

Research Article

Records and Descriptions of Epitoniidae (Orthogastropoda: Epitonioidae) from the Deep Sea off Northeastern Brazil and a Checklist of *Epitonium* and *Opalia* from the Atlantic Coast of South America

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A total of six genera and 10 species of marine gastropods belonging to the family Epitoniidae were collected from dredges of the continental slope off Brazil during the development of the REVIZEE (Live Resources of the Economic Exclusive Zone) Program. These species, referable to the genera *Alora*, *Amaea*, *Cycloscala*, *Epitonium*, *Gregorioiscala*, and *Opalia*, are reported from bathyal depths off northeastern Brazil. *Alora* sp., *Gregorioiscala pimentai* n. sp., and *Opalia revizee* n. sp. are species heretofore unknown to science. A list of the species of *Epitonium* and *Opalia* from the Atlantic coast of South America is presented based primarily on data from the literature. In addition, an overview of the biodiversity and distribution of the genera studied is presented for the Atlantic Ocean.

1. Introduction

Mollusks are a diverse and abundant group, although often inconspicuous in the reef ecosystem. Among gastropods, species of Architectonicidae Gray, 1840, Coralliophilidae Chenu, 1859, Epitoniidae S. S. Berry, 1910, Muricidae Rafinesque, 1815, Nystiellidae Clench and Turner, 1952, Olividae Latreille, 1825, and Ovulidae Fleming, 1822, are known to live on stony and soft corals, hydroids, hydrocorals, discophores, siphonophores, gorgonians, zoanthids, and sea anemones, feeding on living cnidarian tissues [1–5].

Epitoniidae is a cosmopolitan family of carnivorous marine gastropods [1, 6–9] that occurs on a variety of substrata from the intertidal to the abyssal region [1] and feed mainly on cnidarian anthozoans [1–3, 8–17]. These gastropods may also be free-living micropredators [1, 14, 16]

feeding on invertebrates such as annelid worms and nemerteans [14].

The systematics of Epitoniidae remain poorly resolved mainly due to the scarce material collected from the deep sea, which is often represented by one or a few shells [6–9, 14, 16, 18]. Watson [18] reported the first epitoniids for Brazil and Rios [19–22] expanded knowledge on this group in Brazilian waters. However, the alpha taxonomy remains underestimated, and there is fragmented knowledge on the family in the country [22–31].

Brazilian programs of environmental characterization have been very important in the sampling of benthic communities from the continental shelf and deep waters. For example, Miyaji [30] identified five genera and 16 species of Epitoniidae collected in southeastern and southern Brazil

during the REVIZEE (Live Resources of the Exclusive Economic Zone) Program. Dr. R. S. Absalão (pers. comm., April 2011) studied new and little known deep-water Epitoniidae (700 to 1950 m) from the Campos Basin off the state of Rio de Janeiro, Brazil. These studies demonstrate the insufficient understanding of the real diversity of Epitoniidae.

This paper presents gastropods of the family Epitoniidae collected from the continental slope off northeastern Brazil during the REVIZEE Program (2000–2001) and lists the species of the genera *Epitonium* Röding, 1798, and *Opalia* Adams and Adams, 1853, reported for the Atlantic coast of South America. A total of 10 species of Epitoniidae were dredged from bathyal depths. Most of the species studied herein are poorly known, have not previously been recorded for the region, or are previously unknown to science. In several cases, only one or a few specimens with damaged shells were collected, identified, and figured. The goal is to provide more alpha taxonomic knowledge on the diversity and geographic ranges of Epitoniidae fauna in Brazil. In addition, an overview of the biodiversity and distribution of the genera studied is presented for the Atlantic Ocean.

2. Material and Methods

This study is based on 13 empty shells collected through dredging in northeastern Brazil by the fishing vessel “Natureza” between depths of 375 and 720 meters. Generic and specific identification is based on comparisons with descriptions and illustrations [6–9, 16, 32, 33]. A checklist of the species of the genera *Epitonium* (Table 1) and *Opalia* (Table 2) known from the Atlantic coast of South America and their geographic and bathymetric distribution is presented based on data from the literature [7, 9, 16, 22–24, 30–32, 34–41], species registered in the online World Register of Marine Species [42], and databases of western Atlantic marine Mollusca [43] and *Conquiliologistas do Brasil* [44].

The supraspecific taxonomy of Epitoniidae is poorly defined and often inconsistent based solely on shell morphology [6, 8, 16]. Thus, the decision was made to assign species only to the genus level until future-changes-based new evidence from anatomical studies complement the taxonomy. The limits of the subgenera (e.g., *Epitonium* and *Opalia*) have not been clearly defined [6, 16].

Each species was photographed under a ZEISS EVO 40 Scanning Electron Microscope at the Management of Biostratigraphy and Applied Paleoecology of the Petrobrás Research Center or under an FEI QUANTA 200F Scanning Electron Microscope at the Center for Technological Research of Northeastern Brazil.

3. Results

3.1. Taxonomic Account.

Epitoniidae Berry, 1910

Epitonium Röding, 1798.

Epitonium fractum Dall, 1927 (Figures 1(a)–1(c)).

