



The genus *Anatoma* Woodward, 1859 (Gastropoda, Anatomidae) from Azorean seamounts

El género *Anatoma* Woodward, 1859 (Gastropoda, Anatomidae) en los montes submarinos de las Azores

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ABSTRACT

Four species in the genus *Anatoma* Woodward, 1859 were found in bioclastic sediment samples taken on the bathyal slopes of seven Azorean seamounts during the cruises SEAMOUNT 2 by R/V LE SUROIT and M151 ATHENA by R/V METEOR. Three new species are proposed: *Anatoma biscalpta* n. sp., *Anatoma symmetrica* n. sp. and *Anatoma pagoda* n. sp. The former two are probably endemic on the Azorean seamounts.

RESUMEN

Se encontraron cuatro especies del género *Anatoma* Woodward, 1859 en muestras de sedimento bioclástico tomadas en las laderas batiales de siete montes submarinos de las Azores durante los cruceros SEAMOUNT 2 del B/O LE SUROIT y M151 ATHENA del B/O METEOR. Se proponen tres nuevas especies: *Anatoma biscalpta* n. sp., *Anatoma symmetrica* n. sp. y *Anatoma pagoda* n. sp. Las dos primeras son probablemente endémicas en los montes submarinos de las Azores.

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KEY WORDS: Mollusca, Vetigastropoda, Anatomidae, taxonomy, Atlantic Ocean.

PALABRAS CLAVE: Mollusca, Vetigastropoda, Anatomidae, taxonomía, océano Atlántico.

INTRODUCTION

Benthic samples collected during cruises SEAMOUNT 2 by R/V LE SUROIT (GOFAS, 1993) and M151 ATHENA by R/V METEOR (FRANK, 2018) have been investigated to study the biodiversity of bathyal plateaus and slopes on Azorean seamounts. This paper discusses the species in the genus *Anatoma* Woodward, 1859 (Anatomidae McLean, 1989).

Anatomidae are deposit-feeding gastropods living on a large variety of sea bottoms, from the intertidal zone to abyssal depths in all oceans of the world. They were recently separated from the Scissurellidae (GEIGER & JANSSEN, 2004) to form a family which comprises the genus *Anatoma* Woodward, 1859, with currently 85 accepted Recent species, and possibly

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the monotypic genus *Sasakiconcha* Geiger, 2006 (WoRMS, 2020).

GEIGER (2012) provided the first global revision of “little slit shells” that included the family Anatomidae. He described and imaged all hitherto known species in great detail and a large part of the knowledge regarding this complex genus is discussed in his monograph. GEIGER (2012) reported six species from the Azores: *Anatoma crispata* (Fleming, 1828), *Anatoma alta* (Watson, 1886), *Anatoma aspera* (Philippi, 1844), *Anatoma janusa* Geiger, 2012, *Anatoma tenuis* (Jeffreys, 1877), and *Anatoma umbilicata* (Jeffreys, 1883).

This paper is part of a series dealing with the mollusc fauna from the Azorean seamounts. Other recent papers discussed vetigastropods in the genera *Clelandella* (GOFAS, 2005), *Calliostoma* (GOFAS & HOFFMAN, 2020), the family Seguenziidae (HOFFMAN ET AL., 2020a), and the informal group of “skeneimorphs” (HOFFMAN ET AL., 2020b).

ABBREVIATIONS: Morphology: H – height; Ha – height of aperture; W – width. Institutions: MNHN – Muséum National de Histoire Naturelle, Paris; SaM – Senckenberg am Meer, Wilhelms-haven; SMF – Senckenberg Museum, Frankfurt am Main.

MATERIAL AND METHODS

Area of Investigation: This study used benthic samples from seven seamounts south of the Azores: (1) Mar da

Prata / José Gaspar Seamount south of São Miguel, (2) Açor Bank SW of Faial, (3) Atlantis Seamount, (4) Plato Seamount, (5) Hyères Seamount, (6) Great Meteor Seamount and (7) Little Meteor Seamount. The term “Azorean seamounts” within this study refers to the group of all seamounts around and south of the Azores up to and including the Meteor seamounts. GOFAS (1993) listed the station data from the SEAMOUNT 2 cruise and FRANK (2018) gave the data from the M151 cruise.

Sampling and material handling: Refer to HOFFMAN & FREIWALD (2020) for a description of the sampling procedure. Selected shells were imaged using a VEGA3-TESCAN scanning electron microscope (SEM) at SaM (incident energy 10 KeV); the shells were gold-coated to improve image quality. The SEM also made shell measurements.

Additional material: In order to compare anatomids from the Azorean seamounts with other NE Atlantic and Mediterranean species we prepared an additional series of SEM images of shells from *Anatoma pagoda* n. sp., *Anatoma aspera* (Philippi, 1844) and *Anatoma janusa* Geiger, 2012. Some of them were reproduced herein.

Storage of material: Holotypes are deposited in Muséum National d’Histoire Naturelle (MNHN), Paris; paratypes are retained in MNHN and Senckenberg Museum, Frankfurt am Main (SMF). Other reference specimens are stored in the collections at MNHN (Seamount 2) or SaM (Meteor cruise 151).

SYSTEMATICS

Class GASTROPODA Cuvier, 1795
Subclass VETIGASTROPODA Salvini-Plawen, 1980
Superfamily SCISSURELLOIDEA Gray, 1847
Family ANATOMIDAE McLean, 1989
Genus *Anatoma* Woodward, 1859

Type species: *Anatoma crispata* (J. Fleming, 1828), type by monotypy. GEIGER (2012) reported a single shell from the Azores.

DAUTZENBERG (1889) discussed a shell of *Anatoma alta* (Watson, 1886) from off Faial, Azores. The species is also known from the Caribbean Sea, off eastern Florida, Cuba, Gulf of Mexico and off Madeira. GEIGER (2012) indicated a few shells of *Anatoma janusa* Geiger, 2012 from intertidal zones in Sao

Miguel and Pico and from Morocco. *Anatoma crispata*, *Anatoma alta* and *Anatoma janusa* have not been found in the SEAMOUNT 2 and M151 cruises. Our material yielded four species: *Anatoma richardi* (Dautzenberg & Fischer, 1896), *Anatoma pagoda* n. sp., *Anatoma bisculpta* n. sp. and *Anatoma symmetrica* n. sp.

Anatoma richardi (Dautzenberg & Fischer, 1896) (Figs. 1A-K)

Scissurella richardi DAUTZENBERG & FISCHER, 1896: 465, pl. 19 fig. 17.

Anatoma richardi: ORTEGA & GOFAS, 2019: 518-519, figs 3A-E.

