

Fragum vanuatuense spec. nov., a small new *Fragum* from the Central Indo-West Pacific (Bivalvia, Cardiidae)

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Fragum vanuatuense spec. nov. (Cardiidae) is described from various localities in the central Indo-West Pacific. It represents the smallest *Fragum* and is compared with *F. grasi* Ter Poorten, 2009 and *F. sueziense* (Issel, 1869), both occurring partly sympatric with *F. vanuatuense* spec. nov. Figures of the juvenile growth stages of six *Fragum* species are given for comparison.

Key words: Bivalvia, Cardiidae, Indo-Pacific, Recent, taxonomy, new species, distribution

INTRODUCTION

The genus *Fragum* Röding, 1798, is widely distributed in the Indo-Pacific, invariably occupying shallow water habitats, either in exposed coral reef environments or in more sheltered bays and lagoons with sea-grass and mangroves (Ter Poorten, 2009). Perhaps with the exception of *F. mundum* (Reeve, 1845), all species live infaunally in sandy or muddy sediments. Presence of photosymbiotic zooxanthellae was first reported by Kawaguti (1983) and later established for all *Fragum* taxa (Persselin, 1998; Kirkendale, 2009). With the exception of the relatively large *F. unedo* (Linnaeus, 1758), all species are medium to small sized (H 45-10 mm). The taxonomy of the genus is poorly resolved: molecular analyses resulted in a core 'Fragum' group, which also includes *Corculum* Röding, 1798, and *Lunulicardia* J.E. Gray, 1853, and with a controversial position of the earliest derived taxa, viz. *Cardium erugatum* Tate, 1889, and *Cardium sueziense* Issel, 1869

(Kirkendale, 2009; Herrera et al., 2015). Lacking more elaborate DNA data and a formal taxonomic revision, the classification of *Fragum* species remains problematic. At present, the World Register of Marine Species (WoRMS) recognizes eight accepted species (Ter Poorten & Bouchet, 2015), six of which were dealt with by Ter Poorten (2009), treating the Cardiidae of the 2004 Panglao Marine Biodiversity Project and the Panglao 2005 Deep-Sea Cruise. The present study is largely based on *Fragum* material of another large scale expedition: the 2006 Santo Marine Biodiversity Survey to Espiritu Santo, Vanuatu (SANTO 2006) that yielded a total of six *Fragum* species. Collection research makes clear that small *Fragum* species have been largely neglected and often have been lumped together with larger, more well known species or have been left unidentified. This is an attempt toward a better understanding of this group of species. To facilitate easier identification, similar-sized juvenile forms of five SANTO 2006 *Fragum* species are figured herein for comparison with the new species, as well as type material of related species.

Abbreviations: MNHN, Muséum national d'Histoire naturelle, Paris, France; NHMUK, Natural History Museum, London, United Kingdom; NMP, National Museum of the Philippines, Manila, Philippines; NTM, Museum and Art Gallery of the Northern Territory, Australia; RMNH, Naturalis Biodiversity Center, Leiden, The Netherlands; TP, Coll. J.J. ter Poorten, Hilversum, The Netherlands.

H, height; L, length; p.v., paired valves; s.v., single valve; LV, left valve(s); RV, right valve(s).

Species	Bathymetric range of live samples PMBP 2004	Bathymetric range of live samples SANTO 2006	Deepest live-taken sample investigated
<i>Fragum fragum</i> (L., 1758)	0-54 m (n = 5)	0-10 m (n = 12)	2-54 m (MNHN, PMBP 2004, R19)
<i>F. grasi</i> Ter Poorten, 2009	0-2 m (n = 1)	—	0-2 m (MNHN, PMBP 2004, D5)
<i>F. mundum</i> (Reeve, 1845)	0-20 m (n = 13)	1 m (n = 3)	15-20 m (MNHN, PMBP 2004, S22)
<i>F. scruposum</i> (Deshayes, 1855)	—	1-3 m (n = 3)	1-3 m (MNHN, SANTO 2006, LD07)
<i>F. sueziense</i> (Issel, 1869)	0-20 m (n = 8)	2-10 m (n = 11)	36 m (MNHN, LAGON, DW446)
			37 m (MNHN, LAGON, DW438)
<i>F. unedo</i> (Linnaeus, 1758)	0-3 m (n = 3)	—	16 m (MNHN, SUVA 2, CP48)
<i>F. whitleyi</i> Iredale, 1929	0-20 m (n = 9; as <i>F. scruposum</i>)	0-8 m (n = 22)	15-20 m (MNHN, PMBP 2004, S22)
<i>F. vanuatuense</i> spec. nov.	—	8-12 m (n = 3)	12 m (MNHN, SANTO 2006, FS74)

