

# New species of scissurellids from the Austral Islands, French Polynesia, and the Indo-Malayan Archipelago (Gastropoda: Vetigastropoda: Scissurellidae, Anatomidae, Larocheidae)

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## ABSTRACT

Four new species of Scissurellidae, Anatomidae, and Larocheidae are described from the Austral Archipelago, French Polynesia and the Indo-Malayan Archipelago: *Sinezona danieldreieri* new species, *S. wiley* new species (both Scissurellidae), *Anatoma rapaensis* new species (Anatomidae) and *Trogloncha lozoueti* new species (Larocheidae). One of the species is currently only known from the Austral Islands (*T. lozoueti*), while the others seem to show a broad Indo-Malayan Archipelago to western Pacific distribution. Shells of all species and the radulae of *S. danieldreieri*, *T. lozoueti*, and *A. rapaensis* are illustrated with scanning electron micrographs.

*Additional Keywords:* Mollusca, Rapa Island, radula

## INTRODUCTION

The present contribution describes some microgastropods in the families Scissurellidae, Anatomidae, and Larocheidae known from the Austral Islands and beyond. The impetus stems from a French expedition to the southeastern-most Austral island, Rapa (see Lozouet et al., 2004; 2005 for details); for the species found at Rapa, additional material from other localities located in various institutional collections has also been included. This article is part of a series describing the biodiversity of this remote archipelago (e.g., Schwabe and Lozouet, 2006).

Scissurellidae sensu lato comprises lineages of small basal marine snails in Vetigastropoda (Geiger et al., 2008). The phylogenetic position of Anatomidae is currently unsettled. Whereas Geiger and Thacker (2005; unpublished data) resolved a *Lepetodrilus* (Lepetodrilidae) + *Scissurella*, *Sinezona*, *Sukashitrochus* (Scissurellidae sensu stricto) clade with more distantly related *Anatoma* (Anatomidae), Kano (2008) using the same

three genes (Histone 3, COI, 18S) recovered in some of his analyses a clade uniting all three of these lineages (*Lepetodrilus*, *Sinezona*, *Anatoma*). Scissurellidae and Anatomidae are characterized by a slit or foramen in the shell (lacking in Larocheidae), a rhipidoglossate radula, and a lack of nacre. Approximately 140 species are currently described with an additional 90 remaining to be formally recognized (Geiger, 2003; 2008). To date, no species in these families have ever been recorded from the Austral Islands. The species described herein are all new to science, one with its range restricted to the Austral Islands, and three others known from several localities in the broad Indo-Pacific.

## MATERIALS AND METHODS

Standard methods for scanning electron microscopy (SEM) were employed as detailed in Geiger (2006a, b, c) and Geiger et al. (2007). Terminology for shell morphology and details on method of whorl count have been given elsewhere (Geiger, 2003; Geiger and Sasaki, 2008). Specimens cited are dry lots; “: complete” indicates wet-preserved lots with animals. All depth indications refer to bottom depth.

Institutional abbreviations used in the text are: BRC: Bret Raines Collection, Kansas City, USA; DLG: Daniel L. Geiger Collection, Los Angeles, USA; JTC: Jean Tröndlé Collection, Paris, France; LACM: Los Angeles County Museum of Natural History, Los Angeles, USA; MNHN: Muséum national d'Histoire naturelle, Paris, France; SBMNH: Santa Barbara Museum of Natural History, Santa Barbara, USA; USNM: United States National Museum of Natural History, Washington (DC), USA; ZMA: Zoological Museum, Amsterdam, The Netherlands.

Other abbreviations used in text are: M: Monotypy; OD: Original designation; SEM: Scanning electron microscope/microscopy/micrograph.

## SYSTEMATICS

Scissurellidae Gray, 1847

*Sinezona* Finlay, 1926

**Type species:** *Schismope brevis* Hedley, 1904 (OD).

**Remarks:** The genus has recently been treated by Marshall (2002) and Geiger (2003).

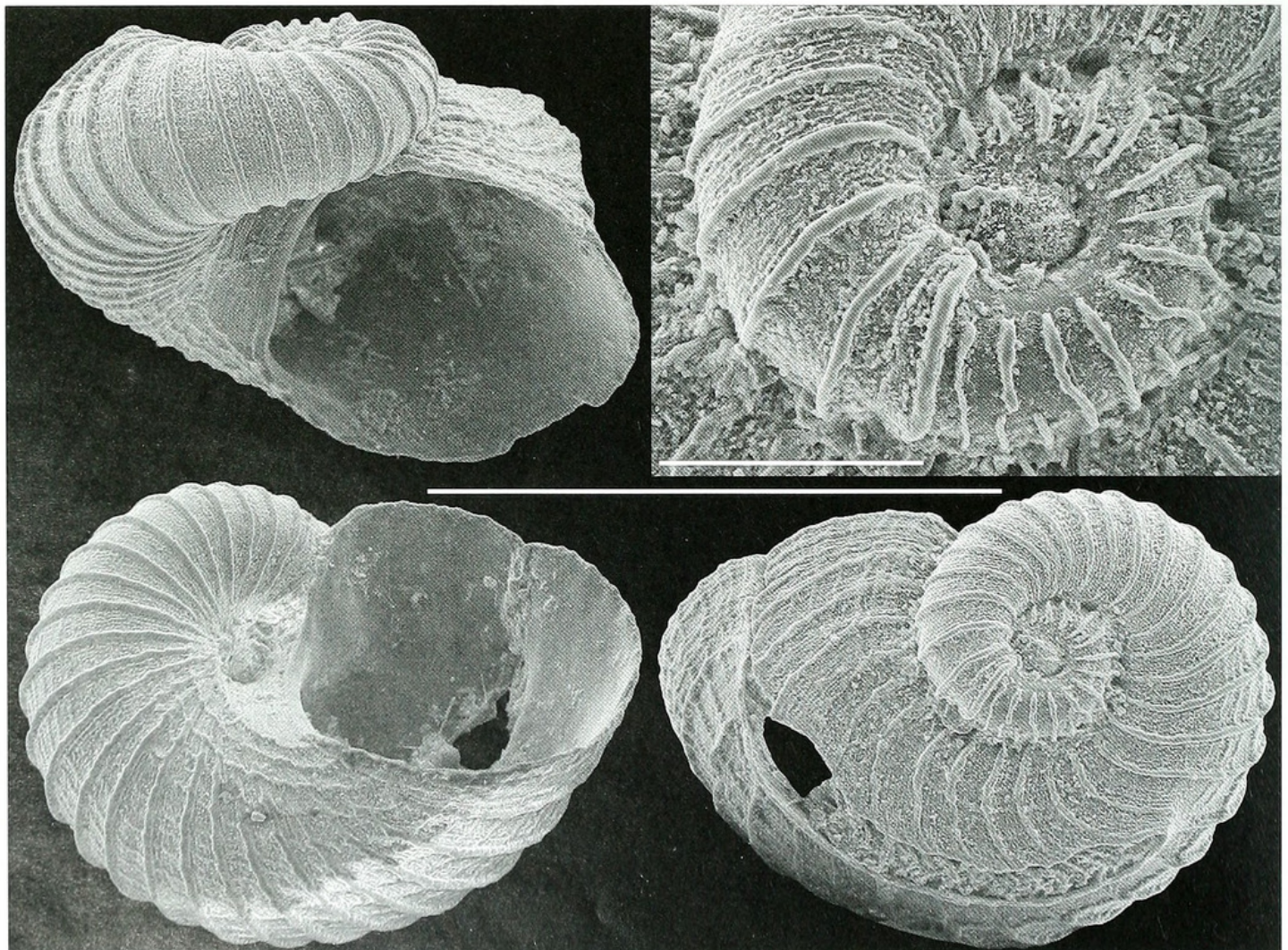
*Sinezona danieldreieri* new species  
(Figures 1–9)

**Description:** Shell small (to 0.77 mm), trochiform. Protoconch of 1 whorl, with strong axial sculpture not reaching apical suture, apertural varix not connected to smooth embryonic cap, apertural margin straight. Teleoconch I of 0.875 whorls, suture at periphery, approximately 9–15 strong, raised axial cords; first spirals after 0.5 whorls. Teleoconch II of 0.6 whorls, approximately four fine spiral cords at onset of selenizone between selenizone and deep suture below periphery, descending noticeably on last 0.25 whorls; shoulder slightly concave, approximately 13–20 axial cords, raised near suture, as

high as wide towards selenizone; approximately 10 spirals, distinct cords near suture, diminishing to very fine cords near selenizone; interstices with fine irregular growth lamellae. Base with constriction below selenizone, approximately 15 elevated spiral cords, crossed and run over by approximately 16 fine spiral lines. Umbilicus cone-shaped, moderately wide, wall smooth, at distinct angle to base. Aperture D-shaped, roof overhanging. Selenizone above periphery, keels quite strong, moderately elevated, distinct lunules, elongated foramen closed anteriorly.

**OPERCULUM:** Thin, flexible, multispiral, with central nucleus.

**RADULA (FIGURES 8–9):** Rachidian tooth triangular cusp with approximately five equal sized denticles. Lateral teeth 1–3 similar; outer edge of cusp with 4–5 denticles. Lateral tooth 4 reduced in size, hook-shaped. Lateral tooth 5 enlarged by broadening, approximately six, large denticles on inner edge, 1–2 small ones on outer edge. Central denticle of inner marginal teeth large, approximately three denticles on inner edge, four on outer



**Figure 1.** Holotype of *Sinezona danieldreieri* new species. (SBMNH 83540). Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E, 0–5 m. Scale bar, shell = 500 µm. Scale bar, protoconch = 100 µm.