Material examined: Azores, Mar da Prata • 45 shells; 37.668°N, 25.926°W; 834 m; 08 Oct. 2018; M151/23109; grab; SaM • 95 shells; 37.673°N, 25.925°W; 595 m; 08 Oct. 2018; M151/23111; grab; SaM • 45 shells; 37.661°N, 25.918°W; 599 m; 08 Oct. 2018; M151/23112; grab; SaM • 1 shell; 37.666°N, 25.966°W; 961 m; 09 Oct. 2018; M151/23121; grab; SaM. Atlantis Seamount • 62 shells; 33.971°N, 30.206°W; 677 m; 21 Oct. 2018; M151/23404; grab; SaM • 2 shells; 33.996°N, 30.177°W; 617 m; 21 Oct. 2018; M151/23408; grab; SaM. Hyères Seamount • 7 shells; 31.387°N, 28.892°W; 480 m; 15 Jan. 1991; SMT2/DW182; dredge; MNHN. Great Meteor Seamount • 1 shell; 29.565°N, 28.339°W; 948 m; 25 Oct. 2018; M151/23425-R1; ROV sample; SaM • 1 shell; 29.565°N, 28.332°W; 945 m; 25 Oct. 2018; M151/23425-R4; ROV sample; SaM • 5 shells; 29.565°N, 28.339°W; 944 m; 25 Oct. 2018; M151/23425-R6; ROV sample; SaM • 3 shells; 29.568°N, 28.339°W; 855 m; 25 Oct. 2018; M151/23425-R9; ROV sample; SaM • 1 shell; 30.082°N, 28.730°W; 1032 m; 26 Oct. 2018; M151/23429-R1; ROV sample; SaM. Little Meteor Seamount • 9 shells; 29.654°N, 29.015°W; 865 m; 27 Oct. 2018; M151/23434-R4; ROV sample; SaM • 33 shells; 29.654°N, 29.015°W; 852 m; 27 Oct. 2018; M151/23436; grab; SaM • 5 shells; 29.654°N, 29.014°W; 811 m; 27 Oct. 2018; M151/23437; grab; SaM.

Distribution: Azorean seamounts (DAUTZENBERG & FISCHER, 1896; this study) and Canary Islands (ORTEGA & GOFAS, 2019).

Remarks: The species was described from the Azores (DAUTZENBERG & FISCHER, 1896). GEIGER (2012: 1104, 1108) synonymized *Anatoma richardi* with *Anatoma tenuis* (Jeffreys, 1877). The latter has a very similar shell but has been described from abyssal depths (2651 m) near the Mid Atlantic Ridge south of Greenland. ORTEGA & GOFAS (2019: 518-519) discussed the morphological differences between the two species and particularly

highlighted the longer teleoconch I (¾ whorl from protoconch to start of selenizone) with a spiral cord in *A. richardi* when compared to *A. tenuis* (½ whorl, without spiral cord) and they retained the status of *A. richardi* as a separate species. We herein follow the interpretation of ORTEGA & GOFAS (2019).

The shells from the Azorean seamounts have a teleoconch I of about ¾ whorls with a spiral cord that may be occasionally weakly developed (Figs. 1D-E,H-I); the apex is dome-shaped (Figs. 1A,C,G,J); the shells have a glossy shine with fine axial and spiral lines (Figs 1F,K).

Anatoma pagoda n. sp. (Figs. 2A-I)

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Type material. *Holotype:* Azores, Mar da Prata • 1 shell (Fig. 2 E-G); 37.666°N, 25.966°W; 952 m; 17 Oct. 2018; M151/23168; grab; MNHN-IM-2000-37014. *Paratypes:* • 2 shells; same data as for holotype; MNHN-IM-2000-37015 • 1 shell; 37.668°N, 25.926°W; 834 m; 08 Oct. 2018; M151/23109; grab; SMF 358946 • 3 shells; 37.666°N, 25.966°W; 961 m; 09 Oct. 2018; M151/23121; grab; SMF 358947.

