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Taxonomical study on the Architectonicidae collected by the Marion Dufresne (MD55) expedition to SE Brazil

(Gastropoda, Heterobranchia)

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Some of the deep-water molluscs collected during the Marion Dufresne (MD55) expedition off SE Brazil have been studied in recent papers. The present work focuses on the heterobranch family Architectonicidae. Four species have their occurrence expanded to/in the SW Atlantic (new records in parenthesis): *Psilaxis clertonii* Tenório, Barros, Francisco & Silva, 2011 (off Cabo Frio, Rio de Janeiro, 610 m); *Solatisonax rudigerbieleri* Tenório, Barros, Francisco & Silva, 2011 (Canopus Bank, off Fortaleza, Ceará state, 260 m; off Cabo Frio, Rio de Janeiro, 610 m); *Spirolaxis centrifuga* (Monterosato, 1890) (off Linhares, Espírito Santo, 340–360 m); *Spirolaxis* cf. *lamellifer* (Rehder, 1935) (off Linhares, Espírito Santo, 640 m depth and off Cabo Frio, Rio de Janeiro, 610 m). Moreover, we describe herein a new architectonicid species, namely *Pseudotorinia phorcysi* spec. nov., collected off Cabo Frio, Rio de Janeiro state, 430–450 m. Its diagnostic features are: a strong beaded sculpture, angular outline and prominent peripheral keel formed by a strong beaded spiral rib and a lower, weaker rib, with fine axial growth lines between them.

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Introduction

The cruise of the R/V Marion-Dufresne (MD55), Terres Australes et Antarctiques Françaises, was a joint project of the Muséum National d'Histoire Naturelle (MNHN, Paris, France) and the Universidade Santa Úrsula (USU, Rio de Janeiro, Brazil), which took place during May and June 1987 (Tavares 1999). The malacologists on board recovered a vast quantity of deep-water Mollusca from the south-eastern Brazilian coast. Despite the considerable time elapsed since the expedition, only a fraction of this material has already been studied (e.g. Leal 1991, Simone & Cunha 2012, Fernandes et al. 2013). The present work continues these studies, dealing

with the Architectonicidae. Recently, the study of deep-sea material has become a priority in Brazil: a more detailed knowledge of deep-water fauna became imperative for environmental analyses since the Brazilian government started the extraction of the “Pré-Sal” (pre-salt) level of petroleum, which is causing major disturbances in depths up to 2000 m off the SE Brazilian coast (Romero et al. 2011).

The heterobranch family Architectonicidae comprises about 140 extant species distributed worldwide, living from shallow to deep waters and classified in 11 genera, nine of which occur in the Western Atlantic (Bieler & Petit 2005, Rosenberg 2009). Architectonicids are popularly known as “sundials” due to the discoid outline of their shells. Herein

we formally describe a new species of *Pseudotorinia* Sacco, 1892, and report new records of five other species of *Pseudotorinia*, *Psilaxis* Woodring, 1928, *Solatisonax* Iredale, 1931, and *Spirolaxis* Monterosato, 1913.

Material and methods

The specimens studied here are all empty shells (except for *Spirolaxis lamellifer*) deposited at the Muséum National d'Histoire Naturelle (MNHN), Paris, France, and the Museu de Zoologia da Universidade de São Paulo (MZSP), São Paulo, Brazil. We offer here a brief description of our material for each species in order to facilitate comparisons with other works. Comparisons with type material were done through the literature (described and illustrated by Bieler 1993 and Tenório et al. 2011). The following abbreviations are used throughout the text for shell measurements (cf. Bieler 1993): SD, shell diameter; H, shell height; P, protoconch width; BF, basal field width; UD, umbilical diameter; w, aperture width; h, aperture height.

Systematics

Family Architectonicidae

Genus *Pseudotorinia* Sacco, 1892

Type species: *Solarium obtusum* Bronn, 1831, by original designation; Tertiary, Europe; recent: Atlantic, Mediterranean, Indo-Pacific.