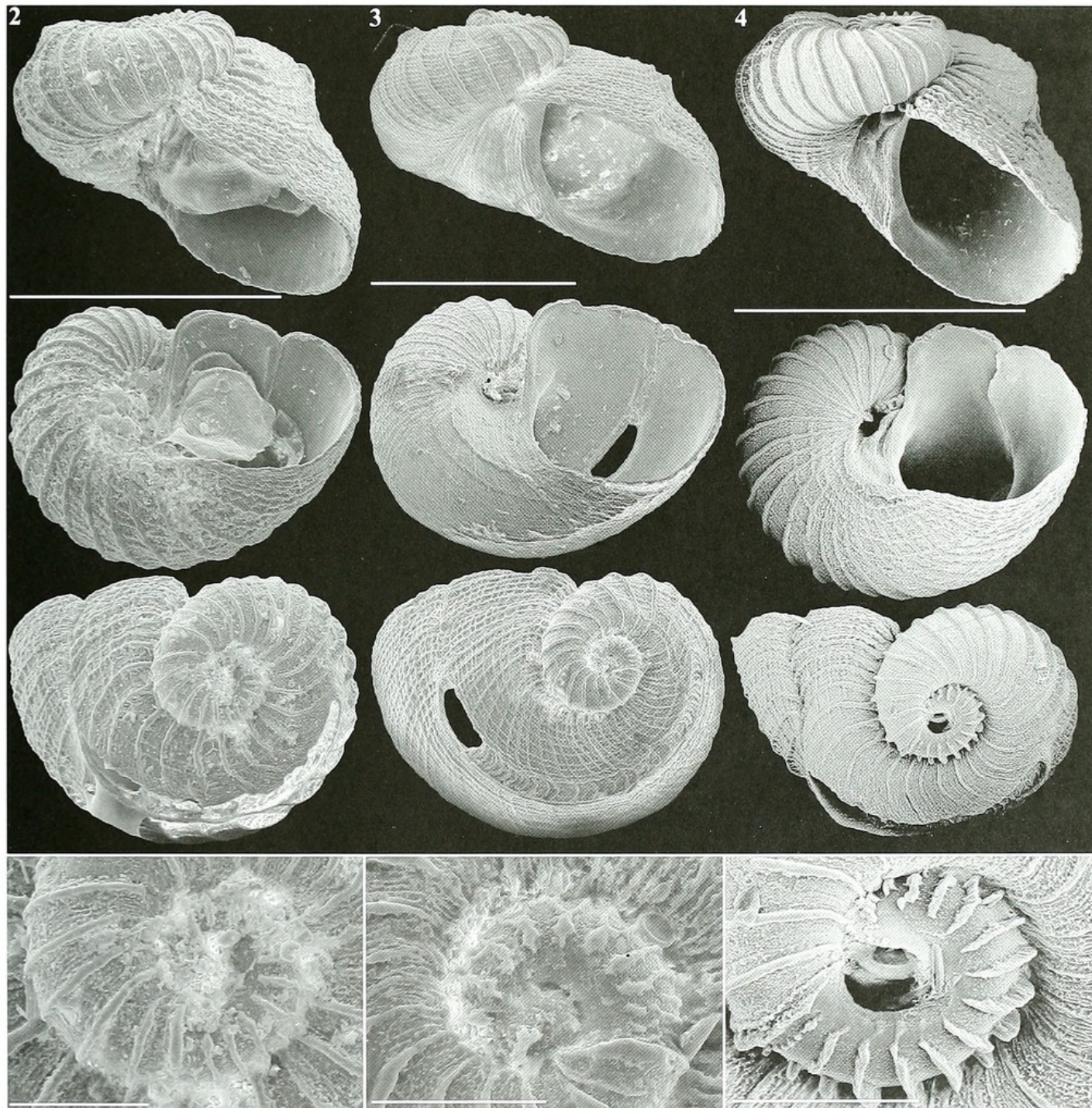
edge; outer marginal teeth spoon-shaped, bilaterally symmetrical with approximately a dozen fine denticles on each side. Radular interlock moderate.

**Type Material:** Holotype: SBMNH 83540: Figure 1. 24 Paratypes: 3–4 m, Little Santa Cruz Island, Mindanao, 6.884° N, 122.04° E (USNM 812453, 1: Figure 2). 1.5 m, Okinawa, Oku, Japan, 26.847° N, 128.287° E (LACM 77-61, 3: one illustrated Figure 3). 20 m, Off

Bohol Is, Pamilacan Island, 9.5° N, 123.917° E (AMS 406342, 1: Figure 4).

**Type Locality:** 0–5 m, Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E. Col. D. L. Geiger Oct. 2005.

**Etymology:** The name honors Daniel Dreier, son of Douglas and Hanna Dreier of Santa Barbara, who have



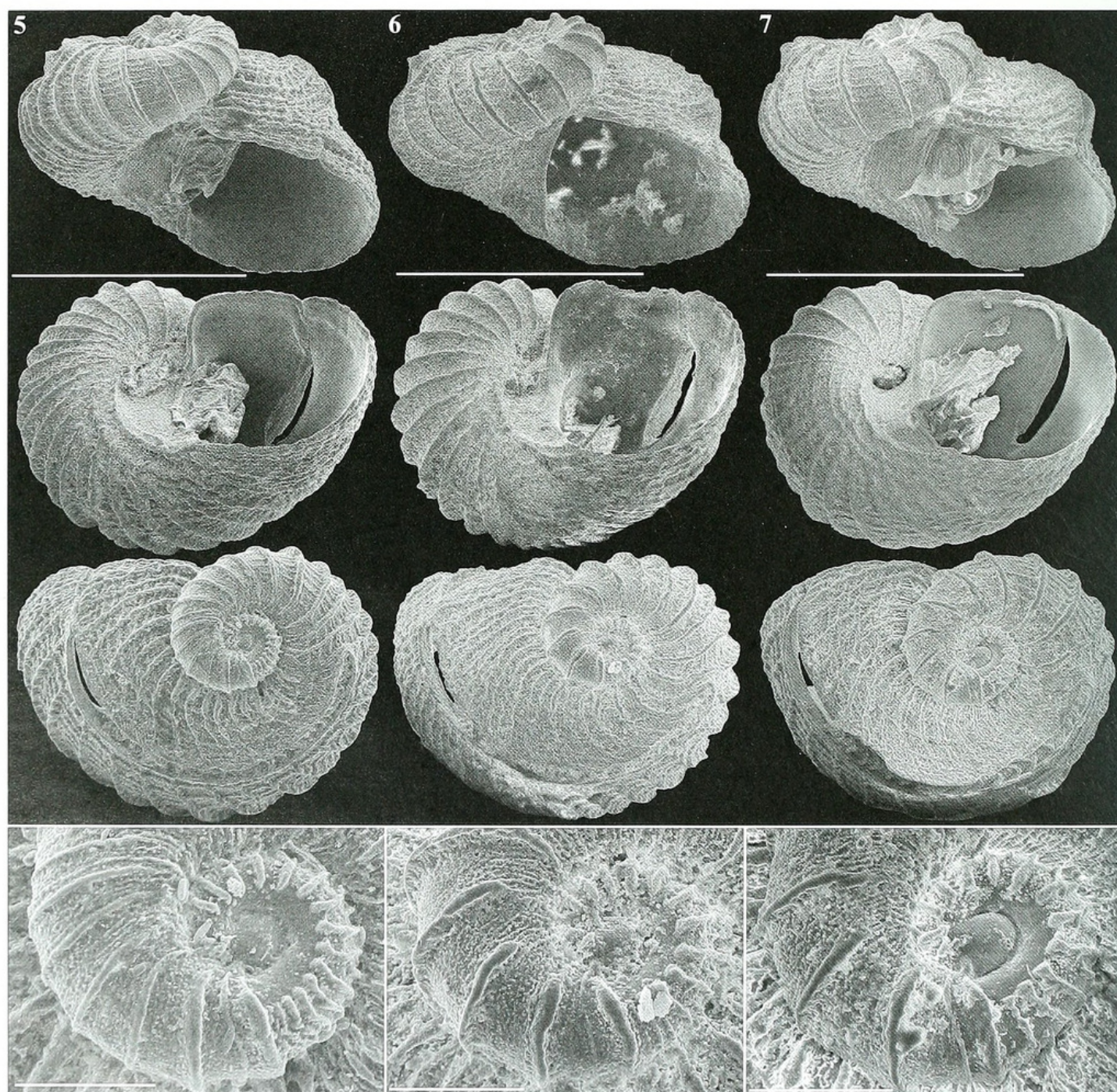
**Figures 2–4.** Paratypes of *Sinezona danieldreieri* new species. **2.** Little Santa Cruz Island, Mindanao, Philippines, 6.884° N, 122.04° E, 3–4 m (USNM 812453, 1). **3.** Okinawa, Oku, Japan, 26.847° N, 128.287° E, 1.5 m (LACM 77-61, 3). **4.** Off Bohol Island, Pamilacan Island, Philippines, 9.5° N, 123.917° E, 20 m (AMS 406342, 1). Scale bars, shell = 500  $\mu$ m. Scale bars, protoconch = 100  $\mu$ m.

made generous contributions to the Santa Barbara Museum of Natural History.

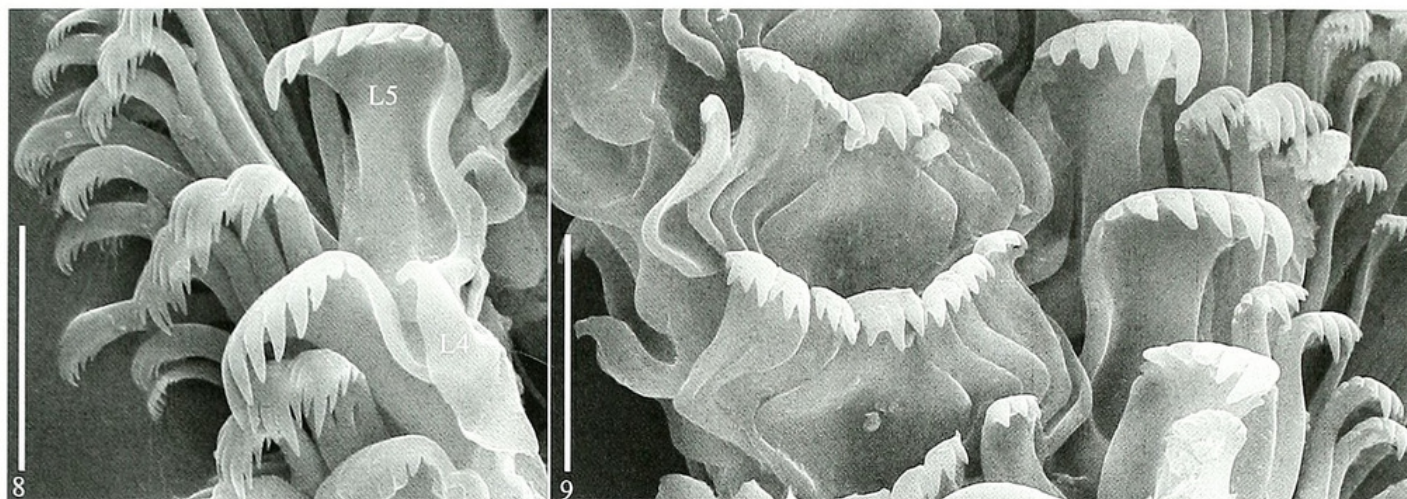
**Distribution:** Indo-Malayan Archipelago to southern Polynesia; shallow reef environments.