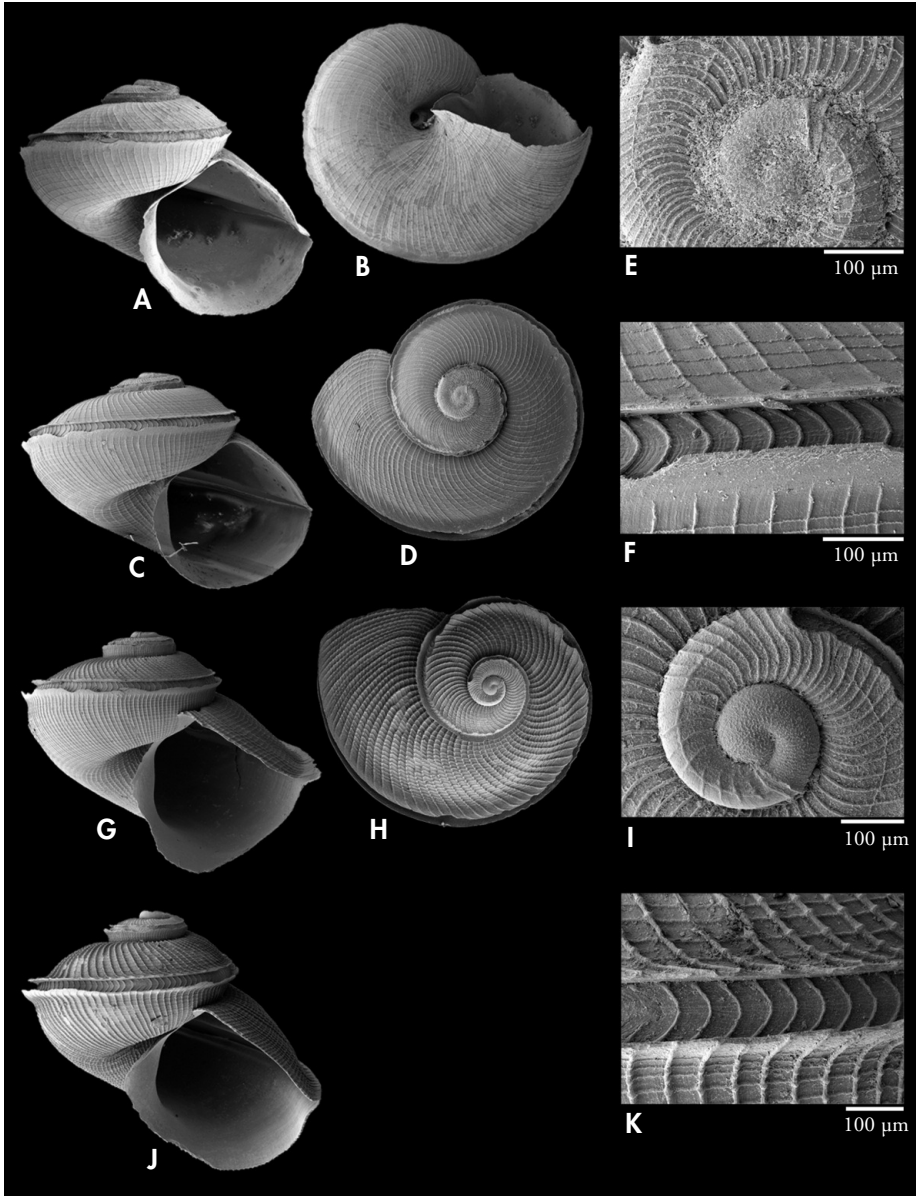


Figure 1. *Anatoma richardi* Dautzenberg & Fischer, 1896. A, B: Azores, Mar da Prata, M151/23109, 834 m (H 1.98 mm, W 2.57 mm, Ha 1.34 mm); C-F: same locality (H 1.69 mm, W 2.25 mm, Ha 1.13 mm, protoconch W 0.18 mm); G: Little Meteor Bank, M151/23436, 852 m (1.85 mm, W 2.27 mm); H, I: same locality (W 2.45 mm, protoconch W 0.18 mm); J, K: same locality (H 2.30 mm, W 2.58 mm).

Figura 1. *Anatoma richardi* Dautzenberg y Fischer, 1896. A, B: Azores, Mar da Prata, M151/23109, 834 m (alto 1,98 mm, ancho 2,57 mm, Ha 1,34 mm); C-F: misma localidad (alto 1,69 mm, ancho 2,25 mm, Ha 1,13 mm, ancho protoconcha 0,18 mm); G: Pequeño Banco Meteor, M151/23436, 852 m (alto 1,85 mm, ancho 2,27 mm); H, I: misma localidad (alto 2,45 mm, ancho protoconcha 0,18 mm); J, K: misma localidad (alto 2,30 mm, ancho 2,58 mm).

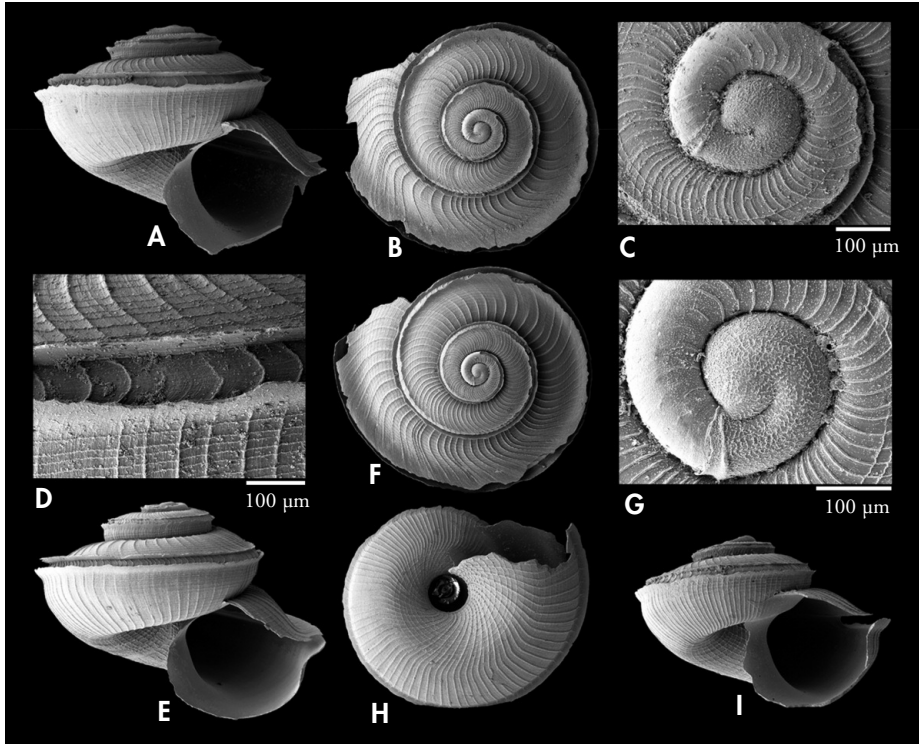


Figure 2. *Anatoma pagoda* n. sp. A-D: Great Meteor Bank, M151/23429-R1, 948 m (H 1.75 mm, W 2.21 mm, protoconch W 0.22 mm); E-G: holotype, Azores, Mar da Prata, M151/23168, 952 m (H 1.69 mm, W 2.41 mm, Ha 1.03 mm, protoconch W 0.24 mm); H, I: paratype, same locality (H 1.09 mm, W 1.54 mm, Ha 0.70 mm).

Figura 2. *Anatoma pagoda* n. sp. A-D: Gran Banco Meteor, M151/23429-R1, 948 m. Alto 1,75 mm, ancho 2,21 mm, ancho protoconcha 0,22 mm); E-G: holotipo, Azores, Mar da Prata, M151/23168, 952 m, alto 1,69 mm, ancho 2,41 mm, Ha 1,03 mm, ancho protoconcha 0,24 mm); H, I: paratipo, misma localidad, alto 1,09 mm, ancho 1,54 mm, Ha 0,70 mm).

Other material examined: Azores, Açor Bank • 2 shells; 38.359°N, 29.050°W; 648 m; 14 Oct. 2018; M151/23135; grab; SaM. Great Meteor Seamount • 2 shells; 30.082°N, 28.730°W; 1032 m; 26 Oct. 2018; M151/23429-R1; ROV sample. Hyères Seamount • 1 shell; 31.318°N, 28.600°W; 1060 m; 18 Jan. 1993; SMT2/DW200; dredge; MNHN • 68 shells; 31.158°N, 28.725°W; 845–990 m; 19 Jan. 1993; SMT2/DW203; dredge; MNHN. Plato Seamount • 36 shells; 33.197°N, 28.949°W; 690–710 m; 31 Jan. 1993; SMT2/DW242; dredge; MNHN.

Type locality: Azores, Mar da Prata, 37.666°N, 25.966°W, 952 m.

Etymology: *pagoda* refers to the pagoda-shaped outline of the shell.

Description of the holotype (Figs. 2E-G, empty shell): Shell with a raised spire, flat apex and pagoda-shaped outline with strongly protruding margins of selenizone; sculpture of flexuous axial ribs and fine spiral cordlets; aperture round with anal slit; suture deep. Height 1.69

mm, width 2.41 mm, height of aperture 1.03 mm (61% of total height); colour opaque white.

Protoconch (Fig. 2G): one flat whorl, with a rough texture formed by numerous short, raised, often branched segments, mostly oriented in axial direc-

tion; about three spiral streaks are formed by aligned micro-sculpture elements; a raised rim with sharp lip terminating the protoconch: transition to teleoconch clear by change in sculpture. Width 0.24 mm.

