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A New Species of *Textilia* from the Marquesas Islands

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ABSTRACT This paper describes a new Conidae species, *Textilia minamiae*, from the Marquesas Islands, French Polynesia. The new species is most closely related to *Textilia bullatus* (Linnaeus, 1758) and *Textilia pongo* (Coomans, Moolenbeek & Wils, 1982). The author compares multiple morphological characteristics to distinguish it from its congeners and provides observations on its biology.

KEY WORDS Conidae, *Textilia*, *Textilia minamiae,* Marquesas Islands (Archipelago), French Polynesia, South Equatorial Current

INTRODUCTION

The extreme isolation of the Marquesas Archipelago caused by its remoteness from other land masses and by oceanographic conditions dominated by the powerful, westward flowing South Equatorial Current has produced an exceptionally high degree of endemism among its marine animals. It is estimated that at least 70% of the key tropical index mollusk families in the Marquesas have endemic species (Petuch & Berschauer, 2020), and over 22% of Conidae there are endemic (Touitou & Balleton, 2022). Given these parameters, close examination of animals resembling familiar, widely distributed Indo-Pacific species often yields new taxa. A new endemic Conidae species is presented here following a detailed study of a Marquesan gastropod historically viewed as a local variant of the widely distributed *Textilia bullatus*.

Abbreviations:

BPBM Bernice Pauahi Bishop Museum, Hawaii
DL David Lum
DW David Watts
HL Harry Lynch
HB Harry Bedell
JL Julian Lee
MB Marty Beals
PK Paul Kanner
WF William Fenzan

Material and Methods

Only mature, normally formed specimens were used for this study. A mature shell is defined as one where the outer lip has developed to the point that there is a zone of reduced patterning and coloration adjacent to the aperture. A total of 46 *T. minamiae* specimens from the Marquesas; 11 *T. bullatus* from the Hawaiian Islands and 47 more from various locations in the Western and Central Pacific (Ryukyu Islands, Philippines, Solomon Islands, and Indonesia, Samoa, Marshall Islands, and Federated States of Micronesia); and two *T. pongo* from the Indian Ocean were utilized for comparison of morphological characteristics and measurements. Dimensional measurements are enumerated in millimeters (mm). Weight is measured in grams (g). Definition of terms and derived comparative indices are:

- Length of shell (maximum) = Lm
- Length of shell measured along central axis = L
- Length of shell measured along central axis from shoulder suture to anterior end = Lsh
- Length of spire = Lsp = L-Lsh
- Width of shell (maximum) = Wm
- Height of shell (measured from lip) = Hl

- Weight = M
- Spire Length Index = SI = (100*Lsp) / L. Lower SI indicates a shell with a shorter spire relative to the length of the shell as measured along the same axis as the spire. The "100" is a scaling factor to ease comparison.
- Tumidity Index = TI = (Wm*Hl) / Lm. Higher TI indicates a more tumid (inflated) shell.
- Weight Index = MI = (1000*M) / (Lm*Wm*Hl). Higher MI indicates a heavier shell relative to volume. The "1000" is a scaling factor to ease comparison.

To adequately establish the uniqueness of *T. minamiae*, a relatively large group of this species was compared to a significant number of *T. bullatus* specimens sampled from multiple locations within its broad range in the Indo-Pacific. Few *T. pongo* specimens were available for comparative study, but this species is quite easily separated from its close relatives by its nondescript outer shell pattern and vermillion aperture. Plates 4-5 provide images of *T. bullatus* from various locations and *T. pongo* for comparison.

All photographs were taken with a Nikon digital single-lens reflex camera. Lens focal length was set at 50 mm or greater to minimize image distortion. Two fluorescent lamps or in-camera flash were used for lighting. In situ live animals were photographed with a handheld GoPro camera with underwater housing. Adobe Photoshop was utilized for minor image adjustments to improve color accuracy.

