Taxonomic review of Triphorinae (Gastropoda: Triphoridae) from the Vitória-Trindade Seamount Chain, southeastern Brazil

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ABSTRACT

In the present work we identified the shells of Triphorinae collected at the seamounts of the Vitória-Trindade Chain off southeastern Brazil by the expeditions MD55 and REVIZEE-Central, the main sources of mollusks from the study site in the last decades. Of the 13 species found in this study, *Cosmotriphora melanura* and *Nototriphora decorata* were previously reported from the Vitória-Trindade Chain. *Cosmotriphora arnoldoi*, *Iniforis carmelae*, *Iniforis pseudothomae*, *Latitriphora albida*, *Coriophora novem*, *Triphora ellyae* and *Triphora elvirae* are reported for the first time from Brazil. The known ranges in Brazil of *Monophorus olivaceus* and *Triphora atlantica* are extended to the Vitória-Trindade Chain. *Isotriphora tigrina* new species, diagnosed by its teleoconch with two main spiral cords and three brown and smooth basal cords, is currently restricted to the Vitória-Trindade Chain and Bahia state. *Isotriphora onca* new species, diagnosed by its teleoconch with two main spiral cords and creamy to light brown color, is currently restricted to the Vitória-Trindade Chain. The number of species of Recent Triphoridae in the Vitória-Trindade Chain increased from six to 15, and in Brazil from 17 to 26.

Additional Keywords: Western Atlantic, MD55, REVIZEE, Mollusca, Triphoroidea, RV Marion-Dufresne

INTRODUCTION

Triphoridae is a large group of marine microgastropods that feed on sponges, mainly distributed in tropical and temperate seas (Marshall, 1983). Triphorids are usually recognized by their left-coiled shell, although species of Metaxiinae are dextral. Bouchet and Rocroi (2005) considered the existence of three subfamilies: Triphorinae, Metaxiinae, and Iniforinae, although the validity of the latter is contested by Marshall (1983). We follow Nützel (1998), recognizing only Triphorinae and Metaxiinae.

The maximum diversity of Triphoridae is found in the tropical Indo-Pacific (Rolán and Fernández-Garcés, 2008). In the western Atlantic, there are 93 recent species (Simone, 2006; Rolán and Fernández-Garcés, 2008, 2009; Faber, 2010; Fernandes and Pimenta, 2011). In Brazil, 17 species are reported (Absalão, 1989; Simone, 2006; Rolán and Fernández-Garcés, 2008; Lee, 2009; Rios, 2009; Fernandes and Pimenta, 2011), although some of them need confirmation.

The Vitória-Trindade Seamount Chain (Vitória-Trindade Ridge; Columbia Fracture Zone) comprises a series of seamounts and oceanic islands between 20°–21° S and 28°50′ – 38°30′ W, off Espírito Santo state, southeastern Brazil. The sequence of seamounts initiates near the base of the continental slope (Champlain and Vitória seamounts), running eastward to Trindade Island and Martin Vaz Archipelago (Figure 1), about 1167 km from the continent (Leal, 1991; O'Hara et al., 2010). Only Trindade Island and Martin Vaz Archipelago rise above sea level, while the seamount summits rise to between 50 and 150 m below the surface. The Vitória-Trindade Chain is under the influence of the warm, saline, southward-flowing Brazil Current (O'Hara et al., 2010).

Two scientific expeditions provided the majority of mollusks collected at the Vitória-Trindade Chain in the last decades: the French-Brazilian Expedition MD55, conducted in 1987, and REVIZEE-Central ("Programa de Avaliação do Potencial Sustentável de Recursos Vivos da Zona Econômica Exclusiva", SCORE Central; "Program of Evaluation of the Sustainable Potential of Living Resources in the Exclusive Economic Zone", SCORE Central), conducted between 1996 and 2002.

The prosobranchs collected at the Vitória-Trindade Chain by the Expedition MD55 were studied by Leal (1991) as the basis for a biogeographic analysis of the oceanic islands of Brazil. Leal (1991) recognized 10 taxa

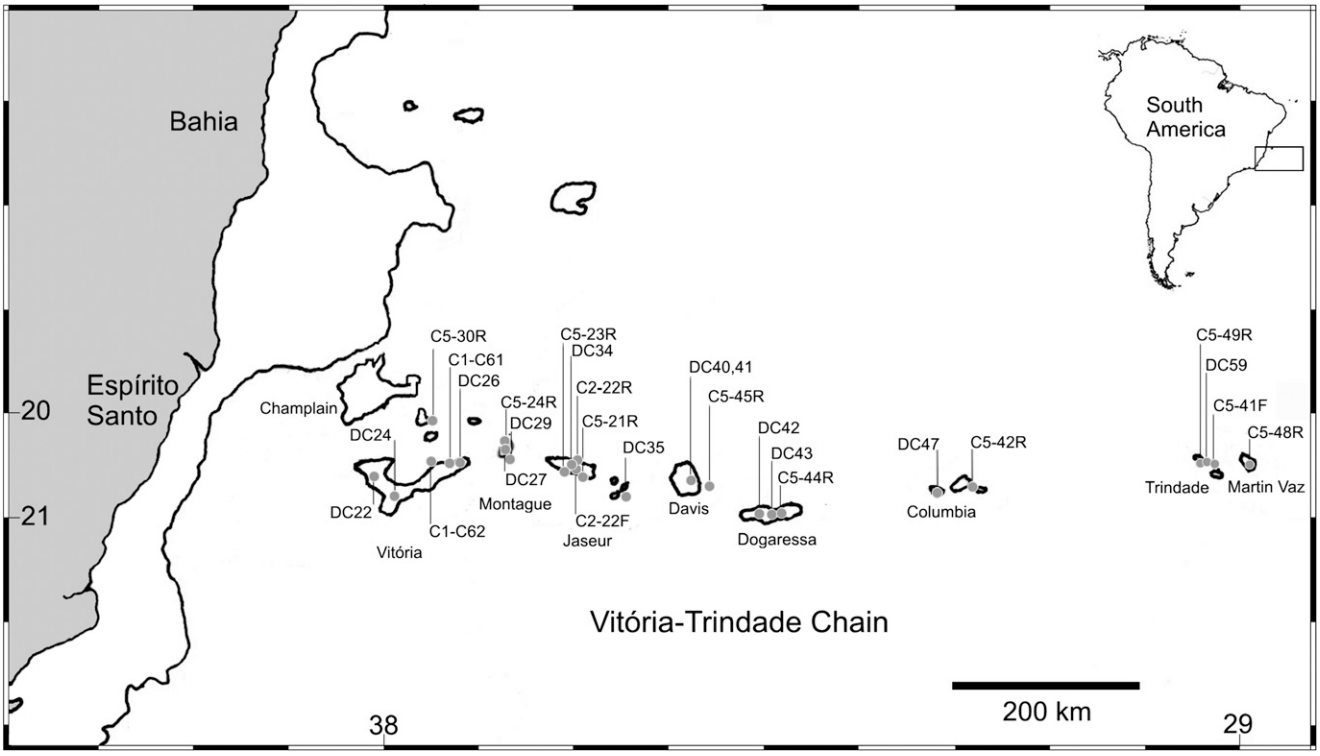


Figure 1. Stations in which shells of Triphoridae were collected at the Vitória-Trindade Chain by Expedition MD55 (DC) and REVIZEE-Central (C1–C5).

for Triphoridae, of which seven were identified only at generic level, although that author admitted that "some of the study species do not fit these classifications at the generic level". Absalão et al. (2006) listed six species of triphorids from the Vitória-Trindade Chain, collected by REVIZEE. Fernandes and Pimenta (2011) reported *Metaxia excelsa* Faber and Moolenbeek, 1991 and *Metaxia prompta* Rolán and Fernández-Garcés, 2008 at the study site.

Within these works, the species reported at the Vitória-Trindade Chain are *Metaxia excelsa*, *Metaxia prompta*, *Cosmotriphora melanura* (C. B. Adams, 1850), *Nototriphora decorata* (C. B. Adams, 1850), *Iniforis turristhomae* (Holten, 1802) and *Marshallora nigrocincta* (C. B. Adams, 1839) in addition to seven morphotypes that remained identified only at generic level.

As the Metaxiinae were already revised for Brazil (Fernandes and Pimenta, 2011), the present work is focused on the taxonomy of Triphorinae from the Vitória-Trindade Chain based on the material collected by the expeditions MD55 and REVIZEE-Central.

MATERIALS AND METHODS

In May/June 1987, the Research Vessel Marion-Dufresne made a series of dredgings and trawlings in southern Bahia state (Abrolhos bank) and in the Southeast region of Brazil, during the Expedition MD55 (Tavares, 1999). There were 66 benthic collecting stations, in depths between 15 and 5100 m, including the top of the seamounts that form the Vitória-Trindade Chain. The stations in which shells of Triphoridae were collected at the Vitória-Trindade Chain by the Expedition MD55 are listed in Table 1.

The program REVIZEE was divided in four regions (one for each SCORE), representing the different oceanographic characteristics of the Brazilian coast (Lavrado, 2006). The SCORE Central comprised the area between Salvador (Bahia state) to Cabo de São Tomé (Rio de Janeiro state), including the Vitória-Trindade Chain. REVIZEE-Central consisted of six campaigns (C1 to C6), of which the first one (C1) was conducted by the Oceanographic Ship Antares and the remainder (C2 to C6) by the supply boat N/RB Astro Garoupa. There were 227 collecting stations, in depths between 12 to 2076 m. The stations in which shells of Triphoridae were collected at the Vitória-Trindade Chain by REVIZEE-Central are listed in Table 2.

All material available consisted of empty shells. The taxonomic identifications were based on conchological comparisons under a stereomicroscope. Each species was also observed in scanning electron microscope (SEM) images. The whorl-counting procedure follows Leal (1991). The embryonic shell is here considered the beginning of the protoconch, typically sculptured on Triphorinae with spherical granules, cruciform granules or reticulated pattern. The remainder whorls of the protoconch constitute the larval shell, usually sculptured on Triphorinae with spiral and axial cords.

Table 1. Stations at the Vitória-Trindade Chain yielding Triphoridae shells during the Cruise MD55. DC: Charcot dredge.

Locality	Station	Date	Latitude S	Longitude W	Depth (m)
Vitória	9-DC22	13/v/1987	20°32′	38°11′	52
	10-DC24	13/v/1987	20°42′	37°50′	48–52
	13-DC26	14/v/1987	20°21′	36°59′	97
Montague	14-DC27	14/v/1987	20°26′	36°42′	81
	16-DC29	14/v/1987	20°27′	36°41′	310–350
Jaseur	20-DC34	15/v/1987	20°28′	35°54′	54
	21-DC35	16/v/1987	20°42′	35°22′	82–105
Davis	23-DC40	17/v/1987	20°40′	34°41′	60
	23-DC41	17/v/1987	20°39′	34°43′	58–70
Dogaressa	24-DC42	17/v/1987	20°55′	34°01′	60
	25-DC43	17/v/1987	20°51′	33°45′	63
Columbia	27-DC47	19/v/1987	20°42′	32°13′	94–105
Trindade	35-DC59	22/v/1987	20°30′	29°19′	52–60

Table 2. Stations at the Vitória-Trindade Chain yielding Triphoridae shells during REVIZEE-Central.

