag Christa Hemmen, Weisbaden. 279 pp, 77 pls.
- Petit de la Saussaye. 1850. Notice sur le genre *Cyclostoma*, et catalogue des espèces appartenant à ce genre. *Journal de Conchyliologie* 1: 36–55.
- Pfeiffer, L. [March] 1846a. Revision der Gattung *Cyclostoma*. *Zeitschrift für Malakozoologie für März 1846* [3]: 32–48.
- Pfeiffer, L. 1846b. Die gedeckelten Lungenschnecken. (Helicinaea et Cyclostomacea). *Systematisches Conchylien-Cabinet von Martini und Chemnitz* (Küster ed.) 1. Part 19. Installment 61: pls. 1–3, 5–7, pp. 1–24.
- Pfeiffer, L. [July] 1847a. Uebersicht aller bekannten Arten von Cyclostomaceen. *Zeitschrift für Malakozoologie* 4: 101–112.
- Pfeiffer, L. 1847b. [foot note on p. 124 to] Philippi, A.R. *Testaceorum novorum centuria*. *Zeitschrift für Malakozoologie* 4: 113–127.

- Pfeiffer, L. 1847c. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 64: pls. 8, 10, 12–14, 17, pp. 25–40.
- Pfeiffer, L. 1847d. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 70: pls. 9, 11, 15, 16, 18, 19, pp. 41–56.
- Pfeiffer, L. 1848. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 82: pls. 26–30, pp. 97–144.
- Pfeiffer, L. 1849. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 85: pp. 145–176.
- Pfeiffer, L. [June] 1850a. Neue Cyclostomaceen. Zeitschrift für Malakozoologie 7(4): 63–64.
- Pfeiffer, L. [July] 1850b. Beschreibungen neuer Landschnecken. Zeitschrift für Malakozoologie 7(5): 65–80.
- Pfeiffer, L. 1851. Conspectus emendatus generum et specierum Cyclostomaceorum. Zeitschrift für Malakozoologie 8(9): 129–144; 8(10): 145–160; 8(11): 161–176; 8(12): 177–178.
- Pfeiffer, L. [post Aug., but before Dec.] 1852a. Monographia pneumonoporum viventium. Cassellis, T. Fischer, 435 pp.
- Pfeiffer, L. 1852b. Conspectus cyclostomaceorum emendatus et auctus. Pneumonoporum monographie prodromus. T. Fischer, Cassellis, pp. 1–50, addenda.
- Pfeiffer, L. 1852c. Diagnoses specierum in Diariis Societatis Zoologicae Londinensis 1850 et 1851 descriptarium. T. Fischer, Cassellis, pp. 50–73.
- Pfeiffer, L. 1853. Catalogue of Phaneropneumona, or terrestrial operculated Mollusca, in the British Museum. British Museum, London, 324 pp.
- Pfeiffer, L. [March] 1854a. Descriptions of sixty-six new land shells, from the collection of H. Cuming, Esq. Proceedings of the Zoological Society for 1852 (20): 56–70.
- Pfeiffer, L. [April] 1854b. Nachträge zur Monographia Pneumonoporum. Malakozoologische Blätter 1: 80–111.
- Pfeiffer, L. 1854c. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 133: pls. 37–42, pp. 269–308.
- Pfeiffer, L. 1854d. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 136: pls. 43–48, pp. 309–356.
- Pfeiffer, L. 1854e. Die gedeckelten Lungenschnecken. (Helicinae et Cyclostomacea). Systematisches Conchylien-Cabinet von Martini und Chemnitz (Küster ed.) 1. Part 19. Installment 137: pls. 49, 50, pp. 357–400.
- Pfeiffer, L. 1855. Beiträge zur Molluskenfauna Westindiens. Malakozoologische Blätter 2: 98–107, pl. 4.
- Pfeiffer, L. 1857. Diagnosen neuer Landschnecken. Malakozoologische Blätter 4: 155–158.
- Pfeiffer, L. 1858. Monographia pneumonoporum viventium, Supplementum Primum. Theodor Fischer, Cassellis. 249 pp.
- Pfeiffer, L. 1859. Zur Molluskenfauna der Insel Cuba. Malakozoologische Blätter 6: 66–102.
- Pfeiffer, L. 1861. Beschreibung neuer Landschnecken. Malakozoologische Blätter 7: 213–217, pl. 3.
- Pfeiffer, L. 1862. Beschreibung neuer Landschnecken. Malakozoologische Blätter 9: 151–156.
- Pfeiffer, L. 1864. Zur Molluskenfauna von Cuba. Malakozoologische Blätter 11: 157–161.
- Pfeiffer, L. 1865. Monographia pneumonoporum viventium, Supplementum Secundum. Theodor Fischer, Cassellis. 284 pp.
- Pfeiffer, L. 1866. Beschreibung neuer Landschnecken. Malakozoologische Blätter 13: 76–91.
- Pfeiffer, L. 1876a. Monographia pneumonoporum viventium, accedente fossilium enumeratione. Supplementum tertium, monographiae auriculaceorum. Parte secunda auctum. T. Fischer, Cassel, x + 479 pp.
- Pfeiffer, L. 1876b. Beschreibung der neuer von Weinland diagnosticirten Schnecken von Haiti. Malakozoologische Blätter 23: 230–234.
- Potiez, V.L.V. and A.L.G. Michaud. 1838. Galerie des mollusques ou catalogue méthodique, descriptif et raisonné des mollusques et coquilles du Muséum de Douai, 1. Baillière, Paris, 560 pp. + Atlas. 70 pls [1844].
- Reeve, L.A. 1861–1862. Monograph of the genus *Cyclostoma*. Conchologica Iconica 13. Reeve & Co., London [pls. 1–8, Nov. 1861a; pls. 9–17, Dec. 1861b; pls. 18–23, Apr. 1862].
- Reeve, L.A. [Jan. – Feb.] 1863a,b. Monograph of the genus *Chondropoma*. Conchologica Iconica 14. Reeve and Co., London [pls. 1–8 + text, Jan. 1863a; pls. 9–11 + text, Feb. 1863b].
- Robinson, D.G., A. Hovestadt, A. Fields, and A.S.H. Breure. 2009. The land Mollusca of Dominica (Lesser Antilles), with notes on some enigmatic or rare species. Zoologische Mededelingen 83: 615–650.
- Shuttleworth, R.J. 1854a. Catalogue of the terrestrial and fluviatile shells of St. Thomas, West Indies. Annals of the New York Lyceum 4(2/4): 68–73.
- Shuttleworth, R.J. [June] 1854b. Beiträge zur näheren Kenntniss der Land- und Süßwasser-Mollusken der Insel Portorico. Mittheilungen der naturforschenden Gesellschaft in Bern (321–322): 89–103.
- Shuttleworth, R.J. 1858. Corrections and additional facts, especially as to the habitat of sundry species. Annals of the New York Lyceum 6: 151–155.
- Solem, A. 1960. Notes on South American non-marine Mollusca. Annali del Museo Civico di Storia Naturale Giacomo Doria 71: 416–435, pls. 14–15.
- Solem, A. 1961. A preliminary review of the pomatiasid land snails of Central America (Mollusca, Prosobranchia). Archiv für Molluskenkunde 90(4/6): 191–213.
- Sowerby I, G.B. [& J. de C. Sowerby]. 1831. The genera of Recent and fossil shells 2 (35). E.J. Stirling, London. Unpaginated, figs. 1–4.
- Sowerby II, G.B. 1843. Thesaurus conchyliorum, or monographs of genera of shells, 1. Monograph of the genus *Cyclostoma*. Sowerby, London, pp. 89–156.
- Speed, R.C. 1989. Tectonic evolution of St. Croix: implications for tectonics of the northeastern Caribbean. In: Hubbard, D.K. (ed.), Terrestrial and Marine Geology of St. Croix, US Virgin Islands. 12th Caribbean Geological Conference, St. Croix: 9–22.
- Torre, C. de la and P. Bartsch. 1938. The Cuban operculate land shells of the subfamily Chondropominae. Proceedings of the U.S. National Museum 85(3039): 193–423, pls. 7–39.
- Torre, C. de la and P. Bartsch. 1941. The Cuban operculate land mollusks of the family Annulariidae, exclusive of the subfamily Chondropominae. Proceedings of the U.S. National Museum 89(3096): 131–385, pls. 9–57.
- Tryon, G.W. 1867. Notices and reviews of new works. American Journal of Conchology 3(1): 82–103.