SYSTEMATICS

Phylum	Mollusca
Class	Gastropoda
Subclass	Sorbeoconcha
Order	Prosobranchia
Infraorder	Neogastropoda
Superfamily	Conoidea
Family	Conidae
Subfamily	Coninae
Genus	*Textilia* Swainson, 1840

Textilia minamiae Lum new species
(Figure 1, Plates 1-3)

Description. Coniform shell with broad shoulder and slightly ovate outlines that gradually tapers toward anterior end; noticeable angular transition occurs on body whorl approximately 1/4 of total length from posterior end of shell; spire sunken or very low profile at outer whorls, becoming projecting in vicinity of

Figure 1. Holotype of *Textilia minamiae* n. sp., La Sentinelle aux Marteaux, Taiohae Bay, Nuku Hiva, Marquesas Islands, 25 m. Lm 58.78 mm. Photos by D. Lum

sharp, pink protoconch and early whorls; gently concave groove with two to three thin, spiraling ridges in space between sutures of spire that, in very mature specimens, results in flaring at posterior extreme of aperture; texture satiny with fine, raised crisscrossing longitudinal and transverse ridges; background shell color white and typically overlaid by mottling of various shades of ochre; pattern with 15 or more thin, well-organized bands of varying width composed of reddish-brown and lighter-colored dashes along entire length of body whorl; coarse blotches of reddish-brown, purple, or muted orange in zones from roughly 1/3 to 2/3 along length of shell; small white triangles and streaks dispersed throughout shell surface with increased concentration on ventral side; outer lip of mature shell less sharp and with zone of pale coloration and reduced pattern immediately above edge; aperture wide and greatly enlarged toward anterior; aperture color typically glossy white, occasionally gradating to faint pink or yellow toward shell interior and edge of lip; aperture rarely entirely pale orange; periostracum is very thin, smooth, tan-colored, and virtually transparent; operculum oval and vestigial with no apparent protective function.

Type Material. All specimens from Taiohae Bay, Nuku Hiva, Marquesas
(Type. LxWxHl, M / repository)
Holotype, 58.78x32.06x26.98, 17 / BPBM catalog # 296608
Paratype 1, 55.34x30.20x25.70, 17 / DL
Paratype 2, 61.68x34.57x28.98, 24 / DL
Paratype 3, 62.10x33.78x28.61, 28 / DL
Paratype 4, 60.00x33.04x28.19, 22 / DL
Paratype 5, 61.17x32.95x27.80, 21 / DL
Paratype 6, 68.65x37.88x31.58, 31 /MB
Paratype 7, 45.40x25.10x21.50, 15 / HB
Paratype 8, 57.62x30.77x26.44, 15 / PK
Paratype 9, 58.83x29.68x26.17, 19 / JL
Paratype 10, 49.40x26.80x22.70, 15 / HL
Paratype 11, 61.14x33.57x28.75, 21 / DW
Paratype 12, 65.55x36.16x30.03, 24 / MB