Teleoconch (Fig. 2E): 3 ¼ regular whorls with flattened shoulder area and rounded base, selenizone slightly above periphery; distance between base of selenizone and suture increasing from start of selenizone, situated well below the selenizone on the body whorl. Teleoconch I from protoconch to start of selenizone: ½ convex whorl, flush with protoconch; about 13 fine axial ribs, flexuous, initial ribs inconspicuous; no spiral cord. Teleoconch II with selenizone: initial two whorls about 65 axial ribs each, body whorl about 58 axial ribs; three fine radial spiral cords starting on the lower shoulder of first whorl, and about 14 spiral cordlets on body- and penultimate whorls; the cordlets deviating downwards and abutting on the selenizone (Figs. 2B-C,F). Margins of selenizone sharply protruding outwards, smooth on upper and lower sides of selenizone, spirally striated inside; strong symmetrical parabolic ribs on the flat surface between margins, somewhat irregularly spaced, closer together than axial ribs; about 13 fine equidistant spiral wiggly threads between ribs (Figs 2D of paratype). Spacing of axial ribs below selenizone similar to that above. Spiral lines below selenizone overrunning axial riblets; emerging below the selenizone and slowly deviating downwards. Umbilicus open, wide and deep; spiral keel at union of

columellar lip with parietal area (Fig. 2I of paratype).

Aperture (Fig. 2E): round, nearly circular, sharp lip, pointed at union with penultimate whorl, concave on parietal area with thin reclining callus. Columellar lip sharp, protruding, rounded at base, flexuous towards parietal area. Semi-circular lower lip; anal slit slightly above periphery with concave edge of lower shoulder, slit ¼ whorl deep with well-rounded sharp margins above and below. Callus thin; inside aperture smooth.

Variability: Little morphological variation observed. Number of axial ribs and spiral cords variable. Height up to 1.8 mm; width up to 2.5 mm.

Distribution: Azorean seamounts (Mar da Prata, Açor Bank, Hyères-, Plato-, Great Meteor Seamount), 648-1060 m.

Remarks: *Anatoma pagoda* n. sp. is similar to *Anatoma umbilicata* (Jeffreys, 1883), an Atlantic species typically known from below 1500 m depth. The lectotype and two paralectotypes of *Anatoma umbilicata* have been imaged by GEIGER (2012: 1124, fig. 924) from off Portugal; its initial teleoconch has a smooth, glossy shoulder area and smooth base with few spiral cordlets and numerous irregular growth lines (JEFFREYS 1883: 88-89). *Anatoma pagoda* n. sp. is matt with flexuous axial ribs and many spiral cordlets at regular intervals.

Empty shells of *Anatoma pagoda* n. sp. were found in bioclastic sand with remains of scleractinians, octocorals, hydrozoans, echinoderms, and foraminiferans.

Anatoma bisculpta n. sp. (Figs. 3A-I)

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Type material. *Holotype*: Little Meteor Seamount • 1 shell; 29.645°N, 28.975°W; 284 m; 27 Oct. 2018; M151/23440; grab; MNHN-IM-2000-37016. *Paratypes*: • 8 shells; same data as for holotype; MNHN-IM-2000-37017 • 10 shells; same data as for holotype; SMF 358948 • 4 shells; 29.654°N, 29.015°W; 852 m; 27 Oct. 2018; M151/23436; grab; SMF 358949 • 9 shells; 29.655°N, 29.004°W; 464 m; 27 Oct. 2018; M151/23438; grab; SMF 358950 • 6 shells; 29.633°N, 28.967°W; 282 m; 27 Oct. 2018; M151/23441; grab; SMF 358951 • 2 shells; 29.633°N, 28.983°W; 274 m; 27 Oct. 2018; M151/23442; grab; SMF 345952.

Other material examined: Azores, José Gaspar Seamount, • 9 shells; 37.675°N, 25.717°W; 329 m; 06 Oct. 2018; M151/23105; grab; SaM • 1 shell; 37.676°N, 25.718°W; 293 m; 12 Oct. 2018; M151/23131;

grab; SaM • 22 shells; 37.675°N, 25.717°W; 311 m; 16 Oct. 2018; M151/23161; box core; SaM. Azores, Mar da Prata • 5 shells; 37.673°N, 25.925°W; 595 m; 08 Oct. 2018; M151/23111; grab; SaM • 2 shells; 37.666°N, 25.966°W; 961 m; 09 Oct. 2018; M151/23121; grab; SaM • 1 shell; 37.688°N, 25.988°W; 600 m; 18 Oct. 2018; M151/23174; grab. Azores, Açor Bank • 77 shells; 38.156°N, 29.084°W; 339 m; 13 Oct. 2018; M151/23139; grab. Atlantis Seamount • 14 shells; 33.971°N, 30.206°W; 677 m; 21 Oct. 2018; M151/23404; grab. • 22 shells; 33.996°N, 30.177°W; 617 m; 21 Oct. 2018; M151/23408; grab. Hyères Seamount • 195 shells and 5 live-collected specimens; 31.387°N, 28.892°W; 480 m; 15 Jan. 1991; SMT2/DW182; dredge; MNHN. Great Meteor Seamount • 1 shell; 29.565°N, 28.339°W; 948 m; 25 Oct. 2018; M151/23425-R1; ROV sample; SaM • 2 shells; 29.565°N, 28.332°W; 945 m; 25 Oct. 2018; M151/23425-R4; ROV sample; SaM • 5 shells; 29.568°N, 28.339°W; 855 m; 25 Oct. 2018; M151/23425-R9; ROV sample; SaM • 6 shells; 30.082°N, 28.730°W; 1032 m; 26 Oct. 2018; M151/23429-R1; ROV sample; SaM.

Type locality: Little Meteor Seamount, 29.645°N, 28.975°W, 284 m.

Etymology: *bisculpta* refers to the different sculpture above and below the selenizone.

Description of the holotype (Figs. 3F-G, empty shell): Shell with a raised spire, with flat apex and rounded whorls; flexuous axial ribs, few on the shoulder and numerous at the base; selenizone above periphery; round aperture with anal slit; suture deep. Height 1.45 mm, width 1.48 mm, height of aperture 0.81 mm (56% of total height); colour opaque white.

Protoconch (Fig. 3I of paratype 1): one flat whorl, coarse granular sculpture; raised rim with sharp lip at the transition to teleoconch: transition clear by change in sculpture. Width 0.18 mm.