Pseudotorinia architae (Costa, 1841)

Figs 1–3

Synonymy see Bieler (1993). Complement:

Heliacis architae: Poppe & Goto, 1991: 46 (pl. 36, figs 26–27).

Pseudotorinia cf. *architae*: Ávila et al., 2000: 154.

Pseudotorinia architae: Redfern, 2001: 139 (pl. 63, fig. 575); Bogi et al., 2002: 36 (figs 16–18); Mancini, 2003: 11; Micali et al., 2004: 24; Antoniadou et al., 2005: 122; Ruestes & Soriano, 2006: 12 (fig. C); Capdevila & Folch, 2009: 40; La Porta et al., 2009: 100; Rosenberg et al., 2009: 670; Concepción et al., 2011: 154; Cortés, 2012: 153.

Type locality. Gulf of Taranto, Italy.

Distribution. Western Atlantic: North Carolina to Cuba, and southeastern Brazil; Eastern Atlantic: Spain to Azores; Mediterranean (Rosenberg 2009, Bieler & Gofas 2012, Cavallari et al. in press).

Material examined. Brazil; off Espírito Santo: continental slope of Abrolhos, 19°40' S 37°48' W, 790–940 m, MNHN, 1 shell, (MD55, sta. CB77; Bouchet, Leal and Métivier col., 27/v/1987).

Brief description

Shell very small (diameter 2.93 mm), lenticular, relatively thick-walled. Protoconch very small (0.46 mm), weakly heterostrophic (Figure 2). Teleoconch of 2¼ whorls, yellowish, sculpture consisting of spiral ribs crossed by slightly weaker, near-orthocline axial ribs, forming granules at intersections and conferring a reticulated appearance. Upper side and peripheral base slightly convex. Aperture circular; easily distinguishable peripheral keel formed by a strong lower peripheral rib; upper peripheral rib strength similar to that of subsutural rib. Infraperipheral rib distinctly separated from lower peripheral rib, as strong as following basal ribs. Basal field sculpture (Fig. 3) similar to upper side, but with strong basal keel dividing basal field into convex peripheral part (bearing smaller, more numerous granules) and a concave inner part (coarser, bigger granules); Umbilicus wide (UD ~30 % of SD); umbilical crenae strong, with weakly demarcated nodules.

Measurements (in mm). SD=2.93, H=0.98, P=0.46, U=0.93, BF=1.0, w=0.73, h=0.74.

Remarks. The present specimen fits in the Western Atlantic form of the *P. architae* group sensu Bieler (1993), an informal group of very similar Indo-Pacific and Atlantic forms. According to that author, forms within the *P. architae* group can be distinguished by their angular shell base, which is ornamented by a prominent keel that divides the base into a convex outer part and a concave inner part. The present occurrence has already been reported by Cavallari et al. (2013); the records presented by these authors greatly expanded the species distribution.