Table 1. Bathymetric ranges of *Fragum* species from the Panglao Marine Biodiversity Project (PMBP 2004) and the Santo Marine Biodiversity Survey (SANTO 2006). n = number of samples.

SYSTEMATIC PART

Family Cardiidae Lamarck, 1809

Subfamily Fraginae Keen, 1951

Fragum Röding, 1798

Fragum Röding, 1798: 189. Type species by absolute tautonomy

Fragum flavum Röding, 1798 [= *Cardium fragum* Linnaeus, 1758]; Recent, 'O. Asiatico, Americano' (Indo-West Pacific, restricted to Ambon, Indonesia by Wilson & Stevenson, 1977: 37).

Hemicardium Swainson, 1840: 373 (non Spengler, 1799). Type species by subsequent designation (J.E. Gray, 1847: 185): *Cardium unedo* Linnaeus, 1758; Recent (type locality not mentioned).

Diagnosis. — Shell small (5 mm) to large (81.5 mm), triangular, trapezoidal or ovoid, inflated, with longitudinal medio-posterior angulation of variable strength. Posterior margins strongly serrated. Ribs ornamented with scales or tubercles. Lunule and escutcheon poorly defined. Hinge not parallel to the ventral margin, often short and rather angled. Cardinal teeth about equal in both valves, joined dorsally in right valve.

Distribution. — Miocene to Recent, Indo-Pacific, South Africa, Japan. Living in shallow water, infaunally or partly epifaunal and adapted to a photosymbiotic lifestyle, harboring dinoflagellate zooxanthellae in the mantle tissue.

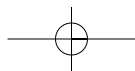
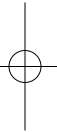
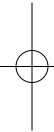
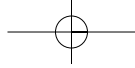
Fragum vanuatuense spec. nov. (Figs 1-6, 12, 18)