Locality	Station	Date	Latitude S	Longitude W	Depth (m)
Champlain	C5-30R	13/vii/2001	20°09′	37°29′	60
Vitória	C1-C61	24/iv/1996	20°31′	37°19′	88
	C1-C62	25/iv/1996	20°30′	37°28′	96
Montague	C5-24R	13/vii/2001	20°21′	36°38′	55
Jaseur	C2-22F	08/xi/1997	20°36′	35°52′	110
	C2-22R	08/xi/1997	20°31′	35°50′	59
	C5-21R	12/vii/2001	20°42′	35°42′	57,5
	C5-23R	12/vii/2001	20°29′	36°06′	55
Davis	C5-45R	12/vii/2001	20°41′	34°35′	108
Dogaressa	C5-44R	11/vii/2001	20°51′	33°38′	65
Columbia	C5-42R	11/vii/2001	20°44′	31°50′	85
Trindade	C5-41F	10/vii/2001	20°30′	29°16′	360
	C5-49R	10/vii/2001	20°31	29°21′	57
Martin Vaz	C5-48R	10/vii/2001	20°29′	28°51′	52

In order to obtain complete sinonimic lists, some citations were included even without direct or indirect examination of the respectively material. In these cases, the expression "not illustrated" follows the citation.

In the section of "material examined", the number inside brackets indicates the quantity of shells in each lot.

Abbreviations used: (ABC Islands) Aruba, Bonaire and Curaçao; (AMNH) American Museum of Natural History, New York, USA; (ANSP) Academy of Natural Sciences, Philadelphia, USA; (CER) E. Rolán, Vigo, Spain; (CFG) R. Fernández-Garcés, Cienfuegos, Cuba; (FLMNH) Florida Museum of Natural History, Gainesville, USA; (IBUFRJ) Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; (IES) Instituto de Ecología y Sistemática, Havana, Cuba; (MCZ) Museum of Comparative Zoology, Cambridge, USA; (MHNS) Museo de Historia Natural, Santiago de Compostela, Spain; (MNCN) Museo Nacional de Ciencias Naturales, Madrid, Spain; (MNHN) Muséum national d'Histoire naturelle, Paris, France; (MNRJ) Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; (MORG) Museu Oceanográfico do Rio Grande, Rio Grande, Brazil; (MZSP) Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; (NHM) Natural History Museum, London, England; (ZMA) Zoologisch Museum Amsterdam, Amsterdam, The Netherlands.

RESULTS

Family Triphoridae Gray, 1847
Subfamily Triphorinae Gray, 1847

Diagnosis: Sinistral shells, with a tubular or subtubular anterior canal, the posterior canal forming a notch, a hole or a tube (based on Wilson, 1993).

Genus *Cosmotriphora* Olsson and Harbison, 1953

Type Species: *Cerithium melanura* C. B. Adams, 1850, original designation; Recent, Atlantic Ocean.

Diagnosis: Embryonic shell with granules on abapical region, larval shell with axial riblets crossed by one spiral cord at beginning, two cords latter; teleoconch with a later development of median spiral cord; radular formula 9-1-1-1-9, with four cusps on central and lateral teeth,

three cusps on internal marginal teeth, two cusps on external marginal teeth (based on the description of the type species of the genus in Bouchet, 1985).

***Cosmotriphora arnoldoi* Faber and Moolenbeek, 1991**
(Figures 2, 18, 29)

Cosmotriphora arnoldoi Faber and Moolenbeek (1991: 81, figs. 1–2); Rolán and Fernández-Garcés (1994: 20, figs. 12–15; 2007: 20, pl. I, figs. 19–21); Lee (2009: 88, text-fig.); Garcia and Lee (2011).
Triphora melanura: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora sp.: Absalão et al. (2006: 238, in part).

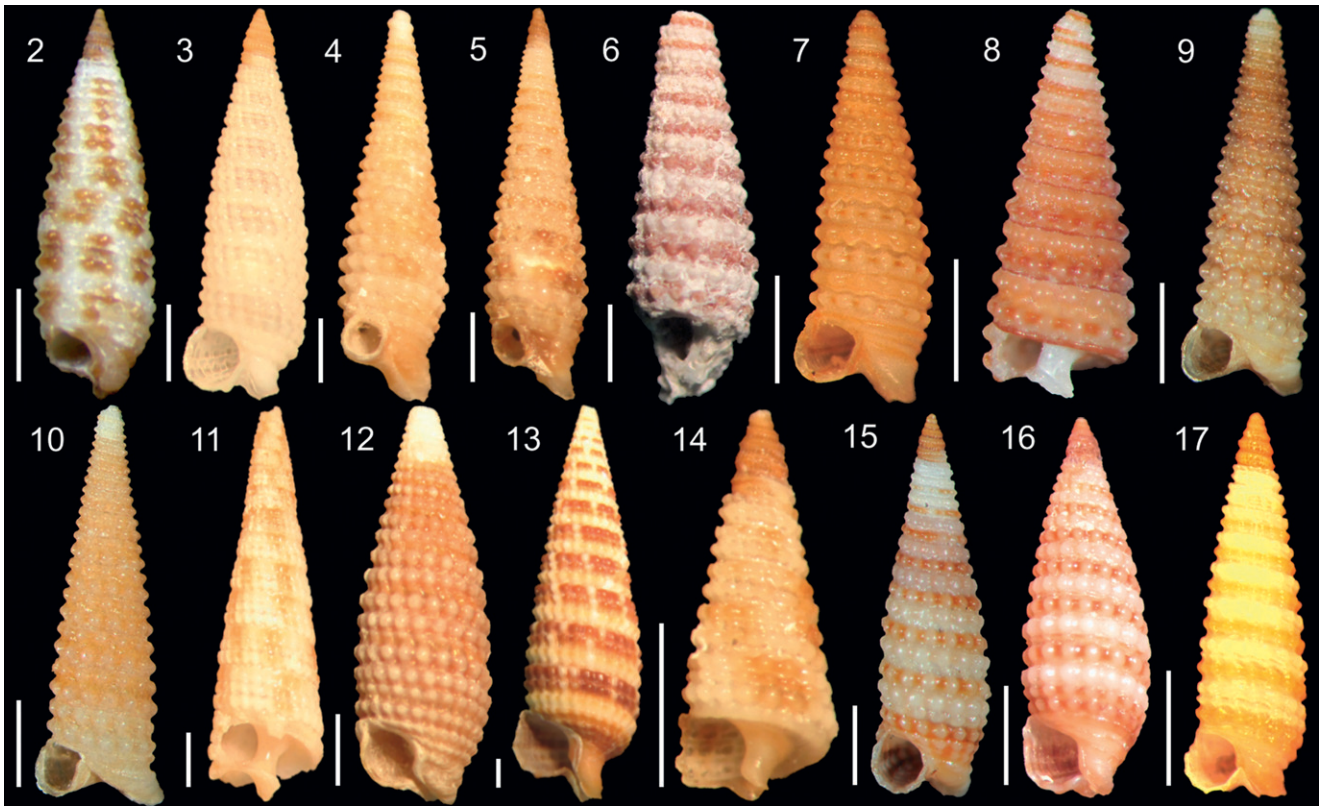
Type Material: Holotype: ZMA 391001. One paratype ZMA 391002.

Type Locality: Playa Lechi, Bonaire.

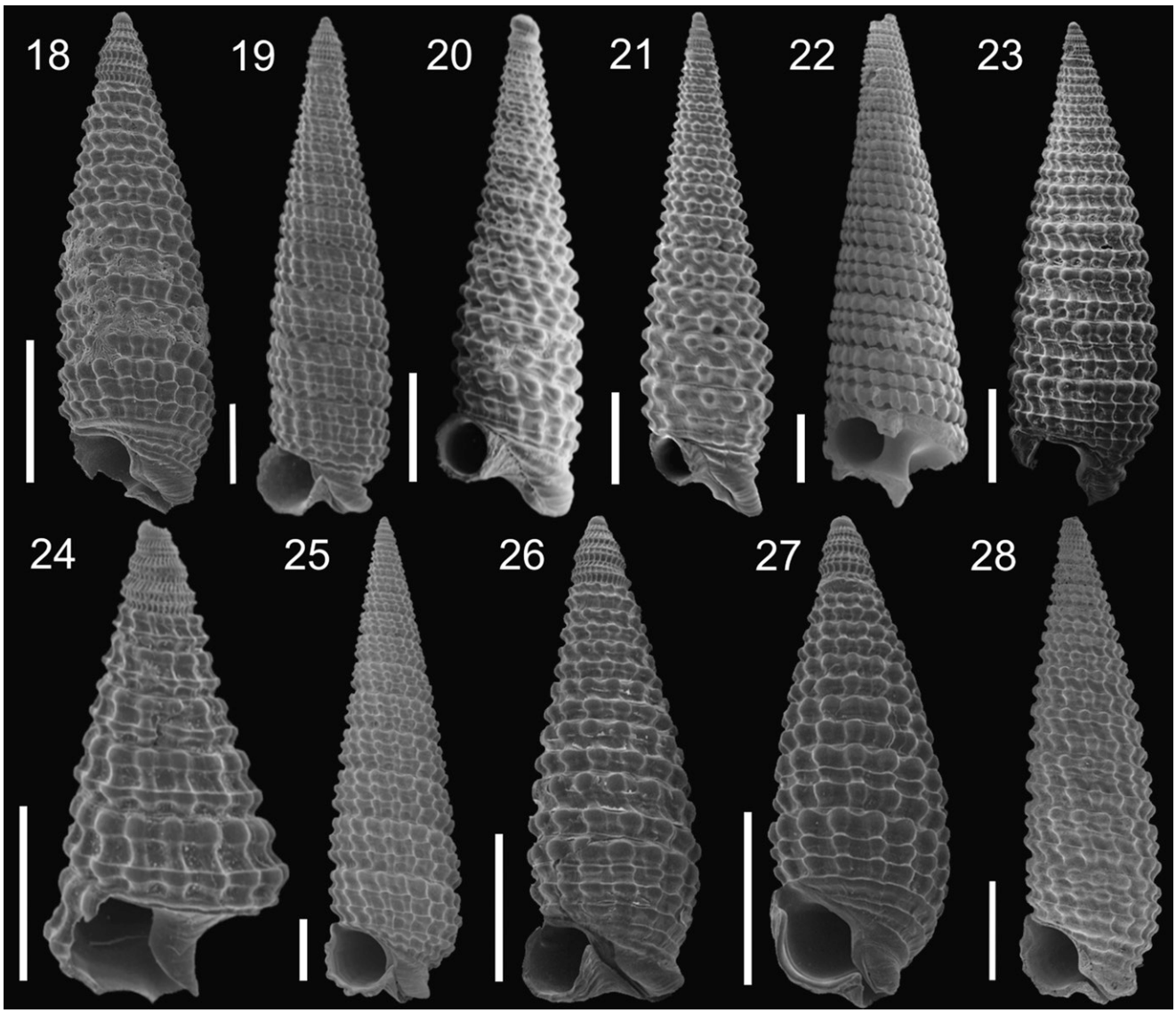
Material Examined: IBUFRJ 13568, REVIZEE C5-24R [1]; IBUFRJ 19447, REVIZEE C1-C62 [2]; MORG 51900, REVIZEE C1-C62 [3]; MNHN, MD55 35-DC59 [1].

