

Two new trochids of the genus *Antimargarita* (Gastropoda: Vetigastropoda: Trochidae) from the Bellingshausen Sea and South Shetland Islands, Antarctica

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Abstract Two new trochids of the genus *Antimargarita*, *A. powelli* and *A. bentarti*, from the Antarctic waters are described here. *A. powelli*, from the Bellingshausen Sea, is distinguished by its rounded whorls, numerous spiral cords, a radula with seven lateral teeth at each side of the rachidian, and an epipodium with eight pairs of tentacles. *A. bentarti*, from the South Shetland Islands, is characterized by having a shell outline gradated by prominent primary spiral cords, a radula with five lateral teeth at each side of the rachidian and an epipodium with six tentacles on the left side. The diagnostic features for *Antimargarita* are redefined considering both shell and anatomical features and its suprageneric placement is discussed.

Keywords Taxonomy · Antarctica · Margaritinae · Margaritini · Southern Ocean

Introduction

In 1907 Smith described *Valvatella dulcis*, a relatively large trochoid gastropod from the Ross Sea, Antarctica.

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Eales (1923) studied the gross anatomy of these specimens, including radula morphology, with light microscopy. These descriptions were subsequently used by Powell (1951) to erect the genus *Antimargarita*. In addition to the type species, Powell (1951) placed under this genus *Minolia thielei* Hedley 1916 and *Submargarita smithiana* Hedley 1916. However, Dell (1990) transferred the former to *Falsimargarita* Powell 1951, based on the calliostomatid-like radula present in the species. The generic placement of *S. smithiana* was never confirmed.

In the present study two new species of *Antimargarita* from the Antarctic waters are described. Based on this new source of information, the diagnostic features for the genus are redefined, and its suprageneric placement discussed.

Materials and methods

The two new species described here were collected during the BENTART Expedition to the West Antarctica (Spanish Antarctic Program), aboard the RV *Hespérides*. This trip was focused particularly on the benthic fauna from the West Antarctic Peninsula to the Bellingshausen Sea. Samples were taken by using an Agassiz trawl and an epibenthic sledge, sorted from the sediment, fixed in 4% borax-buffered formaline solution, and preserved in 70% alcohol.

Shell measurements refer to the maximum height, from apex to basis (*H*), and diameter (*W*), perpendicular to *H* (Table 1). Soft part anatomy was studied by dissection under stereoscopic microscopy. Radulae were dissected, cleaned with a sodium hypochlorite solution, and studied with a scanning electron microscope (SEM). Tentacles were dissected, and hexamethyldisilazane prepared for SEM. The nomenclature of the soft parts anatomy and radula was carried out following Hickman and McLean (1990).

Table 1 Measurements of *Antimargarita* species

Species	H (mm)	W (mm)	H/W
<i>Antimargarita powelli</i> new species			
Holotype (MNCN 15.05/47.521)	11.4	13.2	0.86
Paratype 1 (MNHNC 5045)	9.6	12.0	0.80
Paratype 2 (MLP 12901/1)	11.5	14.2	0.81
Paratype 3 (MNHNC 5046)	11.8	14.3	0.83
Paratype 4 (MNCN 15.05/47.521)	11.4	15.0	0.76
Paratype 5 (MNHNC 5047)	12.7	14.7	0.86
Paratype 6 (MLP 12901/2)	11.8	15.0	0.79
Paratype 7 (MLP 12901/3)	11.2	13.8	0.81
Paratype 8 (MNCN 15.05/47.521)	13.0	15.7	0.83
Paratype 9 (MNCN 15.05/47.521)	11.6	15.1	0.77
Other specimen (MNCN 15.05/47.522)	12.0	13.4	0.90
<i>Antimargarita bentarti</i> new species			
Holotype (MNCN 15.05/47.519)	7.3	10.0	0.73
Paratype 1 (MNHNC 5043)	6.5	8.8	0.74
Paratype 2 (MNHNC 5044)	6.7	9.1	0.74
Paratype 3 (MLP 12902/1)	6.0	8.3	0.72
Paratype 4 (MNCN 15.05/47.519b)	6.7	9.0	0.74
Paratype 5 (MLP 12902/2)	6.4	9.1	0.70
Other specimen (MNCN 15.05/47.520)	6.2	8.9	0.70
<i>Antimargarita dulcis</i> (Smith 1907)			
Syntype 1 (BMNH 1905710479a)	7.6	8.4	0.90
Syntype 2 (BMNH 1905710479e)	7.2	9.0	0.80
Syntype 3 (BMNH 1905710479i)	4.7	5.8	0.81

The specimens described in this study were deposited at the Museo Nacional de Ciencias Naturales de Madrid (MNCN), España; Museo de La Plata (MLP), Argentina; and Museo Nacional de Historia Natural de Santiago (MNHNC), Chile.

For comparative purposes, the specimens reported by Thiele (1912) as *V. dulcis* [Zoologisches Museum Berlin (ZMB), Berlin], and photographs of the type specimens of *V. dulcis* [The Natural History Museum (BMNH), London] and *S. smithiana* [Australian Museum (AMS), Sydney], were examined.

Results

Systematics

Class Gastropoda Cuvier, 1797

Subclass Orthogastropoda Ponder and Lindberg, 1996

Superorder Vetigastropoda Salvini-Pläwen, 1980

Family Trochidae Rafinesque, 1815

Genus *Antimargarita* Powell, 1951

Type species: *Valvatella dulcis* Smith, 1907 (O.D.)

Antimargarita powelli new species

Type locality

The locality was 69°56'59"S, 86°19'16"W, Bellingshausen Sea, Antarctica, 1,426 m.

Type of material

Holotype and three paratypes (MNCN 15.05/47.521); three paratypes more (MNHNC 5045-5047) and three more (MLP 12901) (measurements in Table 1).