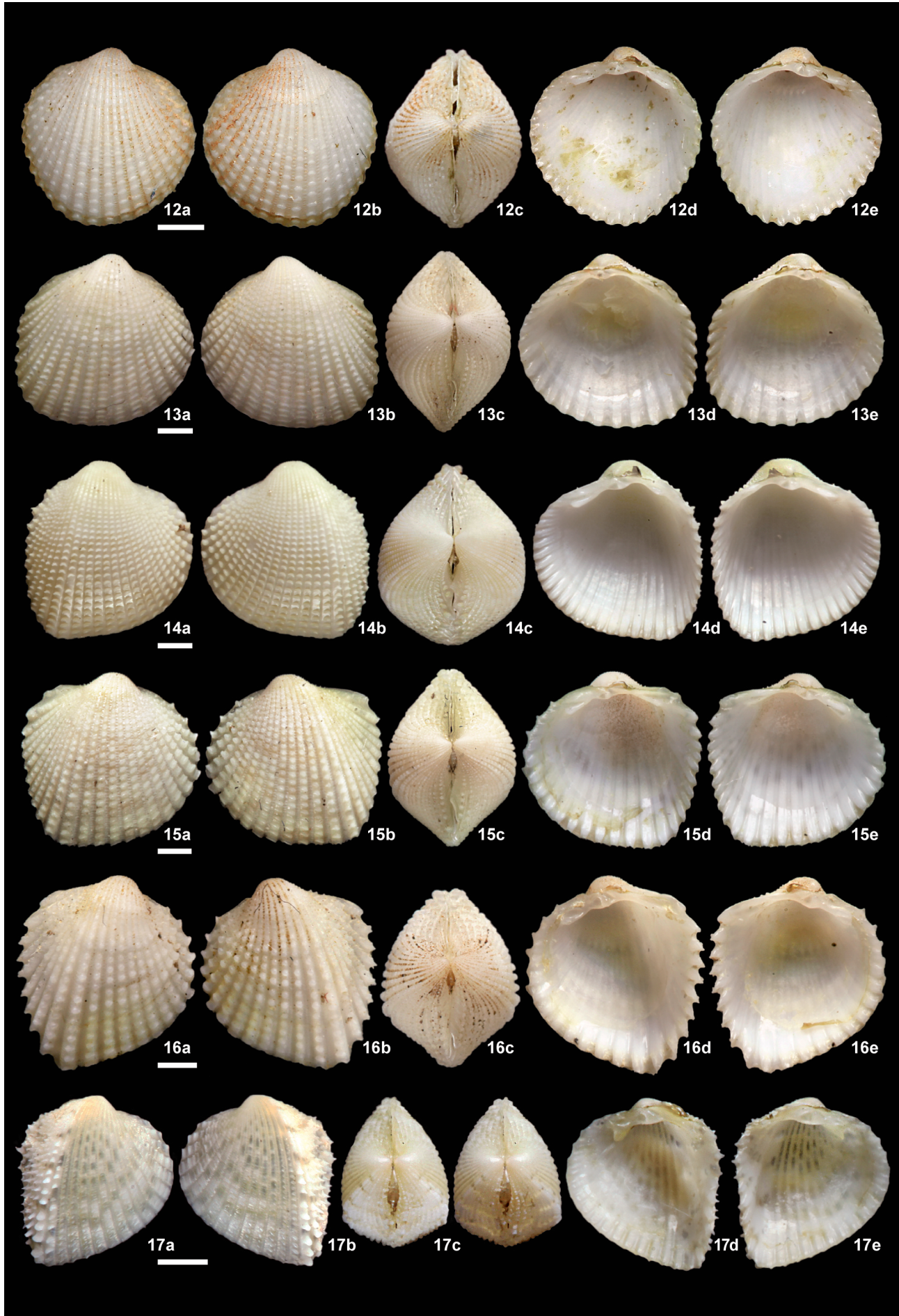
Description. — Shell very small for the genus (H 4-6 mm, largest H 6.8 mm), rather solid, glossy, moderately inflated, ovoid and rather elongate (H generally

exceeding L), inaequilateral with umbo in front of midline and strongly prosogyrous. Antero-ventral margin rounded, postero-ventral margin very weakly angular, postero-dorsal wing angular and fairly