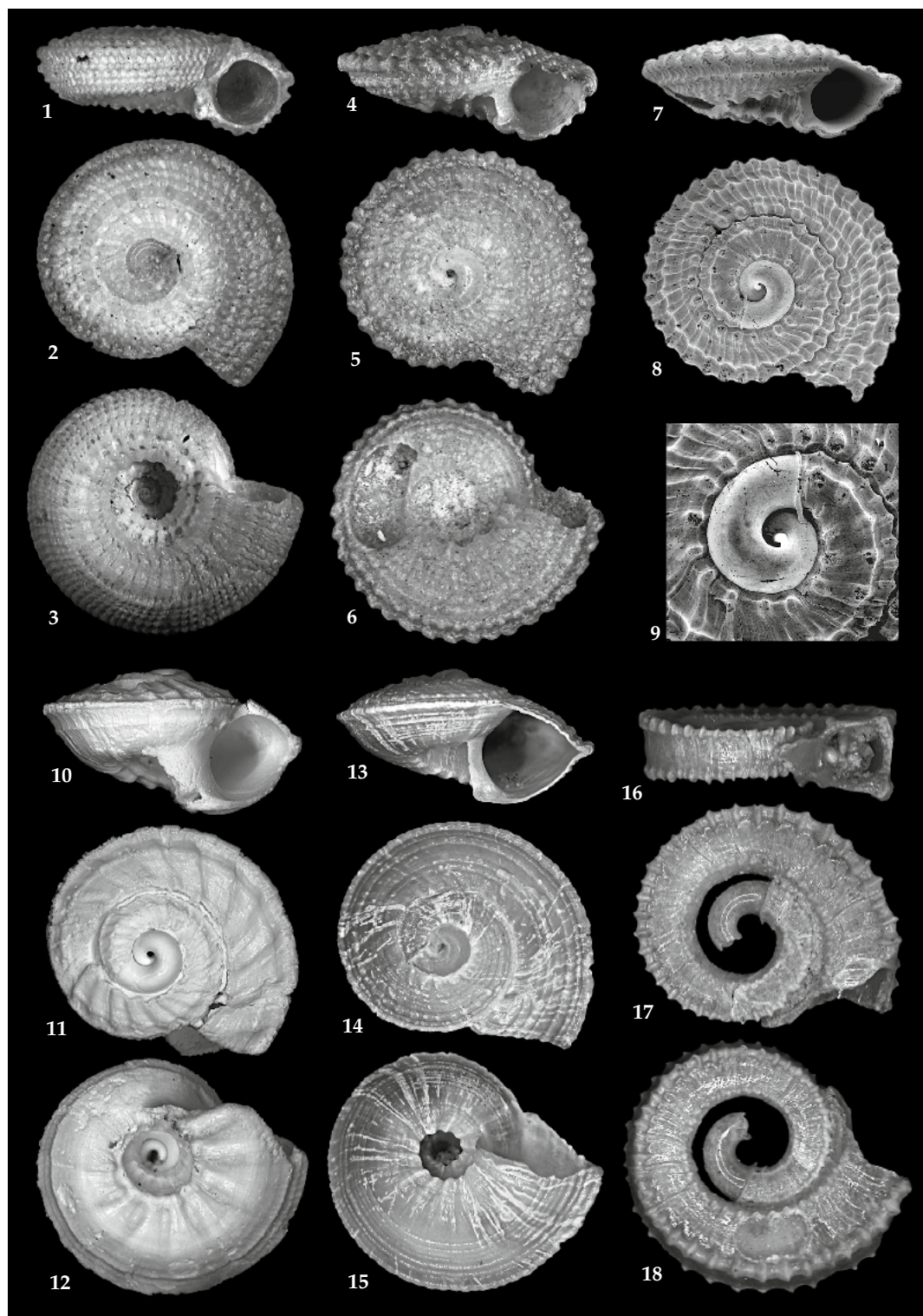
Figs 1–3. *Pseudotorinia architae* MNHN (H=0.89 mm, SD=2.93 mm), from off Espírito Santo, Brazil.

Figs 4–6. *Pseudotorinia phorcysi* spec. nov. holotype MNHN 26363 (H=1.0 mm, SD=2.69 mm, P=0.59 mm) from off Cabo Frio, Rio de Janeiro, Brazil. 7–9. Same, under SEM.

Figs 10–12. *Psilaxis clertoni* MNHN (H=2.0 mm, SD=3.52 mm) from off Cabo Frio, Rio de Janeiro, Brazil.

Figs 13–15. *Solatisonax rudigerbieleri* MNHN (H=2.3 mm, SD=4.35 mm) from off Cabo Frio, Rio de Janeiro.

Figs 16–18. *Spirolaxis centrifuga* MNHN (H=0.43 mm, SD=1.59 mm) from east of mouth of Doce River, Espírito Santo.



Pseudotorinia phorcysi spec. nov.

Figs 4–9

Type material. Holotype MNHN 26363 (MD55, sta. CB104; Bouchet, Leal and Métivier col., 01/vi/1987).

Type locality. Off Cabo Frio, Rio de Janeiro, Brazil, 23°41' S 42°06' W, 430–450 m depth.

Distribution. Known only from type locality.

Etymology. From Greek mythology, alluding to the deep-water habitat of the species: Phorcys is the god of the hidden dangers of the deep.

Material examined. Holotype.

