

Two New Species of *Tenorioconus* (Gastropoda: Conidae) from Aruba

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ABSTRACT Two new members of the Caribbean Province endemic conid genus *Tenorioconus* Petuch and Drolshagen, 2011 are described from the Netherlands Antilles island of Aruba. One of the new species, *Tenorioconus monicae* n. sp., was found to belong to the *Tenorioconus mappa* species complex and is most similar to the Venezuelan coastal species *T. sanguineus* (Kiener, 1850) and *T. caracanus* (Hwass, 1792). The other new species, *T. rosi* n. sp., was found to belong to the *T. aurantius* species complex and is most similar to the Aruban endemic *T. curassaviensis* (Hwass, 1792) and the Curacao and Bonaire endemic *T. aurantius* (Hwass, 1792). The discovery of these two new taxa demonstrates that three distinct, endemic species of *Tenorioconus* occur in shallow water areas around Aruba.

KEY WORDS Aruba, *Tenorioconus*, endemic species, Grenadian Subprovince, *Tenorioconus monicae*, *Tenorioconus rosi*.

INTRODUCTION

Of the 19 genera of the family Conidae found in the Caribbean Molluscan Province (Petuch, 2013; Tucker and Tenorio, 2013), the genus *Tenorioconus*, Petuch and Drolshagen, 2011 stands out as being one of the most aesthetically-pleasing and beautiful groups of cone shells. Since the mid-18th Century, members of the genus have been considered to be among the most desirable of collectible shells and even the species name of the genotype, *Tenorioconus cedonulli* (Linnaeus, 1767) (meaning “I yield to none”), reflects the high esteem to which these cones were held by early European naturalists. As presently understood, 18 species of *Tenorioconus* are known to inhabit the Nicaraguan and Grenadian Subprovinces of the Caribbean Province, with the westernmost species, *T. harlandi* (Petuch, 1987) being found along the coast of Honduras and the Bay Islands (western Nicaraguan

Subprovince) and with the easternmost and northernmost species, *T. insularis* (Gmelin, 1791) being found on Martinique and St. Lucia Islands in the Windward Islands of the Lesser Antilles (Grenadian Subprovince) (Petuch, 2013: 131, 182). Based on the proportionally-large relative sizes of their protoconchs, *Tenorioconus* species can be seen to have direct development, lacking a dispersing planktotrophic larva and hatching directly into a free-crawling juvenile. This lack of vagility has caused many species to become isolated on widely-separated island groups or islands that are separated by deep trenches, producing a classic allopatric vicariance speciation pattern (Valentine, 1973; Briggs, 1995; Petuch, 2013:131-132).

Within the Grenadian Subprovince, the island of Aruba stands out as being of special interest in that it represents the westernmost end of this biogeographical subdivision and is in direct

contact with the Venezuelan Subprovince (Petuch, 2013: 134). Unlike the intervening islands of the Grenadian Subprovince along the northern coast of Venezuela, which are all separated from the mainland by deep water areas, Aruba is actually part of the Venezuelan continental shelf. Because of this connection to the shallow water malacofauna of Venezuela, many of the resident Aruban gastropods are also shared with Venezuela, including the olivids *Americoliva fulgurator* (Röding, 1798), *Americoliva reclusa* (Marrat, 1871), and *Eburna glabrata* (Linnaeus, 1758), the volutid *Voluta musica* (Linnaeus, 1758), the conid *Lindaconus baylei* (Jousseau, 1872) (= *arubaensis* Nowell-Usticke, 1968), and the conilithid *Perplexiconus puncticulatus* (Hwass, 1792). Besides these shared species with the Venezuelan Subprovince, the Aruban malacofauna also contains a distinctive and characteristic component of endemic species, the largest number found on any of the islands of the Grenadian Subprovince. Some of these unique Aruban taxa include the cone shells *Arubaconus hieroglyphus* (Duclos, 1833) (with the genus *Arubaconus* Petuch, 2013 being endemic to the island) and *Tenorioconus curassaviensis* (Hwass, 1792) (Figure 3G, H, and I), the muricid *Murexiella hilli* Petuch, 1987, the olivids *Americoliva sargenti* (Petuch, 1988) and *Eburna balteata* (Sowerby I, 1823), and the conilithid *Perplexiconus wendrosi* (Tenorio and Afonso, 2013).

Until recently, only two species of *Tenorioconus* were known from Aruba; the endemic *T. curassaviensis* (Hwass, 1792), a distinctively-shaped but variably-colored species (Figure 5L, M, and N), and another, smaller species that had been incorrectly referred to the taxon “*aurantius*” by several authors for nearly the past half century (*i.e.* Seamon and Seamon, 1967; Berschauer and Ros, 2014). Within the past few years, however, an

inspired local Aruban-Dutch diver and naturalist, Leo G. Ros, has conducted intensive surveys of relatively unexplored and uncollected areas around the island and has uncovered yet another species of *Tenorioconus*, along with more specimens of the previously-reported Aruban “*Tenorioconus aurantius*”. Subsequent study showed that both species were new to science and these are described in the following sections. The discovery of these new cones by Leo G. Ros brings the combined number of Aruban endemic conoideans to five, the most endemic cone shells found on any one island in the southern Grenadian Subprovince.