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Figs 1-6. *Fragum vanuatuense* spec. nov. **1a-b**, Vanuatu, Espiritu Santo, Segond Channel, vicinity of Maritime College 15°31.4'S, 167°10.0'E, 7-8 m, 13.10.2006, SANTO 2006, st. LD30. MNHN IM-2000-30339, holotype, H 4.0 mm (a: LV exterior, b: RV interior). **2a-b**, Vanuatu, Segond Channel, Chaverot Point 15°31.7'S, 167°09.7'E, 25-25 m, 15.09.2006, SANTO 2006, st. DS22. MNHN IM-2000-30341, paratype, H 6.8 mm (a: LV exterior, b: RV interior). **3a-b**, Same locality as 1. MNHN IM-2000-30340, paratype, H 5.0 mm (a: RV exterior, b: RV interior). **4a-b**, Same locality as 1. MNHN IM-2000-30340, paratype, H 4.3 mm (a: RV exterior, b: RV interior). **5a-b**, Same locality as 1. MNHN IM-2000-30340, paratype, H 4.0 mm (a: RV exterior, b: RV interior). **6a-b**, Same locality as 1. MNHN IM-2000-30340, paratype, H 3.7 mm (a: LV exterior, b: LV interior). **Fig. 7.** *Fragum grasi* Ter Poorten, 2009. Philippines, Panglao Isl., Pontod Islet, 9°33.6'N, 123°43.5'E, soft bottom with seagrass, 0-2 m (alive; with dried animal), 06.06.2004. PMBP 2004, Stn D5. NMP, holotype, H 5.2 mm (a: RV exterior, b: LV exterior, c: dorsal). **Fig. 8.** *Fragum scruposum* (Deshayes, 1855). 'Malacca [= Malaysia, Strait of Malacca]. Coll. Cuming'. NHMUK 1974140, largest of the three syntypes, H 7.8 mm (a: LV exterior, b: RV interior). **Figs 9-11.** *Fragum mundum* (Reeve, 1845). 'Lord Hood's Isl., Pacific Ocean (found among coral sand) Cuming' [= Tuamotu Archipelago, South Marutea, 21°30'S, 135°33'W]. NHMUK 1978138, three syntypes. **9a-d**, H 8.8 mm (a: RV exterior, b: LV exterior, c: RV interior, d: LV interior). **10a-d**, H 6.0 mm (a: RV exterior, b: LV exterior, c: RV interior, d: LV interior). **11a-d**, H 8.8 mm (a: RV exterior, b: LV exterior, c: RV interior, d: LV interior). All scale bars: 1 mm.





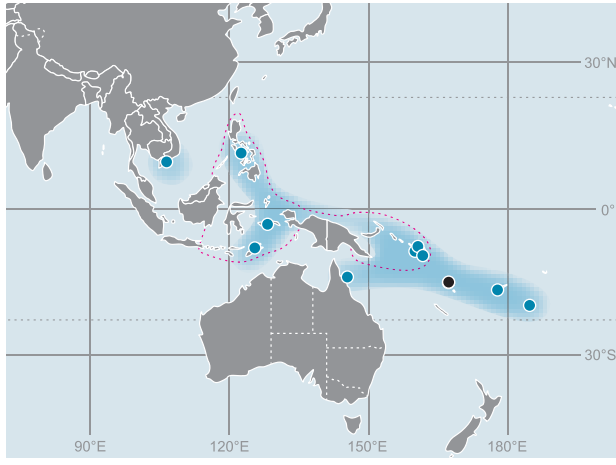


Fig. 18. Central Indo-West Pacific distribution of *Fragum vanuatuense* spec. nov. as currently known. Coral Triangle indicated in red dotted line.

broad. 19-26 rounded radial ribs present, slightly more flattened on postero-dorsal slope. Ribs carrying regularly placed, well-developed knobby scales, becoming more strongly nodular both anteriorly and posteriorly. Scales straight, often weakly curved on the posterior half of the shell. Interstices minutely pitted and rather wide, about half the width of the ribs

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Figs 12-17. *Fragum* species. **12,** *Fragum vanuatuense* spec. nov. Same locality as 1. MNHN IM-2000-30339, holotype, H 4.0 mm (a: RV exterior, b: LV exterior, c: dorsal, d: RV interior, e: LV interior). **13,** *Fragum sueziense* (Issel, 1869). Vanuatu, W Tutuba Island, 15°33.5'S, 167°16.8'E, 8-10 m (alive; with dried animal), 17.10.2006, SANTO 2006, st. LD36. MNHN IM-2014-5519, L 5.3 mm (a: RV exterior, b: LV exterior, c: dorsal, d: RV interior, e: LV interior). **14,** *Fragum fragum* (Linnaeus, 1758). Vanuatu, Malo Island, W Malokilikili, 15°42.7'S, 167°15.1'E, 2-5 m, 05.10.2006, SANTO 2006, st. LD20. MNHN IM-2014-5521, H 5.3 mm (a: RV exterior, b: LV exterior, c: dorsal, d: RV interior, e: LV interior). **15,** *Fragum whitleyi* Iredale, 1929. Vanuatu, Palikulo Bay, 15°29.6'S, 167°14.9'E, 2-5 m (alive; with dried animal), 26.09.2006, SANTO 2006, st. LD05. MNHN IM-2014-5522, H 5.3 mm (a: RV exterior, b: LV exterior, c: dorsal, d: RV interior, e: LV interior). **16,** *Fragum scruposum* (Deshayes, 1855). Vanuatu, Segond Channel, vicinity of Luganville, 15°31.0'S, 167°09.0'E, 1 m (alive; with dried animal), 09/10.2006, SANTO 2006 st. VM71. MNHN IM-2014-5520, H 5.3 mm (a: RV exterior, b: LV exterior, c: dorsal, d: RV interior, e: LV interior). **17,** *Fragum mundum* (Reeve, 1845). Vanuatu, E Aoré Island, 15°33.8'S, 167°12.5'E, intertidal, 07.10.2006, SANTO 2006 st. VM57. MNHN IM-2014-5523, H 3.7 mm (a: RV exterior, b: LV exterior, c: two dorsal views, revealing partly translucent posterior part, d: RV interior, e: LV interior). All scale bars: 1 mm.