Diagnosis. Shell very small, discoid, angular in periphery, with a wide umbilicus and well-marked suture; upper side sculpture with two similarly strong beaded midribs. Sharp peripheral keel formed by single very strong beaded spiral rib and lower, weaker similarly sculptured rib, with fine axial growth lines in the depression between them; basal sculpture with 3–4 beaded spiral ribs, with coarser nodules towards umbilical region. Protoconch–teleoconch transition marked by strong terminal varix.

Description

Shell very small (diameter 2.69 mm), discoid, ~2.7 times as wide as tall, slightly angulated; colour uniformly pale white. Protoconch (Fig. 9) of ~1 whorl after immersion, very small (0.59 mm), smooth, glossy, weakly heterostrophic; protoconch–teleoconch transition visible, with strong terminal varix. Teleoconch of 1¾ slightly convex whorls, with well-marked suture (Fig. 5); peripheral base rounded, more convex than upper side. Sculpture consisting of equally strong spiral and orthocline axial ribs forming large nodules at intersections (Figs 5, 8); midrib area with 1 midrib on early whorls, and 2 on later whorls; upper point of whorl attachment at lower peripheral rib. Aperture rounded, slightly wider than tall, acuminate laterally towards peripheral keel and umbilical crenae (Figs 4, 7). Prominent peripheral keel formed by very strong lower peripheral rib and much weaker infraperipheral rib; depression between lower peripheral rib and infraperipheral rib bears numerous axial growth lines (Fig. 7). Upper peripheral rib strength similar to that of subsutural rib. Infraperipheral rib distinctly separated from lower peripheral rib, stronger (~2 times wider) than following basal ribs. Basal field sculpture similar to upper side, but with thinner spiral and axial ribs, and consequently smaller nodules (Fig. 6); inner rib (not umbilical crenae) wider. Umbilicus wide (UD ~30 % of SD); umbilical side of columellar wall smooth, except for axial growth lines (Fig. 7). Umbili-

cal crenae strong, bearing coarser, larger, angulose and less numerous nodules (Fig. 6). Periostracum and operculum unknown.

Holotype measurements (in mm). SD=2.69, H=1.0, P=0.59, U=0.76, BF=0.96, w=0.88, h=0.71.

Discussion. Species in the genus *Pseudotorinia* have a very small to small lenticular shell (2–8 mm) and a moderately to extremely large umbilicus (19–53 % of SD). They also show axial growth marks on the entire shell surface, usually stronger than the spiral sculpture on the initial whorls; subsutural rib stronger and with coarser nodules than following midribs; prominent upper peripheral rib, also stronger than the midribs; very prominent lower peripheral rib, forming a distinct keel; upper point of whorl attachment at the lower peripheral rib; infraperipheral rib hardly stronger than following 2–3 narrow and distinctly demarcated basal ribs; inner part of basal field formed by wider ribs; UC surrounding umbilicus with strong nodules; umbilical wall with axial growth lines; very small to medium-sized protoconch (0.38–0.98 mm) without an anal keel (Bieler 1993). All these traits can be observed in our specimen, thus endorsing the generic placement even though it is a juvenile damaged shell. Moreover, the aperture profile of the present specimen (Fig. 4, 7) is very similar to the apertural aspect example of Bieler (1993, fig. 224a, left).

Pseudotorinia phorcysi spec. nov. differs from other congeners occurring in the Western Atlantic, such as *P. architae* (Atlantic form), *P. bullisi* Bieler, Merrill & Boss, 1985, *P. jonasi* Tenório, Barros, Francisco & Silva, 2011 and *P. retifera* (Dall, 1892), by a much coarser beaded sculpture with larger nodules, a much more prominent peripheral keel, and a more angular profile. It can be further distinguished from *P. jonasi* by being much larger, with a larger (~6 times wider) and more inflated protoconch, a much more strongly marked peripheral keel with larger nodules, and a more convex base. *P. phorcysi* shares some similarities with Indo-Pacific and Atlantic forms of *P. gemmulata*, especially to the protoconch (which bears a strong terminal varix) and the sculpture of the early teleoconch. The main difference resides in the shell's outline, which is more angular in *P. phorcysi*, with a less convex upper side.