Other material examined

One specimen, 70°29'15"S, 95°14'50"W, off Thurston Island, Bellingshausen Sea, 780 m (MNCN 15.05/47.522) (measurements in Table 1).

Known distribution

Bellingshausen Sea, Antarctica, 780–1,426 m (Fig. 1); in substrates with mud and gravel.

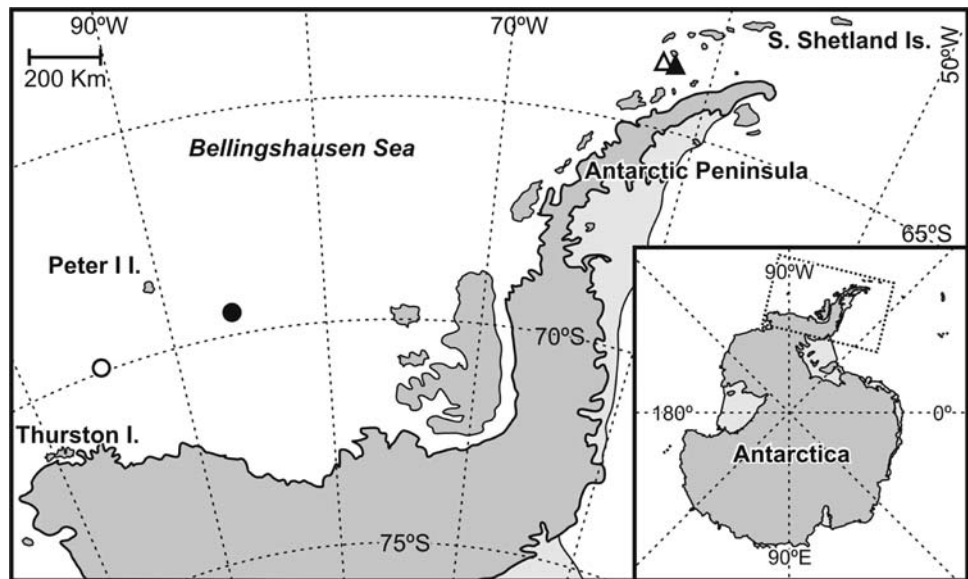
Diagnosis

Shell with a moderate to high spire, with rounded whorls, sculptured with rounded primary spiral cords, four to seven in number at the spire and seven to ten at the uppermost part of the last whorl. Prosocline axial threads producing small granules when crossing the spiral cords. Epipodium with eight tentacles on the left side. Radula with seven laterals on each side of the rachidian.

Description

Shell large for the genus (maximum *W* observed: 15.7 mm), trochoidal to turbinated, with a moderate to high spire ($H/W = 0.82 \pm 0.04$, $n = 11$), with a globose last whorl. Shell surface yellowish, iridescent, and thin. Protoconch of one smooth whorl, about 250 μm in diameter (Fig. 2h). Teleoconch with up to six rounded whorls (Fig. 2a–e); the three-first whorls usually with faint growth lines and one to three spiral grooves (Fig. 2h); fourth and fifth whorls with four to five rounded primary spiral cords; uppermost part of the last adult whorl with seven to ten primary spiral cords, sometimes with intercalated secondary cords; base with 15–20 flat spiral cords, entering into umbilicus (Fig. 2g). In addition to the spiral sculpture, the teleoconch shows prosocline axial threads, producing granulations when crossing the spiral cords (Fig. 2a–f). Umbilicus funiculate. Aperture large, rounded to slightly projected, with somewhat arquated columella and a thin

Fig. 1 Location map. Localities for *Antimargarita powelli* new species: type locality (black dot); other localities (white dot); *Antimargarita bentarti* new species: type locality (black triangle); other localities (white triangle)



outer lip, crenulated by the spiral sculpture. Peristome interrupted; callus thin. The interior is nacreous and reflects the external sculpture. Operculum horny, circular, multispiral, with central nucleus, and a short growing edge.

Radula

Rachidian tooth pyriform at the base, having a short, wide and rounded cutting edge, with a rounded central cusp, and 10–13 narrower and sharper cusps on both sides (Fig. 3a–c). Lateral teeth: seven at each side of rachidian, wide, elongated, and similar in shape; their laterally expanded bases overlap; the basal profile is equivalent to half of that of the central tooth (Fig. 3a–c). Their large tongue-like cutting edges are densely serrated, with narrow and elongated cusps, in number of 10–14 on both side of the central cusp (Fig. 3c). First marginal tooth represented by a lateromarginal plate, with wide triangular base, rudimentary shaft and elongated cutting edge (Fig. 3a, d). The remaining marginal teeth are numerous, long, and narrow, with serrated cutting edges, and acute spines in the outer margin of the shaft (Fig. 3a, e). Within a row, the marginal teeth are steeply graded in solidness and shape: the innermost are stronger, with well-developed serrated edges and the outermost delicate with more sparsely serrated cutting edges.

Soft part anatomy

Snout broad, short and tubular, somewhat expanded distally, with a finely fluted margin, not projected laterally. Cephalic tentacles large, somewhat depressed and densely micropapillated (Fig. 4a). Cephalic lappets minute, with simple margin and rounded tip, located at the inner side of cephalic tentacle bases. Eyestalks stout, short, located at the outer

side of cephalic tentacles bases; eyes large, occupying most of eyestalk; crystalline a half of eye in diameter (Fig. 4a). Epipodium simple, with eight pairs of epipodial tentacles, each of them with a fleshy lobe at the base (Fig. 4b); tentacles are narrow and long, highly contractile and densely micropapillated (Fig. 4b–d); the papillae, arranged in verticils, are globose, each of them showing a distal crown of cilliae (Fig. 4d, e). Neck lobes originating at the base of eyestalk, triangular, with smooth margins, the right one somewhat larger than the left one. Pallial cavity extending for about half a whorl. Ctenidium bipectinate, connected to the mantle skirt by a short afferent membrane (restricted to the basal fourth) and a long efferent membrane.

