

# *Profundiconus robmoolenbeeki* spec. nov.: A new deep water conoidean gastropod from the Solomon Islands (Gastropoda, Conilithidae)

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*Profundiconus robmoolenbeeki* spec. nov. is described from material taken in 400 – 700 m depth north of Malaita, Solomon Islands. The radula and operculum of the new species have been examined and are consistent with the inclusion in genus *Profundiconus*. *Profundiconus robmoolenbeeki* sp. nov. is compared to *Profundiconus cakobaui* (Moolenbeek, Röckel & Bouchet, 2008), *Profundiconus maribelae* Tenorio & Castelin, 2016, and *Profundiconus loyaltiensis* (Röckel, Richard & Moolenbeek, 1995).

Key words: Conoidea, *Profundiconus*, deep-water species, Indo-West Pacific, Solomon Islands.

## INTRODUCTION

The shallow water cone snail fauna of the Solomon Islands has been reviewed by Delsaerdt in a series of papers published between 1988 and 2000 (Delsaerdt, 1988, 1990, 1991, 1994a, b; 2000a, b). Little is known, however, about the deep water species from this region. Since 2001, the MNHN (Muséum National d'Histoire Naturelle, Paris, France) has been carrying out systematic sampling surveys in the Solomon Islands. A series of cruises aboard the r/v "Alis" have been devoted to the exploration of the deep benthic fauna of the Solomon Islands at depths between 100 and 1500 m (SALOMON 1, 2001; SALOMON 2, 2003). Another expedition has aimed to the study of organisms associated with sunken woods of south Pacific margins (SALOMONBOA 3, 2007). The main goal overall is the study of the biodiversity of the insular margins of Solomon islands by carrying out the inven-

tory and description of the deep water fauna. As a result of these campaigns, some novel species of cone snails have been brought to surface and have been recently described. That is the case of *Profundiconus maribelae* Tenorio & Castelin, 2016, reported from the Solomon Islands, including the New Georgia Group (Vella Lavella Island), Santa Isabel and Guadalcanal, at depths between 336 and 690 m. Among the material collected during these research cruises, several specimens of cone snails that do not match any known species described to date have now been found. These specimens were collected north of Malaita Island at depth ranges between 400 and 700 m depth. The analysis of their conchological features as well as radular morphology and operculum indicates that these specimens are in fact individuals of a new species, introduced herein as *Profundiconus robmoolenbeeki* spec. nov.

## METHODS

The taxonomy used in the present article follows Tucker & Tenorio (2009) with the updates and modifications included in Tucker & Tenorio (2013). Specimens of the new species were collected by dredging in deep-water during the campaign SALOMON 1, carried out by the MNHN in the Solomon Islands aboard the r/v "Alis" in 2001, at depth ranges of 400 to 800 m. Other material studied in this work for comparison purposes was previously deposited in the collections of MNHN in Paris. Shell morphology is described using the terminology established in Röckel et al. (1995). I also used their procedure for counting the number of protoconch whorls. For morphometric parameter determination, the shells were measured with

a digital caliper, and the measurements rounded to 0.1 millimeter. Radular morphology is described using the terminology of Tenorio & Castelin (2016). Specimens of shells containing the dried animal inside were digested in concentrated aqueous potassium hydroxide for 24 h. The contents were flushed out of the shell by injecting distilled water through the aperture of the shell by means of a syringe with an incurved needle. The resulting mixture was then placed in a Petri dish and examined with the binocular microscope. The entire radula was removed with fine tweezers and rinsed with distilled water, then mounted on a slide using Aquatex (Merck) Mounting Medium, and examined under the compound microscope. Photos were obtained with a CCD camera attached to the microscope.

Abbreviations: dd = dead; lv = live; MNHN = Muséum National d'Histoire Naturelle, Paris, France; PMD = relative position of the maximum diameter; RD = relative diameter; RSH = relative spire height;  $S_L$  = maximum shell length;  $S_L/T_L$  = shell length/radular tooth length;  $T_L/AP_L$  = radular tooth size/anterior portion length;  $100B_L/AP_L$  = 100 x blade length/anterior portion length.