Based on differences in overall shell morphology, the genus *Tenorioconus* appears to actually comprise two separate species complexes; one composed of broad, stocky species with an internal constriction along the anterior end of the columella (and are morphologically close to *T. mappa* (Lightfoot, 1786); referred to here as the “*T. mappa* species complex”; Figure 5A, B), and the other composed of thinner, more slender species that lack the internal columellar constriction (Vink and von Cosel, 1985) (and are morphologically similar to *T. aurantius* (Hwass, 1792); referred to here as the “*T. aurantius* species complex”; Figure 5L, M, N). All the known members of these two species groups are listed on Table 1 at the end of this paper. The new species discovered by Leo G. Ros each belong to one of these two separate groups, with one being a member of the *T. mappa* species complex (described next) and other being a member of the *T. aurantius* species complex (described later in this paper). The holotypes of the new taxa are deposited in the type collection of the Department of Malacology, Los Angeles County Museum, and bear LACM numbers.

SYSTEMATICS**Class Gastropoda****Subclass Orthogastropoda****Superorder Caenogastropoda****Order Sorbeoconcha****Infraorder Neogastropoda****Superfamily Conoidea****Family Conidae****Subfamily Puncticulinae****Genus *Tenorioconus* Petuch and Drolshagen, 2011*****Tenorioconus monicae* Petuch and Berschauer, new species
(Figures 1, 3A, B, C; 6C; 7)**

Description: Shell of average size for genus, heavy and thickened, proportionally wide across shoulder, inflated and stocky; shoulders of penultimate whorl and body whorl both smooth and rounded, with broad, slightly raised carina, producing shallowly canaliculate spire whorls; spire proportionally high, protracted, elevated, and broadly pyramidal, with stepped, subscalariform whorls; subsutural areas sloping; early whorls of spire heavily ornamented with 18-20 large rounded knobs; concave spire channel sculptured with 3-4 thin, very fine spiral threads; body whorl smooth and shiny, ornamented with 15-18 very thin, low spiral threads, which become more closely-packed toward anterior end; aperture proportionally narrow, flaring slightly toward anterior end; anterior end of columella with wide, broad cord, producing distinct constriction or narrowing of anterior apertural canal; base shell color pale violet-lavender or bluish-tan, overlaid with variable amounts of amorphous flammules and patches; flammules varying in color from dark reddish-orange (as in holotype), to orange-tan, to dark tannish-yellow, contrasting greatly with the pale violet or blue base color; amorphous flammules and base color overlaid with 52-60

thin, closely-packed lines of dark brown and white dots; edge of spire suture marked with single row of very small, thin, evenly-spaced hairline flammules; spire whorls marked with large, widely-spaced, elongated reddish-brown flammules, which often align in radiating rows; anterior end of body whorl darker purple or purple-tan; interior of aperture lavender-purple or pale lavender-tan; earliest whorls pale orange-tan; periostracum very thin, smooth, pale yellow to transparent.



Figure 1. *Tenorioconus monicae*, n. sp. Holotype

Type Material: HOLOTYPE- length 48.29 mm, LACM 3429 (Figure 3A). Other material studied includes a specimen from the same locality as the holotype, in the research collection of the senior author measuring 42.10 mm, two specimens from the same locality as the holotype, in the research collection of the junior author (shown here on Figure 3 as images B and C) measuring 52.23 and 60.82 mm respectively, as well as photographs of twenty three additional specimens from the same

locality as the holotype in the collection of Leo G. Ros.

Type Locality: Found in 6 m depth, exposed on coarse carbonate sand beneath a filamentous green algal mat, off Malmok, Aruba, Netherlands Antilles.

Range: The new species is endemic to the island of Aruba, Netherlands Antilles.

Ecology: *Tenorioconus monicae* prefers coarse carbonate sediment sea floors, beneath filamentous green algae near Turtle Grass (*Thalassia testudinum*) beds, in depths of 5-10 m (see Figure 7). Here, the new species feeds on amphinomid polychaete sea worms and is one of the dominant vermivores of the Turtle Grass beds and adjacent areas.

Etymology: The taxon honors Monica Moron from Punto Fijo, Venezuela, and Aruba, who is an avid amateur naturalist and one of the co-discoverers of the new species.