P. phorcysi shares some similarities with an Indo-Pacific congeneric species, *P. colmani* (Garrard, 1977), mainly in the shell's outline, coloration and sculpture of the early teleoconch whorls. However, there are some discrepancies to be noted, such as the much smaller protoconch (*P. colmani* is regarded by Bieler 1993 as having a proportionally large protoconch, measuring 0.98 mm) and the lack of a strong terminal

varix marking the protoconch-teleoconch transition. *P. phorcysi* can be distinguished from *P. amoena* (Murch & Suter, 1906), from the Indo-Pacific, by a less flattened outline, with a more acuminate peripheral keel, rounder base, less rounded aperture and narrower umbilicus; from *P. numulus* (Barnard, 1963), *P. sestertius* Bieler, 1993 and *P. yaroni* Bieler, 1993 from the Indo-Pacific and the Red Sea, by having a less flattened outline, with a rounder base and upper side, and sculpture consisting of more well-defined, evenly-sized axial ribs and nodules. *P. phorcysi* differs from *P. panamensis* (Bartsch, 1918), from the Eastern Pacific, and *P. kraussi* (Gray in Gray, 1850), *P. delectabilis* (Melvill, 1893) and *P. laseronorum* (Iredale, 1936) from the Indo-Pacific by having a more angulose outline, with a much stronger peripheral keel and overall larger and less numerous nodules. Finally, it can be distinguished from *P. armillata* Bieler, 1993, from the Indian Ocean, by its more numerous and more strongly marked nodules, smaller protoconch, less elevated apex, and by lacking a strong spiral thread immediately above the basal keel.

Genus *Psilaxis* Woodring, 1928

Type species: *Architectonica (Philippia) krebsii* Mörch, 1875, by original designation; recent, Atlantic Ocean.

Psilaxis clertoni Tenório, Barros, Francisco & Silva, 2011 Figs 10–12

Psilaxis clertoni Tenório et al., 2011: 181 (fig. 3A–C).

Type locality. Off Pernambuco state, Brazil, 08°46.5'S 34°44.5'W, 690.

Distribution. Pernambuco, Brazil.

New occurrence. Rio de Janeiro, off Cabo Frio, 610 m depth.

Material examined. Brazil; Rio de Janeiro: off Cabo Frio, 23°46'S 42°10'W, 610 m depth, MNHN, 1 shell, (MD55, sta. CB105; Bouchet, Leal and Métivier col., 02/vi/1987).

Brief description

Shell small, depressed cone-shaped, relatively thick-walled, white coloured. Protoconch medium-sized, inflated, distinctively heterostrophic (Fig. 11). Teleoconch sculpture smooth, except for prosocline axial ribs, stronger in initial whorls; umbilical wall sculptured by fine reticulate pattern of axial ribs and spiral threads. Whorls profile convex, peripheral base more convex than upper side. Aperture

rounded, acuminate laterally towards peripheral keel (Fig. 10); prominent peripheral keel formed by lower peripheral rib, with weaker but easily distinguishable infraperipheral rib; Umbilicus moderately wide (UD ~ 25 % of SD), with strong crenae (Fig. 12). Periostracum and operculum unknown.

Measurements (in mm). SD=3.52, H=2.0, P=0.96, U=0.9, BF=1.31, w=1.21, h=1.16.

Remarks. The examined specimen compares fittingly with the holotype of *P. clertoni* (despite being a considerably damaged juvenile shell) due to its proportions, protoconch and the intact sculpture of the initial whorls (Fig. 8). The new occurrence expands the species' range southward, from Pernambuco to Rio de Janeiro.

Genus *Solatisationax* Iredale, 1931

Type species: *Solatisationax injussa* Iredale, 1931, by original designation; recent, Atlantic, Indo-Pacific.

Solatisationax rudigerbieleri Tenório, Barros, Francisco & Silva, 2011 Figs 13–15

Solatisationax rudigerbieleri Tenório et al., 2011: 175 (fig. 1A–C, E–G).