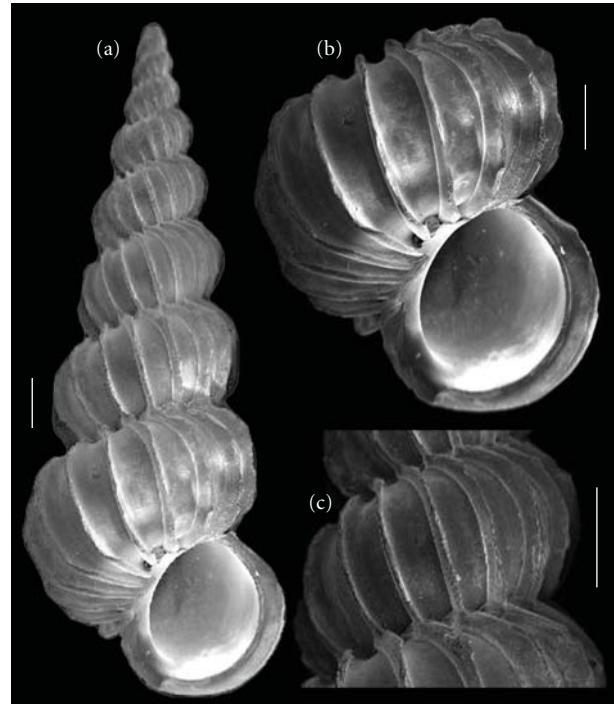


FIGURE 1: (a–c) *Epitonium fractum* (LMUFRPE); (a) ventral view, (b) view of last whorl, and (c) detail of teleoconch ornamentation. Scale bars: (a–c) 500 μ m.

Type Material and Locality. Holotype (USNM 108015, not examined)—off Fernandina, Florida [32].

Material Examined. 1 shell (LMUFRPE), Rio Grande do Norte (Brazil, REVIZEE/NE: “Natureza,” 04°51’S, 35°06’W, 375 m, 24.xi.2001).

Characterization. Shell elongated, somewhat slender, strongly convex whorls attached by blade-like ribs with well-developed angles at shoulder (Figure 1(a)). Protoconch about 3.5 smooth whorls. Teleoconch with 8 to 16 whorls. About 17 to 20 axial ribs on last whorl. Spire extended (Figure 1(a)). Suture deep (Figures 1(a) and 1(c)). Base sculptured with ribs with well-developed angulation (Figure 1(b)). Aperture subcircular, holostomatous (Figure 1(b)). Umbilicus minute, partially hidden by parietal lip and ribs (Figure 1(b)).

Geographic Distribution. Georgia [43], Florida [22, 32, 37, 45], Gulf of Mexico—off Louisiana [43], West Indies [22], Brazil: Rio Grande do Norte (present study), Espírito Santo [22] to São Paulo [30].

Remarks. The characters of the specimen examined here and those presented by Clench and Turner [32], Abbott [37], and Rios [22] fit the concept of *Epitonium fractum* (see original description in Dall [45]) and figure of type material in Clench and Turner [32]. This species has been collected on the continental shelf and slope [22, 32, 37, 45]. It is similar

TABLE 1: Checklist of species of the genus *Epitonium* known for the Atlantic coast of South America with geographic and bathymetric distribution.

Species	Distribution (South America)	Depth (m)
(1) <i>E. albidum</i> (d'Orbigny, 1842)	Colombia, Venezuela, Brazil (CE, PE, AL, ES, RJ, SP, PR, SC), Uruguay	0–366
(2) <i>E. angulatum</i> (Say, 1831)	Colombia, Brazil (AP, CE, PE, AL, BA, ES, RJ, SP), Uruguay	0–219
(3) <i>E. apiculatum</i> (Dall, 1889)	Venezuela	1–90
(4) <i>E. babylonia</i> (Dall, 1889)	Colombia, Brazil (AP, CE, PE, SP)	152–1337
(5) <i>E. candeanum</i> (d'Orbigny, 1842)	Colombia, Venezuela, Suriname, Brazil (AP, CE, PE, AL, SP), Uruguay, Argentina	0–805
(6) <i>E. cf. candeanum</i> *	Brazil (PI)	0–10
(7) <i>E. celesti</i> (Aradas, 1854)	Brazil (RN, CE, RJ, SP, RS)	146–640
(8) <i>E. cf. celesti</i>	Brazil (RN)	384
(9) <i>E. dallianum</i> (Verrill and Smith, 1880)	Brazil (ES, RS)	90–478
(10) <i>E. denticulatum</i> (Sowerby II, 1844)	Colombia, Venezuela, Brazil (AP, PA, CE, PE, AL, RJ)	0–1472
(11) <i>E. fabrizioi</i> Pastorino and Penchaszadeh, 1998*	Argentina	0–2
(12) <i>E. foliaceicosta</i> (d'Orbigny, 1842)	Colombia, Brazil (AL, BA, ES)	0–219
(13) <i>E. fractum</i> Dall, 1927	Brazil (RN, ES, RJ, SP)	64–594
(14) <i>E. frielei</i> (Dall, 1889)	Brazil (AP, CE, RS)	91–2941
(15) <i>E. georgettinum</i> (Kiener, 1838)*	Brazil (BA, ES, SC, RS), Uruguay, Argentina	0–101
(16) <i>E. hispidulum</i> (Monterosato, 1874)	Brazil (RJ)	750–800
(17) <i>E. humphreysii</i> (Kiener, 1838)	Brazil (CE, PE, RS)	0–95
(18) <i>E. krebsii</i> (Mörch, 1875)	Colombia, Venezuela, Brazil (AP, PA, CE, RN, PB, AL, SC)	0–294
(19) <i>E. lamellosum</i> (Lamarck, 1822)	Colombia, Venezuela, Brazil (ES)	0–60
(20) <i>E. magellanicum</i> (Philippi, 1845)*	Brazil (RS), Uruguay, Argentina, Chile	0–545
(21) <i>E. matthewsae</i> Clench and Turner, 1952	Colombia	11–219
(22) <i>E. multistriatum</i> (Say, 1826)	Brazil (AL, RS)	2.5–219
(23) <i>E. novangliae</i> (Couthouy, 1838)	Colombia, Venezuela, Brazil (CE, PE, AL, ES, RJ, SC)	0–457
(24) <i>E. occidentale</i> (Nyst, 1871)	Venezuela, Brazil (CE, PE, AL, BA, RJ, SP)	0–270
(25) <i>E. polacia</i> (Dall, 1889)	Brazil (RJ)	65–419
(26) <i>E. rupicola</i> (Kurtz, 1860)	Colombia, Suriname (Holocene)	0–65
(27) <i>E. sericifila</i> (Dall, 1889)	Colombia	0–7
(28) <i>E. striatissimum</i> (Monterosato, 1878)	Argentina	69–183
(29) <i>E. striatellum</i> (Nyst, 1871)*	Brazil (SP, RS), Uruguay, Argentina	10–70
(30) <i>E. cf. tiberii</i>	Brazil (RN)	384
(31) <i>E. turritellulum</i> (Mörch, 1875)*	Venezuela, Brazil (AP)	6–40
(32) <i>E. unifasciatum</i> (Sowerby II, 1844)	Colombia, Brazil (CE, PE, RS), Uruguay	0–9
(33) <i>E. venosum</i> (Sowerby II, 1844)	Venezuela	61
(34) <i>E. worsfoldi</i> Robertson, 1994	Brazil (ES)	1
(35) <i>E. xenicima</i> (Melvill and Standen, 1903)	Colombia, Brazil (Bahia), Uruguay	0–25