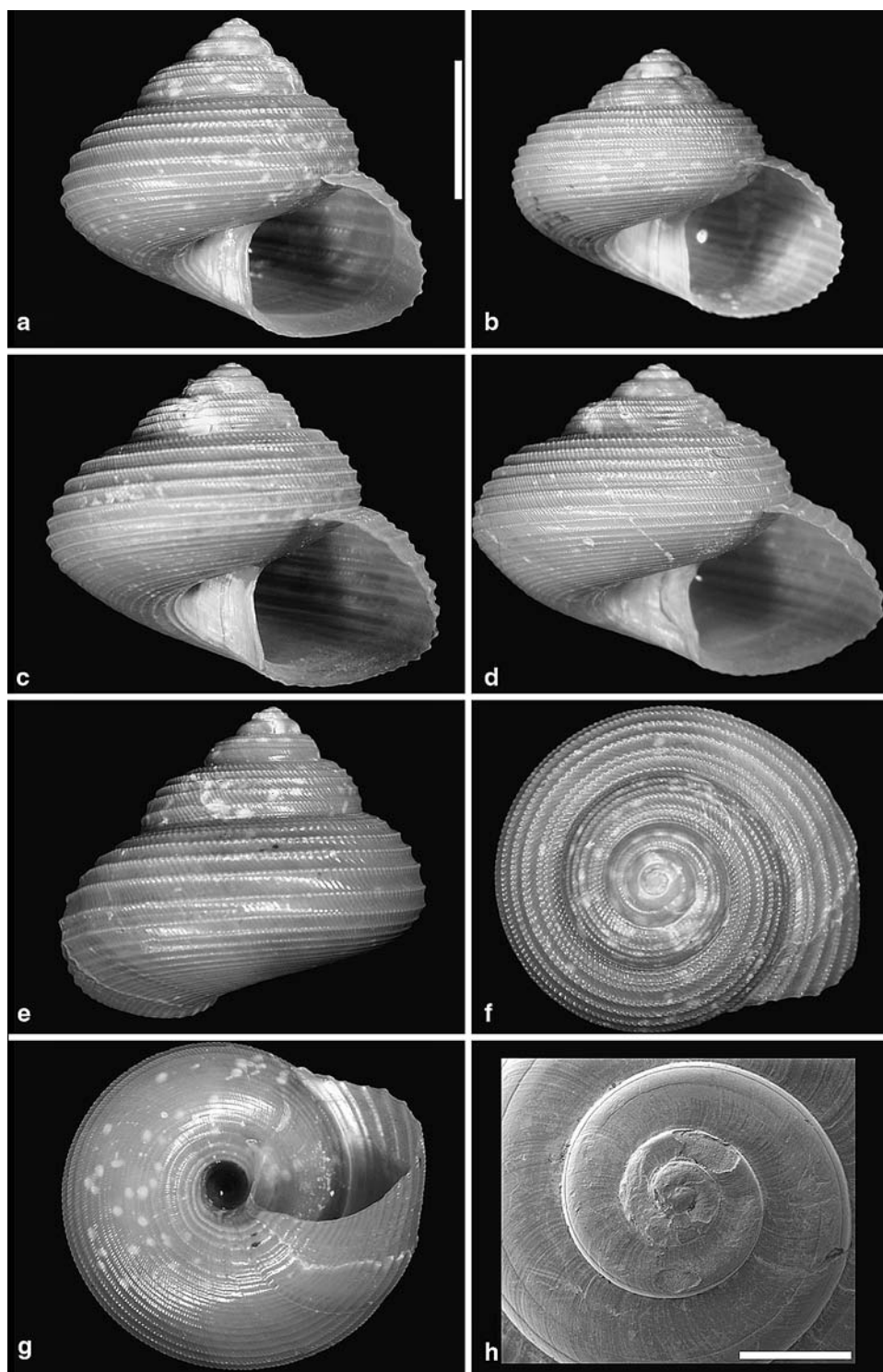
Etymology

The species is named after Dr. Arthur William Baden Powell (1901–1987) in recognition of his contributions to knowledge of the Antarctic molluscan fauna.

Remarks

Antimargarita powelli new species closely resembles *A. dulcis* (Fig. 5), by having a proportionally high spire, rounded whorls and numerous and rounded spiral cords. However, the number of spiral cords appears as distinct when considering both species: *A. powelli* has four to five cords at the spire and seven to ten at the uppermost part of the last adult whorl, while in *A. dulcis* there are three to four cords at the spire and four to five at the uppermost part of the last adult whorl. In addition the axial threads appear more prominently developed in *A. powelli* than in *A. dulcis*, producing prominent granules in the former, when the axial sculpture crosses the spiral one. Furthermore, *A. powelli* has eight pairs of epipodial tentacles,

Fig. 2 *Antimargarita powelli* new species. **a, e–g** Holotype (MNCN 15.05/47.521a). **b–d, h** Paratypes. **a–d** Apertural views. **e** Abapertural view. **f** Apical view. **g** Umbilical view. **h** Detail of protoconch. Scale bars **a–g** 5 mm; **h** 500 μ m