Remarks: In addition to *C. arnoldoi*, the other species of *Cosmotriphora* in the West Atlantic is *C. melanura* (C. B. Adams), which has an earlier development of the median spiral cord (Figure 19) and a white teleoconch (Figure 3), instead of the reddish-brown blotches in the teleoconch of *C. arnoldoi* (Figure 2). This pattern of coloration is similar to *Nototriphora decorata* (C. B. Adams, 1850), a very common species in the West Atlantic. *Cosmotriphora arnoldoi* has a more curvilinear profile; its median spiral cord of the teleoconch has the same size as the adapical and abapical spiral cords on the eighth/ninth whorl (although appearing weakly on the fifth whorl) (Figure 18), while in *N. decorata* it reaches the same size on the fifth/sixth whorl (Figure 25); its axial blotches are more or less parallel, not irregular as in *N. decorata*; the three spiral cords are covered by blotches, except in the body whorl, where the adapical spiral cord is usually totally white (Figure 2).

The generic placement of this species by Faber and Moolenbeek (1991) was made without knowledge of radula and operculum, possibly only using protoconch morphology (Rolán and Fernández-Garcés, 1994). The presence of granules on the entire embryonic whorl of



Figures 2–17. Triphoridae species. **2.** *Cosmotriphora arnoldoi*, MNHN. **3.** *Cosmotriphora melanura*, MNRJ 25019. **4.** *Iniforis carmelae*, MNRJ 25014. *5. Iniforis pseudothomae*, MNRJ 25033. **6.** *Iniforis* sp., IBUFRJ 10563. **7.** *Isotriphora tigrina* new species, MNRJ 25992, holotype. **8.** *Isotriphora tigrina* new species, MNRJ 16227, paratype. **9**. *Isotriphora onca* new species, MNRJ 16236, holotype. **10.** *Isotriphora onca* new species, MNHN IM-2012-2111, paratype. **11.** *Latitriphora albida*, MNRJ 25016. **12.** *Coriophora novem*, MNRJ 25008. **13.** *Monophorus olivaceus*, MNRJ 25027. **14.** *Nototriphora decorata*, MNRJ 25002. **15.** *Triphora atlantica*, IBUFRJ 13142. **16.** *Triphora ellyae*, MNRJ 18955. **17.** *Triphora elvirae*, MNHN. Scale bar = 1 mm.



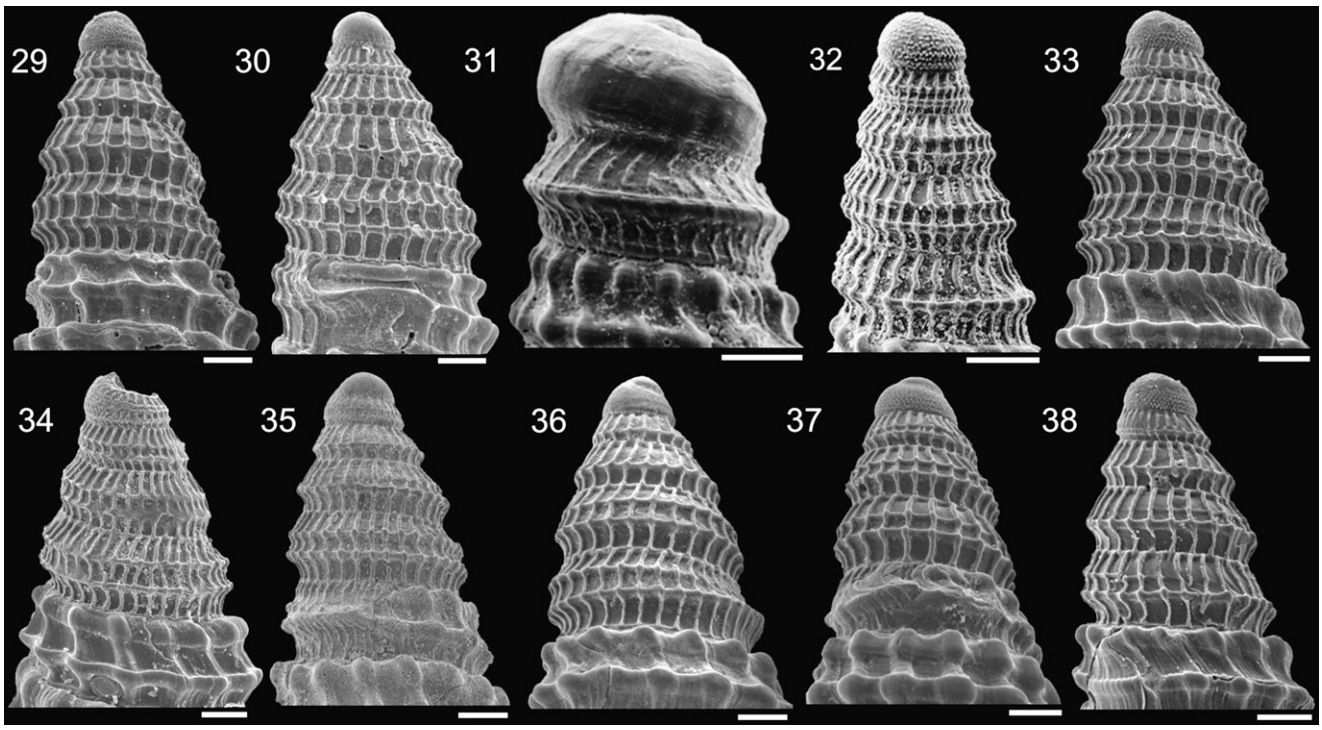
Figures 18–28. Triphoridae species. **18.** *Cosmotriphora arnoldoi*, IBUFRJ 13568. **19.** *Cosmotriphora melanura*, MNRJ 25024. **20.** *Iniforis carmelae*, MNRJ 25541. **21.** *Iniforis pseudothomae*, MNRJ 25033. **22.** *Latitriphora albida*, MNRJ 25016. **23.** *Coriophora novem*, MNRJ 25011. **24.** *Monophorus olivaceus*, MNHN. **25.** *Nototriphora decorata*, MNRJ 25033. **26.** *Triphora atlantica*, IBUFRJ 13142. **27.** *Triphora ellya*e, MNRJ 18955. **28.** *Triphora elvirae*, MNRJ 25032. Scale bar = 1 mm.

C. arnoldoi (Figure 29), not only on its abapical region as in *C. melanura* (Figure 30), suggests an affinity with the genus *Nototriphora* Marshall, 1983, pending confirmation about the importance of this difference between *Cosmotriphora* and *Nototriphora*. Marshall (1983) mentioned only differences in operculum and radula about the two genera.

Distribution: USA: Florida (Lee, 2009), Louisiana (Garcia and Lee, 2002); Gulf of Mexico (Rosenberg et al., 2009); Bahamas (Faber and Moolenbeek, 1991); Cuba (Rolán and Fernández-Garcés, 1994); Puerto Rico (Faber and Moolenbeek, 1991); ABC Islands (type locality); Brazil: Vitória-Trindade Chain (this study).

***Cosmotriphora melanura* (C. B. Adams, 1850)**
(Figures 3, 19, 30)

Cerithium melanura C. B. Adams (1850: 117); Clench and Turner (1950: 307, pl. 38, fig. 10).
Triforis melanura: Dall and Simpson (1901: 423, pl. 58, fig. 7).
Triforis grimaldii Dautzenberg and Fischer (1906: 41, pl. III, figs. 9–10).
Triphora melanura: Rios (1970: 45, not illustrated; 1975: 50, pl. 13, fig. 187; 1985: 161, pl. 53, fig. 761; 1994: 94, pl. 31, fig. 374; 2009: 172, text-fig.); Abbott (1974: 111, fig. 1134); Vokes and Vokes (1983: 18, pl. 27, fig. 14); Jong and Coomans (1988: 49, not illustrated); Absalão



Figures 29–38. Protoconchs. **29.** *Cosmotriphora arnoldoi*, IBUFRJ 13568. **30.** *Cosmotriphora melanura*, MNRJ 25024. **31.** *Iniforis carmelae*, MNRJ 25541. **32.** *Iniforis pseudothomae*, MNRJ 25033. **33.** *Coriophora novem*, MNHN. **34.** *Monophorus olivaceus*, MNHN. **35.** *Nototriphora decorata*, MNRJ 25033. **36.** *Triphora atlantica*, IBUFRJ 13142. **37.** *Triphora ellyae*, MNRJ 18955. **38.** *Triphora elvirae*, MNHN. Scale bar = 100 μm.

(1989: 3, not illustrated); Merlano and Hegedus (1994: 148, pl. XLVI, fig. 524); Absalão et al. (2006: 238, fig. 9, in part); Gomes et al. (2006: 188,not illustrated); Santos et al. (2007: 226, not illustrated).

Cosmotriphora melanura: Marshall (1983: 110, fig. 27 D-F); Bouchet (1985: 35–37, fig. 27); Fernandes and Rolán (1988: 22, pl. 1, fig. 1, pl. 2, fig. 2); Leal (1991: 120, pl. 16, figs. F-G); Rolán and Fernández-Garcés (1994: 19, figs. 11, 25, 26, 30 CM); Redfern (2001: 65, pl. 32, fig. 274); Espinosa and Ortea (2001: 20, not illustrated); Ardovini and Cossignani (2004: 134, text-fig.); Rolán (2005: 106, pl. 30, fig. 438); Rolán and Fernández-Garcés (2007: 20, pl. 1, figs. 14–16); Jensen and Pearce (2009: 128, not illustrated); Lee (2009: 88, text-fig.); Tunnell et al. (2010: 204, text-fig.); Garcia and Lee (2011).

Triphora (Cosmotriphora) melanura: Odé (1989: 109, fig. 3).

Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Lectotype: MCZ 186159.

Type Locality: Jamaica.

Material Examined: IBUFRJ 9309, REVIZEE C1-C61 [52]; IBUFRJ 10222, REVIZEE C1-C62 [11]; IBUFRJ 11952, REVIZEE C5-23R [1]; IBUFRJ 11993, REVIZEE C5-42R [1]; IBUFRJ 12010, REVIZEE C5-45R [1]; IBUFRJ 12018, REVIZEE C5-48R [1]; IBUFRJ 13567, REVIZEE C5-24R [5]; IBUFRJ 13581, REVIZEE C5-23R [6]; IBUFRJ 13594, REVIZEE C5-45R [3]; IBUFRJ 13749, REVIZEE C5-24R [8]; IBUFRJ 14372, REVIZEE C5-45R [1]; IBUFRJ 14577, REVIZEE C5-30R [6]; IBUFRJ 14649, REVIZEE C5-49R [2]; IBUFRJ 14674, REVIZEE C5-44R [14]; IBUFRJ 14694, REVIZEE C5-48R [3]; IBUFRJ 14713, REVIZEE C5-45R [2]; IBUFRJ 14717, REVIZEE C5-42R [3]; IBUFRJ 19457, REVIZEE C1-C61 [14]; IBUFRJ 19458, REVIZEE C1-C62 [8]; MNRJ 12740, REVIZEE C5-42R [5]; MNRJ 12768, REVIZEE C5-21R [1]; MNRJ 25017, MD55 24-DC42 [3]; MNRJ 25018, MD55 23-DC41 [5]; MNRJ 25019, MD55 25-DC43 [5]; MNRJ 25020, MD55 10-DC24 [3]; MNRJ 25021, MD55 14-DC27 [1]; MNRJ 25022, MD55 21-DC35 [28]; MNRJ 25023, MD55 23-DC40 [1]; MNRJ 25024, MD55 9-DC22 [6]; MORG 51899, REVIZEE C1-C62 [3]; MNHN, MD55 20-DC34 [23]; MNHN, MD55 25-DC43 [3]; MNHN, Enseada dos Portugueses, Trindade Is., v/1987 [2].