AP: Amapá, PI-Piauí, CE: Ceará, RN: Rio Grande do Norte, PB: Paraíba, PE: Pernambuco, AL: Alagoas, BA: Bahia, ES: Espírito Santo, RJ: Rio de Janeiro, SP: São Paulo, PR: Paraná, SC: Santa Catarina, RS: Rio Grande do Sul; (*) endemic to the Atlantic coast of South America.

to *E. angulatum* (Say, 1831), *E. babylonia* (Dall, 1889) and *E. dallianum* (Verrill and Smith, 1880) in the extended spire and shoulder angulation but differs from these species by the lack of spiral sculpture or spines on the shoulder (Figures 1(a)–1(c)).

Epitonium cf. celesti (Aradas, 1854) (Figures 2(a)–2(c)).

Type Material and Locality. off Acitrezza (not examined), Sicily [16].

Material Examined. 1 shell (LMUFRPE), Rio Grande do Norte (Brazil, REVIZEE/NE: “Natureza”, 04°51'40"S, 35°08'01"W, 384 m, 24.xi.2001).

Characterization. Shell rather small, broad, slightly globose to turbinate (Figures 2(a) and 2(c)). Protoconch with about 4 whorls (Figure 2(b)). Teleoconch with about 3 almost disjunct whorls attached by blade-like, widely spaced ribs; ribs weakly recurved abaperturally at shoulder (Figures 2(a) and 2(c)). Microscopic sculpture consisting of numerous and

TABLE 2: Checklist of species of the genus *Opalia* known for the Atlantic coast of South America with geographic and bathymetric distribution.

Species	Distribution (South America)	Depth (m)
(1) <i>O. abbotti</i> Clench and Turner, 1952	Brazil (PE, RJ, SP)	64–704
(2) <i>O. aurifila</i> (Dall, 1889)	Brazil	91–311
(3) <i>O. burryi</i> Voss, 1953	Colombia	30–168
(4) <i>O. crenata</i> (Linnaeus, 1758)	Venezuela, Brazil (AP, PA, AL to SC)	0.3–82
(5) <i>O. eolis</i> Clench and Turner, 1950	Brazil (RN), Southeastern Brazil	60–384
(6) <i>O. hotessieriana</i> (d'Orbigny, 1842)	Brazil (AL to SC)	0–165
(7) <i>O. cf. morchiana</i> *	Southeastern Brazil	—
(8) <i>O. pumilio</i> (Mörch, 1875)	Brazil (AP, PI, CE, PE, AL)	0–183
(9) <i>O. cf. pumilio</i> *	Colombia	—
(10) <i>O. revizee</i> n. sp.*	Brazil (AL)	720

AP: Amapá, PA: Pará, PI: Piauí, CE: Ceará, PE: Pernambuco, AL: Alagoas, RJ: Rio de Janeiro, SP: São Paulo, SC: Santa Catarina; (—) depth is not given by Miyaji [30]; (*) endemic to the Atlantic coast of South America.

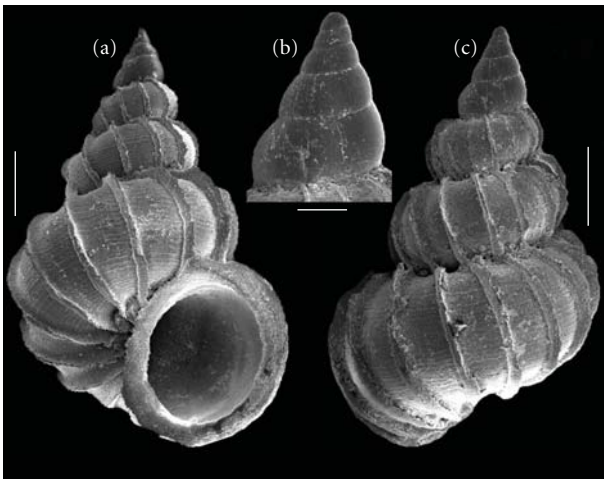


FIGURE 2: (a–c) *Epitonium cf. celesti* (LMUFRPE); (a) ventral view, (b) protoconch, and (c) dorsal view. Scale bars: (a) and (c) 500 μm , (b) 200 μm .

fine spiral threads (Figures 2(a) and 2(c)). Suture deep (Figure 2(c)). Base broad and rounded. Aperture oval, rather thickened and deflected. Umbilicus rather deep, narrow, sometimes slightly covered by reflection of lip, and/or thick extension of columella (Figure 2(a)).