Type locality. Off Pernambuco state, Brazil, 690 m.

Distribution. Off the states of Pernambuco and Alagoas, Brazil; 425 to 720 m.

New occurrences. Ceará state, off Fortaleza, Canopus Bank, 260 m depth. Rio de Janeiro, off Cabo Frio, 610 m depth.

Material examined. Brazil; Ceará: 120 miles off Fortaleza, Canopus Bank, 02°14'25"S 38°22'50"W, MZSP 100409, 6 shells (J. Coltro col., xi/2005). Rio de Janeiro: off Cabo Frio, 23°46'S 42°10'W, 610 m depth, MNHN, 1 shell (MD55 sta. CB105; Bouchet, Leal and Métivier col., 02/vi/1987).

Brief description (MNHN specimen)

Shell large, lenticular, relatively thin-walled. Protoconch medium-sized (diameter 1.02 mm), inflated, distinctively heterostrophic (Fig. 14). Teleoconch with strongly marked parallel spiral sulci; umbilical wall with growth lines only (Fig. 14). Whorls profile slightly convex (Fig. 13). Aperture rounded triangular; very strong peripheral keel formed by lower peripheral rib (Fig. 13); upper peripheral rib weak, but clearly visible above lower peripheral rib. Um-

bilicus moderately wide, with strong crenae (Fig. 15). Periostracum and operculum unknown.

Measurements (in mm). MNHN: SD=4.35, H=2.3, P=1.02, U=0.87, BF=1.74, w=1.89, h=1.64. MZSP 100409 (mean, n=5): SD=8.9±0.24 (8.5–9.5), H=4.5±0.15 (4.3–4.8), P=1.02±0.09 (0.9–1.1), U=1.66±0.23 (1.3–2.1), BF=3.62±0.26 (3.1–4.0), w=3.5±0.08 (3.3–3.6), h=3±0.12 (3.0–3.2).

Remarks. The examined specimens match the description of *S. rudigerbieleri*, one of the largest species in the genus. The only marked difference is the teleoconch sculpture: the basal portion of the body whorl shows fewer spiral sulci (~8; Figs 13, 15) than “typical” *S. rudigerbieleri* (~11; Tenório et al. 2011: fig. 1B). Nevertheless, this is interpreted as simple morphological variation. We report yet another new record from Brazil based on specimens deposited in the MZSP collection (not collected by the MD55 expedition): Canopus Bank, off Ceará state. This is relatively close to the type locality, but this report seemed noteworthy because it is an occurrence from shallower waters and also because some specimens exhibit a different coloration: light brown to yellow protoconch and initial whorls, while the specimens described by Tenório et al. (2011) are all white. The species newly assessed range is from Ceará state to Rio de Janeiro.

Genus *Spirolaxis* Monterosato, 1913

Type species: *Pseudomalaxis centrifuga* Monterosato, 1890, by monotypy; recent, Atlantic Ocean.

Spirolaxis centrifuga (Monterosato, 1890)

Figs 16–18

Synonymy see Bieler (1984). Complement:

Pseudomalaxis centrifuga: Monterosato, 1913: 363; Rios, 1994: 184 (pl. 61, fig. 854).

Pseudomalaxis (*Spirolaxis*) *centrifuga*: Taviani, 1974: 42.

Spirolaxis centrifuga: Boss & Merrill, 1984: 362 (pl. 62, fig. 2); Redfern, 2001: 139 (pl. 63, fig. 574); Rios, 2009: 364; Rosenberg et al., 2009: 670.

Spirolaxis centrifugus: Poppe & Goto, 1991: 46; Rolán, 2005: 178 (fig. 833).

Type locality. Madeira.

Distribution. Western Atlantic: Mexico to Panama; Eastern Atlantic: Madeira to São Tomé; Mediterranean (Bieler & Bouchet 2012a). From Texas and West Indies to Espírito Santo state, Brazil (Rios 1994).

New occurrence. Espírito Santo, off Linhares, 340–360 m depth.