**Other Material Examined:** FRENCH POLYNESIA: 0 m, Rapa Iti Island, Rapa, Austral Islands, 27.622° S, 144.302° W (MNHN, 1). 0 m, Kotuaie Point, Tupuaki Bay, Rapa, Austral Islands, 27.577° S, 144.343° W (MNHN, 1). 2 m, North of Pukitarava, Rapa, Austral

Islands, 27.597° S, 144.227° W (MNHN, 4: two illustrated Figures 5–6). 2–4 m, N of Aturapa Island, Rapa, Austral Islands, 27.572° S, 144.350° W (MNHN, 4). 2 m, N of Rapa Iti Island, Rapa, Austral Islands, 27.620° S, 144.303° W (MNHN, 1). 2 m, N of Anatakuri Bay, Rapa, Austral Islands, 27.623° S, 144.307° W (MNHN, 15). 3–24 m, Hiri Bay, Rapa, Austral Islands, 27.622° S, 144.370° W (MNHN, 4). 5 m, Anarua Bay, Rapa, Austral Islands, 27.605° S, 144.378° W (MNHN, 7: one illustrated Figures 7, 8–9 [radula]). 6 m, Mei Point,



**Figures 5–7.** *Sinuozona danieli* new species. **5–6.** North of Pukitarava, Rapa, Austral Islands, French Polynesia, 27.597° S, 144.227° W, 2 m (MNHN). **7.** Anarua Bay, Rapa, Austral Islands, French Polynesia, 27.605° S, 144.378° W, 5 m (MNHN). Radula of specimen is shown in Figures 8–9. Scale bar, shell = 500  $\mu$ m. Scale bar, protoconch = 100  $\mu$ m.



**Figures 8–9.** Radula of *Sinezona danieldreieri* new species, from specimen shown in Figure 7. Anarua Bay, Rapa, Austral Islands, 27.605° S, 144.378° W, 5 m. **8.** Lateral teeth 4 (L4) and 5 (L5) plus marginal teeth. **9.** Half width of radula with central field. Scale bars = 10  $\mu$ m.

Rapa, Austral Islands, 27.637° S, 144.303° W (MNHN, 1; MNHN, 1). 6 m, SW of Gotenaonao Point, Rapa, Austral Islands, 27.645° S, 144.320° W (MNHN, 3). 15–20 m, Vavai, Rapa, Austral Islands, 27.590° S, 144.381° W (MNHN, 1; MNHN, 1). 16–20 m, Mei Point, Rapa, Austral Islands, 27.637° S, 144.303° W (MNHN, 2). 18 m, Rarapai Island, Rapa, Austral Islands, 27.572° S, 144.368° W (MNHN, 1). 27 m, Kauira Point, Rapa, Austral Islands, 27.592° S, 144.347° W (MNHN, 1). 30 m, NW of Tauna Island, Rapa, Austral Islands, 27.605° S, 144.303° W (MNHN, 17). 36 m, around Rukuaga Point, Rapa, Austral Islands, 27.568° S, 144.368° W (MNHN, 8).

PHILIPPINES: Canipo Island, Cuyo Islands, Palawan Province, 11° N, 120.948° E (USNM 808195, 1).

GUAM: 0.7 m, Ajayan Bay, S. Guam, 13.245° N, 144.717° E (LACM 77-19, 2).

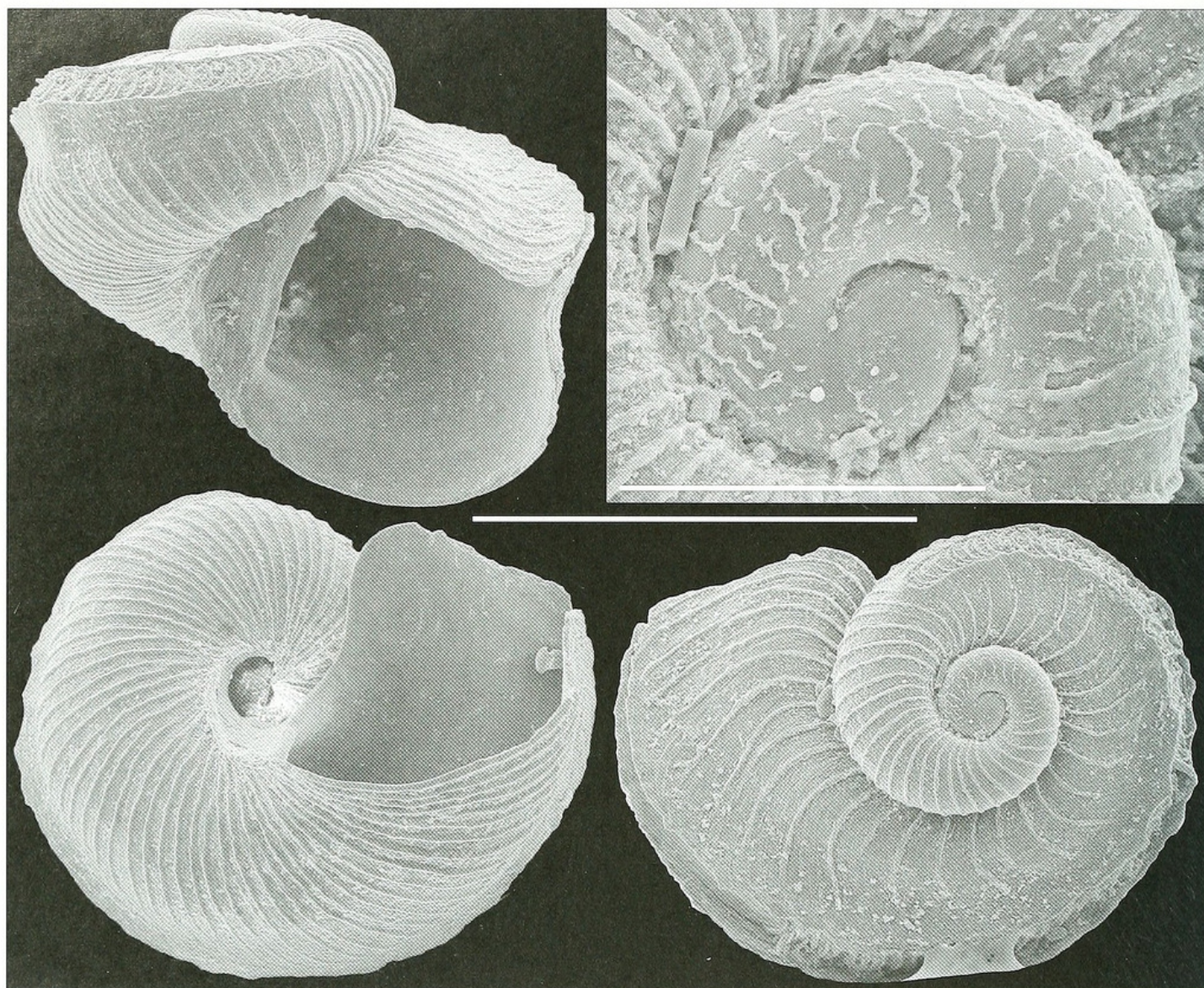
**Remarks:** The protoconch sculpture shows some intraspecific variability in the material examined. More specifically, the strong axial cords are sometimes discontinuous. This character is not restricted to the present species, hence, it does not seem to be of any systematic value. Those axial cords are also somewhat variable in width, the thickenings occasionally seeming to form some faint spiral elements. Given the intra- and inter-specific variability of protoconch sculpture at this level of detail, the presence/absence of faint spiral elements is considered irrelevant for systematic purposes. Discrete differences can be observed between strong and weak axial cords as utilized previously in a systematic context (Geiger, 2003).

*Sinezona plicata* (Hedley, 1899) from the Indo-Pacific has an overall wider and larger shell (2.3 mm; Geiger and Jansen, 2004b), more pronounced but fewer raised axial cords, and a protoconch with spiral lines. *Sinezona ferriezi* (Crosse, 1867) (? = *S. hoernesii* Semper, 1865: whereabouts of Semper types unknown, original illustration lacking detail) with broad Indo-Malayan

Archipelago distribution, is about twice as large, has a smooth protoconch with a distinct apertural varix, and >1 teleoconch I whorls. *Sinezona globosa* Geiger, 2006, from New Caledonia and Wallis Island is more rounded in overall appearance, lacks the elevated spiral cords, is larger (3.1 mm; Geiger, 2006a), and has spiral sculpture on the protoconch. *Sinezona macleani* Geiger, 2006, with broad Indo-Malayan distribution is more globular in overall outline, larger (2.3 mm; Geiger, 2006a), has a protoconch with flocculent sculpture, lacks the raised axial lines and has a wider umbilicus. All the above species grow to much larger size and would be immature with open slit at the maximum size of *S. danieldreieri*.

*Sinezona wileyi* new species  
(Figures 10–16)

**Description:** Shell medium size (up to 1.08 mm) trochiform turreted. Protoconch slightly sunken in, with 1 whorl, fine irregular axials, no apertural varix, apertural margin straight. Teleoconch I with 0.6–0.7 whorls, suture at periphery, usually with approximately 14–22 faint to distinct fine axial cords, usually without spiral lines (occasionally faintest spiral threads only visible by SEM [Figure 11]), interstices with irregular thickenings. Teleoconch II with up to 1.25 whorls, suture below periphery. Shoulder with approximately 32–44 barely perceptible to distinct fine commarginal axial cords, stronger near suture becoming less distinct towards selenizone; approximately eight barely perceptible to very indistinct spiral cords, concentrated on middle of shoulder; occasional specimens with predominant spiral sculpture (Figure 11). Base distinctly constricted below selenizone, axial cords of same strength and density as on shoulder, starting in lower portion of constriction below selenizone; approximately 17 fine, irregularly spaced spiral cords, starting in lower portion of constriction with onset of axial lines. Umbilicus wide, walls straight,



**Figure 10.** Holotype of *Sinezona wileyi* new species. Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E, 0–5 m, (SBMNH 83541). Scale bar, shell = 500  $\mu$ m. Scale bar, protoconch = 100  $\mu$ m.

smooth, periphery at distinct angle to base, bordered by carina. Aperture subquadratic, D-shaped, roof overhanging. Selenizone above periphery, keels moderately strong, quite elevated, lunules distinct at regular interval; foramen narrow, elongated, margins converging and touching, without raphe. Animal unknown.