Remarks: This species is clearly distinguished by its white teleoconch and brown protoconch (Figure 3), with a mammilliform shape (Figure 30). This was by far the most common species on the material studied, and it has an amphi-Atlantic distribution (Rolán and Fernández-Garcés, 1994). However, the shells of *C. melanura* of the East Atlantic seem to have some differences with the Caribbean shells, especially the later development of the median spiral cord in the teleoconch (Bouchet, 1985). In the material examined by Bouchet (1985) and

Rolán and Fernández-Garcés (1994) of the west coast of Africa, the median spiral cord appears between the sixth and eighth whorl, while in the shells herein studied and the Caribbean ones (e.g., Rolán and Fernández-Garcés, 1994) this cord usually begins in the third whorl (Figure 19). Following Rolán and Fernández-Garcés (1994), the protoconchs and radulae of the two populations seem to be similar, and we accept the small divergence in the development of the median spiral cord as an intraspecific variation. This morph is the basis for the well-established synonym *Triforis grimaldii* Dautzenberg and Fischer, 1906, from the west coast of Africa.

Triphora dealbata (C. B. Adams, 1850), from Jamaica, is considered by some authors (e.g. Rolán and Fernández-Garcés, 2008) as a possible synonym for *C. melanura*.

In addition to a wide geographic distribution, *Cosmotriphora melanura* is also considered by Dall (1892) to be present in the Miocene of Florida.

Distribution: Europe (Bouchet, 1985); West coast of Africa (Rolán, 2005); Bermuda (Jensen and Pearce, 2009); USA: North Carolina (Abbott, 1974), Florida (Lee, 2009), Louisiana (Garcia and Lee, 2002), Texas (Tunnell et al., 2010); Mexico (Vokes and Vokes, 1983); Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1994); Belize (Miloslavich et al., 2010); Jamaica (type locality); Puerto Rico (Dall and Simpson, 1901); Virgin Islands; Costa Rica (Espinosa and Ortea, 2001); Colombia (Merlano and Hegedus, 1994); ABC Islands (Jong and Coomans, 1988); Brazil: Amapá to Bahia (Rios, 1985), São Pedro-São Paulo Is. (Rios, 2009), Fernando de Noronha and Vitória-Trindade Chain (Leal, 1991; Gomes et al., 2006), Espírito Santo (Absalão, 1989; Absalão et al., 2006), Rio de Janeiro (Absalão, 1989; Absalão et al., 2006; Santos et al., 2007).

Genus *Iniforis* Jousseaume, 1884

Type Species: *Iniforis malvaceus* Jousseaume, 1884, original designation; Recent, New Caledonia.

Diagnosis: Paucispiral or multispiral protoconch; teleoconch whorls with two rows of large nodules and granulose interspaces; suture indistinguishable; aperture round; posterior and anterior canals short and tubular (based on Wilson, 1993).

Iniforis carmelae Rolán and Fernández-Garcés, 1993
(Figures 4, 20, 31)

Triphora sp. 3: Leal (1991: 123, pl. 17, figs. A–B).
Iniforis carmelae Rolán and Fernández-Garcés (1993: 102, figs. 12–15, 28–30; 2007: 21, pl. II, figs. 18–22).

Type Material: Holotype: MNCN 15.05/6822. Paratypes: One in ZMA 3.93.006, AMNH 226457, IES, NHM 1992134, MNHN; five in the CFG; 15 in the CER.

Type Locality: Cienfuegos, in the South of Cuba.

Material Examined: MNRJ 25013, MD55 35-DC59 [2]; MNRJ 25014, MD55 21-DC35 [1]; MNRJ 25541, MD55 9-DC22 [1].

Remarks: The material here studied agrees with the original description in having the white and relatively broad protoconch with approximately 2.75 whorls (Figure 31) and the later development of a very small median spiral cord on the teleoconch (ninth/tenth whorl, very close to the adapical spiral cord; Figure 20) in addition to the discontinuous brown coloration on the abapical spiral cord of the teleoconch (Figure 4). However, the shells from Vitória-Trindade Chain display some slight differences from the original description: a more tuberculated subperipheral cord (Figure 20, if compared to the figure 28 in Rolán and Fernández-Garcés, 1993), the continuous brown coloration of the abapical spiral cord of the teleoconch on its initial whorls (Figure 4), and the spiral cord on the second whorl of the protoconch is positioned in its middle (Figure 31) although the original description shows this spiral cord situated barely under the middle of the whorl (figs. 29–30 in Rolán and Fernández-Garcés, 1993).

Iniforis carmelae can be best differentiated from *Iniforis immaculata* Rolán and Fernández-Garcés, 1993, a species from Cuba, by the shell color, translucent white in the later. *Iniforis gudeliae* Rolán and Fernández-Garcés, 2009 and *Iniforis pelorcei* Rolán and Fernández-Garcés, 2009, two species from the Caribbean, have the second whorl of protoconch with two spiral cords (*I. carmelae* has only one) in addition to a more continuous brown coloration on the abapical spiral cord of the teleoconch.

Distribution: Gulf of Mexico (Rosenberg et al., 2009); Cuba (type locality); Brazil: Vitória-Trindade Chain (this study).

Iniforis pseudothomae Rolán and Fernández-Garcés, 1993
(Figures 5, 21, 32)

Triphora sp. 2: Leal (1991: 123, pl. 16, figs. L–M).
Iniforis pseudothomae Rolán and Fernández-Garcés (1993: 100, figs. 5–8, 22–23; 2007: 21, pl. II, figs. 9–12).
Triphora decorata: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora melanura: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora sp.: Absalão et al. (2006: 238, in part).
Triphora turristhomae: Rios (2009: 173, text-fig.) non Holten, 1802.

Type Material: Holotype: MNCN 15.05/6820. Paratypes: One in AMNH 226459, MNHN, NHM 1992133, ZMA 3.93.005; five in the IES; ten in the CER and CFG.

Type Locality: Cienfuegos, in the South of Cuba.

Material Examined: IBUFRJ 19443, REVIZEE C5-30R [1]; IBUFRJ 19455, REVIZEE C1-C61 [1]; MNRJ 25033, MD55 9-DC22 [8]; MNRJ 25034, MD55 25-DC43 [2]; MNHN, MD55 20-DC34 [4].

Remarks: As suspected by Rolán and Fernández-Garcés (1993), *Triphora* sp. 2 in Leal (1991) represents *Iniforis pseudothomae*. This species has a teleoconch very similar to *I. carmelae*, with discontinuous brown color on the abapical spiral cord (Figure 5); shells of *I. pseudothomae* never develop a median spiral cord as *I. carmelae*. Also, the brown and elongated protoconch of *I. pseudothomae* has around 5–5.5 whorls and two spiral cords on the larval shell, except on the last whorl (Figure 32), instead of the ~2.75 white whorls of *I. carmelae*, with one spiral cord on the larval shell (Figure 31). The brown and mutispiral protoconch of *I. pseudothomae* also differentiates it from *I. gudeliae* and *I. pelorcei*.

The illustration provided by Rios (2009) as *Triphora turristhomae* (Holten, 1802) actually depicts *I. pseudothomae*. Possibly the records of *Iniforis turristhomae* (Holten, 1802) from Brazil are erroneous (Leal, 1991), and they can be actually referred to *I. pseudothomae*, but this hypothesis demands further investigation. *Iniforis turristhomae* has a continuous brown band on the abapical spiral cord of the teleoconch and two spiral cords on the protoconch in contrast to *I. pseudothomae*, which has a discontinuous brown band on the abapical spiral cord of the teleoconch (Figure 5) and only one spiral cord on the last whorl of the protoconch (Figure 32).

The single shell of *Iniforis turristhomae* (Holten, 1802) from the Vitória-Trindade Chain, reported by Absalão et al. (2006) (IBUFRJ 10563, station REVIZEE C2-22F), is very eroded, making a correct identification difficult. Actually, this shell has a continuous brown band on the abapical spiral cord (Figure 6), ruling out *I. pseudothomae*. The presence of brown color between the two spiral cords and the development of a very small median cord on the body whorl adjacent to the adapical spiral cord are not consistent with *I. turristhomae*. We prefer to maintain this shell as *Iniforis* sp., invalidating the previous record of *I. turristhomae* for the Vitória-Trindade Chain.

Distribution: Gulf of Mexico (Rosenberg et al., 2009); Cuba (type locality); ABC Islands (Miloslavich et al., 2010); Brazil: Vitória-Trindade Chain (this study).

Genus *Isotriphora* Cotton and Godfrey, 1931

Type Species: *Triforis tasmanica* Tenison-Woods, 1875, original designation; Recent, southern Australia.

Diagnosis: Paucispiral protoconch, blunt-tipped, with two nodulose spiral cords; teleoconch whorls heavily nodulose; anterior canal short to moderately long, usually subtubular (based on Wilson, 1993).

Isotriphora tigrina new species
(Figures 7–8, 39–44)

Triphora sp. 4: Leal (1991: 124, pl. 17, figs. C–D).
Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Holotype: MNRJ 25992. Paratypes: REVIZEE C5-49R: MNRJ 16227 [2], IBUFRJ 17051 [2]; type locality: MZSP 105154 [3], MNRJ 25993 [7], MNHN IM-2012-2110 [8].

Type Locality: Trindade Island, Vitória-Trindade Chain, Brazil (20°30′ S, 29°19′ W, 52–60 m). Station 35-DC59 of the Expedition MD55.

Other Material Examined: IBUFRJ 14667, REVIZEE C5-49R [3]; IBUFRJ 14718, REVIZEE C5-48R [3]; MNRJ 25029, MD55 21-DC35 [2]; MNRJ 25030, MD55 35-DC59 [1]; MNHN, Enseada dos Portugueses, Trindade Is., v/1987 [1]; MZSP 100957, Cairu, Morro de São Paulo, Bahia, Petrônio Coelho-Filho coll., 2011 [1].

Diagnosis: Shell with a truncated apex; teleoconch with two main spiral cords, the abapical one with brown inter-nodular spaces during most of the shell; subperipheral cord and two basal cords brown and smooth.