Material examined. Brazil; Espírito Santo: east of the mouth of Doce River, off Linhares, 19°34' S 38°55' W, 340–360 m depth, MNHN, 1 shell (MD55 sta CB92; Bouchet, Leal and Métivier col., 29/v/1987).

Brief description

Shell medium-sized, planispiral, discoid. Protoconch very small (roughly estimated at 0.6 mm), (Figs 17, 18). Teleoconch with weak axial ribs; upper and lower surfaces of whorls similarly sculptured. First teleoconch whorl detached from protoconch (open coiling). Aperture somewhat quadrangular (Fig. 16); two peripheral keels, equally strong, formed by lower peripheral rib and rib from the basal field; two internal keels, somewhat equally strong, formed by the subsutural rib and umbilical crenae. Extremely wide umbilicus, with weak crenae. Periostracum and operculum unknown.

Measurements (in mm). SD=1.59, H=0.43, P=0.48, w=0.41, h=0.4.

Remarks. Despite the somewhat bad preservation of the examined specimen, its shell morphology agrees well with that of *S. centrifuga*. Nevertheless, its sculpture is more strongly marked and the whorls are not completely detached. Such features, however, likely consist in morphological variation. The occurrence of this species in Espírito Santo (Rios 1994, 2009) was the only record of the genus in Brazil. Our newly recorded specimen comes from the same state but from a different locality and also from a distinct bathymetric range (340–360 m).

Spirolaxis lamellifer (Rehder, 1935)

Figs 19–24

Synonymy see Bieler (1983). Complement:

Pseudomalaxis lamellifera: Ardovini & Cossignani, 2004: 39.

Pseudomalaxis (*Spirolaxis*) *lamelliferus*: Bieler, 1984: 81 (pl. 1, fig. 11)

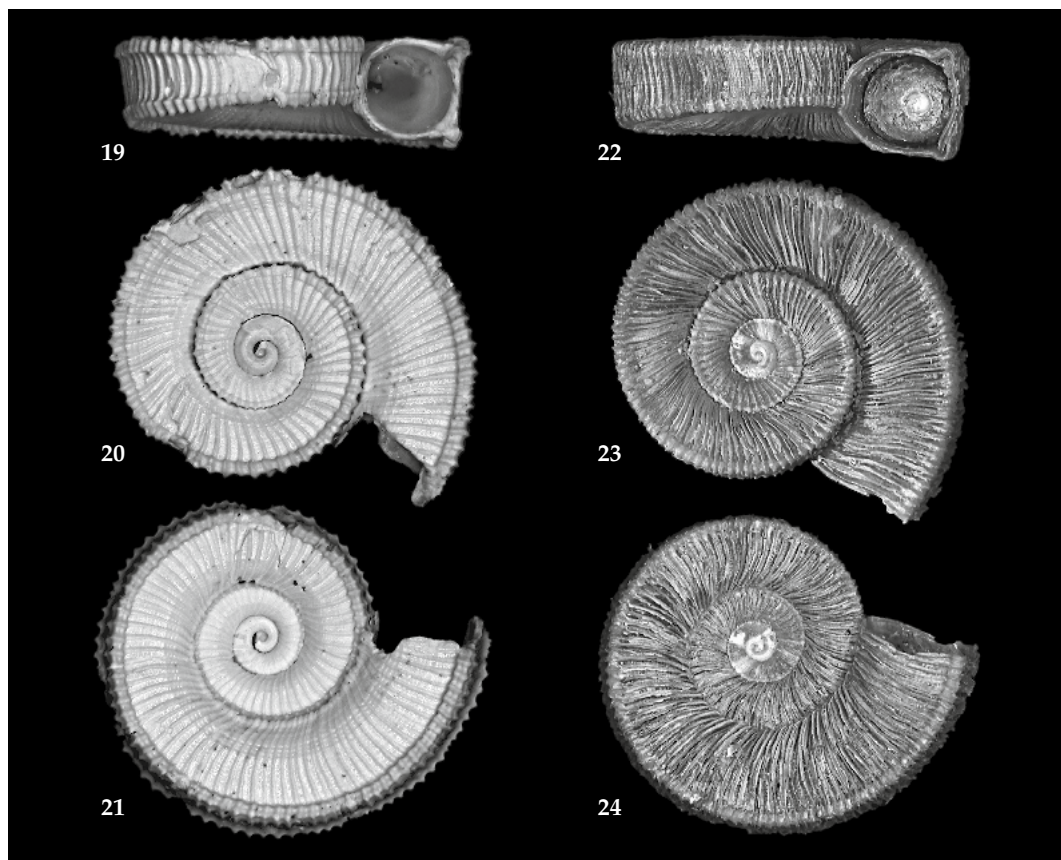
Spirolaxis lamellifer: Smriglio & Mariottini, 2002: 183 (figs 1–13); Rosenberg et al., 2009: 670.