on the median part of the shell, somewhat wider on antero-dorsal side. Rib impressions visible throughout shell interior, anterior and ventral margins crenulated, morphing into a more or less digitate posterior margin. Lunule small but conspicuous and well demarcated by a depressed area just anterior of the umbo. Pallial line entire, relatively distantly located from the ventral margin.

Hinge typical for the genus with LV and RV anterior laterals generally slightly closer to cardinals than posterior laterals, RV cardinal teeth dorsally partly joined and relatively long RV posterior laterals. Nymph plate short.

Exterior and interior coloration white. Periostracum olive green, thin and mainly preserved near the margins.

Distribution. — At present known from Vietnam, Philippines, Indonesia, Timor-Leste, NE Australia, Solomon Islands, Vanuatu, Fiji and Tonga (Fig. 18). Bathymetric range: 8-12 m (alive); 0-581 m (empty). In accordance with other *Fragum* species – with the exception of *F. sueziense* (Issel, 1869) (Fig. 13) – it is confined to shallow water (Table 1), hence the few deep-water records do not reflect the natural habitat but must result from downslope transportation. Most fresh samples were found in mineral sand and coral sand in rather sheltered environments. Given the state of preservation, it cannot be excluded that part of the Philippine sample (MNHN-IM-2014-6001) in fact are subfossil.

Etymology. — Named after the type locality, Vanuatu, from where the vast majority of the samples originate.

Remarks. — Due to its small size, *F. vanuatuense* spec. nov. has probably been neglected, overlooked or mistaken for various juvenile *Fragum* species. This sharply contrasts with the wealth of studied shells (47 samples consisting of just over 1000 valves/specimens), suggesting that it can be locally very common. Unlike other *Fragum* species, unfortunately no DNA samples were taken of this species during the SANTO 2006 expedition. Hence the description is based on morphological characters only.

Contrary to some more modified congeners (e.g. *F. mundum*, Figs 9-10, 17; *F. fragum*, Fig. 14; *F. nivale* (Reeve, 1845)), morphological adaptations for photosymbiosis, i.e. a pattern of translucent 'shell window' microstructure, was not observed on this species.

Differences with congeneric species are given in Table 2. The diagnostic features of the two morphologically closest species are outlined thereafter. *F. grasi* Ter Poorten, 2009 (Fig. 7) differs by a less elongate, more subcircular outline, by a weakly crenulated posterior margin, by the interstices on the median part of the shell being as broad as the ribs, by a lower rib