Discussion: With its stocky, heavy, and broad-shouldered shell and internal columellar constriction, *Tenorioconus monicae* can be seen to be a member of the *T. mappa* species complex. Of the species within this group that are found along the southern section of the Grenadian Subprovince, *T. monicae* most closely resembles *T. sanguineus* (Kiener, 1850) (Figure 5E, F) from the Venezuelan coastline (Puerto la Cruz, Anzoategui State to Cumana and the Cumana Peninsula, the Golfo de Cariaco, to Isla Margarita, Isla Cubagua, and Isla Coche, Nueva Esparta State). The new species differs from its Venezuelan congener in being a stockier, broader, and heavier shell with a much wider shoulder, in having a much more rounded and less angled shoulder (as opposed to the sharply-angled shoulder of the thinner and narrower *T. sanguineus*), and in having broader

and more distinctly pyramidal spire whorls with noticeably sloping subsutural areas. *Tenorioconus sanguineus* also lacks the distinctive pale lavender or purple shell base color and lavender aperture interior that characterize *T. monicae*, having, instead, a white or pale yellow-white base color and white apertural interior.

In having a proportionally broad, stocky shell, the new Aruban species is also similar to *Tenorioconus caracanus* (Hwass, 1792) (Figure 5J, K) from Margarita Island, Nueva Esparta State, Venezuela and the Isla La Tortuga group off the Venezuelan coast. *T. monicae* differs from *T. caracanus* in being a more slender species with a more elongated shell profile, in having a proportionally higher, more protracted spire, and in being a more colorful shell, with larger and more numerous amorphous flammules and color patches. Like *T. sanguineus*, *T. caracanus* also lacks the pale purple or lavender base color of the body whorl and lavender aperture color of *T. monicae*, having, instead, a white aperture and white shell base color. In having densely-packed rows of dark brown and white dots and a high, pyramidal spire, *T. monicae* is also similar to *T. granarius* (Kiener, 1847) (Figure 5C, D), a wide-ranging southern Caribbean (Venezuelan Subprovince) species that ranges from the Golfo de Uraba, Panama-Colombia border, to the Golfo de Venezuela and Golfo Triste, Venezuela. The new Aruban species differs from its wide-ranging congener in having a stockier, broader shell with distinctly more convex sides, and in having a broader, more pyramidal spire. Some specimens of *T. granarius* have a pale purple or lavender shell base color similar to that of *T. monicae* (the form or subspecies *sanctaemarthae* Vink, 1977 from Colombia), but these specimens never exhibit the dense reddish flammulate color patterns seen on the new Aruban endemic.

***Tenorioconus rosi* Petuch and Berschauer,
new species
(Figures 2, 4A-G; 6D; 7)**

Description: Shell small for genus, averaging only around 21 mm in length, elongated, with very high, protracted spire and almost biconic appearance, and with slightly convex sides; shoulder distinctly angled, ornamented with 15-20 large, elongated, evenly-spaced knobs; subsutural areas of spire whorls slightly sloping; spire scalariform, with distinctly stepped whorls, ornamented with 4-6 extremely fine spiral cords; body whorl shiny, ornamented with 18-24 large, prominent, raised spiral cords; spiral cords, in turn, ornamented with proportionally-large, evenly-spaced, rounded beads, giving shell rough-textured appearance; spiral cords and beaded sculpture become larger on anterior one-third of body whorl; shell color white or pale bluish-white, overlaid with proportionally very large, widely-spaced longitudinal flammules, arranged in a zebra-like pattern; longitudinal flammules, which extend from shoulder to anterior tip, vary in color from dark reddish-brown, to dark brown, to black, with most specimens having dark chestnut-brown markings; white base color and dark brown zebra flammules overlaid with 15-20 evenly-spaced rows of tiny dark brown and white spots, which correspond to raised spiral cords; spire white, sparsely marked with very few widely-spaced dark brown flammules; early whorls dark orange-tan, turning to white on later whorls of teleoconch; aperture narrow and straight, white on interior, often with external brown flammules showing through within the interior; protoconch proportionally very large, bulbous, mammilate, composed of one and one-half whorls, colored dark orange-brown (Figure 6D); periostracum thin, smooth, pale yellow to transparent.



Figure 2. *Tenorioconus rosi* n. sp. Holotype

Type Material: HOLOTYPE- length 22.40 mm, LACM 3430 (Figure 4G). Other material studied includes five specimens from the same locality as the holotype, in the research collection of the senior author measuring 13.87, 14.78, 14.84, 15.06 and 16.88 mm respectively, and eight specimens from the same locality as the holotype, in the research collection of the junior author measuring 13.50, 14.45, 14.65, 15.07, 15.55, 17.76, 18.08, and 21.88 mm respectively (six of which are shown here on Figure 4 as images A through F), as well as photographs of fifteen additional specimens from the same locality as the holotype in the collection of Leo G. Ros.

Type Locality: Found in 6 m depth, exposed on carbonate sediments beneath a filamentous green algal mat, off Malmok, Aruba, Netherlands Antilles.