**Type Material:** Holotype: SBMNH 83541 (Figure 10). 35 Paratypes: 0–5 m, Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E (DLG 639, 19: one illustrated in Figure 15). Laisse de plage extérieure, Mururoa, Tuamotu, French Polynesia, 21.842° S, 138.895° W (JTC, 2: one illustrated in Figure 12). 20 m, Herald Pass, W of Ndravuni Island, NW end of Great Astrolabe Reef, Fiji, 18.767° S, 178.467° E (LACM 85-135, 2: one illustrated in Figure 14). 20 m, Herald Pass, W of Ndravuni Island, NW end of Great Astrolabe Reef, Fiji, 18.767° S, 178.467° E (LACM 85-135, 2). 10–20 m, Off Francis Island in Beqa Lagoon,

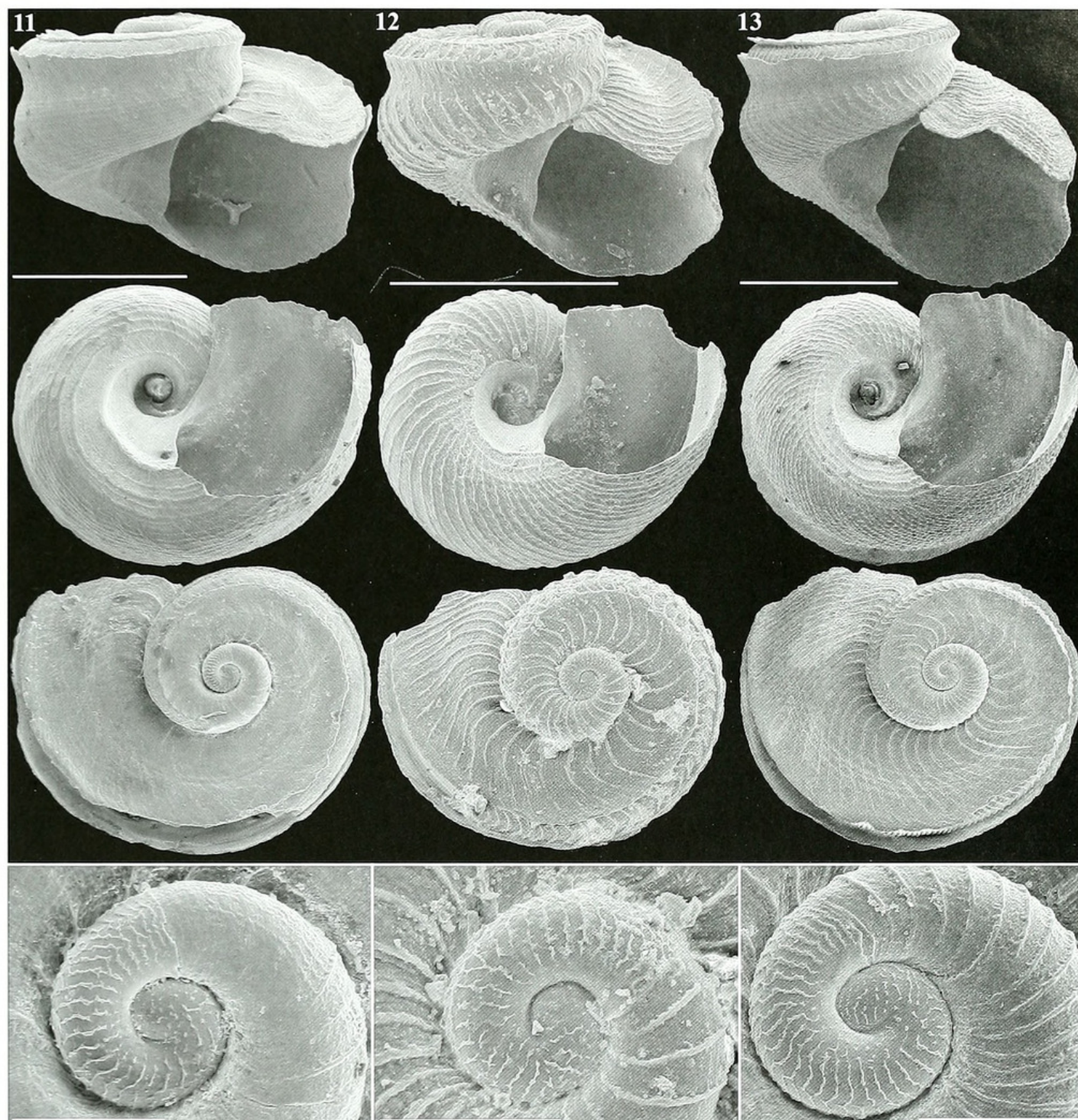
just off of Beqa Island (south of Viti Levu), 18.300° S, 178.067° E (DLG 279, 10: one illustrated in Figure 16).

**Type Locality:** 0–5 m, Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E.

**Etymology:** The name honors the collector of the first known specimens of the species Tony Wiley of Riverside, California, USA.

**Distribution:** Tropical Indo-Malayan Archipelago; shallow shelf.

**Other Material Examined:** FRENCH POLYNESIA: 36 m, Around Rukuaga Bay, Rapa, Austral Islands, 27.568° S, 144.368° W (MNHN, 20: Figures 11, 13). 2–4 m, N of Aturapa Island, Rapa, Austral Islands, 27.572° S, 144.350° W (MNHN, 1). 5 m, Anarua Bay, Rapa, Austral Islands, 27.605° S, 144.378° W (MNHN, 4). 45 m, Haurei Bay, Rapa, Austral Islands, 27.613° S, 144.305° W (MNHN, 1).



**Figures 11–13.** *Scissurella wileyi* new species. **11–12.** Around Rukuaga Bay, Rapa, Austral Islands, French Polynesia, 27.568° S, 144.368° W, 36 m (MNHN, 20). **13.** Laisse de plage extérieure, Mururoa, Tuamotu, French Polynesia, 21.842° S, 138.895° W (Paratype: JTC, 2). Scale bars, shell = 500  $\mu$ m. Scale bars, protoconch = 100  $\mu$ m.

NEW CALEDONIA: 25–30 m, Santal Bay, Lifou, 20.822° S, 167.173° E (MNHN, 1). 55–57 m, Koumac Sector, 20.672° S, 164.195° E (MNHN, 1). 5–25 m, Touho Sector, 20.878° S, 165.325° E (MNHN, 1). 8 m, Touho Sector, 20.742° S, 165.265° E (MNHN, 1).

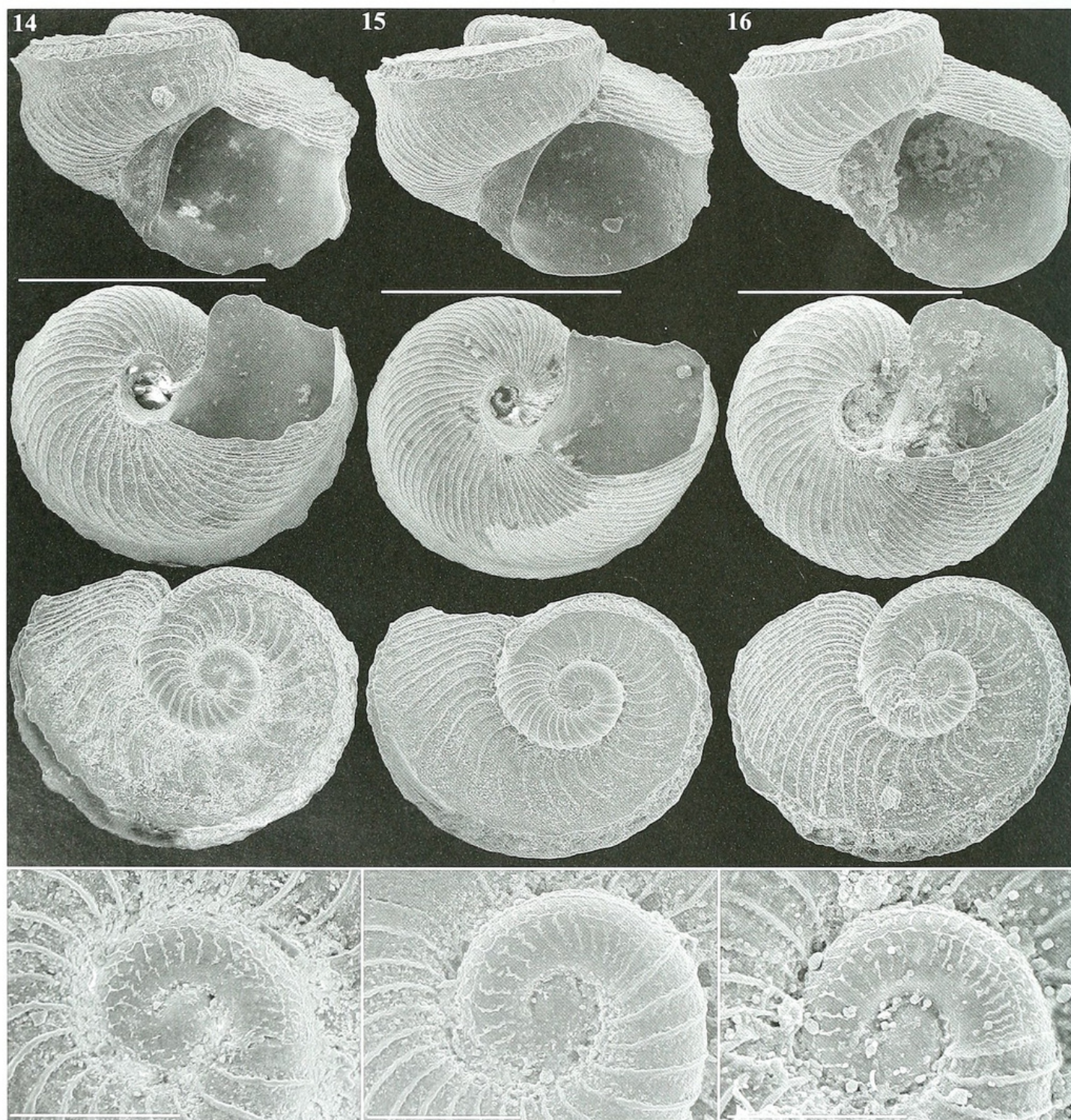
Fiji: 10–20 m, Off Francis Island in Beqa Lagoon, just off of Beqa Island (south of Viti Levu), 18.300° S, 178.067° E (DLG 279, 10).