<i>Fragum</i> species	L/H (adult)	Rib number	Rib sculpture on posterior part	Max. size (L or H)	Umbonal keel	Outline
<i>F. fragum</i> (Linnaeus, 1758)	L<H	32-37	Oblique scales	H 30-45 mm	Very sharp	Rhomboidal-trigonal
<i>F. grasi</i> Ter Poorten, 2009	L=H	15-21	Weakly expressed knobs	H 5-8 mm	Very weak	Subcircular-obliquely oval
<i>F. mundum</i> (Reeve, 1845)	L<H	26-30	Projecting imbricating scales	H 10-12 mm	Very sharp	Trapezoidal
<i>F. scruposum</i> (Desh., 1855)	L<H	19-24	Nodular scales	H 10-14 mm	Sharp	Subquadrate
<i>F. sueziense</i> (Issel, 1869)	L>H	22-28	Oblique curved scales	L 10-12 mm	Weak	Roundly subquadrate
<i>F. unedo</i> (Linnaeus, 1758)	L<H	25-32	Oblique curved scales	H 50-81 mm	Rather sharp	Rhomboidal-trigonal
<i>F. whitleyi</i> Iredale, 1929	H>L	24-29	Circular nodules	H 15-18 mm	Sharp	Subquadrate
<i>F. vanuatuense</i> spec. nov.	L<H	19-26	Nodular scales	H 5-7 mm	Very weak	Ovoid

Table 2. Comparative characters of *Fragum* species. Sculpture and outline based on the predominant condition in adult material; L/H based on the majority of the investigated specimens.

number (15-21), by a more pronounced ribbing on the anterior and median part, a more knobby-tuberculate rib sculpture, and by coloration that, apart from white, is sometimes cream with light brown spots.

F. sueziense (Issel, 1869) (Fig. 13) is larger (L to 12 mm), has a more roundly subquadrate outline, is of a height generally not exceeding its length, has broader and more flattened ribs with narrower interstices, has a generally more close-set rib sculpture, has rib impressions only visible close to the margin (in adults), and occasionally has more vivid coloration, consisting of brown-pink blotches or overall lemon-yellow.

Type material (indicated in bold type) and other material examined:

Vietnam, Ile Tré [= Ben Tre coastal province, South Vietnam], Coll. Saurin (MNHN-IM-2014-6003, 1 s.v., adult)

Philippines, 11°43'N, 122°34'E, 93-99 m, 06.06.1985, MURSORSTOM 3, st. DR140 (MNHN-IM-2014-6001, 1 p.v., 605 s.v., adult-juv.)

Indonesia, Moluccas, Ambon, Hitu, N coast, near Hila: Kaitetu; 22/23.11.1990. Rumphius Biohist. Exp. 1990, st. 23 (RMNH.5003993, 34 s.v., subadult-juv.; **Paratypes**, RMNH.5003992, 7 s.v., adult-subadult); Hitu, Baguala Bay, Suli; 29.11.1990. Rumphius Biohist. Exp. 1990, st. 30 (RMNH.5003994, 14 s.v., subadult-juv.)

Timor-Leste, N coast of East Timor, immediately west of Dili, Tasi Tolu, 8°33.368'S 125°30.516'E, on surface of silty clean sand, near top of steep sandy slope, 8-12 m. Leg. R.H. Willan, 21.10.2012 (**Paratype**, NTM P.50076, 1 s.v., subadult)

Australia, N Queensland, N of Cape Flattery, Great Barrier Reef, SW coast of Lizard Island, S end of Casuarina Beach, 14°40'S 145°28'E, washed ashore at base of sandy beach at ELWN level. Leg. R.H. Willan, 01.10.1982 (**Paratype**, NTM P.54208, 1 s.v., subadult, def.)

Solomon Islands, N of Honiara, Guadalcanal, 9°23'S 159°59'E, 253-356 m, 25.09.2001, SALOMON 1, st. DW1745

(MNHN IM-2014-5517, 2 s.v., subadult); N Malaita, Suafa Bay, 8°19'S, 160°40'E, 98-200 m, 28.09.2001, SALOMON 1, st. DW1767 (MNHN IM-2014-6004, 1 s.v., adult); N of San Cristobal Island, Uki Ni Massi Island, 10°17'S, 161°43'E, 97-223 m, 06.10.2001, SALOMON 1, st. DW1840 (MNHN IM-2014-6005, 1 s.v., adult); Guadalcanal, 9°23'S 160°57'E, 282-427 m, 12.09.2007, SALOMON-BOA 3, st. DW2775 (MNHN IM-2014-5518, 4 s.v., subadult)