Range: The new species is endemic to the island of Aruba, Netherlands Antilles.

Ecology: *Tenorioconus rosi* prefers coarse carbonate sediment sea floors, beneath filamentous green algae near Turtle Grass

(*Thalassia testudinum*), in depths of 5-10 m (see Figure 7). Here, the new species feeds on very small amphinomid polychaete sea worms and probably avoids competition with the two larger vermivorous congeners, *T. monicae* and *T. curassaviensis*, by having specialized in feeding on smaller prey.

Etymology: Named for Leo G. Ros, of Noord, Aruba and Scheveningen, Netherlands, an avid naturalist and molluscan explorer who discovered the new species and, through his extensive diving and exploration around the island, has greatly contributed to our knowledge of the Aruban molluscan fauna.

Discussion: This unusual new endemic species represents the smallest-known member of the genus *Tenorioconus*. Because of its slender and elongated shell shape and lack of an internal constriction on the anterior area of the columella, *T. rosi* can be seen to belong to the *T. aurantius* species complex. Of the known members of this group, *T. rosi* is morphologically closest to *T. curassaviensis* (Hwass, 1792) (Figure 5G, H, I), also endemic to Aruba, and shares the same type of shell outline, with slightly convex sides. The new species differs from its co-endemic congener, however, in being consistently a much smaller shell, in having a proportionally narrower, higher, and more stepped spire, in its large bulbous protoconch, in having a rougher-textured shell, ornamented with strong, beaded spiral cords, and in being a drabber, less-colorful shell, with only widely separated dark brown longitudinal zebra flammules on a white background (as opposed to the intense reds, oranges, and purples seen on *T. curassaviensis*). *Tenorioconus rosi* is also similar to *T. aurantius* from Curacao and Bonaire (Figure 5L, M, N), but, again, differs in being a consistently much smaller shell, by having a stockier and less-

slender shell with distinctly more convex sides, in being a rougher-textured shell, being ornamented with coarse spiral cords and beads, in having a proportionally higher spire, and in being a drabber, less-colorful shell, with only brown or black longitudinal zebra flammules on a white base color.

Tenorioconus rosi has been known to exist in the Malmok area for several decades now, and it is undoubtedly the shell that previously had been misidentified, by several authors, as the “Aruban *aurantius*”. Stating that “...Aruba specimens appeared to be smaller...”, Seamon and Seamon (1967: 8) recognized the presence of this distinctive cone on Aruba but referred to it as “*aurantius*”. A single dead specimen of *T. rosi* was found by the junior author in July 2013 while diving at Malmok with Leo G. Ros, and initially identified as *T. aurantius* at the time. (Berschauer and Ros, 2013) Of the three known members of the *T. aurantius* species complex found on the islands of Aruba, Curacao, and Bonaire, the new species is the least variable in coloration, having large flammules that are consistently a dark reddish-brown, dark brown, or black color.

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TABLE 1. List of Valid *Tenorioconus* Species Arranged by Biogeography**CARIBBEAN PROVINCE****NICARAGUAN SUBPROVINCE****Bay Islands; Coastal Honduras and Nicaragua; Corn Island***Tenorioconus harlandi* (Petuch, 1987)*Tenorioconus juliandreae* (Cargile, 1995)**San Blas Islands***Tenorioconus panamicus* (Petuch, 1990)**VENEZUELAN SUBPROVINCE****Colombia, Gulf of Venezuela, Golfo Triste***Tenorioconus granarius* (Kiener, 1847)**Coastal Venezuela, Isla Margarita, Isla Coche, Isla Cubagua***Tenorioconus sanguineus* (Kiener, 1850)*Tenorioconus caracanus* (Hwass, 1792)*Tenorioconus trinitarius* (Hwass, 1792)**GRENADIAN SUBPROVINCE****Aruba***Tenorioconus curassaviensis* (Hwass, 1792)*Tenorioconus monicae* Petuch and Berschauer n. sp.*Tenorioconus rosi* Petuch and Berschauer n. sp.**Curacao and Bonaire***Tenorioconus aurantius* (Hwass, 1792)**Los Roques Atoll, Islas Los Testigos, Islas Las Aves***Tenorioconus duffyi* (Petuch, 1992)**Trinidad and Tobago, Barbados***Tenorioconus mappa* (Lightfoot, 1786)**Grenada, Grenadines***Tenorioconus pseudoaurantius* (Vink and von Cosel, 1985)*Tenorioconus dominicanus* (Hwass, 1792)**St. Vincent***Tenorioconus cedonulli* (Linnaeus, 1767)**St. Lucia, Martinique***Tenorioconus insularis* (Gmelin, 1791)**PANAMIC PROVINCE***Tenorioconus archon* (Broderip, 1833)**REFERENCES****Berschauer, D. P. and L. G. Ros, 2014.**A Survey of Mollusks Collected on Aruba. *The Festivus* 46 (3): 54-62.**Briggs, J. C., 1995.** *Global Biogeography.*