Geographic Distribution. Eastern Atlantic—Mediterranean Sea, Portugal, Madeira, and Azores Islands [16, 22]; Western Atlantic—New Jersey [7, 16, 22], North Carolina, Florida, Bermuda, Bahamas Islands [7], Gulf of Mexico—Yucatan Strait [43], Cuba [7], Virgin Islands [7, 16, 22], Barbados [7], Brazil [21]: Rio Grande do Norte (present study); São Paulo [30]; Rio Grande do Sul [22].

Remarks. This species is similar to *Epitonium krebsii* (Mörch, 1875) in the globose-turbinate shell and blade-like ribs widely spaced and slightly abaperturally recurved at the shoulder but differs in that it has numerous fine spiral threads and

does not have the wide umbilicus characteristic of *E. krebsii*. Clench and Turner [32], Abbott [37], and Rios [21] did not recognize any spiral sculpture on the teleoconch of *E. krebsii*.

The only specimen collected matches *Epitonium celesti* in the conical protoconch with about 4 whorls as well as in the shell shape and in axial and spiral sculpture (see Bouchet and Warén [16]). The prominent axial ribs strongly recurved abaperturally at the shoulder forming a spine in *Epitonium celesti* that seems to be somewhat different from the specimens illustrated herein. However, the only shell collected here is somewhat worn.

Epitonium cf. tiberii (de Boury, 1890) (Figures 3(a)–3(c)).

Material Examined. 1 shell (LMUFRPE), Rio Grande do Norte (Brazil, REVIZEE/NE: “Natureza,” 04°51'40''S, 35°08'01''W, 384 m, 24.xi.2001).

Characterization. Shell conical-turbinate (Figure 3(a)). Protoconch conical, about 3.5 whorls, sculptured with sub-sutural spiral threads and opisthocline incremental lines (Figure 3(b)). Teleoconch about 3.5 whorls attached by prosocline blade-like ribs, slightly expanded, angulated, and with weak spine at shoulder (Figures 3(a) and 3(c)). Microscopic sculpture of numerous spiral threads (Figure 3(c)). First, second, and third teleoconch whorl sculptured with about 14, 18, and 22 axial ribs, respectively (Figure 3(a)). Suture deep and very constricted. Base conical, moderately elongated. Aperture oval. Outer and inner lip thin. Umbilicus minute, partially hidden by parietal lip and ribs (Figure 3(a)).

Geographic Distribution. Eastern Atlantic—Bay of Biscay to Cape Verde Islands [46]; western Atlantic—continental slope of Rio Grande do Norte (northeast Brazil: present study).

Remarks. Despite the wear, concretions on the surface of the teleoconch and the juvenile stage of the shell, this specimen approaches *E. algerianum* (Weinkauff, 1866), *E. tiberii* (de

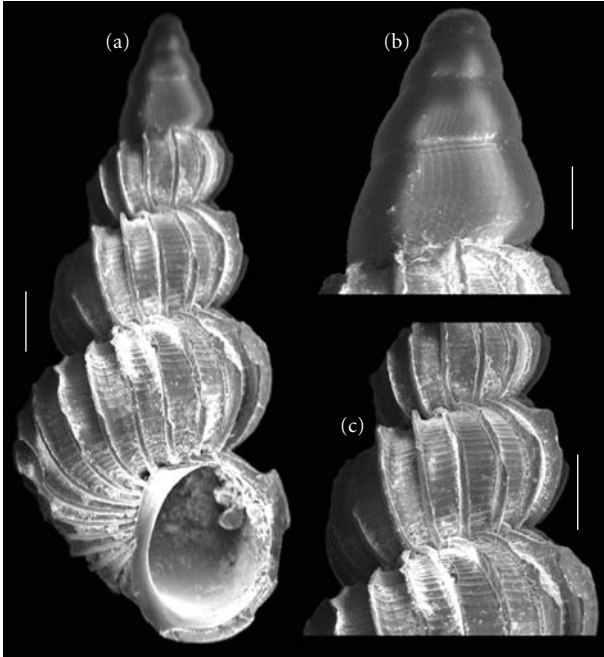


FIGURE 3: (a–c) *Epitonium* cf. *tiberii* (LMUFRPE); (a) ventral view, (b) protoconch and (c) detail of teleoconch ornamentation. Scale bars: (a) and (c) 500 μ m, (b) 200 μ m.

Boury, 1890), and *E. tryoni* (de Boury, 1913) (all from the eastern Atlantic) in shape and pattern of axial and spiral sculpture, including the slightly spinose projections at the shoulder. *Epitonium algerianum* has a robust shell and sinuous axial lamellae; *E. tryoni* has orthocline axial lamellae and an open umbilicus, while *Epitonium* cf. *tiberii* is characterized by a thin shell, prosocline axial ribs, and a minute umbilicus. *Epitonium* cf. *tiberii* approaches *E. tiberii*, although the protoconch of the present specimen is rather different from that shown by Bouchet and Warén [21] for *E. tiberii*. More material is necessary for further comparisons.

Cycloscala Dall, 1889.

Cycloscala echinaticosta (d'Orbigny, 1842) (Figures 4(a)–4(c)).

Type Material and Locality. Holotype (not examined)—probably in NHMUK and St. Thomas—Virgin Islands [32].

Material Examined. 1 shell (MNRJ 17.165), Rio Grande do Norte (Brazil, REVIZEE/NE: “Natureza,” 04°51'40"S, 35°08'01"W, 384 m, 24.xi.2001).