Vanuatu, N Urélapa Island 15°36'S 167°03'E, 86-118 m, 29.09.2006, SANTO 2006, st. AT44 (MNHN IM-2014-5486, 1 s.v., subadult); Segond Channel, vicinity of Luganville 15°30.9'S 167°11'E, 10-14 m, 13.10.2006, SANTO 2006, st. DB14 (MNHN IM-2014-5487, 3 s.v., subadult-juv.); E Aoré Island 15°34.7'S 167°13.8'E, 14-25 m, 18.09.2006, SANTO 2006, st. DB33 (MNHN IM-2014-5488, 1 s.v., juv.); Segond Channel, Coolidge wreck 15°31.4'S 167°14.1'E, 25-25 m, 11.09.2006, SANTO 2006, st. DS04 (MNHN IM-2014-5489, 1 s.v., subadult); Segond Channel, vicinity of Luganville 15°30.9'S 167°11.1'E, 8-15 m, 11.09.2006, SANTO 2006, st. DS06 (MNHN IM-2014-5490, 5 s.v., adult-juv.); S Aoré Island 15°36.6'S 167°10.1'E, 6-24 m, 12.09.2006, SANTO 2006, st. DS10 (MNHN IM-2014-5491, 21 s.v., juv.); Segond Channel, Sarakata river mouth 15°31.3'S 167°10.4'E, 5-10 m, 14.09.2006, SANTO 2006, st. DS18 (MNHN IM-2014-5492, 1 p.v., subadult; 33 s.v., subadult-juv.); Segond Channel, Chaverot Point 15°31.7'S 167°09.7'E, 25-25 m, 15.09.2006, SANTO 2006, st. DS22 (**Paratypes**, MNHN IM-2000-30341, 61 s.v., adult-juv.); Segond Channel, Chaverot Point 15°31.4'S 167°09.8'E, 2-4 m, 16.09.2006, SANTO 2006, st. DS27 (MNHN IM-2014-5493, 1 p.v., very juv.; 23 s.v., adult-juv.); Segond Channel, Chaverot Point 15°31.4'S 167°09.7'E, 5 m, 17.09.2006, SANTO 2006, st. DS31 (MNHN IM-2014-5494, 27 s.v., adult-juv.); Segond Channel, Wambu river mouth 15°33.7'S 167°08.4'E, 7 m, 06.10.2006, SANTO 2006, st. DS91 (MNHN IM-2014-5495, 4 s.v., subadult-juv.); Segond Channel, vicinity of Maritime College 15°31.7'S 167°09.7'E, 18-21 m, 11.09.2006, SANTO 2006, st. ED02 (MNHN IM-2014-5496, 16 s.v., adult-juv.); Segond Channel, vicinity of Maritime College 15°31.7'S 167°09.4'E, 9-13 m, 12.09.2006, SANTO 2006, st. ED05 (MNHN IM-2014-5497, 12 s.v., subadult-juv.); Segond Channel, Wambu river mouth 15°33.9'S-15°34.2'S