Teleoconch (Figs. 3G of holotype, 3H of paratype 1): 2 $\frac{3}{4}$ regular whorls with rounded outline, selenizone slightly above periphery; distance between base selenizone and suture below rapidly increasing at start of selenizone; increasing distance slower thereafter; stepped outline. Teleoconch I from protoconch to start of selenizone: $\frac{3}{4}$ rounded whorl, flattened, flush with protoconch; about 30 fine axial ribs, flexuous; one spiral cord, frequently weak, runs from lip of protoconch in middle of shoulder, to beginning of selenizone. Teleoconch II with selenizone: initial whorl 38 axial ribs, second (body) whorl 28 axial ribs; fine radial spiral cords starting on the upper shoulder, spiraling down and ending at selenizone in about 1 $\frac{1}{2}$ whorls. Margins of selenizone sharply protruding outwards. sculpture upper and lower selenizone with ends of axial ribs; inside margins smooth; symmetrical parabolic lines on flat surface between margins, at higher frequency as adapical ribs, lower frequency as abapical ribs.

Sculpture below selenizone much more dense to that above. Base of inflated body whorl with 110 tightly set flexuous axial ribs and about 35 overrunning fine spiral lines. Axial ribs and spiral lines regularly distributed over most of the spire; frequency of adapical axial ribs increasing and bifurcating near the lip. Umbilicus open, narrow and deep, with a deeply-placed sharp spiral keel abutting on the inner lip of the aperture; steeply inclining into umbilicus.

Aperture (Fig. 3G): round, nearly circular, sharp, pointed at union with penultimate whorl. Columellar lip sharp, protruding, rounded at base and towards parietal area. Nearly circular outer lip; anal slit at periphery, slit $\frac{1}{4}$ whorl deep with well-rounded sharp margins above and below. Callus thin; inside aperture smooth.

Variability: Shell height up to 1.5 mm; height to width ratio 0.85-1.00; protoconch width 0.16-0.20 mm; 26-32 adapical (shoulder) ribs; 98-150 abapical (base) ribs; ratio ad- versus abapical ribs 0.2-0.3; first stage teleoconch 0.6-0.8 whorl.

Distribution: Azorean seamounts (Mar da Prata, José Gaspar Seamount, Açor Bank, Atlantis-, Hyères-, Great Meteor- and Little Meteor Seamount), 274-961 m.

Remarks: *Anatoma aspera* (Philippi, 1844) is similar and shares, among other characters, the presence of a sharp ridge inside the umbilicus; its neotype has been imaged by GEIGER (2012: 779, fig. 627) from a Pleistocene outcrop (Terreti, Italy). In *Anatoma aspera*, the ratio of the

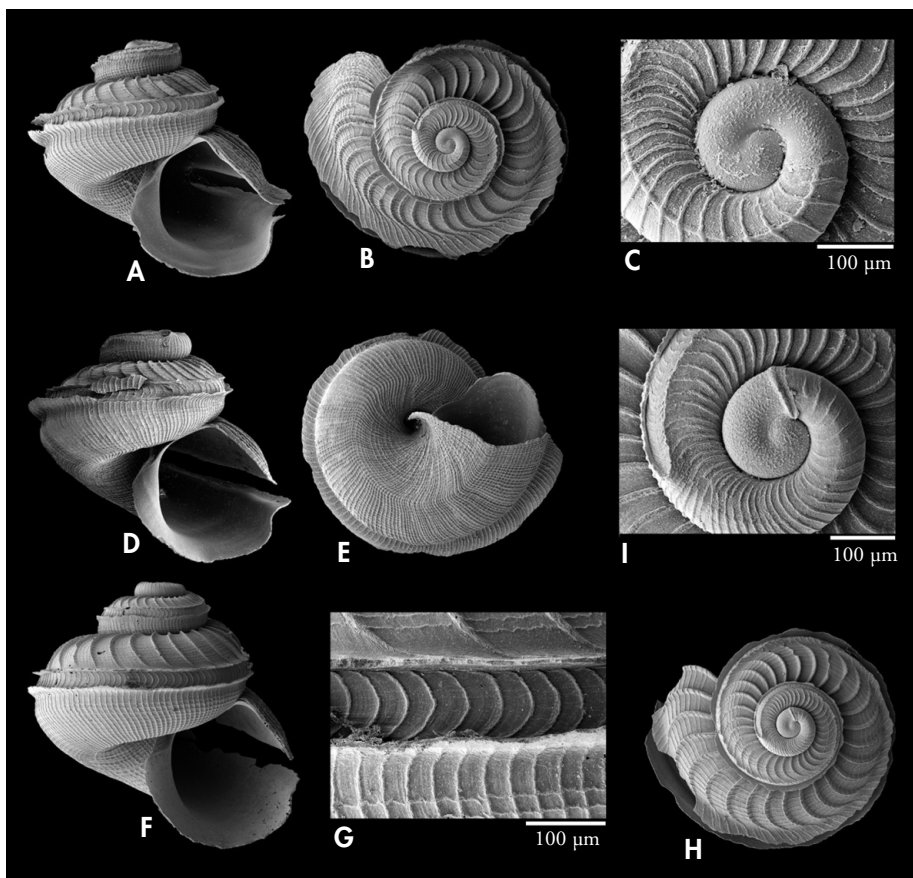


Figure 3. *Anatoma biscalpta* n. sp. A-C: Azores, Mar da Prata, M151/23139, 339 m (H 1.40 mm, W 1.52 mm, Ha 0.83 mm, protoconch W 0.20 mm); D, E: same locality (H 1.19 mm, W 1.36 mm, Ha 0.72 mm); F, G: holotype, Little Meteor Bank, M151/23440, 284 m (H 1.45 mm, W 1.48 mm, Ha 0.81 mm); H, I: paratype, same locality (W 1.39 mm, protoconch W 0.18 mm).

Figura 3. *Anatoma biscalpta* n. sp. A-C: Azores, Mar da Prata, M151/23139, 339 m (altura 1,40 mm, ancho 1,52 mm, Ha 0,83 mm, ancho protoconcha 0,20 mm); D, E: misma localidad (alto 1,19 mm, ancho 1,36 mm, Ha 0,72 mm); F, G: holotipo, Pequeño Banco Meteor, M151/23440, 284 m (H 1,45 mm, W 1,48 mm, Ha 0,81 mm); H, I: paratipo, misma localidad (ancho 1,39 mm, ancho protoconcha 0,18 mm).

number of adapical ribs on the shoulder (37-73 ribs) and the abapical ribs (72-126 ribs) is 0.4-0.7 whereas this ratio is only 0.2-0.3 in *Anatoma biscalpta* n. sp.. The number of abapical ribs is higher (98-150 ribs) and these are finer in *Anatoma biscalpta* n. sp. and the number of adapical ribs is lower (26-32 ribs).

Anatoma symmetrica n. sp. is also similar but its profile is more depressed

and it has a ratio of adapical and abapical ribs of 0.8-1.0, the number of abapical ribs is 48-55, the ridge inside the umbilicus is not so conspicuous and its selenizone is above the periphery on the body whorl.