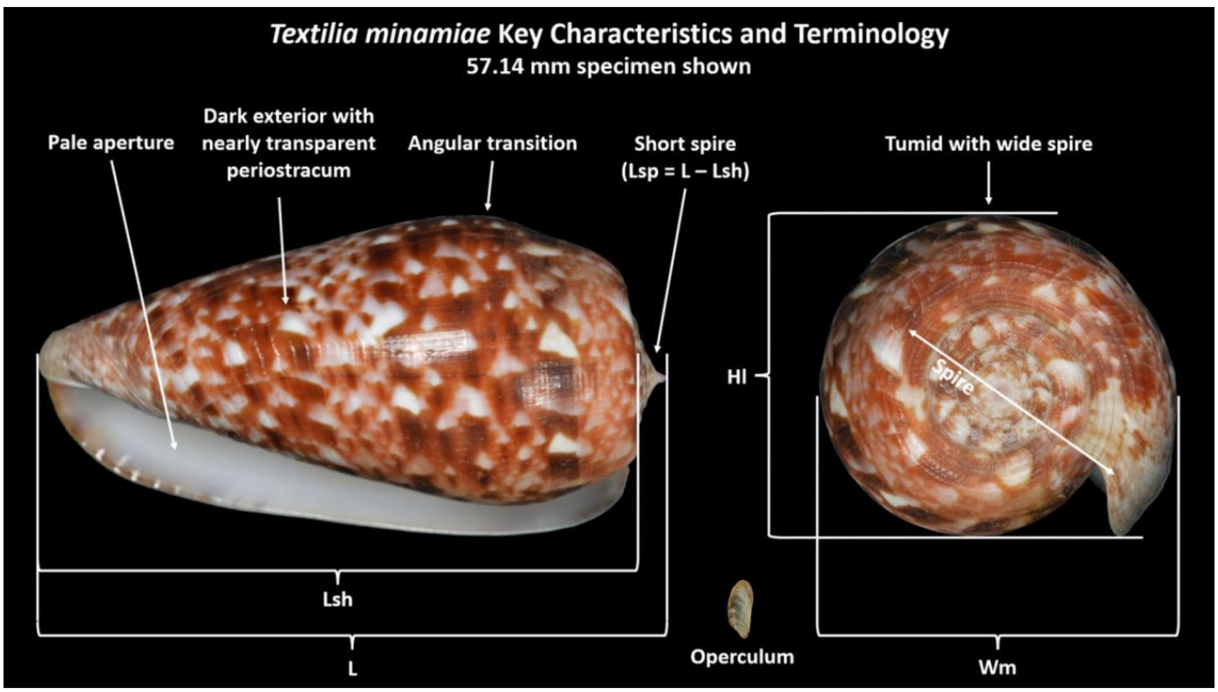

Figure 2. Images of Paratype 17 showing defining characteristics of *Textilia minamiae* and locations of morphometric measurements. Photo by D. Lum.

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Paratype 13, 64.86x32.86x29.20, 24 / JL
Paratype 14, 54.31x29.62x24.95, 18 / PK
Paratype 15, 62.80x34.10x29.10, 21 / HB
Paratype 16, 61.60x34.69x29.30, 21 / WF
Paratype 17, 57.14x31.06x26.60, 17 / DL

Other material examined include 28 additional paratypes located in the following collections (maximum length of each specimen in mm):
MB: 51.10, 58.94, 59.08,
HB: 48.1, 49.5, 52.0, 57.3, 57.4, 59.0
PK: 52.51
JL: 50.60, 50.97, 54.43, 56.22, 56.79, 57.67, 59.64, 63.05
DL: 52.64, 55.43, 56.06, 57.67, 59.07, 59.84, 59.87, 62.20
HL: 52.83
DW: 61.09

Animal Characteristics. Dorsal surface of foot with marbled pattern of white, dull yellow, reddish-brown, and black. The ventral surface of foot colored with randomly mottled brown and creamy yellow. Siphon evenly mottled brown and white. Siphon and proboscis capable of extending a distance at least the length of shell. Eyestalks white with small eye at base of each. Reddish-brown tentacles connected to eyestalks. Sexes separate with females being larger. More specific details of morphology and coloration of *T. minamiae* are best conveyed in the live animal image (Plate 7, A). Some internal organs (particularly the large liver) exhibit a mottled pattern with coloration resembling that of the outer shell surface.
Type Locality. The holotype (Figure 1) was collected in Taiohae Bay, Nuku Hiva, Marquesas Islands, French Polynesia.
Distribution. Marquesas Islands, French Polynesia.
Habitat and Biology. Found primarily at the base of reef slopes in areas of deep sand and gravel beds with overlying rocks and coral rubble. The author has observed them at depths from 14 to 30 meters with most specimens at around 20 meters, but they have been collected from 60 meters (Touitou & Balleton 2022). They likely have a much greater depth range given that their food source and preferred type of habitat are not restricted to the shallows. Their coloration and pattern allow them to blend in with their surroundings, particularly in deeper water where color contrast is diminished, and grey and blue tones dominate (Plate 6, B).

During the day and bright moonlit conditions, they burrow into fine substrate, particularly underneath hard slabs and structures that offer additional protection. They have been found concealed in over 10 cm of substrate, likely to evade larger predators (*e.g.*, the Marbled Stingray, *Taeniura meyeni* Müller & Henle, 1841) (Plate 6, D). Predation from stingrays and crabs is evidenced by freshly broken shells.

The author has observed them emerging to hunt at night shortly after sunset (within an hour), mostly over sand and gravel but occasionally along boulder and coral surfaces and crevices. They bury themselves again shortly after consuming prey. Freshly captured specimens will sometimes regurgitate their prey, which consists mostly of small fish that are less active at night, such as *Pseudanthias* Bleeker, 1871. Moon phase alone does not affect their foraging as long as their environment remains dark (*e.g.*, moon still blocked by dense clouds or mountains).The venomous sting delivered by the proboscis and radular harpoon is capable of causing sharp radiating pain that can last at least three weeks (Paul Kanner, personal communication).