Characterization. Shell slightly globose to elongate-turritate. Protoconch with 3.5 to 4 whorls. First postnuclear whorls attached and remaining disjunct or usually all disjunct whorls, sculptured with widely spaced axial ribs (Figure 4(a)). First postnuclear whorl narrowly coiled (Figure 4(a)). Second postnuclear whorl much more widely coiled (Figure 4(a)). First and second postnuclear whorls

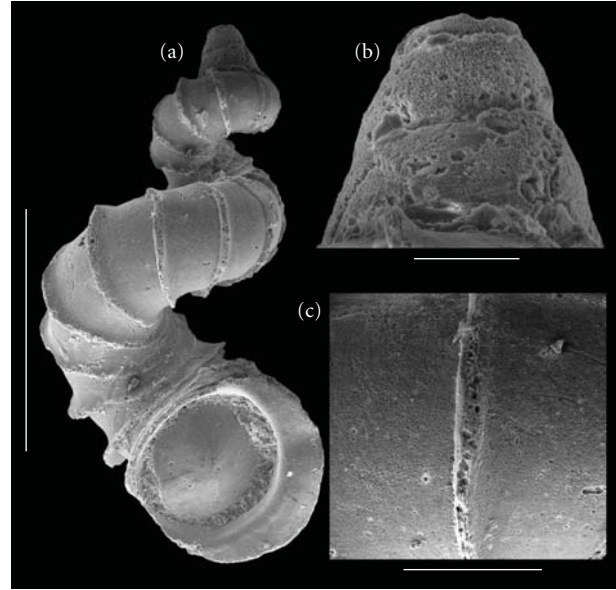


FIGURE 4: (a–c) *Cycloscala echinaticosta* (MNRJ 17.165); (a) ventral view, (b) protoconch view, and (c) detail of teleoconch ornamentation. Scale bars: (a) 1 mm, (b) 100 μ m, and (c) 200 μ m.

with 8 to 9 scalloped axial costae completely encircling teleoconch (Figure 4(a)). Axial interspaces smooth (Figure 4(c)). Aperture circular (Figure 4(a)). Outer and inner lip thin (Figure 4(a)).

Geographic Distribution. North Carolina [43], Florida [22, 24, 32, 37], Bermuda [22, 24, 32, 33, 43, 47, 48], Bahamas [32, 33, 48, 49], Gulf of Mexico—off Louisiana [43], Belize [33], Costa Rica, Panama [43], Turks and Caicos, Cuba [32], Jamaica [32, 50], Haiti, Dominican Republic, Puerto Rico [43], Virgin Islands [32, 51–53], Anguilla [32], Barbados [32, 37], Bonaire [33, 54], Colombia [43], Brazil [22, 23, 37]: Pará [31], Rio Grande do Norte (present study), Fernando de Noronha Archipelago [22, 24, 48], Espírito Santo [43].

Remarks. Woodring [50] and Clench and Turner [32] classified this species as *Epitonium* (*Cycloscala*). Later, Kilburn [8] considered the subgenus to have characters sufficiently well defined to warrant full generic status. However, subsequent studies continued to recognize *Epitonium echinaticosta* [23, 24, 31, 48, 49, 54], except Garcia [33], who also discussed distinguishing characters in favor of treating *Cycloscala* on the generic level, mainly due to the disjunct postnuclear whorl, scalloped costae (Figure 4(a)), and shell body lacking spiral ornamentation (Figure 4(c)) [8, 33].

Currently, *Cycloscala* is a valid genus with about 13 species in the Pacific Ocean [46] and only *Cycloscala echinaticosta* in the Atlantic Ocean (between depths of 2 and 384 m) [8, 22, 33, 55]. This taxon has considerable conchological variability [32, 33, 48, 49].

Amaea H. and A. Adams, 1853.

Amaea retifera (Dall, 1889) (Figures 5(a)–5(d)).

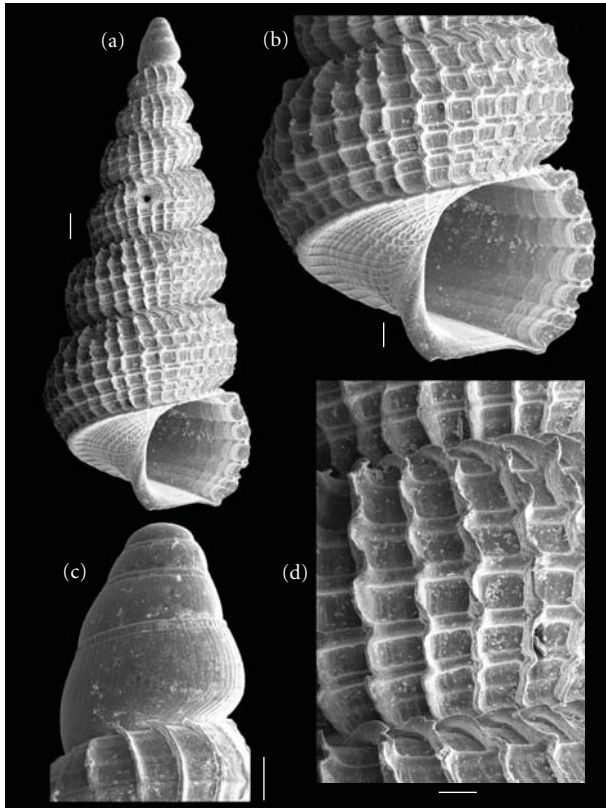


FIGURE 5: (a–d) *Amaea retifera* (LMUFRPE); (a) ventral view, (b) view of last whorl, (c) protoconch, and (d) detail of teleoconch ornamentation. Scale bars: (a), (b) and (d) 500 μ m, (c) 100 μ m.

Type Material and Locality. Holotype (USNM 83733, not examined)—off Cape Hatteras, North Carolina [6].

Material Examined. 1 shell (LMUFRPE)—Pernambuco (Brazil—REVIZEE/NE: “Natureza,” 08°46’00’’S, 34°44’00’’W, 690 m, 18.xi.2000).