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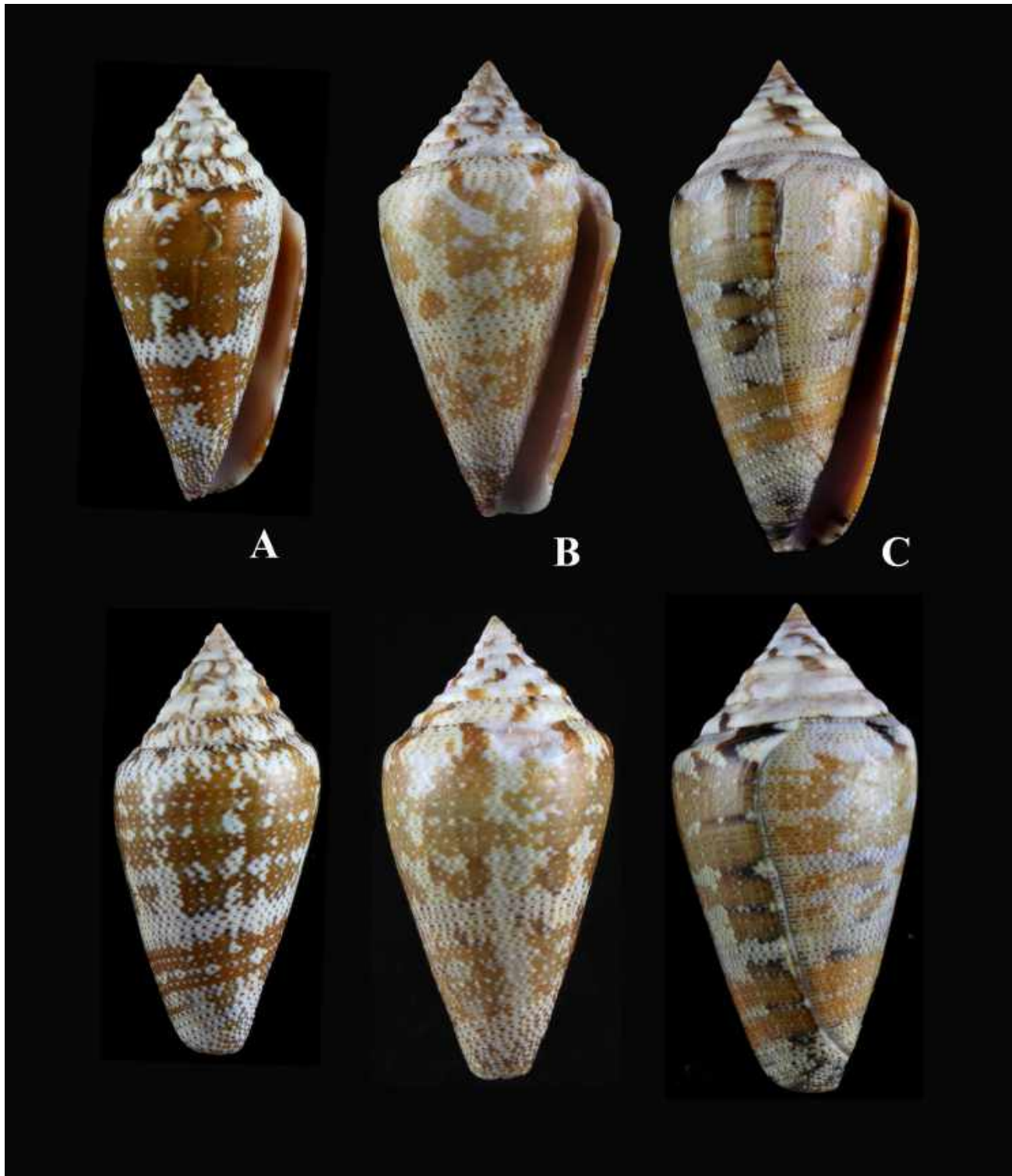


Figure 3: *Tenorioconus monicae* n. sp., **A**= Holotype (LACM 3429) length 48.23mm; **B, C** = other material studied, length 52.23 and 60.82 mm respectively, Berschauer Collection.