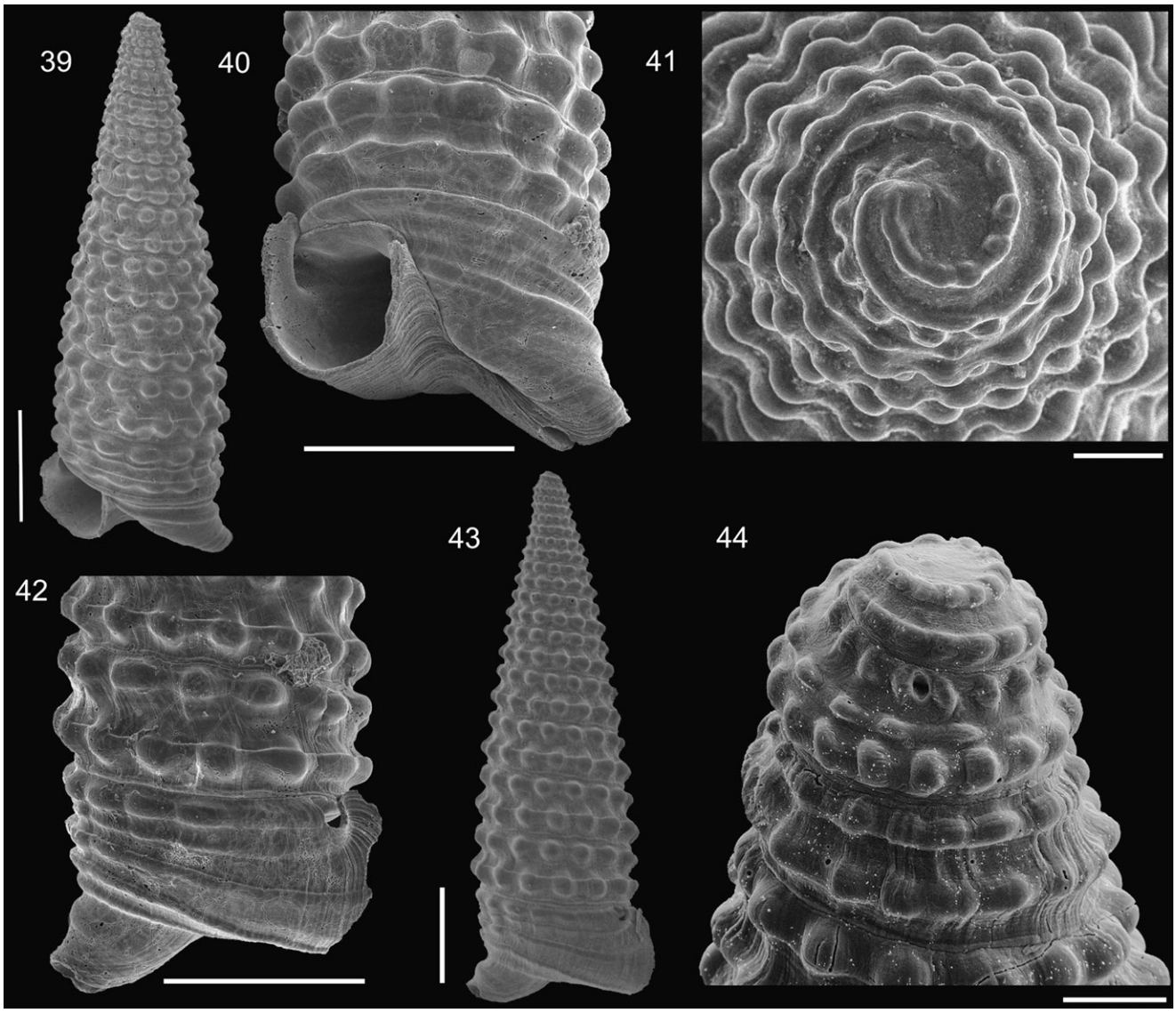
Description: Shell elongated, conical, reaching 5.2 mm in length, 1.4 mm in width, with up to 13 whorls. Paucispiral protoconch with truncated apex and without clear differentiation from teleoconch. After the very narrow nucleus, two white spiral cords (one adapical and one small median) and a brown abapical spiral cord emerge; after approximately one whorl the small median spiral cord disappears, almost simultaneously with a change in color of abapical spiral cord (brown to white) and adapical spiral cord (white to brown) on next whorl; adapical spiral cord tinted with brown for ~ two whorls, where it gradually fades, assuming color of shell background, which varies from creamy to light brown; simultaneously, abapical spiral cord becomes brown in inter-nodular spaces, until shell ends. Nodules of abapical spiral cord more spaced than adapical one; at the 11th whorl, a very small and wavy median spiral cord appears very close to adapical one; suture barely distinct, with a small cord more visible on last whorls; subperipheral cord and two basal cords, all smooth and brown; aperture ovoid, with a small posterior canal; outer lip well projected to front of shell; long and nearly closed siphonal canal, curving downward/backward. Animal unknown.

Etymology: This species is named for its brown subperipheral and basal cords, resembling the stripes of a tiger.

Remarks: A similar species to *I. tigrina* in the western Atlantic is *Isotriphora guanahacabibes* Rolán and Fernández-Garcés, 2008, a species from Caribbean. However *I. tigrina* has a unique color pattern of brown bands, in the adapical spiral cord of earlier whorls and

mainly in the inter-nodular spaces of the abapical spiral cord of the remaining whorls (instead of the whitish shells of *I. guanahacabibes*) (Figures 7–8); two distinct basal cords (while *I. guanahacabibes* has only one) (Figure 40), and a later development of the median spiral cord (in the 11th whorl of the shell in *I. tigrina*, ninth in *I. guanahacabibes*, as figured in Rolán and Fernández-Garcés, 2008). *Isotriphora peetersae* (Moolenbeek and Faber, 1989), another species from Caribbean, has a totally different color than *I. tigrina*, with about five initial whorls of the shell being white and the remainder dark brown, in addition to a median spiral cord appearing on the fourth/fifth whorl of the teleoconch. *Isotriphora taenialba* Rolán and Espinosa, 1994, a species from Cuba, has the adapical spiral cord of the teleoconch and suture dark brown, and the median spiral cord becomes nodulous much earlier on the fourth/fifth whorl of the teleoconch.

Isotriphora tigrina shares with *Iniforis carmelae* and *Iniforis pseudothomae* the discontinuous brown color on the abapical spiral cord of the teleoconch, but in *I. tigrina* this color is mainly restricted to the inter-nodular spaces. The protoconch typical of the genus *Isotriphora* (with nodular spiral cords) (Figure 44), the presence of a smooth subperipheral cord (Figure 40) and a small posterior canal above the aperture (not deflected to the other side of the shell, as in *Iniforis*) are other features that distinguish *I. tigrina* from these two species. Also, a small and non-tuberculated median spiral cord appears on the teleoconch of *I. tigrina* (Figures 39–40), while *I. pseudothomae* never develops it.



Figures 39–44. *Isotriphora tigrina* new species. **39, 43.** Entire shell. **40, 42.** Last whorl and base. **41.** Adapical view of protoconch. **44.** Protoconch and beginning of teleoconch. 39–40, 42–44. MNRJ 25993, paratype. 41. IBUFRJ 14718. Scale bar = 1 mm to figures 39–40, 42–43, 100 μm to figures 41, 44.

Distribution: Brazil: Bahia state and Vitória-Trindade Chain (this study).

***Isotriphora onca* new species**
(Figures 9–10, 45–50)

Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Holotype: MNRJ 16236. Paratypes: MD55 27-DC47: MNHN IM-2012-2111 [1]; REVIZEE C5-42R: MZSP 112068 [2], IBUFRJ 14367 [7], MNRJ 16230 [8].

Type Locality: Trindade Island, Vitória-Trindade Chain, Brazil (20°30′S, 29°16′W, 360 m). Station C5-41F of REVIZEE-Central.

Other Material Examined: IBUFRJ 12123, REVIZEE C5-42R [1]; IBUFRJ 14411, REVIZEE C5-42R [22]; MNRJ 16232, REVIZEE C5-42R [4]; MNRJ 17918, REVIZEE C5-42R [3].

Diagnosis: Shell with a truncated apex; color creamy to light brown, except the whitish apex; teleoconch with two main spiral cords.

Description: Shell elongated, conical, reaching 5.6 mm in length, 1.4 mm in width, with up to 14 whorls. Paucispiral protoconch with truncated apex and without clear differentiation from teleoconch. After the very narrow nucleus two spiral cords emerge; after approximately one whorl the adapical spiral cord disappears, and a small cord starts to develop above that, becoming a new adapical spiral cord. Creamy to light brown background color, nodules slightly lighter, inter-nodular spaces slightly darker than background color, especially on abapical spiral cord; two–three initial whorls whitish, with a faded brown abapical spiral cord. Nodules of the abapical spiral cord may be slightly more spaced than adapical one; few shells have a very small median spiral cord after the 13th whorl, very close to adapical spiral cord; suture barely distinct, with a small cord more visible on last whorls; subperipheral cord and two basal cords, all smooth and of same color as background; adapical basal cord, closer to subperipheral cord, smaller and absent in a few shells; aperture ovoid, with small posterior canal; outer lip well projected to front of shell; long and nearly closed siphonal canal, curving downward/backward. Animal unknown.

Etymology: The specific name alludes to the jaguar (*Panthera onca*), due to the similarity with the previously described species, *Isotriphora tigrina*.

Remarks: This species resembles *I. tigrina*, including the general shape of the shell (although *I. onca* has a more slender profile), the truncated apex with similar development of the spiral cords, the suture barely distinct and the presence of two main spiral cords. However, *I. onca* has a different color pattern (Figure 9–10), being almost entirely creamy to light brown, with a whitish apex, and the subperipheral-basal cords are not tinted with brown. *Isotriphora onca* has a smaller (sometimes absent) adapical basal cord (Figure 46), in addition to narrower whorls and closer nodules on the abapical spiral cord of the teleoconch than *I. tigrina*. Also, the very small median spiral cord appears later on *I. onca*.

Isotriphora onca is distinguished from *I. guanahacabibes* by significant differences in color (whitish in *I. guanahacabibes*, or with small areas of light brown; creamy to light brown in *I. onca*, with the apex whitish) and the later development of the small median spiral cord on *I. onca*. As mentioned before, *I. peetersae* has about five whitish whorls on the beginning of the shell, instead of the two/three initial whorls on *I. onca*. Furthermore, the dark color on the remainder whorls on the teleoconch of *I. peetersae* (creamy to light brown in *I. onca*) and the earlier development of a strong median spiral cord clearly distinguishes both species. *Isotriphora taenialba* has a totally different color pattern and an earlier development of a strong median spiral cord.

Material from the type locality (including the holotype) was most likely deposited by turbidity currents, as all other shells were collected at shallower depths (~ 85-105 m).

Distribution: Brazil: Vitória-Trindade Chain (this study).

Genus *Latitriphora* Marshall, 1983

Type Species: *Triphora latilirata* Verco, 1909, original designation; Recent, southern Australia.

Diagnosis: Multispiral protoconch, embryonic shell with hemispherical granules, larval shell with two spiral threads and uninterrupted axial riblets; teleoconch with three spirals cords commencing simultaneously; nodules strongly flattened, with sharp edges that overhang sides of spirals (based on Marshall, 1983).