## RESULTS

Family Conilithidae Tucker & Tenorio, 2009

*Profundiconus* Kuroda, 1956

### *Profundiconus robmoolenbeeki* spec. nov. (Figs 1–6)

Type material examined. — Holotype (Figs 1–2): MNHN IM-2012-43954, 25.1 × 10.7 mm (lv), r/v "Alis", expedition SA-LOMON 1, st. DW 1775, N Malaita, Solomon Islands, 8°12'36"S, 160°41'42"E, 498–600 m depth. Paratype 1 (Figs 3–4): MNHN IM-2012-43955, 24.3 × 10.3 mm (dd), r/v "Alis", expedition SA-LOMON 1, st. DW 1770, N Malaita, Solomon Islands, 8°19'36"S, 160°38'42"E, 453–542 m depth. Paratype 2 (Figs 5–6): MNHN IM-2012-43953, 23.7 × 9.5 mm (dd), r/v "Alis", expedition SA-LOMON 1, st. DW 1772, N Malaita, Solomon Islands, 8°15'48"S, 160°40'24"E, 570–756 m depth.

Type locality. — N Malaita, Solomon Islands, 8°12'36"S, 160°41'42"E, 498–600 m depth.

Distribution and habitat. — Only known from the type locality and its vicinity, N Malaita, Solomon Islands. Confirmed live specimen from depths of 498–600 m (holotype).

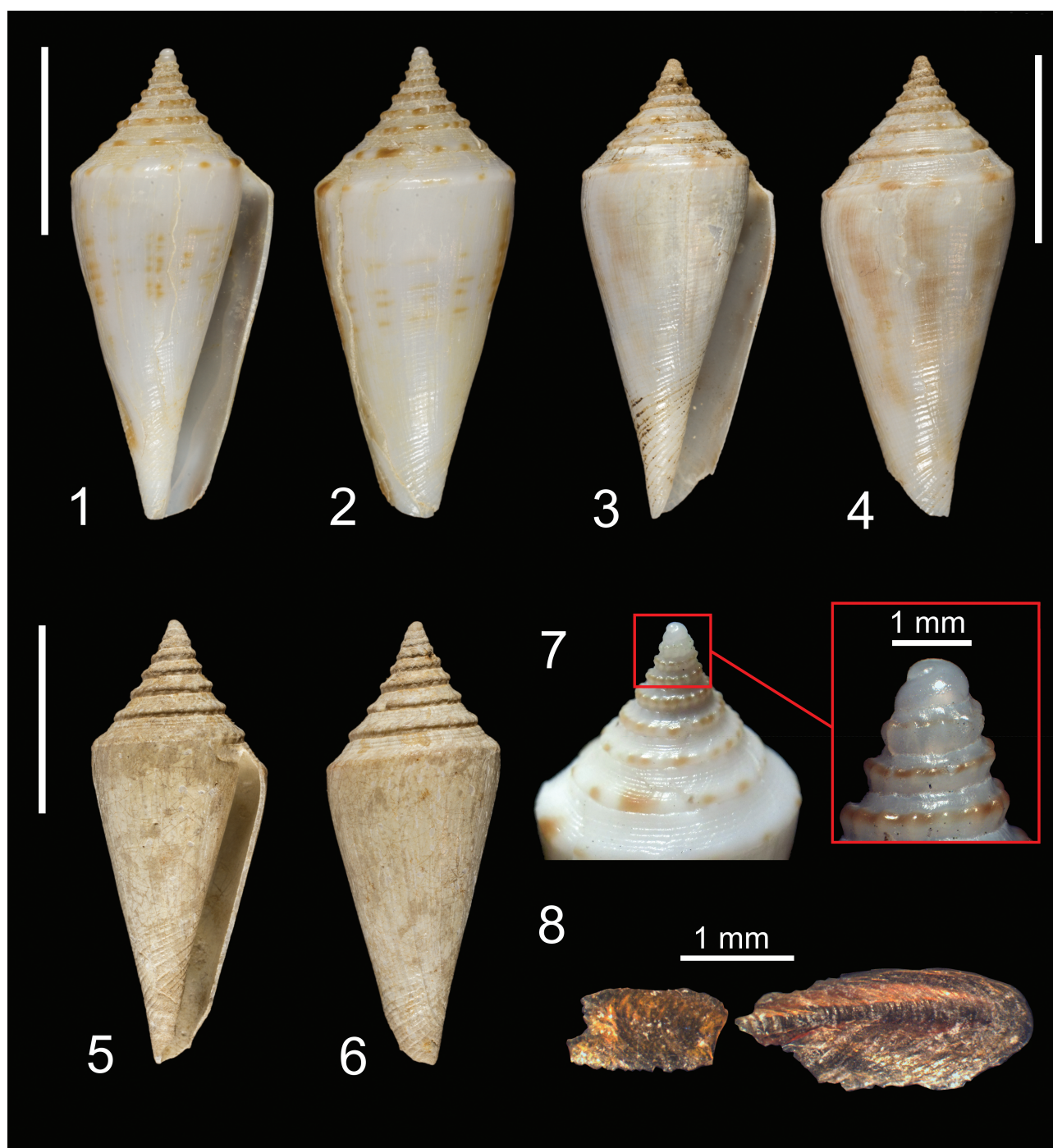
Etymology. — The species is named after Dr. Robert Moolenbeek, well-known Dutch malacologist, in recognition for his many and important contributions of a lifetime devoted to the study of mollusks