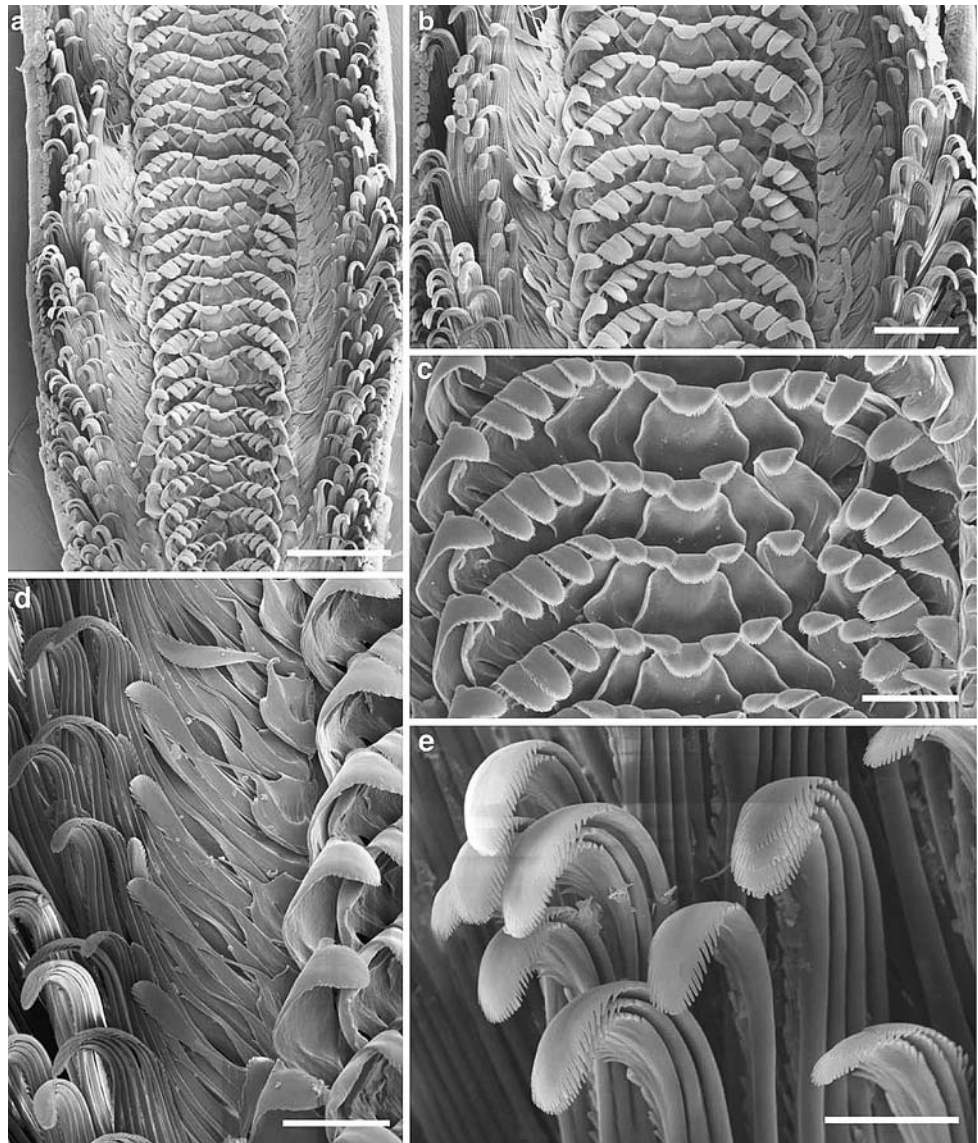
while *A. dulcis*, according to Eales (1923), usually has seven pairs and sometimes an additional tentacle at the left side. Another difference arises in the radula: *A. powelli* has seven lateral teeth on each side of the rachidian tooth, while *A. dulcis* has only five, and the former also has a minor number of stronger cusps in both the central and lateral teeth.

Antimargarita bentarti new species

Type locality

The locality was 63°25'49"S, 62°12'14"W, off Low Island, South Shetland Islands, 82 m.

Fig. 3 *Antimargarita powelli*: radula. **a, b** General view. **c** Detail of central and lateral teeth. **d** Detail of first marginal teeth. **e** Outer marginal teeth. Scale bars **a** 200 μm ; **b** 100 μm ; **c, d** 50 μm ; **e** 20 μm



Type material

Holotype and one paratype (MNCN 15.05/47.519), two paratypes more (MNHNC 5043-5044) and two more (MLP 12902) (measurements in Table 1).

Other material examined

One specimen, 63°25'54"S, 62°12'42"W, off Low Island, South Shetland Islands, 86 m (MNCN 15.05/47.520) (measurements in Table 1).

Known distribution

South Shetland Islands, 82–86 m (Fig. 1); in rocky substrates with bryozoans.