- van der Schalie, H. 1948. The land and fresh-water mollusks of Puerto Rico. Miscellaneous Publications, Museum of Zoology, University of Michigan (70): 1-134.
- Van Osselaer, C. 1999. Counting shell whorls. Remarks. Apex 14: 33-42.
- Vernhout, J.H. 1914. The land- and freshwater-molluscs of the Dutch West-Indian islands. Notes from the Leyden Museum 36: 177-189.
- Watters, G.T. 2006. The Caribbean landsnail family Annulariidae. A revision of the higher taxa and catalog of the species. Backhuys Publ., Leiden, 584 pp.
- Weinland, D.F. 1876. Diagnoses molluscorum Haitiensium. Malakozoologische Blätter 23: 170-174.
- Weinland, D.F. 1880. Zur Molluskenfauna von Haiti. Jahrbücher der Deutschen Malakozoologischen Gesellschaft nebst Nachrichtenblatt 7(4): 338-378, pl. 12.



Watters, G. Thomas. 2014. "A preliminary review of the Annulariidae (Gastropoda: Littorinoidea) of the Lesser Antilles." *The Nautilus* 128(3), 65–90.

View This Item Online: <https://www.biodiversitylibrary.org/item/220914>

Permalink: <https://www.biodiversitylibrary.org/partpdf/220910>

Holding Institution

Smithsonian Libraries and Archives

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: In Copyright. Digitized with the permission of the rights holder

Rights Holder: Bailey-Matthews National Shell Museum

License: <https://creativecommons.org/licenses/by-nc-sa/4.0/>

Rights: <https://www.biodiversitylibrary.org/permissions/>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.