with emphasis on cone snails, including the description of several species of *Profundiconus*.

Description. — Morphometric parameters:  $S_L$  = 23–26 mm; RD = 0.55–0.57; RSH = 0.24–0.28; PMD = 0.82–0.91. Shell shape is biconical. This is a small to moderately small sized species. The spire is high, concave and stepped, especially towards the apex. The whorl tops are concave in cross section. The paucispiral protoconch of 1.5 whorls is white, porcellaneous and translucent, with a maximum diameter of 0.95 mm (Fig. 7). The early teleoconch whorls are white, with small tubercles which become obsolete or absent by whorl six. The first three teleoconch whorls have no cords but display arcuate radial striae. Cords are present from whorl four onwards, increasing from 4 to 6 on late teleoconch whorls. The suture is narrow and shallow. The shoulder is angulated, with a distinctive ridge present, which may be undulated or weakly tuberculated. The sides of the shell are straight or very slightly convex just below the shoulder. The last whorl is smooth or with very fine spiral striae, with 10–12 spiral grooves around the basal quarter. The posterior notch is shallow and C-shaped. There is no anterior notch. Ground color white. Early teleoconch whorls white, with small, fused brown blotches arranged in spiral forming a narrow band over the tubercles. These small brown blotches become sparse and separated from each other on late teleoconch whorls, but may eventually reach the shoulder. Last whorl overlaid with sparse irregular axial brown streaks. Some specimens also show brown dashes forming several interrupted, well-spaced spiral lines, especially around the midbody and toward the shoulder region. The columella is white. The aperture is white, straight and rather narrow. The periostracum is yellowish, thin and transparent. The operculum of the holotype is elongated, yellow-brown and serrated (Fig. 8).

Radular teeth examined in the holotype (Fig. 9). 41 teeth in radular sac. Radular tooth large-sized: its total length relative to shell length  $S_L/T_L$  = 29, rather elongated. The anterior portion is shorter than the posterior section of the tooth ( $T_L/AP_L$  = 2.67). There is one barb and a pointed, well-defined blade, which covers 42% of the anterior portion of the tooth. There is an external cusp located at approximately the lower quarter of the anterior portion of the tooth, extending between 74% and 85% of the length of the anterior portion of the tooth. The external cusp is laterally expanded and with 8–9 small denticles. A characteristic fringe of closely spaced projections pointing towards the apex located below the waist is present. Shaft fold is present. Large and prominent basal spur present on top of the slanted base of the tooth.