PAPUA NEW GUINEA: 70 m, off South Ema Reef, Kimber Bay, New Britain, 5.202° S, 150.152° E (DLG 768, 3).

**Remarks:** The organization of the foramen in this species seems to be intermediary between the typical open slit in *Scissurella* and the closed foramen in *Sinezona*. Although the margins of the slit are converging and fused anteriorly, a raphe is not evident. The facts

that there is a marked downward deflection of the last quarter whorl and that the roof of the peristome attaches below the periphery of the previous whorl demonstrate that those specimens are fully grown and share more similarities with *Sinezona* than with *Scissurella* with an open slit. Accordingly, *S. wileyi* is placed in *Sinezona*.

The species seems to have variable strengths of sculpture. Most specimens have predominant axial sculpture (Figures 10, 12, 14–15), while in occasional specimens (Figure 11) the axial sculpture is barely perceptible and the spiral structures, particularly on the adumbilical part of base, become most prominent. As there are intermediate specimens (Figure 13) with distinct adumbilical



**Figures 14–16.** *Sinezona wileyi* new species, paratypes. **14.** Herald Pass, W of Ndravuni Island, NW end of Great Astrolabe Reef, Fiji, 18.767° S, 178.467° E, 20 m (LACM 85-135, 2). **15.** Lumu Reef, Kimbe Bay, New Britain, Papua New Guinea, 5.283° S, 150.131° E, 0–5 m (DLG 639, 19). **16.** Off Francis Island in Beqa Lagoon, just off of Beqa Island (south of Viti Levu), Fiji, 18.3° S, 178.067° E, 10–20 m (DLG 279, 10). Scale bars, shell = 500 µm. Scale bars, protoconch = 100 µm.

spiral lines and relatively weak axial lines, combined with identical condition of the protoconch and very small size, these sculptural differences are considered to constitute intraspecific variability.

There are no similar species in the Indo-Pacific. *Sinezona ferriezi* (Crosse, 1867) with broad Indo-Malayan Archipelago distribution is most similar, but is about twice the size of *S. wileyi*, has a smooth protoconch with distinct apertural varix, a teleoconch I with more than whorl, is more rounded overall, and a distinct raphe anterior to the closed foramen. *Sinezona garciai* Geiger, 2006, from the Caribbean, shares the protoconch sculpture, the absence of an apertural varix on the protoconch, the relatively short teleoconch I with 0.6 whorls, and the narrow umbilicus. However, in addition to its occurrence in a separate ocean, *S. garciai* has a more inflated shell with an oval aperture, which connects to the previous whorl barely below the periphery, has only about 0.6 teleoconch II whorls, and bears a distinct raphe anterior to the foramen.

Anatomidae McLean, 1989

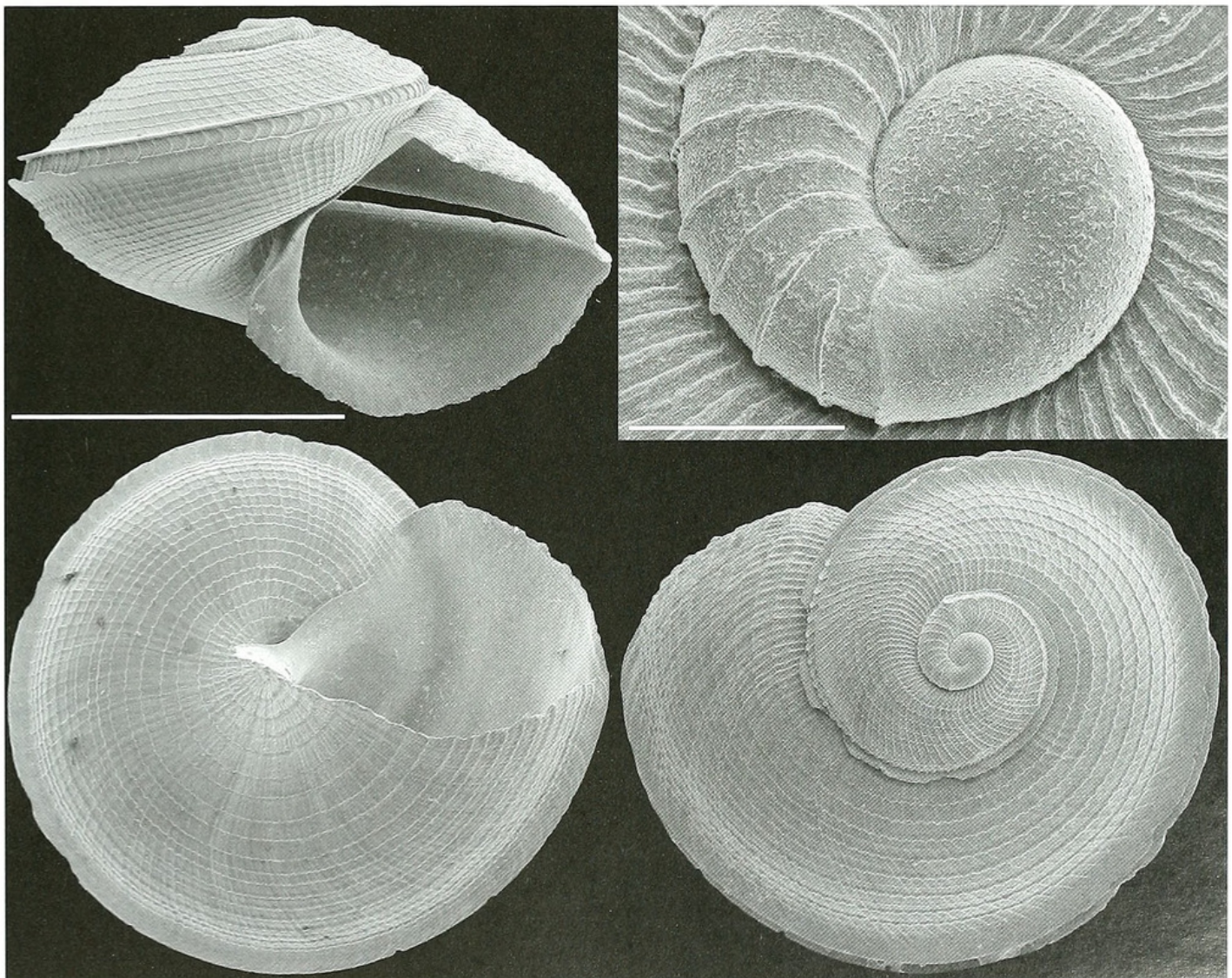
*Anatoma* Woodward, 1859

**Type Species:** *Scissurella crispata* Fleming, 1828 (M).

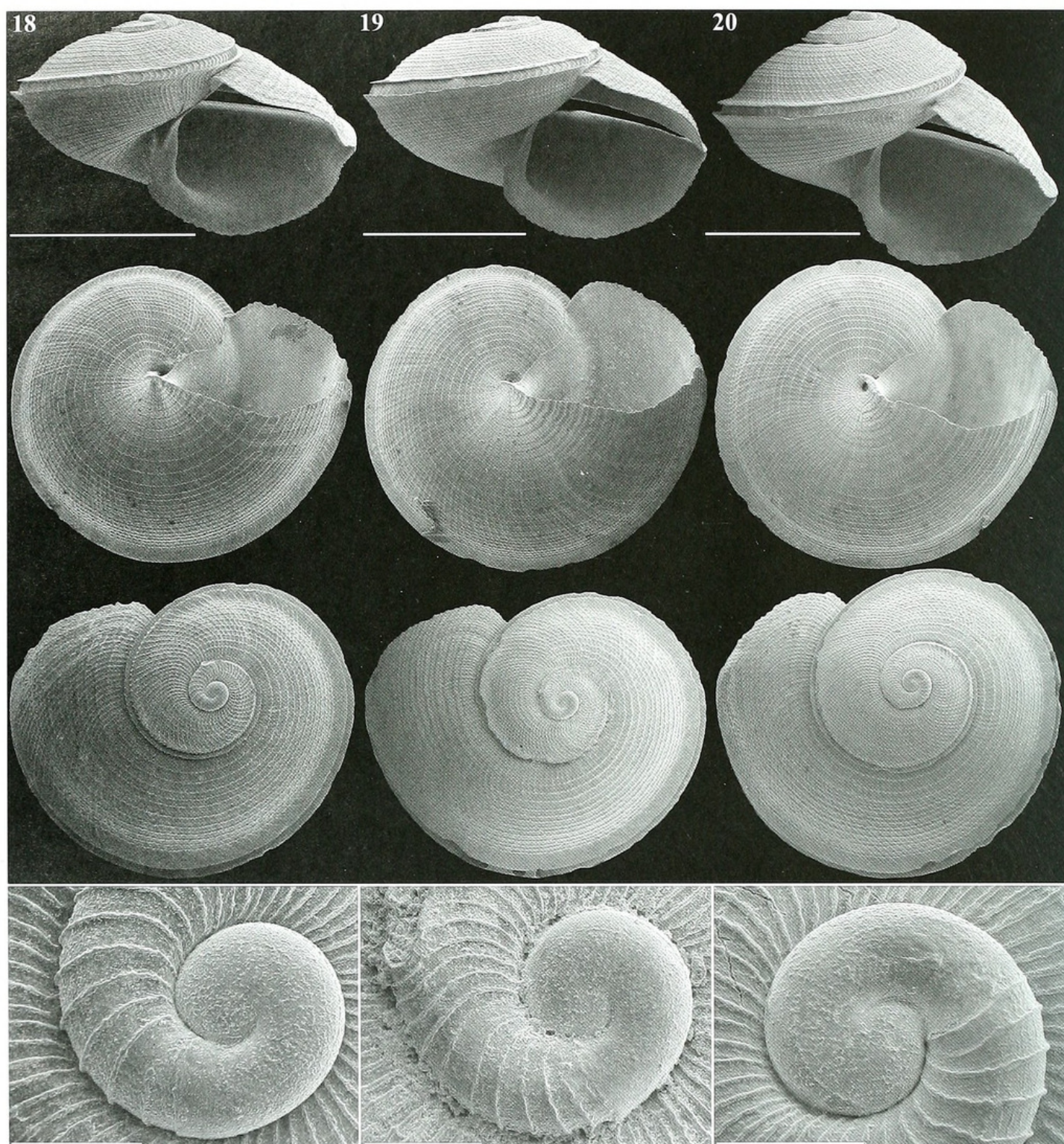
**Remarks:** The genus has recently been treated by Marshall (2002), Geiger (2003), and Geiger and Jansen (2004a).