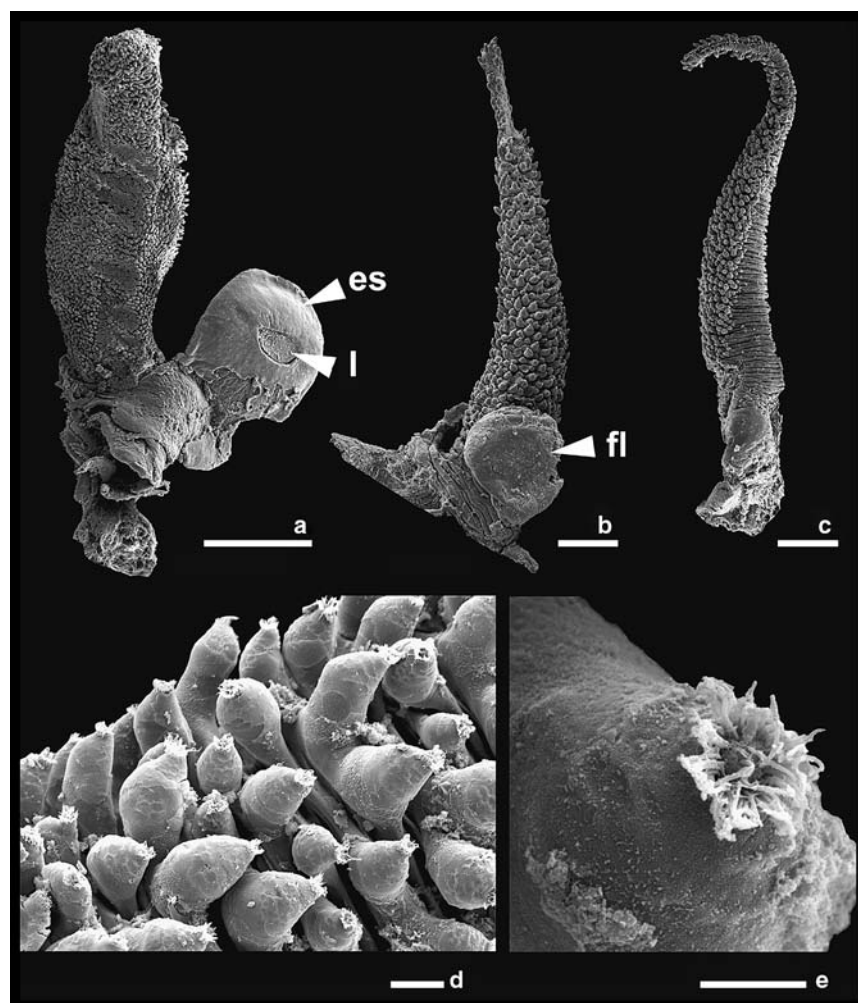
Diagnosis

Shell somewhat depressed, with the last whorl widely laterally expanded. Outline gradated by prominent and smooth primary spiral cords, two or three in number at the spire and four in the uppermost part of the last whorl. Epipodium with six tentacles on the left side and seven on the right. Radula with five lateral teeth on each side of the rachidian.

Description

Shell medium in size (maximum W observed: 10.0 mm), trochoidal, with a relatively low spire ($H/W = 0.72 \pm 0.02$, $n = 7$); shell surface whitish, iridescent, and thin. Protoconch smooth, with one whorl, about 300 μm in diameter; apertural margin convex (Fig. 6h). Teleoconch of up to four

Fig. 4 *Antimargarita powelli*: anatomy. **a** Cephalic tentacle. **b–e** Epipodial tentacle. **b** Dorsal view. **c** Lateral view. **d** Detail of papillae. **e** Detail of crown of cilliae. Scale bars **a** 500 μm ; **b, c** 200 μm ; **d** 20 μm ; **e** 5 μm . *es* eyestalk, *fl* fleshy lobe, *l* lens



gradated whorls (Fig. 6a–f); first, second, and third whorls with three primary cords, being the abapical at the suture; uppermost part of last adult whorl with four primary cords, sometimes with intercalated (secondary) cords; base with 10–15 flat cords, entering into umbilicus (Fig. 6g). All the spiral cords are smooth. The teleoconch whorls also show prosocline axial threads (Fig. 6a–f). Umbilicus funiculate. Aperture large, angulose, with a slightly arquated columellar margin and a thin, and projected outer lip, crenulated by spiral sculpture. Peristome interrupted; callus very thin. The interior is nacreous, greenish pearly, and reflects the external sculpture. Operculum horny, circular, multispiral, with central nucleus, and a short growing edge.

Radula

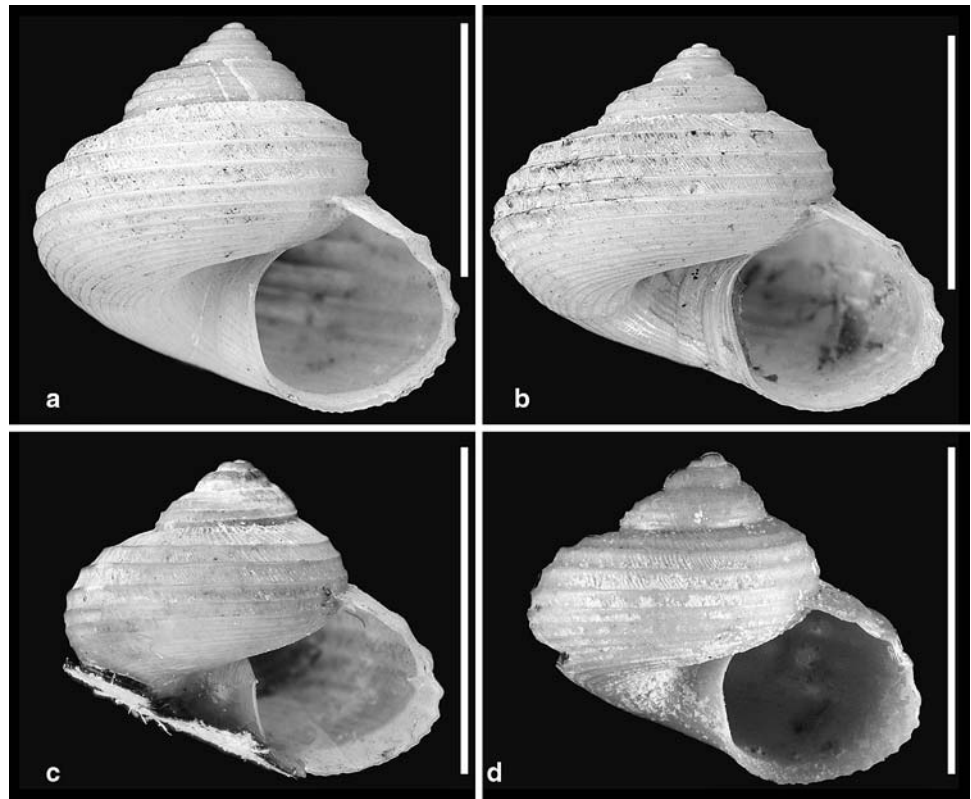
Rachidian tooth pyriform at base, with triangular and elongated cutting edge, having a blunt to widely rounded central cusp, and nine to eleven narrower and sharper cusps on both sides (Fig. 7b). Lateral teeth: five on each side of the rachidian, wide, elongated, and similar in shape; their

laterally expanded bases overlap; the basal profile is equivalent to the half of that of the central tooth (Fig. 7a, b); their large tongue-like cutting edges are prominently serrated, with seven to nine elongated cusps, sometimes bifurcated at the base at each side of the main cusp (Fig. 7b). First marginal tooth represented by a lateromarginal plate, with a wide triangular base, rudimentary shaft, and elongated cutting edge (Fig. 7a, c). The remaining marginal teeth are numerous, long and narrow, with serrated cutting edges, and acute spines in the outer margin of the shaft (Fig. 7a, d). Within a row, the marginal teeth are steeply graded in solidness and shape: the innermost are stronger, with well-developed serrated edges and the outermost delicate with more sparsely serrated cutting edges.