Discussion. — In spite of the few specimens avail-



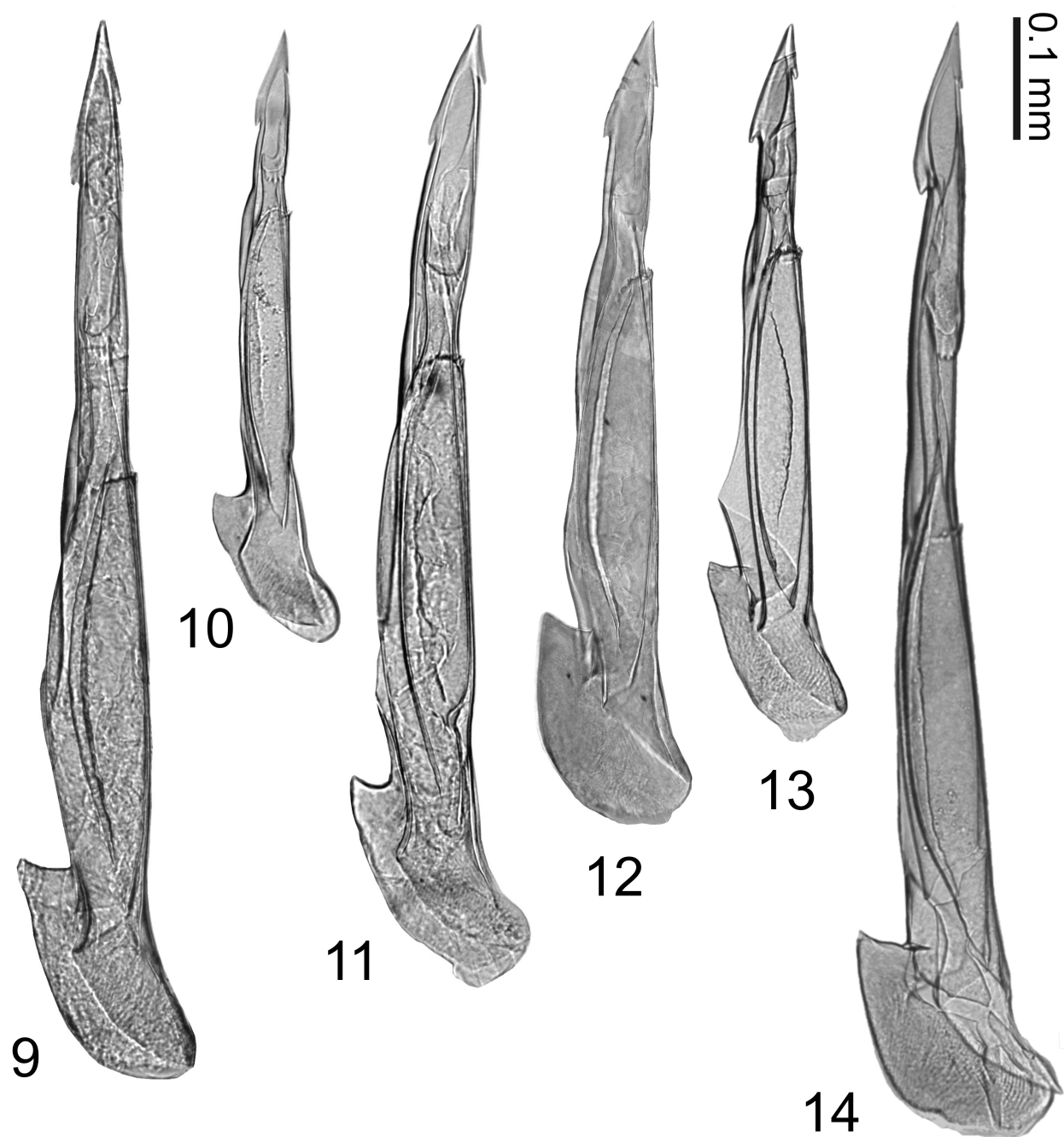
**Figs 1-8.** *Profundiconus robmoolenbeeki* spec. nov. **1-2**, holotype, MNHN IM-2012-43954, 25.1 x 10.7 mm, N Malaita, Solomon Islands, 8°12'36"S, 160°41'42"E, 498–600 m depth; **3-4**, paratype 1, MNHN IM-2012-43955, 24.3 x 10.3 mm, N Malaita, Solomon Islands, 8°19'36"S, 160°38'42"E, 453–542 m depth; **5-6**, paratype 2: MNHN IM-2012-43953, 23.7 x 9.5 mm, N Malaita, Solomon Islands, 8°15'48"S, 160°40'24"E, 570–756 m depth; **7**, protoconch and early teleoconch whorls of *P. robmoolenbeeki* spec. nov. (holotype); **8**, fragments of the operculum of *P. robmoolenbeeki* spec. nov. corresponding to the holotype, showing serrations in the lower margin. Scale bar represents 10 mm unless otherwise stated.