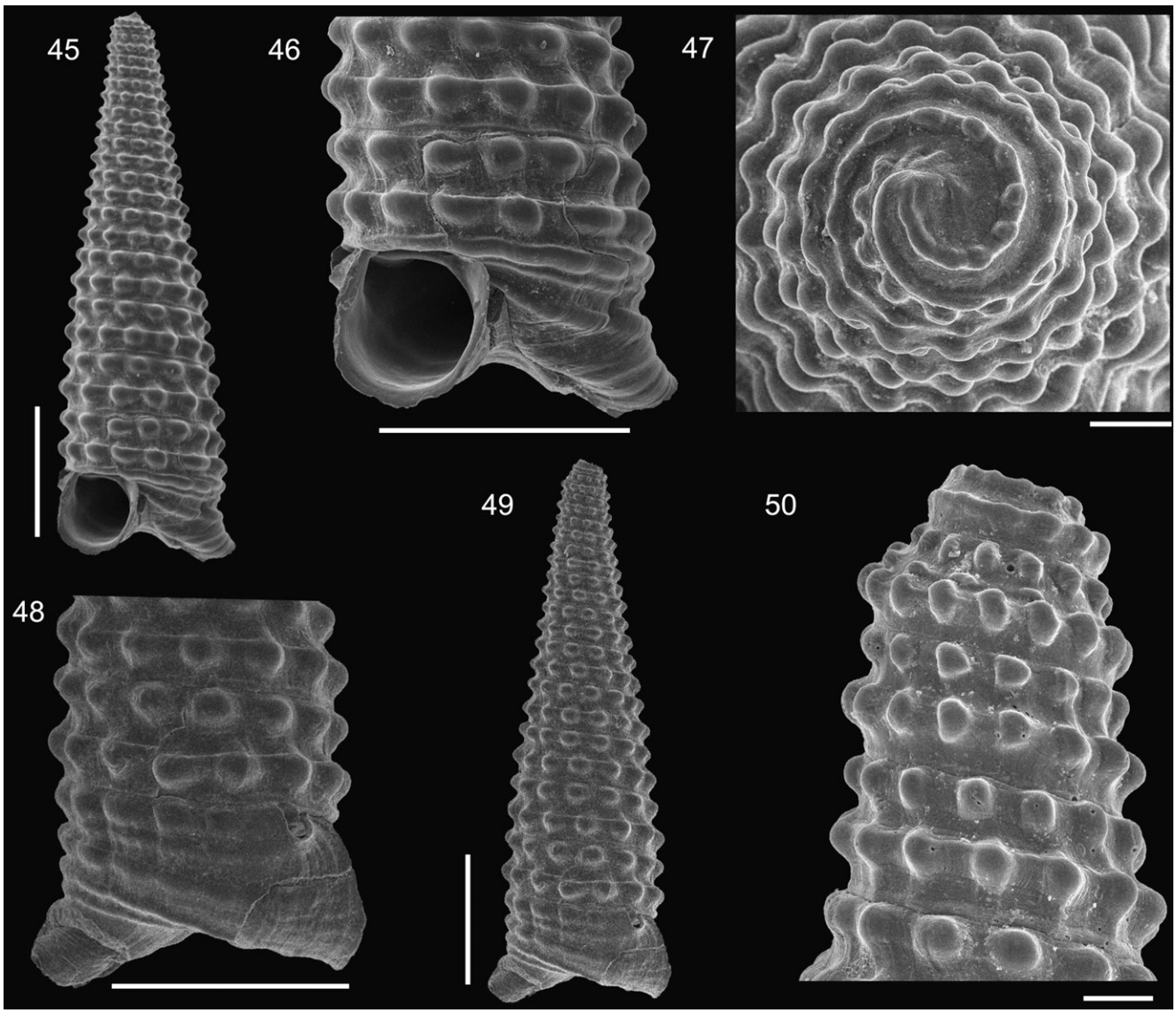
***Latitriphora albida* (A. Adams, 1854)**
(Figures 11, 22)

Triphoris albidus A. Adams (1854: 278).
Triforis (Sychar) samanae Dall (1889: 248); Dall and Simpson (1901: 423, pl. 54, fig. 18).
Triphora samanae: Jong and Coomans (1988: 51, pl. 34, fig. 245).
Triphora sp. 5: Leal (1991: 124).
Latitriphora albida: Rolán and Fernández-Garcés (1995: 14, figs. 29–32; 2007: 22, pl. III, figs. 8–9); Redfern (2001: 67, pl. 33, fig. 280); Lee (2009: 89, text-fig.).
Triphora decorata: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.

Type Material: Lectotype: NHM 196563. Paralectotype: NHM 196654.

Type Locality: Honduras.

Material Examined: MNRJ 17922, Praia do Andrada, Trindade Is., J. H. Leal, C. B. Castro and W. Zwink coll., 17/xii/1982 [1]; MNRJ 25005, Enseada dos



Figures 45–50. *Isotriphora onca* new species. **45, 49.** Entire shell. **46, 48.** Last whorl and base. **47.** Adapical view of protoconch. **50.** protoconch and beginning of teleoconch. **45–50.** MNRJ 16230, paratype. Scale bar = 1 mm to figures 45–46, 48–49, 100 μm to figures 47, 50.

Portugueses, Trindade Is., 10 m depth, P. Bouchet and J. H. Leal coll., 22/v/1987 [1]; MNRJ 25015, MD55 25-DC43 [1]; MNRJ 25016, MD55 9-DC22 [1].

Remarks: This is the only species of the genus *Latitriphora* at the West Atlantic. The shell of *L. albida* is very similar to that of *Nototriphora decorata*, but the teleoconch of *L. albida* has a more flattened profile of its axially elongated and very close-set beads (Figure 22). Also, the beads of the adapical spiral cord almost reach the beads of the abapical spiral cord of the adjacent whorl, and smaller and paler brown blotches are present on *L. albida* (Figure 11). The median spiral cord of the teleoconch of *L. albida* begins earlier—in the third whorl, following Lee (2009), instead of the transition between fourth and fifth whorl on *N. decorata* (Figure 25)—but it could not be determined in which whorl it develops in the material examined of *L. albida*, as all the shells had the apex broken. In the comments on *L. albida*, Lee (2009) cited that this species develops the median spiral cord later than *N. decorata*, when the opposite actually occurs.

Distribution: Bermuda (Jensen and Pearce, 2009); USA: Georgia (Rosenberg, 2009), Florida (Lee, 2009); Gulf of Mexico (Rosenberg et al., 2009); Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1995); Belize (Miloslavich et al., 2010); Honduras (type locality); Hispaniola (Miloslavich et al., 2010); Puerto Rico (Dall and Simpson, 1901, cited as *Triforis samanae*);

Colombia (Lee, 2009); ABC Islands (Jong and Coomans, 1988, cited as *Triphora samanae*); Brazil: Vitória-Trindade Chain (this study).

Genus *Coriophora* Laseron, 1958

Type Species: *Coriophora negrita* Laseron, 1958, original designation; Recent, western Pacific.

Diagnosis: Paucispiral or multispiral protoconch; on the latter, embryonic shell with hemispherical granules, larval shell with axial riblets crossed by a central spiral thread; teleoconch with a later development of median spiral cord; radular formula 24-1-1-1-24, central and marginal teeth with three cusps, lateral teeth with four to five cusps (based on the diagnosis of *Mesophora* on Marshall, 1983 and Wilson, 1993).

Synonym: *Mesophora* Laseron, 1958 non Borgmeier, 1937; see Özdikmen (2013).

***Coriophora novem* (Nowell-Usticke, 1969)**
(Figures 12, 23, 33)

Triphora novem Nowell-Usticke (1969: 12, pl. 2, fig. 20); Jong and Coomans (1988: 49, pl. 34, fig. 236).
Triphora sp. indet. A: Odé (1989: 111, fig. 6).
Marshallora sp. 1: Leal (1991: 121, pl. 16, figs. H–I).
Mesophora aff. *novem*: Rolán and Fernández-Garcés (1995: 11, figs. 12–16).
Mesophora novem: Rolán and Fernández-Garcés (1995: 11, figs. 8–11; 2007: 23, pl. IV, figs. 1–5); Redfern (2001: 67, pl. 33, fig. 282); Lee (2009: 90, text-fig.); Tunnell et al. (2010: 205, text-fig.); Garcia and Lee (2011).
Triphora decorata: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora melanura: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora nigrocincta: Absalão et al. (2006: 238); Gomes et al. (2006: 187) non C. B. Adams, 1839.
Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Holotype: AMNH 195419.

Type Locality: Virgin Islands.

Material Examined: IBUFRJ 11992, REVIZEE C5-42R [1]; IBUFRJ 19442, REVIZEE C5-30R [1]; IBUFRJ 19444, REVIZEE C1-C61 [4]; IBUFRJ 19452, REVIZEE C5-49R [1]; IBUFRJ 19453, REVIZEE C1-C61 [1]; MNRJ 25006, MD55 16-DC29 [1]; MNRJ 25007, MD55 9-DC22 [1]; MNRJ 25008, MD55 35-DC59 [1]; MNRJ 25009, MD55 25-DC43 [2]; MNRJ 25010, MD55 23-DC41 [1]; MNRJ 25011, MD55 21-DC35 [1]; MZSP 105164, Enseada dos Portugueses, Trindade Is., v/1987 [1]; MNHN, MD55 35-DC59 [1]; MNHN, MD55 20-DC34 [1].

Other Material Examined: Sulphur Bank: IBUFRJ 13321, REVIZEE C5-13R, 16°47′ S, 37°41′ W, 50 m, 30/vi/2001 [1].

Remarks: This is the only species of the genus *Coriophora* at the West Atlantic. The shells here identified as *C. novem* exhibit a unique color pattern, with the three initial whorls of the teleoconch white and the others with a brown background and violet/greyish nodules (Figure 12). The median spiral cord appears around the eighth/ninth whorl of the teleoconch, or even at the end of the seventh whorl, but always closer to adapical spiral cord (Figure 23).

Rolán and Fernández-Garcés (1995) distinguished two morphs, *M. novem* and *M.* aff. *novem*; later the two morphs were named as *M. novem* only (Rolán and Fernández-Garcés, 2007). The shells herein examined are much more similar to *M.* aff. *novem* sensu Rolán and Fernández-Garcés (1995), especially with respect to the darker teleoconch color (except for the initial white whorls), the same color between the spiral cords (and also lacking a darker adapical spiral cord) and the apparent shorter length of the siphonal canal when compared to the figures 3 and 4 (plate IV) of Rolán and Fernández-Garcés (2007). The few shells with protoconch in the material here examined initially present two spiral cords in the larval shell with the subsequent disappearance of the adapical one later on the first whorl of larval shell, strengthening of this cord at the end of the second whorl, and later disappearance of this cord on the last whorl (Figure 33), again similar to *M.* aff. *novem* of Rolán and Fernández-Garcés (1995). The shells of *C. novem* from Cuba have two spiral cords throughout the larval shell (Rolán and Fernández-Garcés, 1995). Conservatively, we prefer to regard this darker morph also as *C. novem*.

The shells illustrated by Tunnell et al. (2010) and Garcia and Lee (2011) as *M. novem* appear to be its darker morph, just like the brief description of this species in Lee (2009). In contrast, Redfern (2001) describes the paler morph.

Although Marshall (1983) and Wilson (1983) reported that the protoconch of *Mesophora* (synonym of *Coriophora*) bears only one spiral cord, Laseron (1958) considered that the protoconch in this genus "may be singly or doubly keeled," which supports the allocation of this species to *Mesophora* by Rolán and Fernández-Garcés (1995). The radular formula 24-1-1-1-24 of *Mesophora* (Marshall, 1983) is different from that of *M.* aff. *novem* (actually *C. novem*) in Rolán and Fernández-Garcés (1995), 12-1-1-1-12, although the number of cusps in each tooth cohort is the same.

Marshallora gutta Fernandes and Rolán, 1988, a species from Cape Verde, has some similarities with the shells herein studied. It includes protoconch features (high density of granules on the first whorl; presence of two spiral cords, except the initial whorls and the very end of the protoconch), the initial whorls of the teleoconch being white, large size of the rounded nodules, suture indistinct and later development of the median spiral cord. The main differences between the two species include some anatomical (like the radular formula) and shell features (*C. novem* has more nodulose subperipheral and basal cords, a homogeneous color on

base and a major extension of the white color on the beginning of the teleoconch).

The material that Absalão et al. (2006) named as *Triphora nigrocincta* (C. B. Adams, 1839) to REVIZEE-Central (IBUFRJ 11992 to the Vitória-Trindade Chain; IBUFRJ 13321, to the Sulphur Bank, near Abrolhos), and Gomes et al. (2006) reproduced, is actually formed by two shells of *C. novem*.

The single shell of *C. novem* collected at the station MD55 16-DC29 (depth of 310–350 m) is probably a taphonomic anomaly (possibly resulting from deposition by turbidity currents), as the remaining shells from Vitória-Trindade Chain and records in the literature indicate that this species is observed only in shallower depths (~ 20–105 m).