Characterization. Shell turritiform, elongate, thin. Teleoconch whorls with 6 to 16 whorls strongly convex, constricted (Figures 5(a) and 5(b)), sculptured with blade-like axial ribs (about 32 on last whorl) and spiral threads (7 to 8 on last whorl) with reticulated pattern (Figure 5(d)). Sculpture with rectangular intervals ornamented by axial striae (Figure 5(d)). Suture deep (Figures 5(a), 5(b) and 5(d)). Basal disc well developed, flat, sculptured with axial and spiral threads, delimited by prominent cord (Figure 5(b)). Base imperforate. Aperture oval (Figure 5(b)). Outer lip thickened (Figure 5(b)). Inner lip thin (Figure 5(b)).

Geographic Distribution. North Carolina [6, 37, 53, 56], Florida [6, 37, 56], Mexico [6, 56], Cuba, Puerto Rico [56], Anguilla, St. Barthelémy/St. Bartholomew, Antigua [43], Barbados [6, 56], Colombia, Venezuela, Surinam [43], Brazil [37]: Amapá, Pará [22, 31], and Pernambuco (present study).

Remarks. *Amaea retifera* and *A. mitchelli* Dall, 1896 are the only species reported for the western Atlantic [6, 22, 37, 39, 56, 57]. The conchological characters of *Amaea retifera* are unequivocal and differ from *Amaea mitchelli* by the presence of blade-like axial ribs and strongly convex, constricted whorls. *Amaea retifera* has been recorded by Rios [21, 22] and Oliveira and Rocha-Barreira [31] only in northern Brazil (Amapá and Pará).

Alora H. Adams, 1861.

Alora sp. (Figures 6(a)–6(f)).

Material Examined. 3 shells (MNRJ 17.166) and 2 shells (MZSP 101282)—Pernambuco (Brazil—REVIZEE/NE: “Natureza,” 08°46’00’’S, 34°44’00’’W, 690 m, 18.xi.2000).

Characterization. Shell thin, fragile, small, biconic, white (Figures 6(c) and 6(d)). Protoconch multispiral, conical, with 3.75 slightly convex whorls, sculptured with subsutural band, faint axial, and spiral striae (Figures 6(a) and 6(b)). Transition to teleoconch marked by straight axial edge and faint riblets (Figures 6(a) and 6(b)). Spire low, about 1/4 of total length (Figures 6(c) and 6(d)). Teleoconch with about 3 convex whorls; whorls rapidly increasing in diameter (Figures 6(c) and 6(e)), sculptured with closely spaced and-fine axial incremental lines and raised spiral threads, rather irregularly disposed (Figure 6(f)); axial elements undulating as they cross spiral threads (Figure 6(f)). Suture rather deep (Figures 6(d) and 6(e)). Last whorl capacious, with strong peripheral carina, about 2/3 of total length of shell (Figures 6(c)–6(e)); posterior half strongly convex, sculptured with about 15 spiral threads; base subtrigonal, delimited posteriorly by carina; 15 to 20 spiral threads below carina (Figures 6(c), 6(d) and 6(f)). Aperture large, rather ovate (Figure 6(c)). Parietal region straight (Figure 6(c)). Inner lip and columella straight (Figure 6(c)). Umbilicus enlarged, half-moon shaped (Figure 6(c)).

Geographic Distribution. Known from the continental slope off northeastern (Pernambuco: present study) and southeastern Brazil (Dr. R. S. Absalão—pers. comm., April 2011).

Remarks. Only two deep sea epitoniids of the genus *Alora* H. Adams, 1861, are described for the Atlantic Ocean: *A. tenerrima* (Dautzenberg and Fischer, 1896) and *A. retifera* Bouchet and Warén, 1986. *Alora tenerrima* is amphi-Atlantic (USA: Georgia and eastern Atlantic: Azores [16, 45]), while *A. retifera* is described for the northeastern Atlantic.

Alora sp. is an undescribed species from the Atlantic Ocean. Dr. R. S. Absalão (pers. comm., April 2011) identified this species for the Campos Basin (Brazil: Rio de Janeiro) based on dozens of specimens. A formal specific epithet is being provided by this researcher. *Alora* sp. and *A. tenerrima* are similar in the convexity of the teleoconch whorls (except for the last whorl), in the dominating spiral sculpture, in the shape of the aperture, parietal region, and straight inner lip, in the deep suture and in the enlarged umbilicus (half-moon

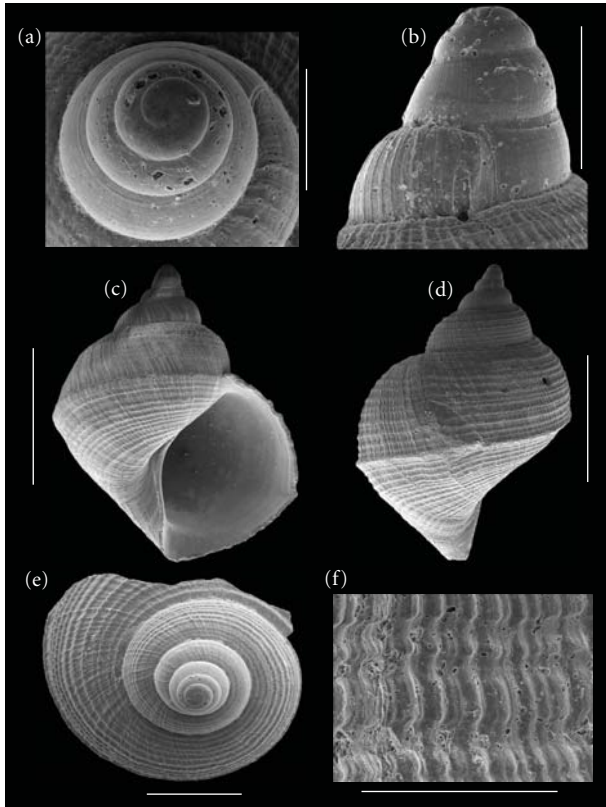


FIGURE 6: (a–f) *Alora* sp. (MNRJ 17.166); (a) and (b) protoconch view, (c) ventral view, (d) dorsal view, (e) apical view, and (f) detail of teleoconch ornamentation. Scale bars: (a) 200, (b) 300, (c) 1 mm, (d) 2 mm, (e) 500 μ m, and (f) 400 μ m.