The sexes are separate. The author observed and photographed a pair mating above the sand at night with the male up on the spire and slightly to the left of the female (Plate 6, C).

Due to similar habitat and food requirements, *Textilia adamsonii* (Broderip, 1826) is found in the same areas as *T. minamiae*. Paul Kanner discovered an individual of each species under the same rock during our 2013 trip to Nuku Hiva.

Virtually no specimens exhibit more than very slight damage to the body whorl, in contrast to most other Conidae species, including its relative *T. adamsonii*, which often exhibit large shell scars. Also, most have intact protoconchs. These facts indicate that *T. minamiae* is a fast-maturing species.

In addition to being a mechanism of biological isolation, the powerful South Equatorial Current interacting with the Marquesas Islands causes strong upwelling and high biological productivity in the nearshore environment (Martinez *et al.*, 2009). The nutrient-rich waters from deep combine with intense, tropical sunlight year-round to encourage very high phytoplankton density, as evidenced by nearshore murky 'pea soup' water conditions (Plate 6, A). This results in high productivity at all higher trophic levels, including among the fish on which *T. minamiae* feed. From personal observation, the high prevalence of piscivorous Conidae species in the Marquesas seems to reflect the abundance of prey, with *T. minamiae* possibly being the most numerous among fish eaters, followed by *Pionoconus easoni* Petuch & Berschauer, 2018, *Pionoconus gauguini* (Richard & Salvat, 1973), *Gastridium obscurus* (Sowerby I, 1833), *Textilia adamsonii*, and *Gastridium eldredi* (Morrison, 1955).

Empty shells are often found occupied by the endemic cone shell hermit crab species *Ciliopagurus vakovako* Poupin, 2001 (Plate 7, B). Its habitat is from the intertidal zone to 53-57 m, but mainly between 10-20 m, which corresponds almost exactly with where *T. minamiae* is found (Poupin, 2001).

Etymology. Named for author's daughter, Minami, a dedicated student of biology and future medical professional whose name translates from Japanese to "Beautiful Wave" (美波).

Comparison. *T. minamiae* can be readily distinguished from its closest relatives (*T. bullatus* and *T. pongo*) by the following key characteristics: a more robust, tumid (inflated) shape; a significantly shorter spire relative to total length; a shell with slightly greater relative

Species	***T. minamiae* (n=46)**	***T. bullatus* (n=58)**	***T. pongo* (n=2)**
Shell shape	Tumid (TI=14.31)	Least tumid (TI=12.71)	Less tumid (TI=12.75)
Shell length average (range)	57.33 (45.40-68.65) mm	55.65 (43.80-73.62) mm	62.37 (66.57-58.17) mm
Spire shape	Very short (SI=3.40)	Extended (SI=5.82)	Extended (SI=5.79)
Relative weight	Light (MI=4.15)	Lighter (MI=3.98)	Lightest (MI=3.83)
Shell color (outer surface)	Reddish-brown, purple, or muted orange blotches on white and ochre	Pastel orange to red (when fresh) blotches on white and salmon-pink	Orange to red blotches on white and salmon pink
Shell pattern (outer surface)	Distinct coarse blotches and mottling with spiraling dashed lines	Most specimens with distinct finer mottling and spiraling dashed lines; occasional shells with indistinct blotches	Much less distinct, diffuse blotches
Aperture color	White, rarely pale orange	Salmon-pink to orange	Vermillion red
Distribution	Marquesas Islands	Western Pacific & Hawaii	Indian Ocean

Table 1. Comparison of *T. minamiae* with congeners *T. bullatus* and *T. pongo*. n = # of specimens.

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weight; and outer shell pattern typically with blotches of darker, more muted color; and a typically bright white instead of a salmon-pink, orange, or vermillion aperture. Table 1 provides a detailed comparison between *T. minamiae* and its congeners. Plates 1 through 5 show sample specimens of each species to more clearly elucidate their differences.