*Anatoma rapaensis* new species  
(Figures 17–23)

**Description:** Shell of medium size (to 1.82 mm), trochiform biconical. Protoconch with 0.75 whorls, flocculent sculpture, no apertural varix, apertural margin slightly sinusoid. Teleoconch I with 0.3–0.4 whorls, approximately 9–12 axial cords, interstices with fine flocculent sculpture, occasionally (holotype) flocculent sculpture somewhat concentrated in position of selenizone. Teleoconch II with up to 2.25 whorls, suture immediately below selenizone in early growth, offset by width of selenizone



**Figure 17.** Holotype of *Anatoma rapaensis* new species. St. 43, Haurei Bay, Rapa, Austral Islands, French Polynesia, 27.613° S, 144.305° W, 45 m, (MNHN 20823). Scale bar shell = 1 mm. Scale bar protoconch = 100  $\mu$ m.



**Figures 18–20.** *Anatomia rapaensis* new species, paratypes (MNHN). **18–19.** St. 43, Haurei Bay, Rapa, Austral Islands, French Polynesia, 27.613° S, 144.305° W, 45 m (MNHN 20824). **20.** St. 48, around Rukuaga Point, Rapa, Austral Islands, French Polynesia, 27.568° S, 144.368° W, 36 m (MNHN, 30). Scale bars, shell = 1 mm. Scale bars, protoconch = 100  $\mu$ m.

in fully grown specimens. Shoulder convex, approximately 53–66 ( $n = 4$ ) axial cords on first teleoconch II whorl, same density on remaining whorls; first fine spiral cords after 0.125 whorls, approximately 7–10 after one teleoconch II whorl, approximately 15–22 at apertural margin of fully grown specimen, becoming less distinct and more unevenly spaced towards apertural margin; intersections of

axial and spiral cords forming minute points. Base continuously sloping with narrow umbilicus; axial cords of same density and strength as on shoulder, approximately 19 spiral cords, fine spiral cords below selenizone turning into low steps from mid-base onwards; intersection of spiral and axial cords with fine points. Aperture ovoid D-shaped, roof overhanging, basal adumbilical portion

flared. Selenizone at periphery, keel moderately strong, moderately elevated, slit open, margins converging towards apertural margin.

**OPERCULUM** (FIGURE 23): As large as aperture, thin, corneous, nucleus central, multispiral.

**RADULA** (FIGURES 21–22): Rachidian tooth trapezoid, central denticle with 3–4 denticles on each side. Lateral teeth 1–3 similar, development of cusp reduced peripherally, terminal denticle largest, 4–2 denticles on outer edge. Lateral tooth 4 reduced in size, hook-shaped, with one minute point on each side. Lateral tooth 5 enlarged with four strong denticles on inner margin. Inner marginal teeth elongated, terminal denticle largest, 3–4 smaller denticles on inner margin, three larger denticles on outer margin. Outer marginal teeth with cup-shaped cusp with many small denticles.

**Type Material:** Holotype: MNHN 20823 (Figure 17). 60 Paratypes: 45 m, RAPA St. 43, Haurei Bay, Rapa, Austral Islands, French Polynesia, 27.613° S, 144.305° W (MNHN 20824, 29; two illustrated in Figures 18–19). 36 m, RAPA St. 48, Around Rukuaga Point, Rapa, Austral Islands, 27.568° S, 144.368° W (MNHN, 30; one illustrated in Figure 20). 145 m, MUSORSTOM 9 St. CP 1159, Eiao Island, 7.972° S, 140.728° E (MNHN, 1; Figures 21–23 [radula, operculum]).

**Type Locality:** 45 m, RAPA St. 43, Haurei Bay, Rapa, Austral Islands, French Polynesia, 27.613° S, 144.305° W.

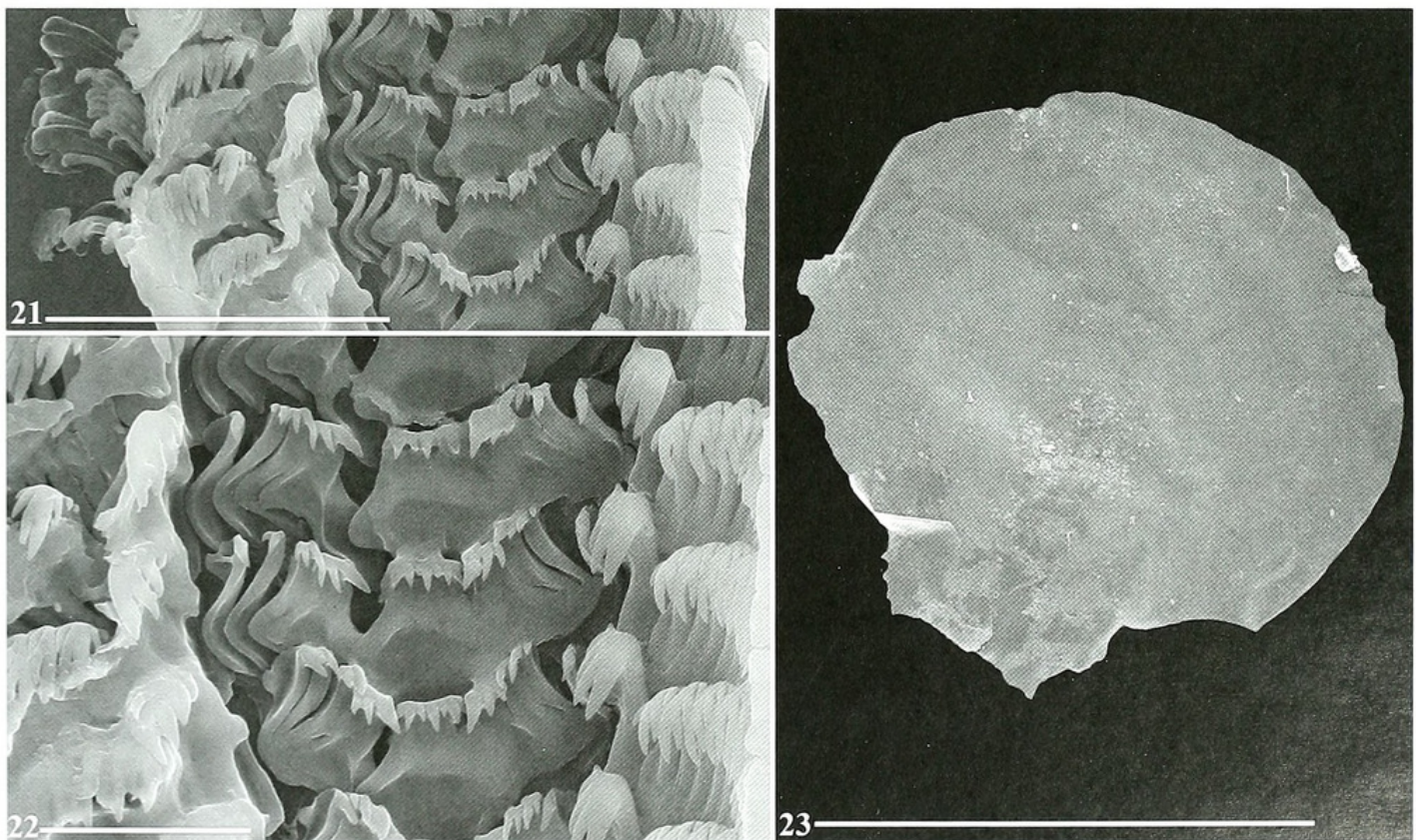
**Etymology:** The species is named after its type locality, Rapa Island, French Polynesia.

**Distribution:** Tropical Indo-Malayan Archipelago and Western Pacific; shallow shelf to upper slope.

**Other Material Examined:** FRENCH POLYNESIA: 10–15 m, Pake Bay, Rapa, Austral Islands, 27.617° S, 144.310° W (MNHN, 2). 30 m, NW of Tauna Island, Rapa, Austral Islands, 27.605° S, 144.303° W (MNHN, 50). 33 m, Haurei Bay, Rapa, Austral Islands, 27.612° S, 144.318° W (MNHN, 10). 52–57 m, SE of Tauna Island, Rapa, Austral Islands, 27.608° S, 144.295° W (MNHN, 50; MNHN, 20). 100 m, North of Raivavae, Austral Islands, 23.828° S, 147.693° W (MNHN, 2).

PHILIPPINES: 92–97 m, 12.517° N, 120.650° E (MNHN, 8).

NEW CALEDONIA: 105–110 m, Poindimie Sector, 20.817° S, 165.317° E (MNHN, 9). 250–350 m, southern New Caledonia, 22.500° S, 166.400° E (MNHN, 1). 250–350 m, southern New Caledonia, 22.500° S, 166.400° E (MNHN, 1). 495 m, southern New Caledonia, 22.367° S, 166.233° E (MNHN, 3). 600–616 m, northern New Caledonia, 18.817° S, 163.250° E (MNHN, 3).