able, the distinctive combination of shell and radular morphology along with the accurate field data warrants the introduction of *P. robmoolenbeeki* as a new species. The morphology of the radular tooth and the serrated operculum are fully consistent with the placement of this species in genus *Profundiconus*

Kuroda, 1956, as discussed in Tucker & Tenorio (2009) and Tenorio & Castelin (2016).

*Profundiconus robmoolenbeeki* is most similar to *P. cakobaui* (Moolenbeek, Röckel & Bouchet, 2008) (Figs. 15-16), *P. maribelae* (Fig. 17), and *Profundiconus loyal-tiensis* (Röckel, Richard & Moolenbeek, 1995) (Fig. 18).





**Figs 9-14.** Radular teeth of *Profundiconus* species. **9**, *Profundiconus robmoolenbeeki* spec. nov., tooth from holotype,  $S_L$  25.1 mm; **10**, *P. cakobaui*, tooth from unnumbered paratype, MNHN IM-2000-21033, Ride de Lau, Somo-somo Strait, Fiji, 414-510 m,  $S_L$  18.4 mm; **11**, *P. cf. cakobaui*, tooth from specimen MNHN IM-2008-1243, Bligh Water, Fiji, 567-699 m,  $S_L$  24.8 mm; **12**, *P. maribelae*, tooth from paratype 1, MNHN IM-2007-30935, NW Isabel, Solomon Islands, 336-341 m depth,  $S_L$  30.0 mm; **13**, *P. loyaltiensis*, tooth from uncataloged specimen, MNHN, Ile des Pins, New Caledonia,  $S_L$  17.4 mm; **14**, *P. virginiae*, tooth from holotype, MNHN IM-2007-30854, Plateau des Chesterfield, 519-522 m depth,  $S_L$  42.5 mm. Scale bar 100  $\mu$ m.

The scarce number of specimens of *P. robmoolenbeeki* available for study prevented any statistical comparison of shell morphometry among different taxa. *Profundiconus cakobaui*, known from the Fiji Islands, has a smaller shell length ( $S_L$  10–25 mm) and a broader

body whorl (RD 0.60–0.66), with a spire of straight profile instead of concave compared to *P. robmoolenbeeki*. *Profundiconus cakobaui* has nodules on the 3–4 first teleoconch whorls. In *P. robmoolenbeeki* the nodules extend to whorl 5 and eventually reach the shoul-





**Figs 15-19.** *Profundiconus* species. **15**, *Profundiconus cakobauui*, holotype, MNHN IM-2000-21030, Somo-somo Strait, South of Vanua Levu, Fiji, 426-487 m,  $S_L$  18.9 mm; **16**, *P. cf. cakobauui*, MNHN IM-2008-1243, Bligh Water, Fiji, 567-699 m,  $S_L$  24.8 mm; **17**, *P. maribelae*, paratype 1, MNHN IM-2007-30935, NW Isabel, Solomon Islands, 336-341 m depth,  $S_L$  30.0 mm; **18**, *P. loyaltiensis*, holotype, MNHN IM-2000-2545, Ride des Loyauté, New Caledonia, 480 m,  $S_L$  21.8 mm; **19**, *P. virginiae*, holotype, MNHN IM-2007-30854, Plateau des Chesterfield, 519-522 m depth,  $S_L$  42.5 mm. Scale bar 10 mm.