Soft part anatomy

Snout broad, short, and tubular, somewhat expanded distally, with a finely fluted margin, not projected laterally. Cephalic tentacles massive, wide, somewhat depressed, densely micropapillated (Fig. 8b, c); papillae are tubular, bearing

Fig. 5 *Antimargarita dulcis*.
a–c Three syntypes of *Valvatella dulcis* (BMNH 1905710479a, BMNH 1905710479e, and BMNH 1905710479i).
d Specimen from Gauss-Station (Davis Sea) reported by Thiele (1912) (ZMB 63040).
 Scale bars 5 mm



distal cilliae (Fig. 8c). The cephalic lappets are located at the base of cephalic tentacles (at the inner side) and the eyestak (at the outer side) (Fig. 8b). Cephalic lappets minute, trapezoidal, with smooth margins. Eyestalks elongated, relatively short; eyes large, occupying most of eyestalk (Fig. 8b). The epipodium is simple, with six epipodial tentacles on the left side and seven on the right side, each of them with a fleshy lobe at the base (Fig. 8a); tentacles are narrow and long, highly contractile, and densely micropapillated; papillae are polygonal in section. Neck lobes originating at the base of eyestalk, triangular, with smooth margins, the right somewhat larger than the left one. Ctenidium expanding for three-fourths of the palial cavity length, bipectinate, connected to the mantle skirt by a short afferent membrane, restricted to the basal fourth and a long efferent membrane.

Etymology

The species is named after the “BENTART”, the Antarctic Spanish Expedition that collected the material.

Remarks

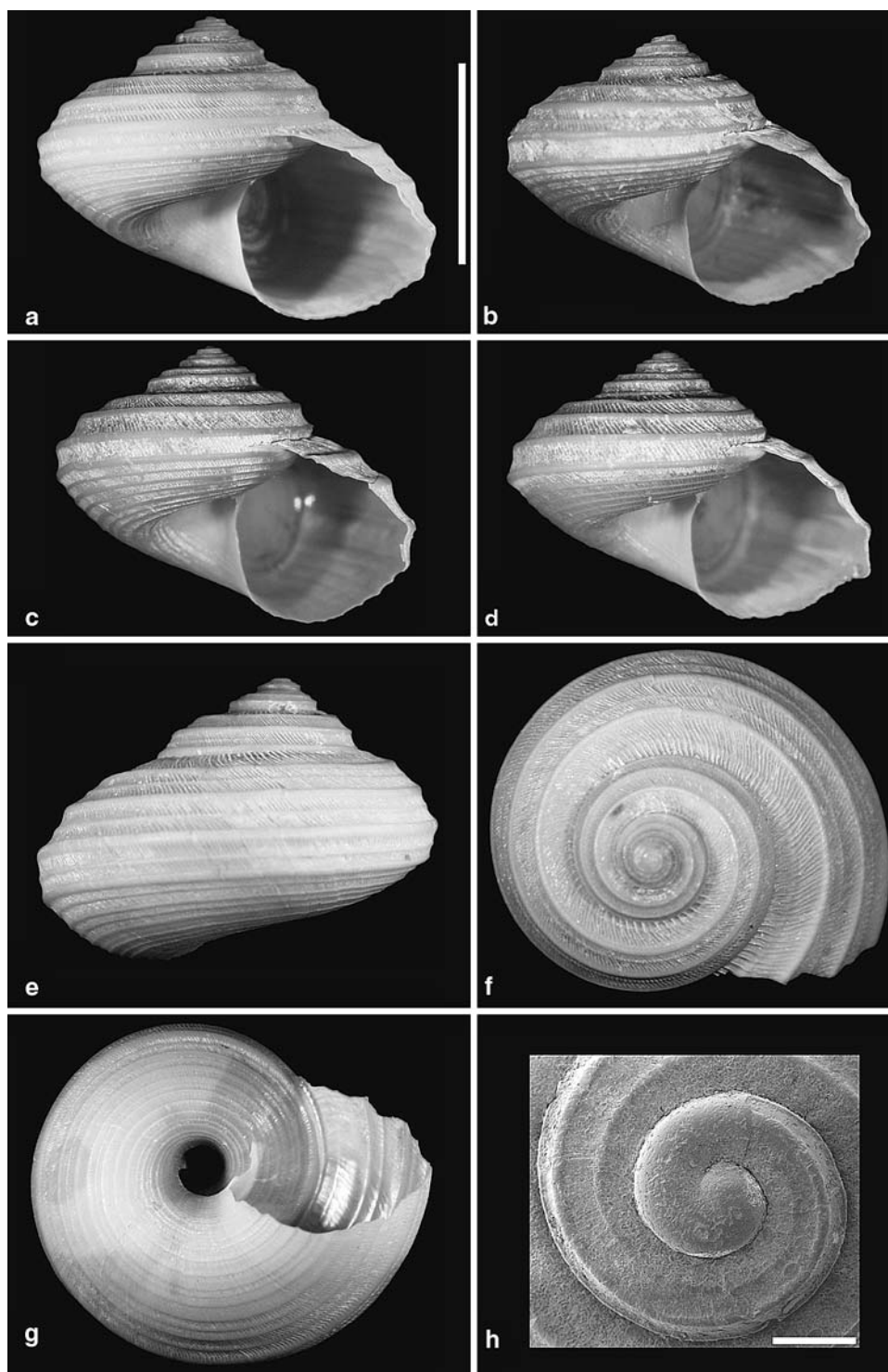
Antimargarita bentarti new species differs from *A. dulcis* (Fig. 5) and *A. powelli* (Figs. 2, 3, 4) by having a more laterally expanded (not inflated) last adult whorl and lower spire. In addition, the primary spiral cords in *A. bentarti* are