**Figures 21–23.** Radula and operculum of *Anatoma rapaensis* new species. Eiao Island, Marquesas Islands, 7.972° S, 140.728° E, 145 m (MNHN, 1). **21–22.** Radula. **23.** operculum. Scale bar, radula Figure 21 = 50 µm. Scale bar, radula Figure 22 = 20 µm. Scale bar, operculum = 500 µm.

MARQUESAS ISLANDS: 145 m, Eiao Island, 7.972° S, 140.728° E (MNHN, 1; paratype). 200–220 m, Ua Huka Island, 8.900° S, 139.633° W (MNHN, 6). 352–358 m, Hiva Oa Island, 9.850° S, 139.150° W (MNHN, 1).

Fiji: 149–168 m, S of Viti Levu, 18.207° S, 178.552° E (MNHN, 1). 260–305 m, S of Viti Levu, 18.308° S, 178.097° E (MNHN, 6). 275–430 m, S. of Viti Levu, 18.297° S, 177.907° E (MNHN, 1). 441–443 m, S. of Viti Levu, 18.320° S, 177.862° E (MNHN, 1).

**Remarks.** *Anatoma rapaensis* is characterized by the rather flattened overall shape, the short teleoconch I with less than 0.5 whorls, and the fine reticular sculpture that is axial-dominated on the first half teleoconch II whorl, subsequently becoming spiral-dominated. The most similar species is *Anatoma* (sensu lato) *exquisita* Schepman, 1908, from the Indo-Malayan Archipelago; the comparison is based on SEM imaging of the holotype (ZMA 3.08.101; Figure 24). The shell is slightly taller, the spiral and axial lines are denser, forming more prominent points at their intersection, and the axial lines are slightly stronger than the spiral lines even in larger

specimens (specimens 1.8–3.5 mm examined); protoconch and teleoconch I are eroded beyond recognition. *Anatoma paucispiralia* Bandel, 1998, from Satonda, Indonesia, has a smooth protoconch, a shorter teleoconch I (0.125 vs. 0.3–0.4 whorls), and a slightly undulating shoulder profile. All other Indo-Pacific species are either more turreted or have noticeably different sculpture on shoulder and base. The only other documented case of a species that shows a change of sculpture on the teleoconch II is *Anatoma jantae* Geiger, 2006, known from 2,500 m off the west coast of North America (Geiger, 2006c).

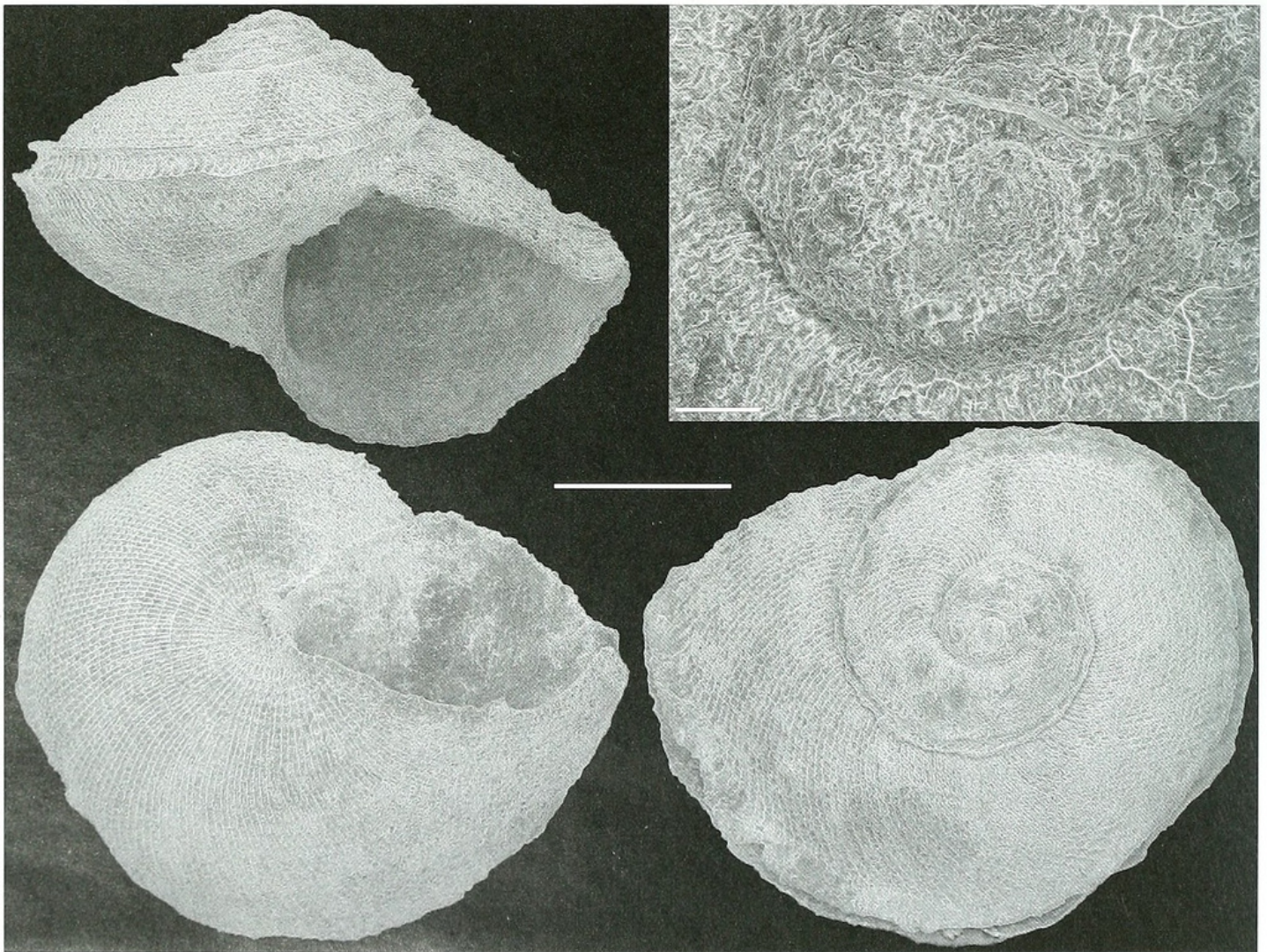
Larochelidae Fleming, 1927

*Trogloncha* Kase and Kano, 2002

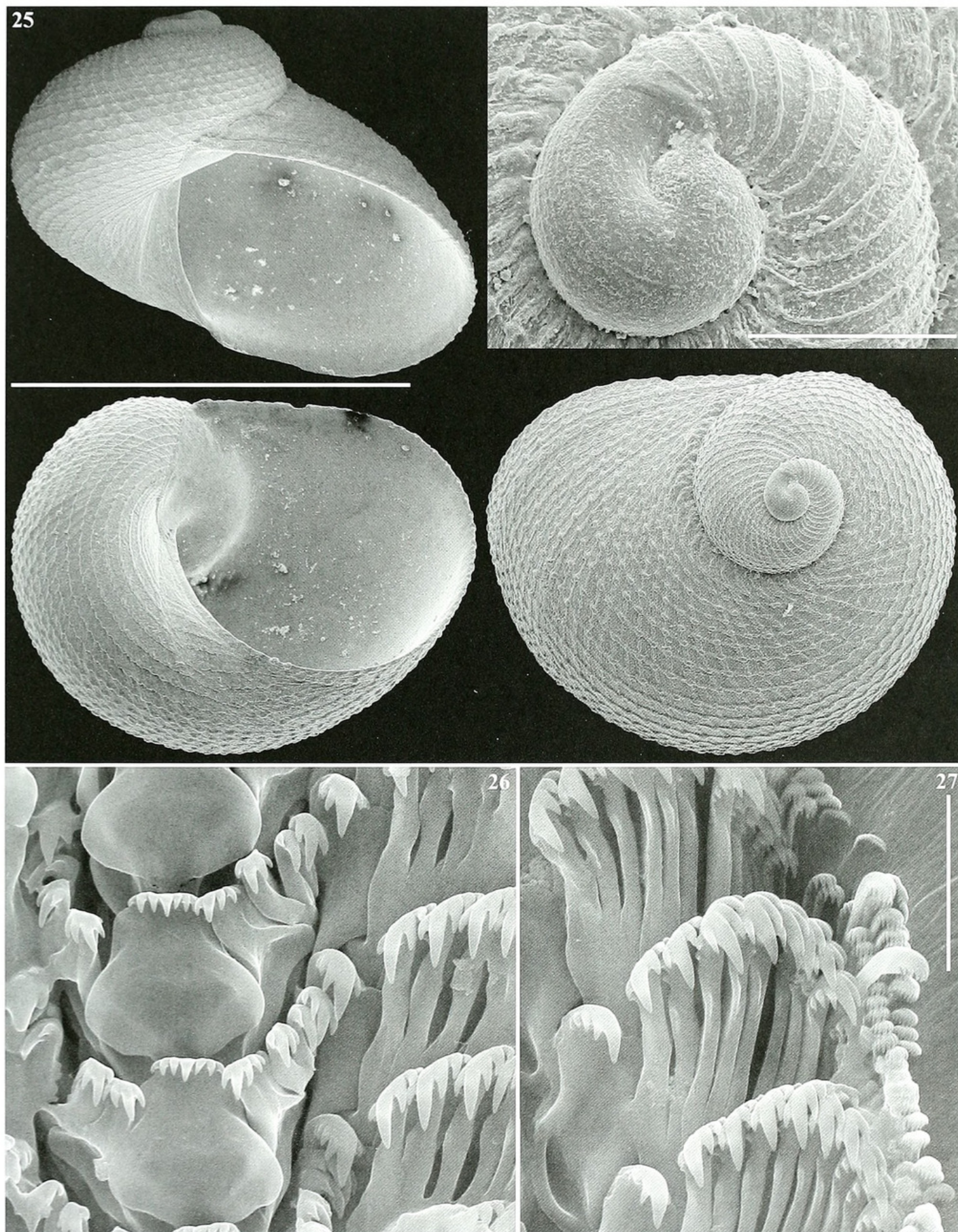
**Type Species:** *Trogloncha ohashii* Kase and Kano, 2002 (OD).