DISCUSSION

The significant differences between *T. minamiae* and its congeners have been noted by the author and other observers for some time, but this unique population of *Textilia* has not been previously analyzed in a systematic manner. The basis for describing it as a full species, rather than only as a subspecies of *T. bullatus*, incorporates:

- Unambiguous and consistent morphological characteristics. Some variability occurs between populations of *T. bullatus* within its extensive range, but no population exhibits the full combination of characteristics found in *T. minamiae*.
- Precedence for recognition of Marquesan gastropods within other genera as unique. For example, *Lambis pilsbryi* Abbott, 1961 from *Lambis crocata* (Link, 1807); *Lividiconus conco* Puillandre, Stöcklin, Favreau, Bianchi, Perret, Rivasseau, Limpalaër, Monnier & Bouchet, 2015 from *Lividiconus lividus* (Hwass, 1792); *Pionoconus easoni* from *Pionoconus catus* (Hwass, 1792); and *Harpa kolaceki* Cossignani, 2011 from *Harpa amouretta* Röding, 1798.
- Taxonomic separation within the *T. bullatus* clade where *T. pongo* is considered a different species from *T. bullatus* despite their close morphological affinity.

The discovery of a new *Textilia* species in the Marquesas was not overly surprising given the high propensity for endemism there. The author hypothesizes that *T. bullatus* is most likely the ancestor of *T. minamiae*. After the founding population of *T. bullatus* established itself in the Marquesas, the very significant geographic and oceanographic isolation mechanisms in and around this archipelago minimized opportunity for gene flow from other populations of *T. bullatus*. With its closest relatives (*i.e.*, possible sources of reinforcing ancestral genes) being hundreds to thousands of kilometers to the west or southwest in the Tuamotu and Society Archipelagos, the southwestward flowing Pacific segment of the highly stable South Equatorial Current became a particularly significant barrier (Martinez *et al*, 2020). Excellent visualizations of this current can be found on NASA's "Perpetual Ocean" animation. Over time, the isolation led to the evolution of *T. minamiae* through the founder effect (National Human Genome Research Institute, 2023).

Genetic profiling has not been conducted yet on this species, but an expedition in the near future to the Marquesas will seek to collect animal samples of *T. minamiae* for molecular analysis.

Notable information derived from this study in regard to the sister taxon *T. bullatus* include:

- The Hawaiian population possessing the longest spired (SI=6.87) and heaviest (MI=4.21) shells out of all the *Textilia* populations studied. Certain specimens also exhibit patterns with bold triangular markings not found in specimens from other locations. Additionally, they dwell relatively deep with all but one of the Hawaiian specimens found below 30 meters. With their unique characteristics, further study with a larger sample size may prove these shells to be a separate taxon.
- Marshall Island and Micronesian specimens being pale shells with fine patterning. These may also be unique.

• Many Indonesian shells tending to be a darker red than in other populations.

The molluscan fauna of the Marquesas is immensely fascinating, and further research will undoubtedly yield new species. Among the Conidae, *T. adamsonii* in the Marquesas deserves a similar assessment as was done here for *T. minamiae*, given its differences in shape, coloration, size, and other characteristics from typical *T. adamsonii* found in the Cook Islands and other locations.

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Plate 1. Paratypes 1-4 of *Textilia minamiae* with length (Lm) and collection information for each. Top two specimens are a pair with female at top. All specimens with intact periostracum. Photos by D. Lum.

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Plate 2. Paratypes 6-9 of *Textilia minamiae* with length (Lm) and collection information for each. Photos of smallest specimen (45.4 mm) by H. Bedell. Other photos by D. Lum.

Plate 3. Paratypes 5, 10-12 of *Textilia minamiae* with length (Lm) and collection information for each. Photos by D. Lum.

Plate 4. *Textilia bullatus* from various locations in the Western Pacific. Note the variability of *T. bullatus* in this and the next plate. Photos by D. Lum

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Plate 5. *Textilia bullatus* from the Central Pacific and *Textilia pongo* from the Indian Ocean. Photos by D. Lum.