der. The latter also has more cords on the late teleoconchs whorls than *P. cakobauui*, which usually only has 4 on the periphery. There is one specimen identified as *P. cakobauui* (MNHN IM-2008-1243, Fig. 16) which is much larger and narrower-bodied than the specimens of *P. cakobauui* in the type series and might in fact represent a different species. I will refer to this

particular specimen from now on as *Profundiconus cf. cakobauui*. This specimen is more similar in size and shape to *P. robmoolenbeeki* than any other specimen of *P. cakobauui*, but it is still wider-bodied ( $RD = 0.60$ ) and has a straight spire instead of concave.

The radular teeth of *P. cakobauui* (Fig. 10) and *P. cf. cakobauui* IM-2008-1243 (Fig. 11), and the tooth of *P.*

*robmoolenbeeki* (Fig. 9) are different. The anterior portion of the tooth of *P. robmoolenbeeki* is longer than in *P. cakobaui*, as reflected by the parameter  $T_L/AP_L = 2.67$  for *P. robmoolenbeeki*, and 3.2–3.8 for *P. cf. cakobaui*/*P. cakobaui*. The external cusp in *P. robmoolenbeeki* has 8–9 denticles, but only 6 in *P. cakobaui*, and in the latter this structure is located at a lower position of the anterior portion of the tooth, closer to the waist.

The shells of *P. maribelae* and *P. loyaltiensis* exhibit stronger sculpture on the last whorl in the form of spiral grooves and flat ribbons, and have fewer but more developed cords on the sutural ramp compared to *P. robmoolenbeeki*. The spire in *P. maribelae* is straight and stepped instead of concave. In *P. loyaltiensis* the spire is concave, but the shell is white and patternless at variance with *P. robmoolenbeeki*, which exhibits a pattern of sparse brown axial streaks and fine dashes arranged in spiral.

The radular tooth of *P. robmoolenbeeki* (Fig. 15) is different from the teeth of *P. maribelae* (Fig. 16) and *P. loyaltiensis* (Fig. 18). The anterior portion of the tooth in *P. robmoolenbeeki* is longer than in the other species ( $T_L/AP_L = 3.4$  for *P. maribelae*, and 3.6 for *P. loyaltiensis*). In *P. robmoolenbeeki* The blade covers proportionally less extension of the anterior portion,  $100B_L/AP_L = 42\%$ , whereas in *P. maribelae* this parameter is 50%, and 60% in the case of *P. loyaltiensis*.

Whereas the relative sizes of the teeth of *P. robmoolenbeeki* and *P. loyaltiensis* are similar ( $S_L/T_L = 29$ –30 in both cases), the relative size of the tooth of *P. maribelae* is significantly smaller, with  $S_L/T_L = 45$ .

The radular tooth of *P. robmoolenbeeki* is similar in its elongated shape to that of *P. virginiae* Tenorio & Castelin, 2016 (Figs. 14 and 19), a recently described species from the Plateau des Chesterfield. Although the parameters  $T_L/AP_L = 2.6$ –2.7 and  $100B_L/AP_L = 40$ –43% for this species match those of *P. robmoolenbeeki*, it has a smaller relative size as indicated by the parameter  $S_L/T_L = 37$ –45, and only 5–6 small denticles on the external cusp. The shell of *P. virginiae* (Fig. 19) is very different to that of *P. robmoolenbeeki*. It has a larger shell which is broader and with a lower sigmoid spire. The shoulder is subangulate, forming a characteristic ridge, covered with axial costae on last whorl. Apart from these conchological differences with *P. robmoolenbeeki*, the protoconch of *P. virginiae* is multispiral with 3–3.5 whorls instead of paucispiral.

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