stronger, resulting in a gradated shell outline, while *A. dulcis* and *A. powelli*, are more evenly rounded. The radula of *A. bentarti*, as well as that of *A. dulcis*, has five lateral teeth on each side of the rachidian tooth; this condition distinguishes these species from *A. powelli*, where seven laterals are present. Concerning the epipodium, *A. bentarti* has six epipodial tentacles on the left side and seven on the right, while in *A. powelli* there are eight tentacles on both sides. Eales (1923) reported seven pairs of tentacles for *A. dulcis*, with an additional tentacle sometimes occurring at the left side. Concerning the habitat, *A. bentarti* appears to be a shallow water species (occurring between 82 and 86 m depth), while *A. powelli* as a deep-water species (currently known between 780 and 1,426 m depth). *A. dulcis* was broadly reported to be found at 22 (Hain 1990) to 731-m depth (Hedley 1916), but it is not certain if all the records previously assigned to that species actually correspond to a single species.

Discussion

Although Trochidae is a widely diversified family in the Southern Ocean, there are no exhaustive works to quantify the true diversity of species living currently in the area. The absence of specific studies of members of this family results in the presence of many misused names, as well as

Fig. 6 *Antimargarita bentarti* new species. **a, e–g** Holotype (MNCN 15.05/47.519a). **b–d, h** Paratypes. **a–d** Apertural views. **e** Abapertural view. **f** Apical view. **g** Umbilical view. **h** Detail of protoconch. Scale bars **a–g** 5 mm; **h** 200 μ m



in the existence of several still undescribed species. Among the former, the previous reports of member of the genus *Margarites* for the area could be mentioned, which were recently reassigned to *Margarella* by Zelaya (2004); among the second, the description of a new species of *Margarella* by Linse (2002: *M. whiteana*) and the two new species of *Antimargarita* described herein.

To date, only one species (the type of the genus) may be assigned with certainty to *Antimargarita*. Powell (1951), suggested that two other species, *M. thielei* and *S. smithiana*, might also probably correspond to the genus. This assumption was based on the similarities of shell morphology of these species with *Antimargarita dulcis*. However, Dell (1990) after studying the radula of *M. thielei* concluded that

Fig. 7 *Antimargarita bentarti*: radula. **a** General view. **b** Detail of central and lateral teeth. **c** Detail of first marginal tooth. **d** Outer marginal teeth. Scale bars **a** 100 μm ; **b** 50 μm ; **c**, **d** 20 μm

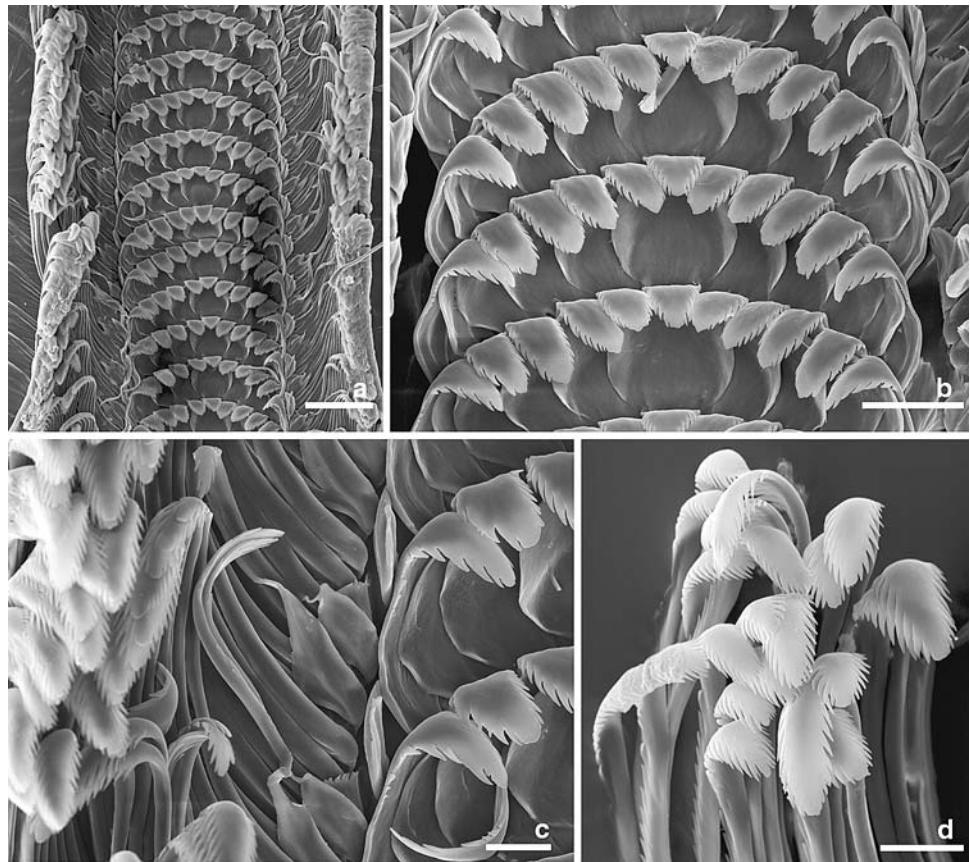
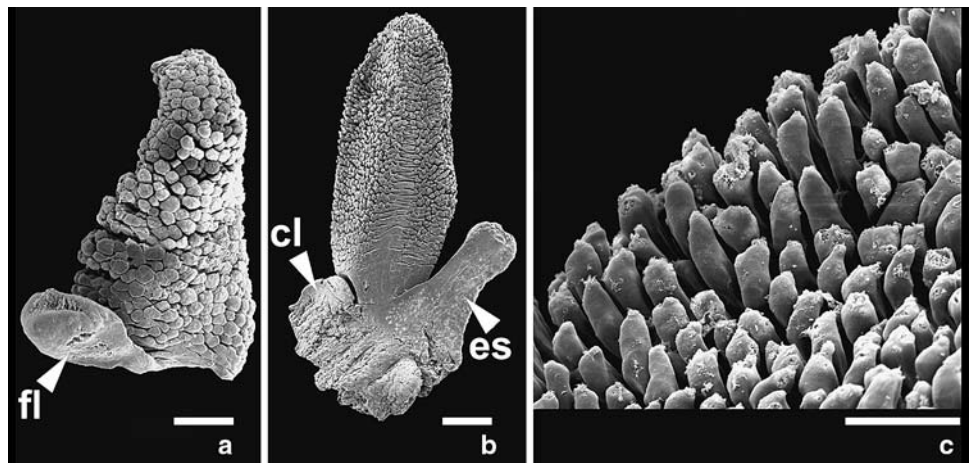