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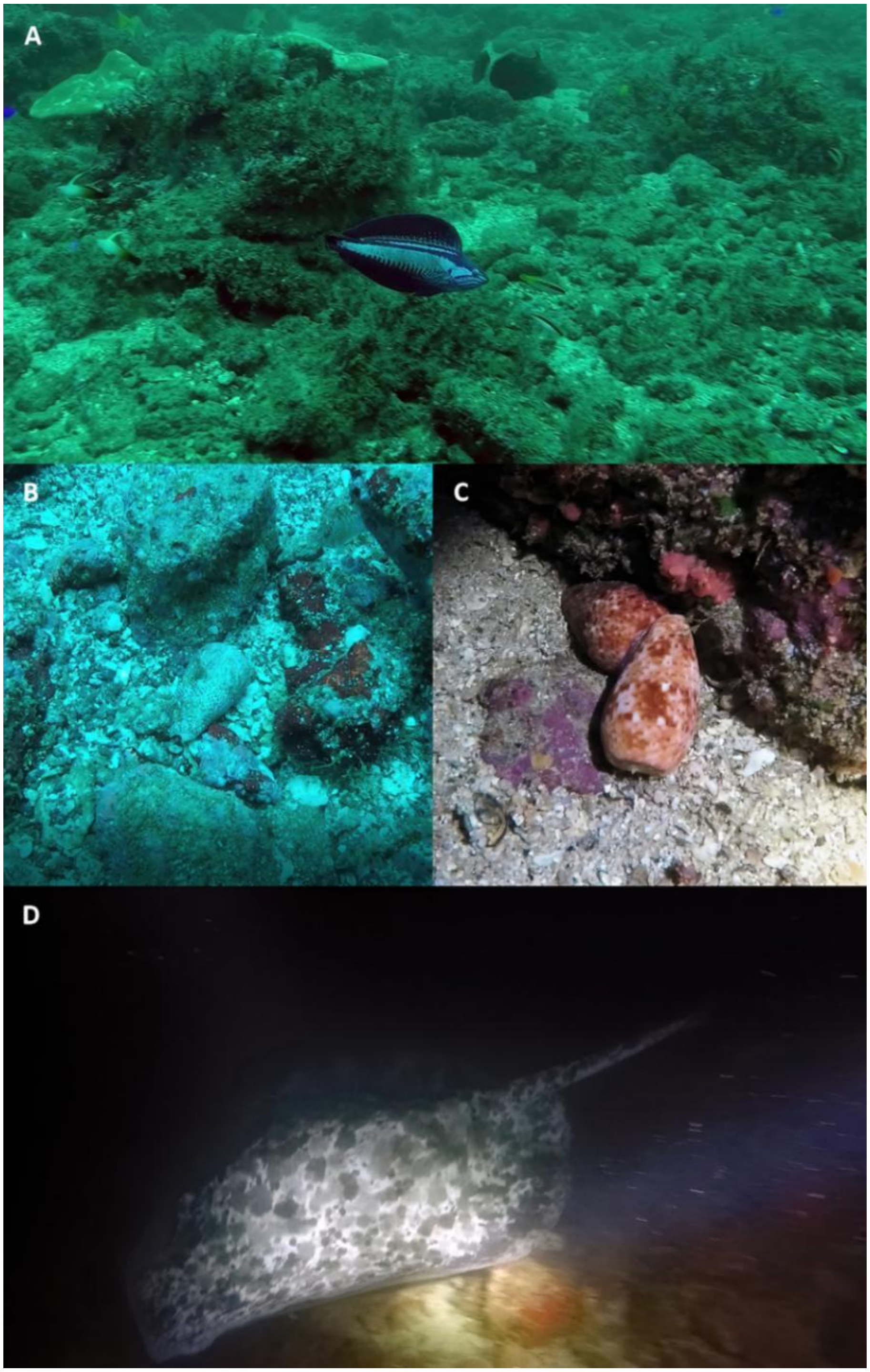

Plate 6. Natural history of *Textilia minamiae*. Photos by D. Lum.
A = Typical coral rubble, gravel, and sand habitat of *Textilia minamiae*. The green tint of the water from abundant phytoplankton is normal for the nearshore environment of the Marquesas. Male endemic Hewett's Wrasse (*Coris hewetti* Randall, 1999) in a territorial display at center.
B = *T. adamsonii* blending in with coarse gravel during daytime in deep water.
C = Pair of *T. minamiae* mating at night. The male is the lighter colored specimen.
D = The giant Marbled Stingray *Taeniura meyeni* Müller & Henle, 1841 is a ravenous predator of mollusks in *T. minamiae*'s habitat.