Type locality. Florida Straits, USA, ~375 m.

Distribution. Amphi-Atlantic from central Western to central Eastern Atlantic; Mediterranean (Smriglio & Mariottini 2002, Bieler & Bouchet 2012b).

New occurrences. Espírito Santo, off Linhares, 640 m depth. Rio de Janeiro, off Cabo Frio, 610 m depth.

Material examined. Brazil; Espírito Santo: off Linhares, east of the mouth of Doce River, 19°36' S 38°53' W, 640 m depth, MNHN 2 shells, MZSP 112792, 1 shell (MD55 sta CB93, Bouchet, Leal and Métivier col., 30/v/1987). Rio



Figs 19–21. *Spirolaxis lamellifer* MNHN (H=1.56 mm, SD=3.95 mm), from off Cabo Frio, Rio de Janeiro, Brazil.
Figs 22–24. *Spirolaxis lamellifer* MNHN (H=1.58 mm, SD=5.81 mm), from off Linhares, Espírito Santo, Brazil.

de Janeiro: off Cabo Frio, 23°46'S 42°10'W, 610 m depth, MNHN 1 shell (MD55 sta. CB105; Bouchet, Leal and Métivier col., 02/vi/1987).

Brief description

Shell large, planispiral, discoid. Protoconch very small (0.51–0.6 mm). Teleoconch with strong, well-developed axial ribs (Figs 20, 21); upper and lower surfaces of whorls similarly sculptured. Aperture rounded quadrangular (Figs 19, 22); two peripheral keels, equally strong, formed by lower peripheral rib and rib from basal field. Extremely wide umbilicus, with almost indistinct crenae. Periostracum yellowish brown. Operculum pagoda-like, with foliated projections (Fig. 22).

Measurements (in mm). MNHN: specimen #1 (off Linhares, Figs 22–24) SD=5.81, H=1.58, P=0.6, U=2.7, BF=1.5, w=1.82, h=1.58; specimen #2 (off Linhares) SD=5.0, H=1.5, P=0.6, U=2.8, BF=1.6,

w=1.6, h=1.5; specimen #3 (off Cabo Frio, Figs 19–21) SD=3.95, H=1.56, P=0.51, U=2.3, BF=0.82, w=1.82, h=1.58. MZUSP 112972: (off Linhares) SD=4.7, H=1.5, P=0.61, U=2.5, BF=1.1, w=1.6, h=1.5.

Remarks. The present specimens are closely similar to the typical *S. lamellifer*, but some differences can be easily noticed: they are slightly larger and have a more depressed spire (and thus a more discoid shell), a slightly proportionally smaller protoconch (although in the same size category, sensu Bieler 1993) and a wider umbilicus, with more distinct crenae. All these differences seem to point towards intraspecific variation and could be interpreted as traits specific of a south Brazilian population, far removed from the remaining distribution. Nevertheless, more studies are necessary to clarify this issue. Additionally, the presence of a preserved periostracum and even an operculum on the specimens from Linhares (Fig. 22) indicates that the animals were

alive when collected and the present record is thus a good indicator of bathymetric range. Unfortunately, specimens were preserved dry and the soft tissue is mummified. Several authors regard *S. lamellifer* as an amphiatlantic species, though its distribution is restricted to the central W/E Atlantic (Bieler 1983, Smriglio & Mariottini 2002). Our record expands its range to the SW Atlantic.

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