Anatoma janusa Geiger 2012 (Figure 5), described from the intertidal zone of the Azores, resembles *A. biscalpta* n. sp. in many respects but is smaller, has

more adapical (shoulder) ribs, flattened sloping shoulders, has no spiral cords on the first teleoconch whorl and has these restricted to the outer part of the shoulder on the last whorl; its initial teleoconch has only ½ whorl versus 0.6–0.8 whorl in the present species. The umbilicus is also markedly narrower. The shell from Seine Seamount figured

in BECK *ET AL.* (2003) and assumed to be *A. janusa* by GEIGER (2012) belongs to the present species.

Anatoma bisculpta has been predominantly found in a shallower depth range 274–450 m. Shells and few live specimens have been encountered in bioclastic sand with remains of scleractinians, hydrozoans, echinoderms, and foraminiferans.

Anatoma symmetrica n. sp. (Figs. 4A–N)

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Type material. *Holotype*: Azores, Mar da Prata • 1 shell; 37.668°N, 25.926°W; 834 m; 08 Oct. 2018; M151/23109; grab; MNHN-IM-2000-37018. *Paratypes*: • 20 shells; same data as for holotype; MNHN-IM-2000-37019 • 22 shells; same data as for holotype; SMF 358953 • 13 shells; 37.673°N, 25.925°W; 595 m; 08 Oct. 2018; M151/23111; grab; SMF 358954. • 2 shells; 37.666°N, 25.966°W; 952 m; 17 Oct. 2018; M151/23168; grab; SMF 358955.

Other material examined: Azores, Açor Bank, • 2 shells; 38.359°N, 29.050°W; 648 m; 14 Oct. 2018; M151/23135; grab; SaM. Atlantis Seamount • 64 shells; 33.971°N, 30.206°W; 677 m; 21 Oct. 2018; M151/23404; grab; SaM. Plato Seamount • 36 shells; 33.197°N, 28.949°W; 690–710 m; 31 Jan. 1993; SMT2/DW242; dredge; MNHN. Hyères Seamount • 68 shells; 31.158°N, 28.725°W; 845–990 m; 19 Jan. 1993; SMT2/DW203; dredge; MNHN • 1 shell; 31.318°N, 28.600°W; 1060 m; 18 Jan. 1993; SMT2/DW200; dredge; MNHN. Great Meteor Seamount • 1 shell; 29.565°N, 28.339°W; 948 m; 25 Oct. 2018; M151/23425-R1; ROV sample; SaM • 1 shell; 29.565°N, 28.332°W; 945 m; 25 Oct. 2018; M151/23425-R4; ROV sample; SaM • 2 shells; 29.565°N, 28.339°W; 944 m; 25 Oct. 2018; M151/23425-R6; ROV sample; SaM • 3 shells; 29.568°N, 28.339°W; 855 m; 25 Oct. 2018; M151/23425-R9; ROV sample; SaM • 2 shells; 30.086°N; 28.726°W; 906 m; 26 Oct. 2018; M151/23429-R8; ROV sample; SaM. Little Meteor Seamount • 3 shells; 29.654°N, 29.015°W; 865 m; 27 Oct. 2018; M151/23434-R4; ROV sample; SaM • 18 shells; 29.654°N, 29.015°W; 852 m; 27 Oct. 2018; M151/23436; grab; SaM • 2 shells; 29.654°N, 29.014°W; 811 m; 27 Oct. 2018; M151/23437; grab; SaM.

Type locality: Azores, Mar da Prata, 37.668°N, 25.926°W, 834 m.

Etymology: the sculpture on either side of the selenizone is nearly symmetrical.

Description of the holotype (Figs. 4A–B, empty shell): Shell with a moderately raised spire, with flat apex and rounded whorls; flexuous axial ribs, about the same number on the shoulder and on the base; round aperture with anal slit; suture deep. Height 1.63 mm, width 1.87 mm, height of aperture 1.08 mm (66% of total height); colour opaque white.

Protoconch (Fig. 4E of paratype 1): one flat whorl, coarse granular sculpture; raised rim with sharp lip at the transition to teleoconch; transition clear by change in sculpture. Width 0.19 mm.

Teleoconch (Fig. 4A–B of holotype, Fig. 4C–D of paratype 1): 2 ¾ regular whorls with rounded raised outline, selenizone slightly above periphery; dis-

tance between base selenizone and suture below slowly increasing from start of selenizone; outline dome-shaped top spire. Teleoconch I from protoconch to start of selenizone: ¾ rounded whorl, flat coiling in plane with protoconch; 12 strong axial ribs, slightly prosocline, flexuous and stronger towards periphery; one spiral cord, running from lip of protoconch in middle of shoulder to start selenizone; axial ribs thickened at crossings. Teleoconch II with selenizone: initial whorl 38 axial ribs, body whorl 46 axial ribs. Fine radial spiral cords starting on the upper shoulder (Fig. 4D of paratype), 6 cords on the shoulder of the first whorl, about 22 on the body whorl, spiraling down and ending at selenizone in about 1 ½ whorls; rectangular