**Remarks:** The genus was recently treated by Geiger (2003).

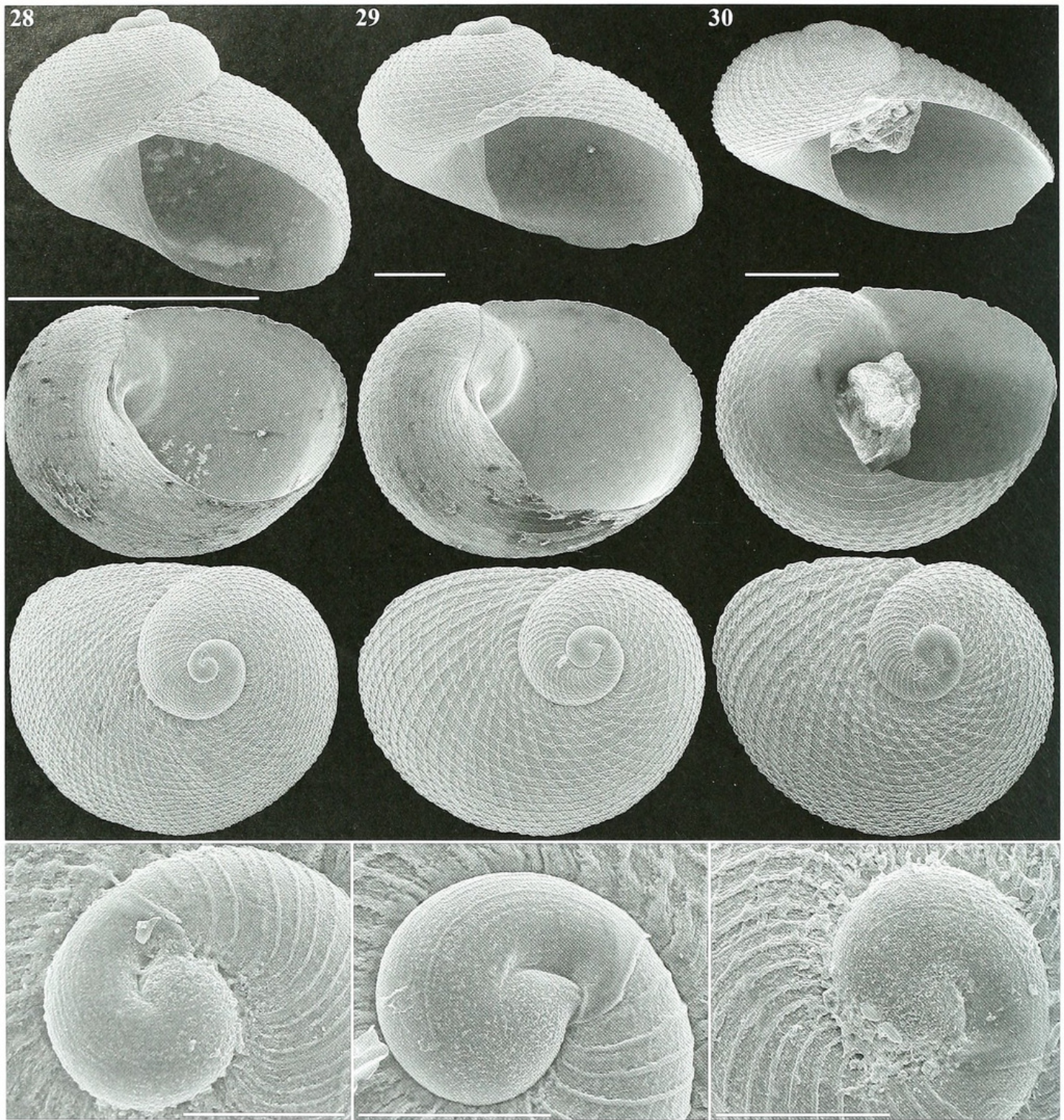
*Trogloncha lozoueti* new species  
(Figures 25–30)



**Figure 24.** Holotype of *Anatoma exquisita* Schepman, 1908 (ZMA 3.08.101). Siboga Station 95, 5°43.5' N, 119°40' E, 522 m [between Sabah, Malaysia, and southeastern Tawitawi Group, Philippines]. Scale bar, shell = 1 mm. Scale bar, protoconch = 100 μm.



**Figures 25–27.** *Trogloconcha lozoueti* new species. **25.** Holotype. Vavai, Rapa, Austral Islands, French Polynesia, 27.590° S, 144.381° W, 15–20 m (MNHN 20825). **26–27.** Radula from specimen shown in Figure 30. Hiri Bay, Rapa, Austral Islands, French Polynesia, 27.622° S, 144.37° W, 3–24 m (MNHN). Scale bar, shell = 1 mm. Scale bar, protoconch = 100  $\mu$ m. Scale bar, radulae = 10  $\mu$ m.



**Figures 28–30.** *Trogloconcha lozoueti* new species. Paratypes. **28–29.** Vavai, Rapa, Austral Islands, French Polynesia, 27.590° S, 144.381° W, 15–20 m (MNHN 20826). **30.** Hiri Bay, Rapa, Austral Islands, French Polynesia, 27.622° S, 144.37° W, 3–24 m (MNHN, 20). Scale bar, shell 28 = 1 mm. Scale bars, shell 29–30 = 200  $\mu$ m. Scale bars, protoconch = 100  $\mu$ m.

**Description:** Shell medium size (to 1.17 mm), trochi-form globular, with rapidly increasing whorls. Protoconch with 0.75 whorls, flocculent sculpture somewhat spirally arranged, weak apertural varix, apertural margin convex. Teleoconch with up to two whorls, approximately 15 axial cords on first 0.3–0.5 whorls with no spiral sculpture, interstices with fine flocculent sculpture; onset of spiral cords after 0.5 whorls; approximately

31 spiral cords, from suture to mid-base as fine spiral cords, transitioning to low spiral steps in 5–6 adumbilical spirals; approximately 70 fine axial cords on last whorl, forming distinct points at intersections; overall appearance of shell fine reticulate and spiky. Suture bordered by strong irregularly lamellate thickening on shoulder. Base anomphalus with weak callus in umbilical region. Aperture oval, roof overhanging.

**OPERCULUM:** Corneous, round, multispiral, with central nucleus, covering only approximately  $\frac{1}{3}$  of aperture.

**RADULA (FIGURES 26–27):** Rachidian tooth triangular, cusp with central denticle largest, three denticles on each side, arranged in convex curve. Lateral teeth 1–4 similar, L-shaped, cusp with apical denticle largest, 3–4 denticles on outer margin, 1–3 denticles on inner margin; lateral tooth 5 enlarged by half, apical denticle largest, 3–4 denticles on each side. Inner marginal teeth with elongated shaft central denticle largest, 3–4 denticles on inner margin, 5–6 denticles on outer margin; outer marginal teeth with cup shape cusp, with many fine denticles on each side. Radular interlock of central field strong.

**Type Material:** Holotype: MNHN 20825. 26 Paratypes: 15–20 m, RAPA St. 32, Vavai, Rapa, Austral Islands, 27.590° S, 144.381° W (MNHN 20826, 6: two illustrated in Figure 28–29). 3–24 m, RAPA St. 9, Hiri Bay, Rapa, Austral Islands, 27.622° S, 144.370° W (MNHN, 20: one illustrated in Figure 30).

**Type Locality:** 15–20 m, RAPA St. 32, Vavai, Rapa, Austral Islands, French Polynesia, 27.590° S, 144.381° W.

**Etymology:** Named in honor of Pierre Lozouet (MNHN) for his accomplishments particularly in the field of fossil mollusks including Scissurellidae sensu lato, and his work in connection with the Rapa expedition.

**Other Material Examined:** FRENCH POLYNESIA: 36 m, Around Rukuaga Point, Rapa, Austral Islands, 27.568° S, 144.368° W (MNHN, 100). 33 m, Haurei Bay, Rapa, Austral Islands, 27.612° S, 144.318° W (MNHN, 6). 52–57 m, SE of Tauna Island, Rapa, Austral Islands, 27.608° S, 144.295° W (MNHN, 20). 30 m, NW of Tauna Island, Rapa, Austral Islands, 27.605° S, 144.303° W (MNHN, 3). 8 m, S of Tarakoi Island, Rapa, Austral Islands, 27.093° S, 144.308° W (MNHN, 1). 52–57 m, SE of Tauna Island, Rapa, Austral Islands, 27.608° S, 144.295° W (MNHN, 9).

**Remarks:** *Troglonconcha ohashii* from southern Japan has fewer spiral and axial elements that also form elevated points and a wide umbilicus. *Troglonconcha tessellata* Kase and Kano, 2002, from the Indo-Malayan Archipelago has a smooth protoconch and lacks the fine points at the intersection of axials and spirals. *Troglonconcha christinae* Geiger, 2003, from Western Australia lacks spiral sculpture and has flattened-flocculent protoconch sculpture.

The new species is currently only known from the Austral Islands. The radula represents the general vetigastropod pattern (rhipidoglossate) and shows the typical larocheid arrangement of similar lateral teeth 1–4, without reduced, hook-shaped lateral tooth 4; the radula confirms the placement of the species in Larocheidae. The lack of a brood pouch seen in *Larochea* and *Larocheopsis* places the species in *Troglonconcha*. Juveniles have a proportionally wider appearance with the suture approximately at the periphery of the

previous whorls. Fully grown specimens have a more elevated appearance with the suture connecting well below the periphery of the previous whorl.

## DISCUSSION

The new species all belong to recognized genera. They are diagnosed by particular character combinations not known from any described species. The two *Sinezona* species are among the smaller species in the genus, while the *Anatoma* and *Troglonconcha* species are within the usual size range for their respective genera. All species show characters of shell and radular morphology that are known from other species; no new character states were found. The combination of particular features and their particular strength of development, however, are unique for each of the new species.

The distribution of three species reaches beyond the Austral Islands towards the equator (*Sinezona wileyi*, *S. danieldreieri*, and *Anatoma rapaensis*), while one species (*Troglonconcha lozoueti*) is currently only known from Rapa Island. This pattern suggests a closer faunal affinity of the Austral archipelago with the broad Indo-Malayan Archipelago, rather than with the temperate Southern Ocean. The two more widely distributed species *S. danieldreieri* and *S. wileyi* are also those that have been found in deeper water, confirming the idea that deep-water species in general show a wider distribution than those restricted to shallow water.

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