167°08.0/08.4'E, 20-28 m, 13.09.2006, SANTO 2006, st. ED07 (MNHN IM-2014-5498, 5 s.v., adult-juv.); Segond Channel, vicinity of Luganville 15°31.3'S-15°31.6'S 167°10.0/10.4'E, 22-29 m, 16.09.2006, SANTO 2006, st. ED13 (MNHN IM-2014-5499, 1 s.v., juv.); Segond Channel, vicinity of Maritime College 15°32'S 167°09.6'E, 23-27 m, 17.09.2006, SANTO 2006, st. ED17 (MNHN IM-2014-5500, 12 s.v., adult-juv.); Segond Channel, vicinity of Maritime College 15°31.5'S 167°10.2'E, 23-24 m, 16.09.2006, SANTO 2006, st. ET14 (MNHN IM-2014-5501, 1 p.v., juv.; 1 s.v., very juv.); Tangoa Island 15°35.4'S 166°59.2'E, 0 m, 10.10.2006, SANTO 2006, st. FB64 (MNHN IM-2014-5502, 1 s.v., subadult, def.); Tangoa Island 15°35.4'S 166°59.7'E, 11 m, 11.10.2006, SANTO 2006, st. FB68 (MNHN IM-2014-5503, 2 s.v., subadult); Tangoa Island 15°35.4'S 166°59.7'E, 4 m, 11.10.2006, SANTO 2006, st. FS67 (MNHN IM-2014-5504, 1 s.v., subadult); Tangoa Island 15°35.4'S 166°59.7'E, 37 m, 11.10.2006, SANTO 2006, st. FS70 (MNHN IM-2014-5505, 1 s.v., juv.); Strait N Tangoa Island 15°35.7'S 166°59.3'E, 12 m, 12.10.2006, SANTO 2006, st. FS74 (MNHN IM-2014-5506, 4 p.v., juv., alive; 3 s.v., subadult-juv.); Bruat Channel, Port Lautour 15°36.7'S 167°10.6'E, 5-6 m, 04.10.2006, SANTO 2006, st. LD16 (MNHN IM-2014-5507, 2 s.v., adult-juv.); Malo Island, W Malokilikili 15°42.7'S 167°15.1'E, 2-5 m, 05.10.2006, SANTO 2006, st. LD20 (MNHN IM-2014-5508, 2 s.v., juv.); Segond Channel, vicinity of Maritime College 15°31.4'S 167°10.0'E, 4-7 m, 07.10.2006, SANTO 2006, st. LD24 (MNHN IM-2014-5509, 21 s.v., subadult-juv.); N Tangoa Island 15°35.3'S 166°59.3'E, 3-5 m, 13.10.2006, SANTO 2006, st. LD27 (MNHN IM-2014-5510, 1 p.v., very juv.; 23 s.v., adult-juv.); W Tangoa Island 15°35.4'S 166°58.7'E, 3-8 m, 13.10.2006, SANTO 2006, st. LD28 (MNHN IM-2014-5511, 1 s.v., juv.); Strait of Tangoa Island 15°35.3'S 166°59.4'E, 10-12 m, 13.10.2006, SANTO 2006, st. LD29 (MNHN IM-2014-5512, 2 p.v., very juv., alive; 3 s.v., subadult-juv.); Vanuatu, Espiritu Santo, Segond Channel, vicinity of Maritime College 15°31.4'S 167°10.0'E, 7-8 m, 13.10.2006, SANTO 2006, st. LD30 (**Holotype**, MNHN IM-2000-30339, 1 p.v., subadult; **paratypes**, MNHN IM-2000-30340, 20 s.v., adult-juv.); Segond Channel, vicinity of Maritime College 15°31.4'S 167°09.9'E, 10-15 m, 14.10.2006, SANTO 2006, st. LD33 (MNHN IM-2014-5513, 11 s.v., adult-juv.); W Tutuba Island 15°33.5'S 167°16.8'E, 8-10 m, 17.10.2006, SANTO 2006, st. LD36 (MNHN IM-2014-5514, 1 p.v., very juv., alive); W Tangoa Island 15°35.4'S 166°58.7'E, 6-9 m, 18.10.2006, SANTO 2006, st. LD39 (MNHN IM-2014-5515, 1 s.v., juv.); Segond Channel, vicinity of Maritime College 15°31.4'S 167°09.8'E, 2-3 m, 02.10.2006, SANTO 2006, st. NS37 (MNHN IM-2014-5516, 6 s.v., adult-juv.)

Fiji, Bligh Water, 17°19'S, 177°47'E, 102-106 m, 08.08.1998, MUSORSTOM 10, st. DW1329 (MNHN-IM-2014-6002, 9 s.v., subadult-juv.)

Tonga Islands, Tongatapu Island, 21°02'S, 175°19'W, 555-581 m, 31.05.2000, BORDAU 2, st. DW1508 (MNHN IM-2014-5527, 1 s.v., subadult)

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