Distribution: USA: Florida (Lee, 2009), Louisiana (Garcia and Lee, 2002), Texas (Tunnell et al., 2010); Gulf of Mexico (Rosenberg et al., 2009); Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1995); Jamaica (Rosenberg, 2009); Puerto Rico (Lee, 2009); Virgin Islands (type locality); ABC Islands (Jong and Coomans, 1988); Brazil: Sulphur Bank and Vitória-Trindade Chain (this study).

Genus *Monophorus* Grillo, 1877

Type Species: *Trochus perversus* Linnaeus, 1758, by monotypy; Recent, Europe and northern Africa.

Diagnosis: Paucispiral or multispiral protoconch; on the latter, embryonic shell with cruciform tubercles, larval shell with axial riblets crossed by two median spiral cords, with or without a smooth spiral zone; teleoconch with a later development of median spiral cord; radular formula (8-12)-1-1-1-(8-12), central tooth with five cusps, lateral teeth with five to seven cusps, most of marginal teeth with four to five cusps (based on Marshall, 1983).

Synonyms: *Biforina* Bucquoy, Dautzenberg and Dollfus, 1884; *Notosinister* Finlay, 1927; according to Marshall (1983).

Monophorus olivaceus (Dall, 1889)
(Figures 13, 24, 34)

Triforis decorata var. olivacea Dall (1889: 244).
Triphora ornata auct. non Deshayes, 1832: Warmke and Abbott (1962: 76, pl. 13, fig. i); Rios (1970: 45, not illustrated; 1975: 51, pl. 13, fig. 189; 1985: 161, pl. 53, fig. 763; 1994: 95, pl. 31, fig. 376; 2009: 173, text-fig.); Jong and Coomans (1988: 50, not illustrated); Absalão (1989: 3, not illustrated); Merlano and Hegedus (1994: 149, pl. XLVI, fig. 527); Absalão and Pimenta (2005: 29, fig. 64); Absalão et al. (2006: 238, in part); Gomes et al. (2006: 187;not illustrated); Santos et al. (2007: 226; not illustrated).
Triphora (Cosmotriphora) ornata auct. non Deshayes, 1832: Odé (1989: 110).
Triphora sp. 1: Leal (1991: 122).
Monophorus olivaceus: Rolán and Fernández-Garcés (1994: 17, figs. 1–3, 6, 8, 30 MO; 2007: 23, pl. IV, figs. 23–27; 2008: 87, figs. 4 B–F, H–K); Redfern (2001: 67, pl. 33, fig. 284); Espinosa and Ortea (2001: 20, not illustrated); Lee (2009: 90, text-fig.); Garcia and Lee (2011).
Triphora sp.: Absalão et al. (2006: 238, in part).
Cosmotriphora ornata auct. non Deshayes, 1832: Tunnell et al. (2010: 204, text-fig.).

Type Material: Lectotype: MCZ 7379.

Type Locality: Key West, west of Florida, Gulf of Mexico, 91 m.

Material Examined: MNRJ 25025, MD55 23-DC41 [1]; MNRJ 25026, MD55 20-DC34 [2]; MNRJ 25027, MD55 13-DC26 [2]; MNRJ 25028, MD55 10-DC24 [1]; MNHN, MD55 20-DC34 [2].

Remarks: In this species, the adapical and median (appearing later) spiral cords of the teleoconch have the color pattern of one white bead usually intercalary between two or three brown beads, although not being a rule, and the abapical spiral cord is white (Figure 13). *Monophorus olivaceus* has a large shell size for the family, up to 14.77 mm and 14 whorls of teleoconch in the shells of this study (apex missing).

Monophorus ateralbus Rolán and Fernández-Garcés, 1994 is the other species of *Monophorus* from the West Atlantic. The shell of *M. ateralbus* has continuous dark brown color on adapical and median spiral cords, while *M. olivaceus* has a discontinuous brown and white color on these cords.

According to Faber and Moolenbeek (1991) and Rolán and Fernández-Garcés (2008), the previous records of *Triphora ornata* from the western Atlantic (e.g. Abbott, 1974; Jong and Coomans, 1988; Rios, 1994) actually represent *M. olivaceus*, since the type material of *T. ornata* does not match the western Atlantic species (Rolán and Fernández-Garcés, 2008).

Triphora sp. 1 in Leal (1991) is herein considered to be *M. olivaceus*. However, the record of *Triphora ornata* by Leal (1991), based on material from Fernando de Noronha Archipelago (off Brazil), is pending examination, since it was not illustrated.

Monophorus olivaceus is reported to show some variation in size and in hue of its brown color, as pointed in the original description and in Rolán and Fernández-Garcés (2007; 2008). Also, Rolán and Fernández-Garcés (2008) included a shell from Florida with a predominant white coloration on the median spiral cord of the teleoconch as belonging to this species.

Distribution: USA: Florida (type locality), Louisiana (Lee, 2009), Texas (Tunnell et al., 2010, cited as *Cosmotriphora ornata*); Gulf of Mexico (Rosenberg et al., 2009); Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1994); Belize (Miloslavich et al., 2010); Virgin Islands; St. Vincent; Grenada (Rolán and Fernández-Garcés, 2008); Costa Rica (Espinosa and Ortea,

2001); Colombia (Merlano and Hegedus, 1994, cited as *Triphora ornata*); Venezuela (Rolán and Fernández-Garcés, 2008); ABC Islands (Jong and Coomans, 1988, cited as *T. ornata*); Brazil: Amapá to Bahia (Rios, 1985, cited as *T. ornata*), Fernando de Noronha and Abrolhos (Rios, 1985; Gomes et al., 2006, cited as *T. ornata*), Vitória-Trindade Chain (this study), Espírito Santo (Absalão, 1989, cited as *T. ornata*), Rio de Janeiro (Absalão, 1989; Absalão and Pimenta, 2005; Santos et al., 2007; cited as *T. ornata*).

Genus *Nototriphora* Marshall, 1983

Type Species: *Notosinister aupouria* Powell, 1937, original designation. Recent, New Zealand.

Diagnosis: Paucispiral or multispiral protoconch; on the latter, embryonic shell with hemispherical granules, larval shell with axial riblets crossed by two median spiral cords, the adapical one initially strong, but soon weakening and reappearing later; teleoconch with a later development of median spiral cord; radular formula 9-1-1-1-9, central tooth with three cusps, lateral teeth with four cusps, marginal teeth with short outer cusps and long median cusps (based on Marshall, 1983).

Nototriphora decorata (C. B. Adams, 1850)
(Figures 14, 25, 35)

Cerithium decoratum C. B. Adams (1850: 117); Clench and Turner (1950: 272, pl. 38, fig. 2).
Triphoris variegatus A. Adams (1854: 277).
Triforis arthuri Jousseaume (1884: 221) [*nomen nudum*].
Triphora decorata: Rios (1970: 45, not illustrated; 1975: 50, pl. 13, fig. 186; 1985: 160, pl. 53, fig. 760; 1994: 94, pl. 31, fig. 373; 2009: 172, text-fig.); Abbott (1974: 111, fig. 1133); Jong and Coomans (1988: 51, not illustrated); Absalão (1989: 3, not illustrated); Leal (1991: 122, pl. 16, figs. J–K); Merlano and Hegedus (1994: 148, pl. XLVI, fig. 521); Absalão et al. (2006: 238, in part); Gomes et al. (2006: 187; not illustrated); Santos et al. (2007: 226, not illustrated).
Triphora (Cosmotriphora) decorata: Odé (1989: 110, fig. 5).
Nototriphora decorata: Rolán and Fernández-Garcés (1994: 19, figs. 10, 14, 16, 30 ND; 2007: 24, pl. V, figs. 1–5); Redfern (2001: 68, pl. 33, fig. 285); Espinosa and Ortea (2001: 20, not illustrated); Lee (2009: 91, text-fig.); Tunnell et al. (2010: 206, text-fig.).
Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Lectotype: MCZ 186178.

Type Locality: Jamaica.

Material Examined: IBUFRJ 9313, REVIZEE C1-C61 [2]; IBUFRJ 19445, REVIZEE C5-44R [1]; IBUFRJ 19450, REVIZEE C5-48R [1]; IBUFRJ 19454, REVIZEE C1-C62 [4]; IBUFRJ 19456, REVIZEE C1-C62 [6]; MNRJ 17924, REVIZEE C5-42R [1]; MNRJ 25001, MD55 35-DC59 [3]; MNRJ 25002, MD55 9-DC22 [1]; MNRJ 25003, MD55 13-DC26 [1]; MNHN, MD55 20-DC34 [3]; MNHN, Enseada dos Portugueses, Trindade Is., v/1987 [5].

Remarks: This is a very common species in Brazil and the only representative of the genus *Nototriphora* on the West Atlantic. Its teleoconch has brown spots over a creamy-white background (Figure 14), and the median spiral cord appears around the fourth/fifth whorl (Figure 25). This pattern of coloration on *N. decorata* can cause problems in separating this species from other triphorids. In addition to significant differences on the protoconch (e.g., number of spiral cords on larval shell), the shell of *Nototriphora decorata* has a more axial and irregular pattern of brown spots than *Monophorus olivaceus*, which has a more spiral pattern (and its abapical spiral cord never shows beads tinted with brown, contrary to *N. decorata*). Also, the median spiral cord appears later in the teleoconch of *M. olivaceus*, only around the fifth/sixth whorl (Rolán and Fernández-Garcés, 1994) or after the seventh whorl (Lee, 2009). *Nototriphora decorata* has more numerous and smaller nodules than *M. olivaceus*, contrary to Abbott (1974), as pointed out by Odé (1989) and Lee (2009). The differences between *N. decorata* and *Latitriphora albida* / *Cosmotriphora arnoldoi* were mentioned in the remarks under the last two species.

Lee (2009) recognized intraspecific variation in *N. decorata*, with a morph delicately beaded and with blotches present at any of the three spiral cords, and another coarsely beaded and with dark blotches restricted to the adapical and median spiral cords. The shells here examined correspond to Lee's (2009) first morph (Figure 14). Beyond that, Rolán and Fernández-Garcés (2008) commented on a violet coloration (instead of brown) in some shells of *N. decorata* from Cuba, possibly resultant of an ecological variation.

Nototriphora decorata is reported to have an amphi-Atlantic distribution in some works (e.g. Leal, 1991; Rios, 1994, 2009), but it is actually due to a confusion with the eastern Atlantic distribution of *Nototriphora canarica* (Nordsieck and Talavera, 1979), initially described as a subspecies of *N. decorata* and later elevated to species by Bouchet (1985).

According to Rolán and Fernández-Garcés (2008), *Triphoris variegatus* A. Adams, 1854 is a synonym of *N. decorata*. *Triforis arthuri* Jousseaume, 1884, *nomen nudum*, was proposed as a replacement name for *Triphoris variegatus* A. Adams, 1854 non *Cerithium variegatum* C. B. Adams. However, *Cerithium variegatum* C. B. Adams does not exist, being created as result of a *lapsus calami* by Jousseaume (1884) while copying the list of names of both C. B. Adams and A. Adams presented by Mörch (1875).

Distribution: Bermuda (Jensen and Pearce, 2009); USA: North Carolina (Rosenberg, 2009), Florida (Lee, 2009), Louisiana (Garcia and Lee, 2002), Texas (Tunnell et al., 2010); Gulf of Mexico (Rosenberg et al., 2009);

Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1994); Jamaica (type locality); Belize; Puerto Rico; Lesser Antilles (Miloslavich et al., 2010); Costa Rica (Espinosa and Ortea, 2001); Panama; Colombia; Venezuela (Miloslavich et al., 2010); ABC Islands (Jong and Coomans, 1988); Brazil: Amapá to Rio de Janeiro (Rios, 1985), Fernando de Noronha and Vitória-Trindade Chain (Leal, 1991; Gomes et al., 2006).