shape). *Alora* sp. differs from *A. tenerrima* by the presence of a peripheral carina, more numerous and weaker spiral threads, more closely spaced axial incremental lines, and a subtrigonal, not regularly convex last whorl. *Alora tenerrima* has about 5 spiral threads above the peripheral cord and 7 to 9 stronger threads below the cord; axial incremental lines are well spaced, and the last whorl is globose and regularly convex [16].

Opalia H. and A. Adams, 1853.

Opalia abbotti Clench and Turner, 1952 (Figures 7(a)–7(e)).

Type Material and Locality. Holotype (MCZ 184511, not examined) and off Puerto Tanamo, Cuba [7, 16].

Material Examined. 1 shell (IBUFRJ 18.828), Pernambuco (Brazil, REVIZEE/NE: “Natureza,” 08°46′00″S, 34°44′00″O, 690 m, 18.xi.2000).

Characterization. Shell small, conical, whitish. Protoconch with 3.5 to 4 whorls sculptured with subsutural spiral band, slight axial threads, and microscopic pits (Figures 7(a) and 7(b)). Teleoconch with 5 to 7 whorls, regularly convex, constricted, sculptured with strong, thick, high, rounded, widely

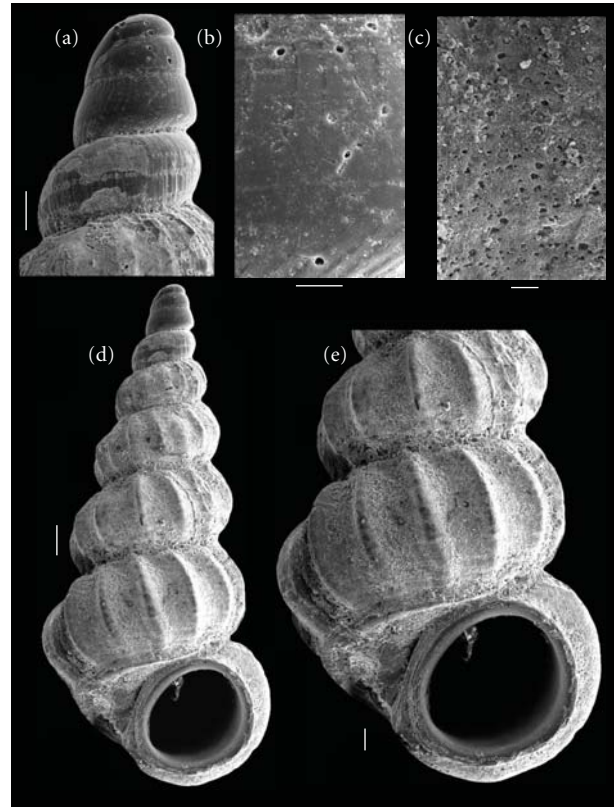


FIGURE 7: (a–e) *Opalia abbotti* (IBUFRJ 18.828); (a) protoconch, (b) detail of protoconch ornamentation, (c) detail of teleoconch ornamentation, (d) ventral view, and (e) view of last whorl and penultimate whorl. Scale bars: (a) 100 μ m, (b) 20 μ m, (c) 10 μ m, (d) 200 μ m, and (e) 100 μ m.

spaced, and prosocline axial ribs (about 12 on last whorl) (Figures 7(d) and 7(e)) and numerous microscopic pits (Figure 7(c)). Basal disc delimited by prominent basal ridge (Figures 7(d) and 7(e)). Aperture circular (Figure 7(e)). Peristome thickened (Figure 7(e)). Umbilicus narrow and chinked (Figure 7(e)).

Geographic Distribution. Eastern Atlantic–northeastern Atlantic [16]; western Atlantic—Florida [7, 16, 37], Gulf of Mexico—off Louisiana [43], Cuba [16, 37, 56], Brazil: Pernambuco (present study) and São Paulo [30].

Remarks. This is an amphi-Atlantic species, but with extensive geographic distribution throughout the western Atlantic [7, 16, 30, 37, 56]. There are no previous records of *Opalia abbotti* for northeastern Brazil.

The only shell found here did not exhibit any morphological variation with respect to the specimens illustrated by Clench and Turner [7] and Bouchet and Warén [16]. According to Clench and Turner [7], the axial ribs on the last whorl in this species do not extend to the basal disc. However, these ribs may slightly invade the region (see Bouchet and Warén [16]).

Opalia eolis Clench and Turner, 1950 (Figures 8(a)–8(c)).