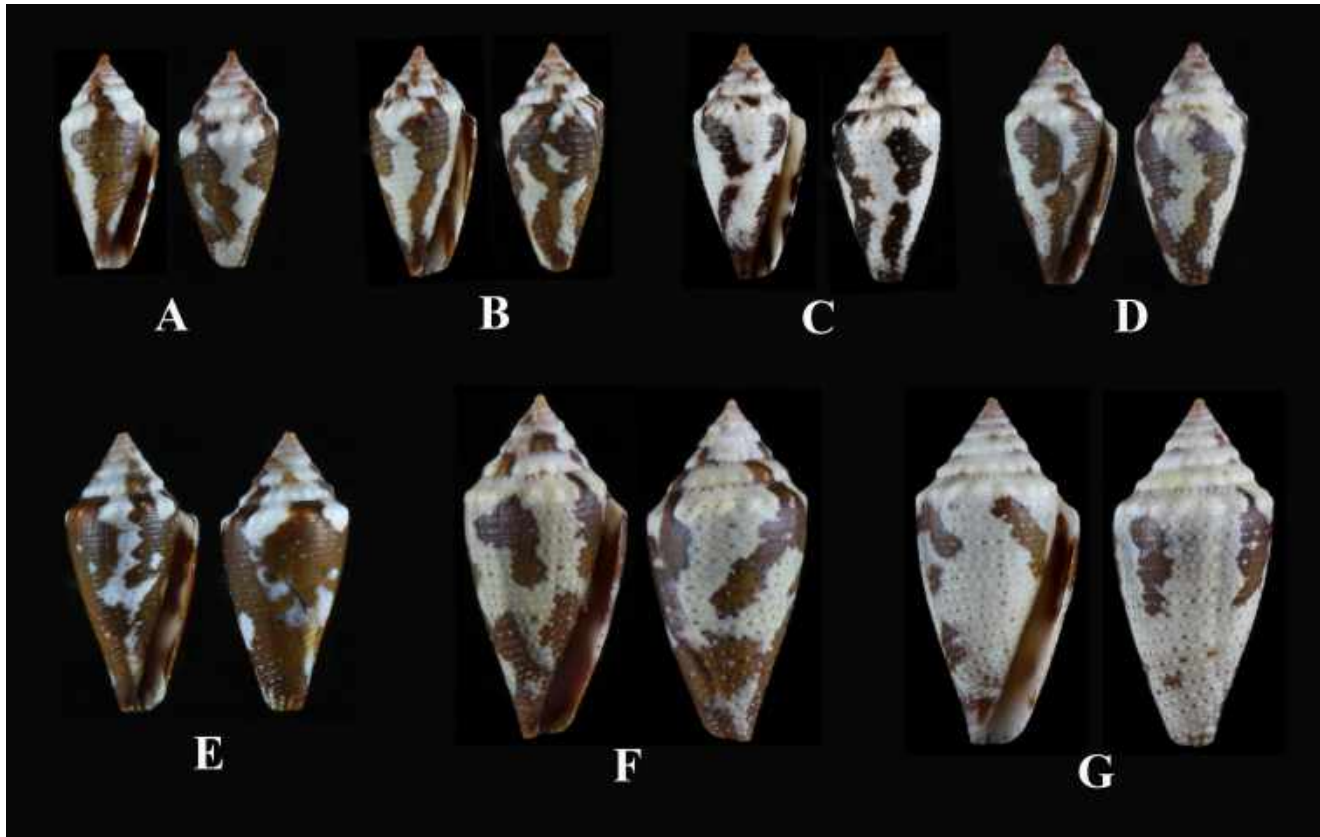


Figure 4: *Tenorioconus rosi* n. sp., **G** = Holotype (LACM 3430) length 22.40 mm; **A-F** = other material studied, length 13.50, 14.45, 15.07, 15.55, 17.76, and 21.88 mm respectively, Berschauer Collection. Note the distinctive proportionally-large bulbous protoconch.



Figure 7: Image of live specimens of *Tenorioconus monicae* and *T. rosi* *in situ*, removed from under the filamentous green algae and placed immediately adjacent to their natural habitat. (photo courtesy of Leo G. Ros, taken with a Canon GoPro).