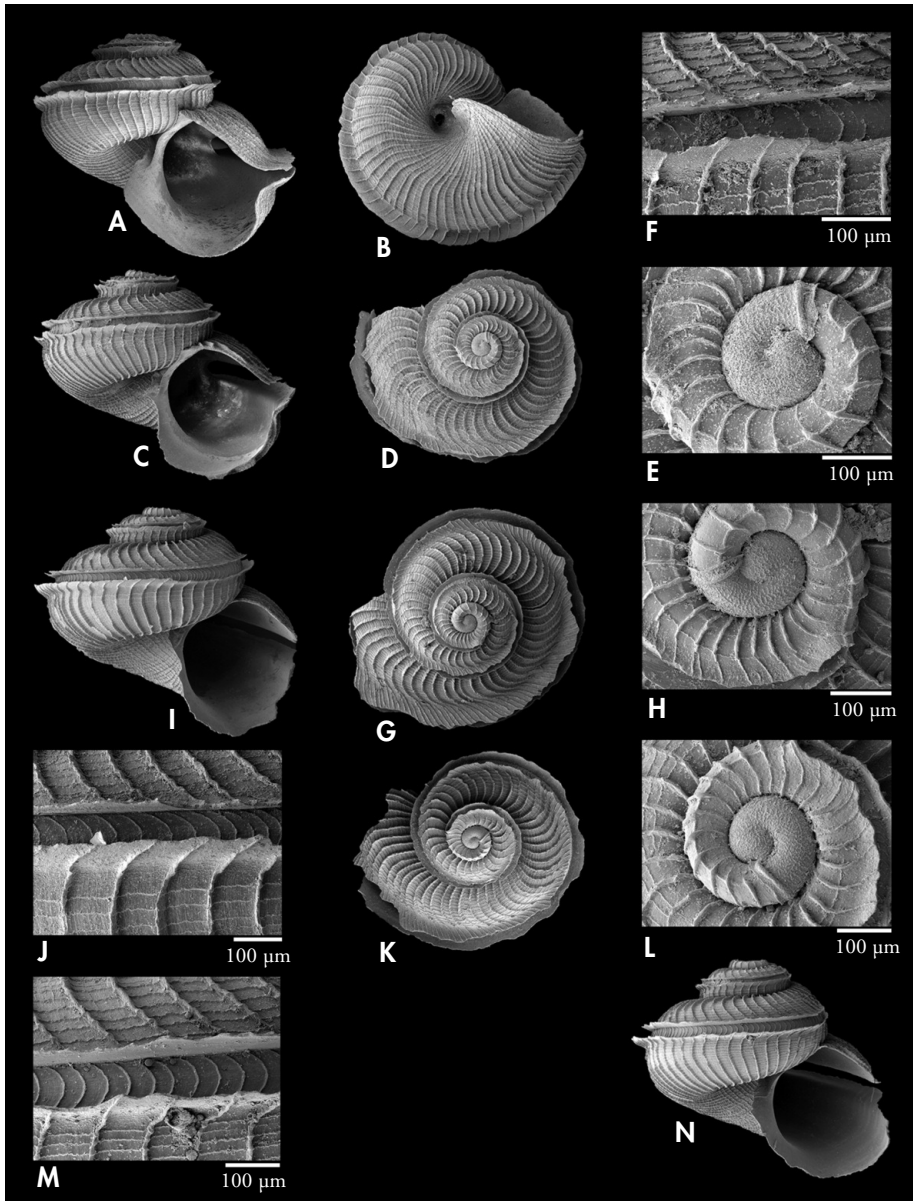


Figure 4. *Anatoma symmetrica* n. sp. A, B: holotype, Azores, Mar da Prata, M151/23109, 834 m (H 1.63 mm, W 1.87 mm, Ha 1.08 mm); C-F: paratype, same locality (H 1.40 mm, W 1.70 mm, Ha 0.86 mm, protoconch W 0.19 mm); G, H: Little Meteor Bank, M151/23436, 852 m (W 1.84 mm, protoconch W 0.20 mm); I, J: same locality (H 1.72 mm, W 1.98 mm, Ha 1.03 mm); K, L: same locality (W 1.61 mm); M, N: same locality (H 1.69 mm, W 1.98 mm, Ha 1.01 mm).

Figura 4. *Anatoma symmetrica* n. sp. A, B: holotipo, Azores, Mar da Prata, M151/23109, 834 m (H 1,63 mm, W 1,87 mm, Ha 1,08 mm); C-F: paratipo, misma localidad (alto 1,40 mm, ancho 1,70 mm, Ha 0,86 mm, ancho protoconcha 0,19 mm); G, H: Pequeño Banco Meteor, M151/23436, 852 m (ancho 1,84 mm, ancho protoconcha 0,20 mm); I, J: misma localidad (alto 1,72 mm, ancho 1,98 mm, Ha 1,03 mm); K, L: misma localidad (ancho 1,61 mm); M, N: misma localidad (alto 1,69 mm, ancho 1,98 mm, Ha 1,01 mm).

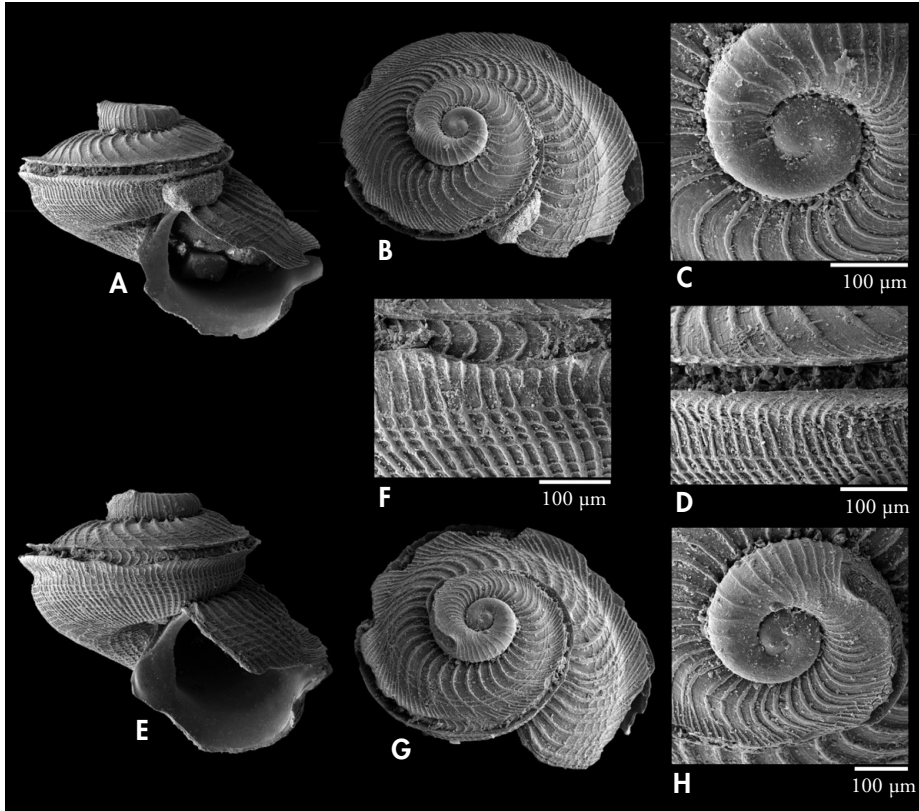


Figure 5. *Anatoma janusa* Geiger, 2012. A-D: Azores, Faial, Monte da Guia, 35 m. (Collection Delongueville (CD22458), H 1.0 mm, W 1.3 mm, protoconch W 0.18 mm). E-H: Same locality (Collection Scaillet (RS20534), H 1.0 mm, W 1.2 mm, protoconch W 0.18 mm).

Figura 5. *Anatoma janusa* Geiger, 2012. A-D: Azores, Faial, Monte da Guia, 35 m (Colección Delongueville (CD22458), alto 1.0 mm, ancho 1.3 mm, ancho protoconcha 0.18 mm). E-H: Misma localidad (Colección Scaillet (RS20534), alto 1.0 mm, ancho 1.2 mm, ancho protoconcha 0.18 mm).

sculpture of crossing dominant axial ribs and overrunning fine spiral lines. Margins of selenizone sharply protruding outwards; axial ribs continued on the upper and lower sides of the selenizone (Fig. 4F of paratype); inner margins smooth; parabolic axial lines on flat surface between the margins with same spacing as axial cords (Fig. 4F). Sculpture below selenizone nearly symmetrical with that above. Base of inflated body whorl with 48 strong flexuous axial ribs and about 32 overrunning fine spiral lines. Axial ribs and spiral lines regularly distributed over most of the

spire; density of axial ribs increasing near the outer lip, with some bifurcating ribs. Umbilicus open and deep, with deeply-placed sharp spiral keel (Fig. 4B).