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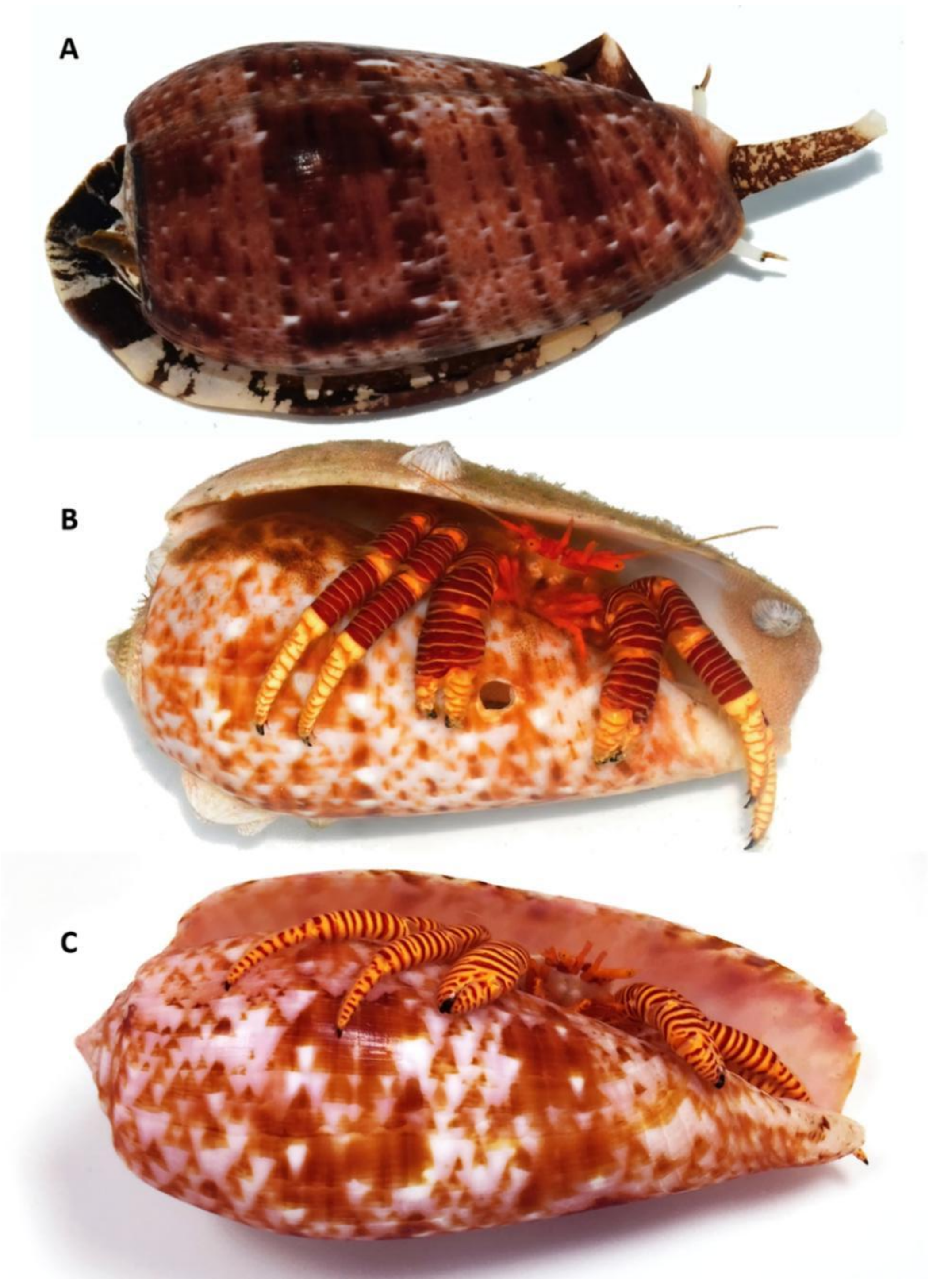

Plate 7. Shell occupants. Photos by D. Lum.
A = *T. minamiae* showing typical animal characteristics.
B = Empty *T. minamiae* shells are almost always occupied by hermit crabs, particularly the endemic *Ciliopagurus vakovako* Poupin, 2001.
C = In other parts of the Pacific, including Hawaii, *T. bullatus* shells are often inhabited by *Ciliopagurus strigatus* (Herbst, 1804). Note the differences from its Marquesan relative.