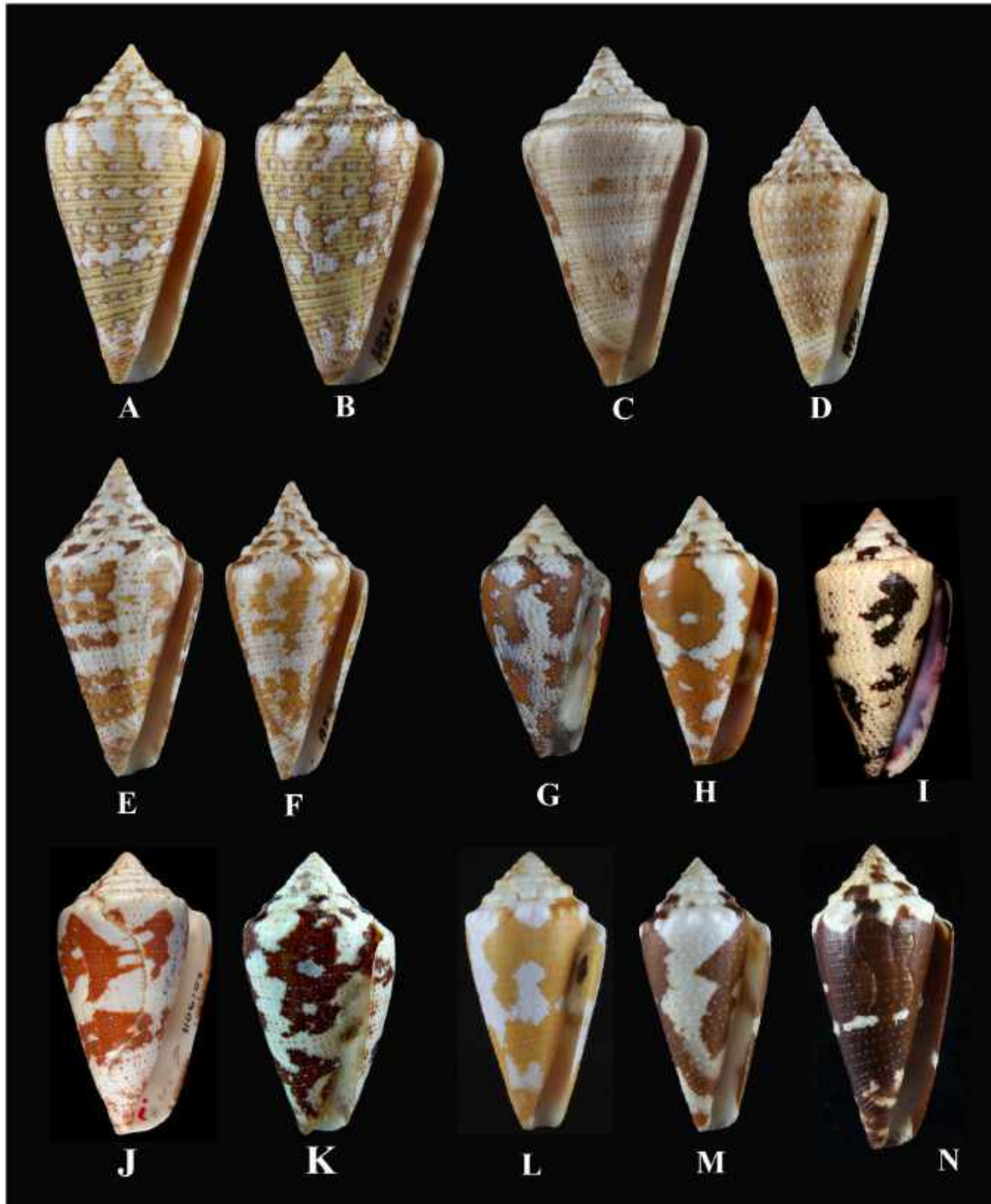


Figure 5: Various related *Tenorioconus* species. **A, B** = *T. mappa* (Lightfoot, 1786) 57.40 and 56.69 mm from Tobago; **C, D** = *T. granarius* (Kiener, 1847) 56.49 mm (*sanctaemarthae* form, from the Gulf of Colombia; from the Rick Negus Collection) and 44.41 mm from Colombia; **E, F** = *T. sanguineus* (Kiener, 1847) 47.60 and 38.58 mm from Colombia (from the Rick Negus Collection); **G, H, I** = *T. curassaviensis* (Hwass, 1792) 38.65 mm, 40.69 mm (from the Rick Negus Collection), and 39.20 mm (from the Petuch Collection) from Malmok, Aruba; **J, K** = *T. caracanus* (Hwass, 1792) Holotype 47 mm from off Caracas, Venezuela (photo courtesy of Paul Kersten), and 34.4mm from coastal Venezuela (photo courtesy of Alexander Medvedev); **L, M, N** = *T. aurantius* (Hwass, 1792) 46.55 mm from Bonaire, 43.33 mm from Curacao, and 52.80 mm from Curacao (from the Rick Negus Collection).