Fig. 8 *Antimargarita bentarti*: anatomy. **a** Epipodial tentacle. **b** Cephalic tentacle. **c** Detail of cephalic tentacle. Scale bars **a** 100 μm ; **b** 200 μm ; **c** 50 μm . *cl* cephalic lappet, *es* eyestalk, *fl* fleshy lobe



the species actually corresponds to *Falsimargarita*. The soft part anatomy and radula of “*Submargarita*” *smithiana* is unknown; consequently, the generic placement of that species was never confirmed. Despite the overall similarities in shell morphology reported by Powell (1951) for “*Submargarita*” *smithiana* with *A. dulcis*, the presence of an incomplete peristome, rounded outer margin of aperture, and the absence of funiculate umbilicus in the former (Fig. 9), strongly suggest that these species are not congeneric. In the present study, *Antimargarita* is used to refer to thin, iridescent, trochoidal to turbinated shells, with thin

outer margin of aperture, funiculate umbilicus, and shell sculptured with solid spiral cords and prosocline axial threads. However, as pointed out by Powell (1951), shells alone are not enough for distinguishing among trochids, due to the convergence in shell morphology exhibited by different genera (such as members of *Antimargarita*, *Falsimargarita* Powell 1951, and *Solariella* Wood, 1842). Despite that, these genera may be clearly distinguished when regarding anatomy, mainly radula morphology.

The radula of *A. powelli* and *A. bentarti* resembles that of *A. dulcis* (described by Eales 1923). The main difference

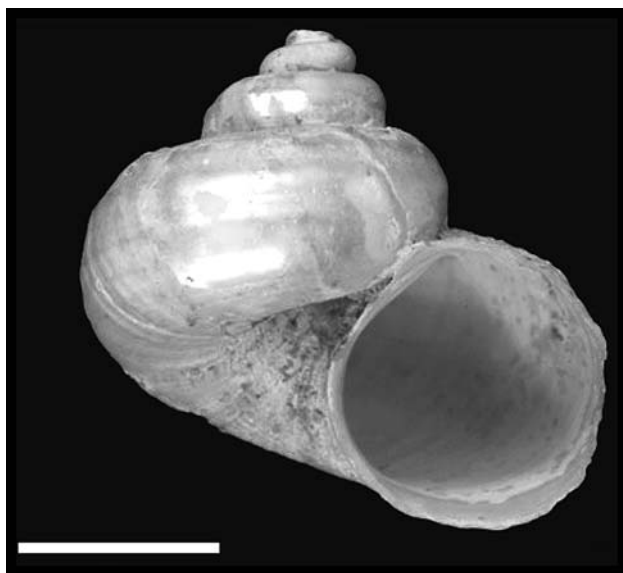


Fig. 9 Holotype of *Submargarita smithiana* (AMS 46505). Scale bar 5 mm

arises in the morphology of the first marginal tooth, figured by Eales (1923) as an elongated element, similar in outline to the other marginals but represented by a lateromarginal plate, with reduced shaft and cutting edge, in *A. bentarti*. It seems to be clear that the description by Eales corresponds to the shaft and cutting edge only and that the triangular base of this tooth was overlooked by the author, with a light microscope. The SEM photographs of the radula of another specimen of *A. dulcis* by Hain (1990) strongly support this hypothesis.

From an anatomical point of view, *Antimargarita* is characterized by having the ctenidium with a short afferent membrane, the epipodium and neck lobes with simple margins, and a relatively high number of epipodial tentacles (6–8). All these characters suggest that *Antimargarita* corresponds to the Margaritinae. Hickman and McLean (1990) recognized two tribes within this subfamily: Margaritini and Gazini, which can be distinguished by radula morphology and external anatomy. The prominently cusped radula, with the first margin tooth represented by a strong lateromarginal plate and the oral tube only slightly distally expanded, pleads for the allocation of *Antimargarita* in the Margaritini. In addition, other features reported by Simone and Cunha (2006) for the Gazini genus *Gaza*, such as a series of orifices along the latero-dorsal region of the foot, the operculum with a sigmoid inner edge, and the rachidian tooth with square base, are not present in the species studied here.

Antimargarita closely resembles the genus *Margarites* Gray, 1847. In both cases the radula shows a variable number of laterals teeth among species, a condition considered as usual for the Margaritini by Hickman (1998). However, some particular details on the radula and anatomy allow

separating *Antimargarita* and *Margarites*: in the former the cutting edges of the central and lateral teeth are shorter, broader and more evenly rounded, bearing a major number of smaller and sharper cusps; in addition, the cephalic lappets are smaller in *Antimargarita* than in *Margarites*.

The present study provides the first reliable evidence on the occurrence of the Margaritinae in the Southern Hemisphere. For long time, this subfamily was wrongly reported for the area based on the genus *Margarites*. However, Zelaya (2004) showed that the species previously reported as *Margarites* from the South Western Atlantic Ocean actually correspond to *Margarella*, which is not a Margaritinae, but a Trochinae.

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