Genus "*Triphora*" Blainville, 1828

Type Species: *Triphora gemmatum* Blainville, 1828, by monotypy. Recent, Mauritius.

Remarks: Although Marshall (1983) tried to define a diagnosis for *Triphora*, this genus still has uncertain limits. It is commonly used as a "catch-all" taxon when generic assignment is not possible, as "*Triphora*" s.l. (Rolán and Fernández-Garcés, 2008; Lee, 2009).

Synonyms: *Tristoma* Menke, 1830; *Triphoris* Deshayes, 1832 (orthographic variant), non *Triforis* Deshayes, 1834; according to Marshall (1983).

***Triphora atlantica* (Smith, 1890)**
(Figures 15, 26, 36)

Triforis atlantica Smith (1890: 292, pl. XXI, fig. 26).
Triphora decorata: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora melanura: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora pulchella: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora turristhomae: Absalão et al. (2006: 238, in part) non Holten, 1802.
Triphora sp.: Absalão et al. (2006: 238, in part).
Triphora atlantica: Rolán and Fernández-Garcés (2008: 146, figs. 25 A–I); Lee (2009: 92, text-fig.); Garcia and Lee (2011).

Type Material: Lectotype and paralectotypes on NHM 89.10.1.1874-93.

Type Locality: St. Helena Island.

Material Examined: IBUFRJ 13142, REVIZEE C2-22R [2]; IBUFRJ 14422, REVIZEE C5-30R [3]; IBUFRJ 19446, REVIZEE C1-C62 [1]; MNRJ 25012, MD55 35-DC59 [1]; MZSP 105148, Enseada dos Portugueses, Trindade Is., v/1987 [1].

Remarks: The shells examined agree with the lectotype designated by Rolán and Fernández-Garcés (2008), as with the description given by the authors. The teleoconch of *T. atlantica* has a brown abapical spiral cord with lighter nodules, while the adapical spiral cord is white with slightly darker inter-nodular spaces (Figure 15). A median spiral cord appears on the eight/ninth whorl of the teleoconch (Figure 26). The larval shell begins with one spiral cord, later developing an additional spiral cord (the adapical one), which fades in the last whorl (Figure 36). Compared to a shell from Florida (figure 25-I on Rolán and Fernández-Garcés, 2008), the development of the adapical spiral cord of protoconch seems to occur later on the shells of *T. atlantica* from the Vitória-Trindade Chain (Figure 36). Rolán and Fernández-Garcés (2008) described the axial ribs as being prosocline, but they are actually opisthocline.

Triphora atlantica has a wide distribution throughout the Atlantic Ocean, and its type locality is an island in the south-central Atlantic; however, few Caribbean records are given for this species. The shells figured in Abbott (1974) as *Triphora lilacina* (Dall, 1889) may be *T. atlantica*, as pointed out by Rolán and Fernández-Garcés (2008) and Lee (2009). The shell drawn in the original description (Smith, 1890) does not show the brown color on the abapical spiral cord of the body whorl, possibly due to an oversight by the author.

Distribution: USA: Florida (Lee, 2009), Louisiana (Lee, 2009); Puerto Rico (Rolán and Fernández-Garcés, 2008); St. Helena (type locality); Brazil: Espírito Santo (Rolán and Fernández-Garcés, 2008), Vitória-Trindade Chain (this study).

***Triphora ellyae* Jong and Coomans, 1988**
(Figures 16, 27, 37)

Triphora ellyae Jong and Coomans (1988: 50, pl. 34, fig. 242); Rolán and Fernández-Garcés (1995: 13, figs. 23-25; 2007: pl. V, figs. 17–21); Lee (2009: 92, text-fig.).
Triphora orteai Espinosa (2001: 21, fig. 7).
Triphora sp.: Absalão et al. (2006: 238, in part).

Type Material: Holotype: ZMA 3.87.072.

Type Locality: Aruba/Curaçao (ABC Islands).

Material Examined: IBUFRJ 14637, REVIZEE C5-48R [2]; Bacia de Campos, Rio de Janeiro state: MNRJ 15400, 22°42′ S, 40°40′ W, 5 m, iii/2007 [9]; MNRJ 18753, 22°42′ S, 40°40′ W, 110–120 m, 2006 [5]; MNRJ 18955, 22°42′ S, 40°40′ W, 5–10 m [2].

Remarks: As the two shells from Vitória-Trindade Chain were eroded, although allowing a taxonomic determination, we illustrated a shell from Bacia de Campos (Campos Basin), deposited at the molluscan collection of MNRJ (Figures 16, 27, 37). The shells examined have an ovoid shape, with almost all the shell being brown, except the white adapical spiral cord of the teleoconch and the entire first whorl of teleoconch (Figure 16). Also, the nodules of the median and abapical spiral cords are lighter than the background color. The median spiral cord develops in the fifth/sixth whorl of the teleoconch, and the base is short, with three smooth cords (including the subperipheral cord) (Figure 27). The shells here studied showed some color variation on the base, which can be light brown to whitish, with the subperipheral and basal cords slightly darker.

Triphora ellyae can be best differentiated from *T. atlantica* by the earlier development of the median spiral cord (fifth/sixth whorl of teleoconch in *T. ellyae*, eight/ninth whorl in *T. atlantica*), the darker brown median spiral cord, and the smooth subperipheral cord (very nodulose in *T. atlantica*). Further, the shell of *T. ellyae* is smaller than *T. atlantica* and it has a slight ovoid shape.

The study of the animal described by Espinosa (2001) as *Triphora orteai* (synonymized by Rolán and Fernández-Garcés, 2008 with *T. ellyae*) may point to the generic position of this species.

Distribution: USA: Florida, Louisiana (Lee, 2009); Gulf of Mexico (Rosenberg et al., 2009); Cuba (Rolán and Fernández-Garcés, 1995); Costa Rica (Espinosa, 2001, cited as *Triphora orteai*); ABC Islands (type locality); Brazil: Vitória-Trindade Chain and Rio de Janeiro state (this study).

***Triphora elvirae* Jong and Coomans, 1988**
(Figures 17, 28, 38)

Triphora elvirae Jong and Coomans (1988: 50, pl. 34, fig. 240); Rolán and Fernández-Garcés (1995: 13, figs. 20–22; 2007: pl. V, figs. 22–23); Garcia and Lee (2011).
Cosmotriphora elvirae: Redfern (2001: 65, pl. 32, fig. 273).
Triphora pulchella: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.
Triphora sp.: Absalão et al. (2006: 238, in part) non C. B. Adams, 1850.

Type Material: Holotype: ZMA 3.87.071.

Type Locality: Curaçao.

Material Examined: IBUFRJ 12105, REVIZEE C5-30R [1]; MNRJ 12771, REVIZEE C5-30R [2]; MNRJ 25031, MD55 9-DC22 [1]; MNRJ 25032, MD55 35-DC 59 [1]; MORG 51901, REVIZEE C1-C62 [3]; MNHN, MD55 23-DC40 [1]; MNHN, MD55 20-DC34 [1].

Remarks: This species has a brown abapical spiral cord, in contrast with the adapical and median white spiral cords (Figure 17). In addition to the abapical spiral cord, the teleoconch of *T. elvirae* also shows the subperipheral cord and usually the final portion of the base tinted with brown. In the shells examined, the median spiral cord appears in the seventh whorl of the teleoconch, showing the same size as the abapical spiral cord (the adapical one is slightly bigger) two whorls later (Figure 28). The material here studied is more similar to the shells of Cuba (Rolán and Fernández-Garcés, 1995) than to the holotype, which presents the light brown color of the abapical spiral cord extending beyond the nodules (Rolán and Fernández-Garcés, 1995).

Triphora elvirae is similar to *T. atlantica*, especially in the brown coloration on the abapical spiral cord; however, the coloration is continuous in *T. elvirae* (Figure 17) and restricted to the inter-nodular spaces on *T. atlantica* (Figure 15). The shell of *T. ellyae* has an ovoid shape and a brown median spiral cord on the teleoconch (Figure 16), while the shell of *T. elvirae* is conical and the median spiral cord of the teleoconch is white (Figure 17).

Redfern (2001) placed this species in *Cosmotriphora*, but this generical allocation requires further investigation, as the animal and radula have not yet been seen (Rolán and Fernández-Garcés, 1995). In addition to the description of protoconch of this species by Rolán and Fernández-Garcés (1995), the last whorl presents a weakening of the adapical spiral cord (Figure 38). Actually, the sequence of spiral cords on the protoconch of *T. elvirae* is similar to that observed on *Coriophora novem* (Figure 33).

The shell illustrated in Merlano and Hegedus (1994) as *Triphora intermedia* (C. B. Adams, 1850) appears to belong to *T. elvirae*.

Distribution: USA: Louisiana (Garcia and Lee, 2002); Gulf of Mexico (Rosenberg et al., 2009); Bahamas (Redfern, 2001); Cuba (Rolán and Fernández-Garcés, 1995); Belize (Miloslavich et al., 2010); Curaçao (type locality); Brazil: Vitória-Trindade Chain (this study).

DISCUSSION

Of the 13 species found in this study, *Cosmotriphora melanura* and *Nototriphora decorata* were previously reported from the Vitória-Trindade Chain. *Cosmotriphora arnoldoi*, *Iniforis carmelae*, *Iniforis pseudothomae*, *Latitriphora albida*, *Coriophora novem*, *Triphora ellyae* and *Triphora elvirae* were previously restricted to the Caribbean and Gulf of Mexico, although *L. albida* is also present in Bermuda and the southeastern coast of USA. These species are reported for the first time from Brazil. The known ranges of *Monophorus olivaceus* and *Triphora atlantica* in Brazil are herein extended to the Vitória-Trindade Chain.

Absalão et al. (2006) and Gomes et al. (2006) listed the occurrence of *Marshallora nigrocincta* (C. B. Adams, 1839), under the name *Triphora nigrocincta* (C. B. Adams, 1839), to the Vitória-Trindade Chain. As mentioned before, their taxonomic identification was erroneous, actually corresponding to *Coriophora novem*. Thus, the presence of *M. nigrocincta* at the study site is here invalidated. Furthermore, the occurrence of this species in Brazil needs further investigation as it may represent a complex of species (Bouchet, 1985).

The previous record of *Iniforis turristhomae* at the Vitória-Trindade Chain (Absalão et al., 2006) is here invalidated, as the single shell studied is very eroded, and it could not be positively identified.

Until now, only three species of *Isotriphora* were recognized in the western Atlantic (Rosenberg, 2009) and 11 worldwide (Rosenberg, 2011). *Isotriphora tigrina* new species is currently restricted to the Vitória-Trindade Chain and Bahia state and *Isotriphora onca* new species to the Vitória-Trindade Chain. The records of the two

species above represent the entirety of occurrences of *Isotriphora* for Brazil. The non-planktotrophic mode of development suggested by the protoconch in this genus indicates a greater possibility for endemism.

With the present study, the number of species of Triphoridae in the Vitória-Trindade Chain is increased from six to 15 and in Brazil from 17 to 26. Many other species still need to be described or otherwise reported from Brazil. Further scrutiny of this and other relatively understudied elements are certain to greatly improve our knowledge of the western Atlantic malacofauna in coming years.

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