Aperture (Fig. 4A, 4C): round, sharp, nearly circular. Columellar lip protruding, continuously rounded towards parietal area; lip pointed at joint with penultimate whorl. Anal slit above periphery, slit $\frac{1}{4}$ whorl deep with well rounded sharp margins above and below. Callus thin; inside aperture smooth.

Variability: Shell height up to 1.7 mm, width up to 2.0 mm; height to

width ratio 0.80-0.90; protoconch width 0.19-0.21 mm; 44-47 adapical (shoulder) ribs; 48-55 abapical (base) ribs; ratio adversus abapical ribs 0.8-1.0; first stage teleoconch 0.7-0.8 whorl.

Distribution: Azorean seamounts (Mar da Prata, Açor Bank, Atlantis-, Plato-, Hyères-, Great Meteor- and Little Meteor Seamount), 595-1060 m.

Remarks: Only empty shells have been found in bioclastic sand with remains of scleractinians, hydrozoans, echinoderms and foraminiferans.

A quite similar species is *Anatoma orbiculata* Geiger, 2012, described from shallow water in northern Morocco and also reported from Angola. This species shares with *A. symmetrica* n. sp. the presence of a strong cord between protoconch and the beginning of the selenizone, and a similar rib count above and below the selenizone. It differs in having a protoconch with a finer, distinctly reticulate pattern of microsculpture and with the terminal rim inconspicuous or absent, in having almost twice as many

ribs on the teleoconch 1 and also more ribs on the teleoconch 2, and in being more narrowly umbilicate.

The shells of *Anatoma bisculpta* n. sp. have a fine abapical sculpture, a partly closed umbilicus, a finer axial rib sculpture on teleoconch I, the sutsel is stronger developed from the start of the selenizone and maintaining its height yielding a stepped rather than a more rounded outline as in *Anatoma symmetrica* n. sp. A similar taxon is *Scissurella crispata* var. *paucicostata* Jeffreys, 1865 but has at least twice as many base ribs when compared to shoulder ribs and it has an early development of the sutsel yielding an outline like *Anatoma aspera*; GEIGER (2012) synonymized it with *A. aspera*. *Anatoma micalii* Geiger, 2012 and *Anatoma janusa* Geiger, 2012 have a short teleoconch I of ½ whorl and have a finer sculpture on the base (Figure 5).

Anatoma symmetrica has been found sympatrically with *Anatoma bisculpta*, in the upper part of its depth range, but is mostly found deeper.

DISCUSSION

Table I refers to seven species in the genus *Anatoma* Woodward, 1859 known from the Azores and Azorean seamounts. Two deep-water species reported by GEIGER (2012) have not been encountered in our material: *Anatoma alta* (Watson, 1886) and *Anatoma crispata* (Fleming, 1828). These bathyal species could as well have been misidentified, both having remote type localities (respectively in the Caribbean and Scottish seas) albeit the report of *Anatoma alta* originates from WATSON (1886: 113) himself.

The three new species are commonly found on the upper bathyal slopes of the seamounts south of the Azores and it is likely that these new species are endemic. Their simple protoconchs suggest a direct development or at best a very short planktonic stage. It is yet unclear how they manage to spread across the abyssal gaps of about 500 km between the seamounts. Similar enigma-

tic distribution traits have been observed in other vetigastropod taxa from the Azorean seamounts, like for example species in *Clelandella* (GOFAS, 2005), *Calliostoma* (GOFAS & HOFFMAN, 2020), Seguenziidae (HOFFMAN ET AL., 2020a), Skeneidae and unassigned Seguenzioidae (HOFFMAN ET AL., 2020b).

GEIGER (2012) reported *Anatoma richardi* (Dautzenberg & Fischer, 1896) under the name *Anatoma tenuis* (Jeffreys, 1883); we retain the taxon from DAUTZENBERG & FISCHER (1896) as valid in this study. Two of the new species were most likely reported by GEIGER (2012) under a different name. It is likely that the species reported from the Azores as the Mediterranean and NE Atlantic *Anatoma aspera* (Philippi, 1844) was the similar *Anatoma bisculpta* n. sp. The deep-water *Anatoma umbilicata* (Jeffreys, 1883) was probably confused with the similar *Anatoma pagoda* n. sp.

Table I. Distribution of anatomids from the Azorean seamounts. LMS = Little Meteor Seamount, GMS = Great Meteor Seamount, HS = Hyères Seamount, PS = Plato Seamount, AS = Atlantis Seamount, AB = Açor Bank, MdP = Mar da Prata, JG = José Gaspar Seamount. Azores Geiger refers to reporting by GEIGER (2012); (X) refers to species probably reported under a different name. NE = North East Atlantic, NW = North West Atlantic, Med = Mediterranean Sea.

Tabla I. Distribución de anatomídeos de los montes submarinos de las Azores. JG = Banco José Gaspar, MdP = Mar da Prata, AB = Banco Açor, AS = Banco Atlantis, HS = Banco Hyères, PS = Banco Plató, GMS = Gran Banco Meteor, LMS = Pequeño Banco Meteor. Azores Geiger se refiere a las citas de GEIGER (2012); (X) se refiere a especies probablemente citadas con un nombre diferente. NE = Atlántico nororiental, NW = Atlántico noroccidental, Med = Mar Mediterráneo.

Species	LMS	GMS	HS	PS	AS	AB	MdP	JG	Azores Geiger	Atl. Ocean Mediterranean
<i>Anatoma alta</i>									X	NW
<i>Anatoma biscalpta</i> n. sp.	X		X		X	X	X		(X)	
<i>Anatoma crispata</i>									X	NE NW Med
<i>Anatoma janusa</i>									X	
<i>Anatoma pagoda</i> n. sp.	X		X	X				X	(X)	
<i>Anatoma richardi</i>	X				X			X	(X)	NE
<i>Anatoma symmetrica</i> n. sp.	X		X	X	X	X	X			

Anatoma biscalpta n. sp. and *Anatoma symmetrica* n. sp. are both likely to be locally derived representatives of the *Anatoma aspera* (Philippi, 1844) species group, and *Anatoma pagoda* n. sp. of the of *Anatoma umbilicata* (Jeffreys, 1883) species group. This parallels other cases where similar and certainly related species replace the mainland species on the seamounts (e.g. *Clelandella* (GOFAS, 2005), *Danilia* (DAUTZENBERG & FISCHER, 1896) and *Pseudamussium* (DIJKSTRA & GOFAS, 2004)).

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