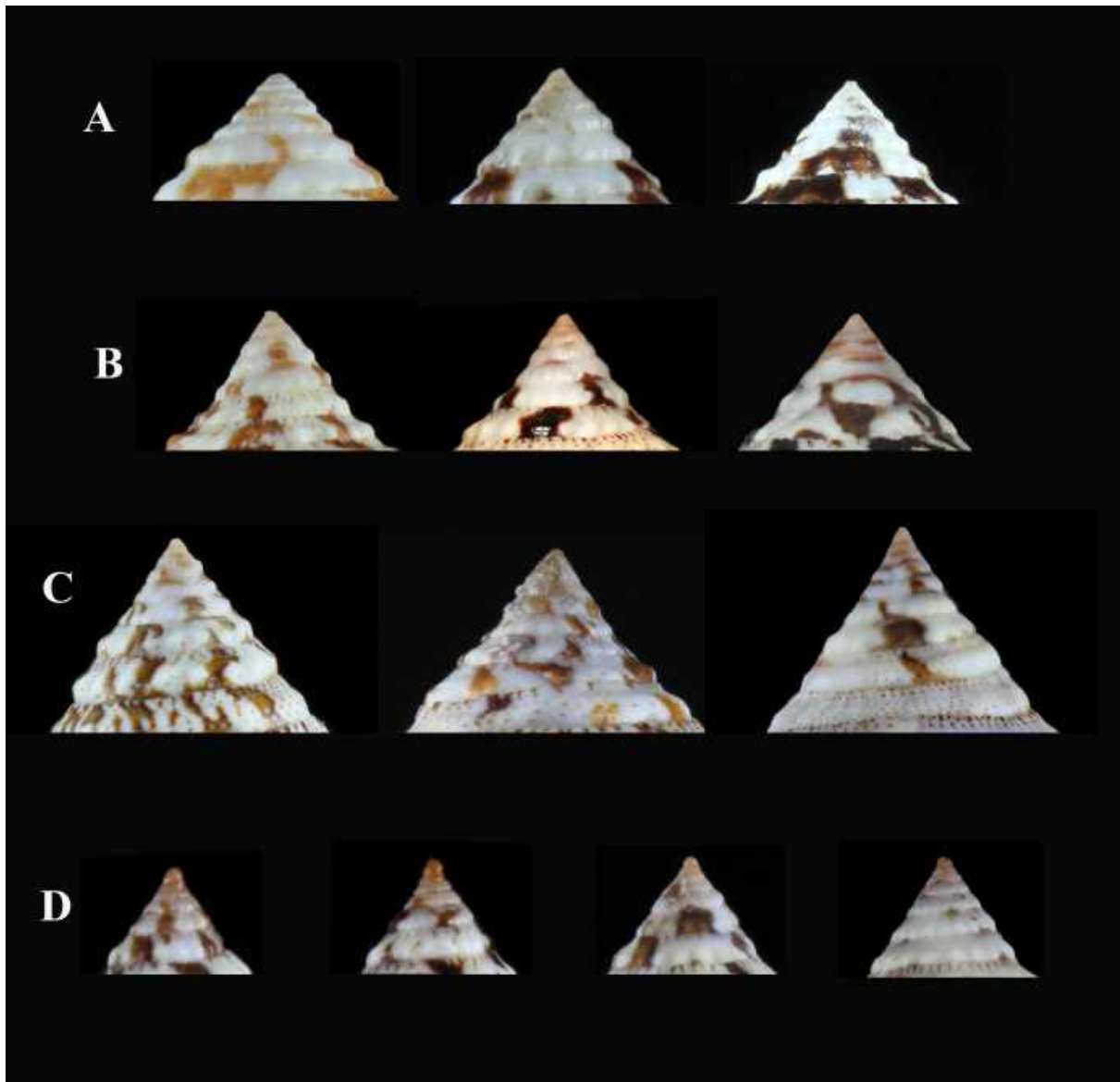


Figure 6: Spire images. **A** = *T. aurantius*; **B** = *T. curassaviensis*; **C** = *T. monicae*; **D** = *T. rosi*.

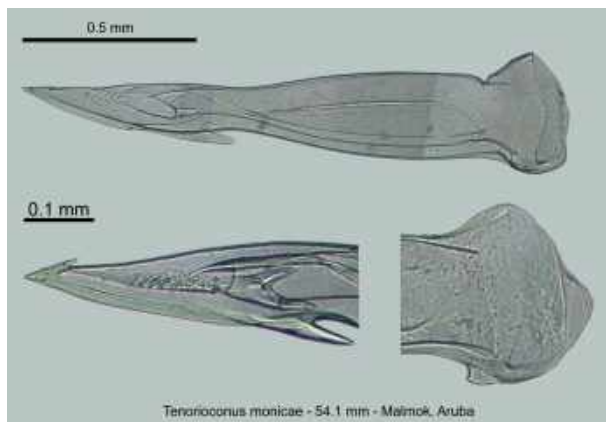


Figure 8: Radular study of a specimen of *Tenorioconus monicae* from Carlos Afonso collection, taken in Malmok, Aruba (shell length 54.1 mm). Radula has 22 teeth in radular sac. Radular tooth of medium relative size (Shell length/tooth length = 43), with the typical features corresponding an specialised amphinomid polychaete eater (as other members of genus *Tenorioconus*): radular tooth broad and stout; anterior portion shorter than posterior portion; small apical barb opposing to a strong, sharply pointed blade covering most of the anterior portion of the tooth; 8 denticles in serration arranged in one row becoming two rows; penultimate serration enlarged and internal; large pointed terminating cusp; small lateral basal cusp present. The different radular morphology along with the presence of the columellar restriction in *T. monicae* (characteristic of the *T. mappa* complex) is consistent with the hypothesis of a distinct species. (Radular study and image courtesy of Manuel J. Tenorio)