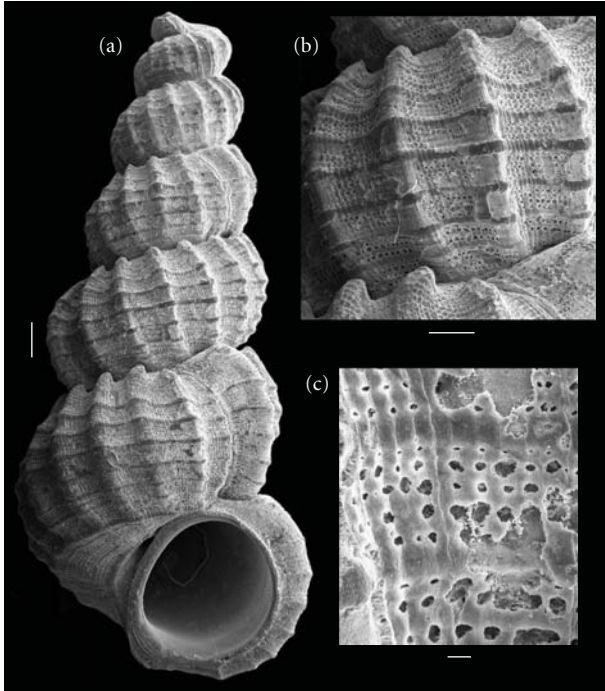


FIGURE 8: (a–c) *Opalia eolis* (MNRJ 17.170); (a) ventral view and (b), (c) detail of teleoconch ornamentation. Scale bars: (a) 500 μm and (b), (c) 100 μm .

Type Material and Locality. Holotype (MCZ 187110, not examined) and off Looe Key, Lower Florida Keys, Florida (128 to 164 m); paratypes (USNM, not examined) and off Fowey Light, Sand Key, and Palm Beach, Florida [6].

Material Examined. 1 shell (MNRJ 17.170), Rio Grande do Norte (Brazil, REVIZEE/NE: “Natureza,” 04°51′40″S, 35°08′01″W, 384 m, 24.xi.2001).

Characterization. Shell conical, elongate. Protoconch smooth, with 3 whorls. Teleoconch with 8 to 11 whorls regularly convex, rounded, constricted, sculptured with 16 to 20 strong, high, prosocline axial ribs, with crenulations at suture, 7 to 10 spiral threads, varix prosocline (Figures 8(a) and 8(b)), surface covered by intritacalx sculptured with microscopic pits in oval pattern (Figure 8(c)). Intersection of ribs and threads forming slight nodules (Figure 8(b)). Suture deeply impressed (Figure 8(b)). Basal disc delimited by slight spiral thread (Figure 8(a)). Aperture subcircular (Figure 8(a)). Outer and inner lip thickened (Figure 8(a)). Umbilicus narrow and chinked (Figure 8(a)).

Geographic Distribution. Florida [6, 22], Mexico, Bahamas [49], Anguilla, Barbados [6, 22], Brazil: Rio Grande do Norte (present study), Rio de Janeiro [22], and São Paulo [30].

Remarks. This species is described in some studies as imperforate [6, 22]. In some specimens, however, there is a small chink-like umbilicus [49]. Although not usually in

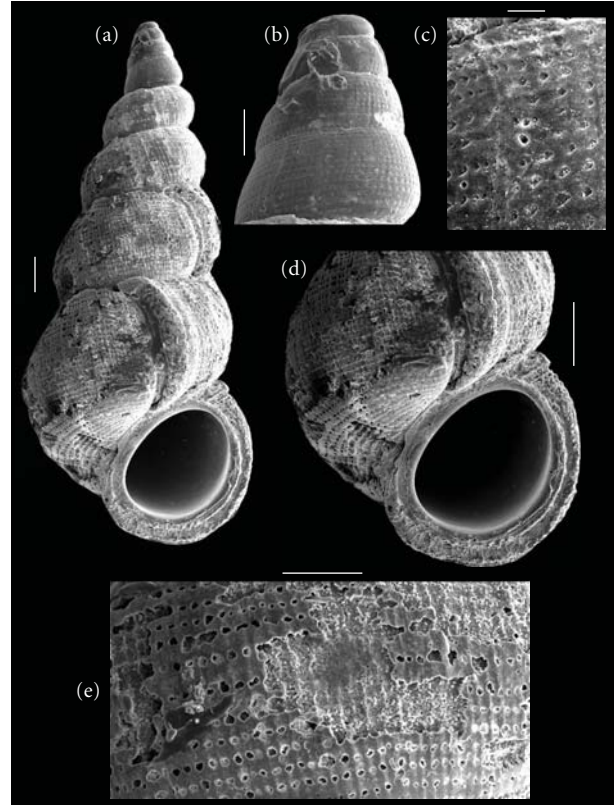


FIGURE 9: (a–e) *Opalia revizee* new species (holotype—MNRJ 18.307); (a) ventral view, (b) protoconch, (c) detail of protoconch ornamentation, (d) last whorl and aperture view, and (e) detail of teleoconch ornamentation. Scale bars: (a) 300 μm , (b) and (e) 100 μm , (c) 20 μm , and (d) 200 μm .

the description of this species, varices are seen in the images [6, 22].

Opalia revizee n. sp. (Figures 9(a)–9(e)).

Type Material. Holotype, 1 shell (MNRJ 18.307), Alagoas (Brazil, REVIZEE/NE: “Natureza,” 10°06′35″S, 35°46′41″W, 720 m, 16.xii.2001).

Description. Shell small, conical, whitish (Figure 9(a)). Protoconch conical, with 3 slightly convex whorls (Figure 9(b)), sculptured with spiral rows of microscopic pits (Figure 9(c)). Teleoconch with 5 rounded whorls, regularly convex (Figure 9(a)), surface covered by intritacalx densely sculptured with spiral rows of microscopic pits (Figure 9(e)). Varix prosocline and strong on penultimate whorl (Figures 9(a) and 9(d)). Suture well impressed (Figure 9(a)). Base weakly convex, without basal ridge, disc or umbilicus (Figure 9(d)). Aperture ovate (Figure 9(e)); peristome thickened, complete (Figure 9(e)).

Etymology. Named for the REVIZEE Program (Live Resources of the Exclusive Economic Zone).

Type Locality. State of Alagoas ("Natureza," 10°06'35"S, 35°46'41"W) at a depth of 720 meters, muddy bottom, 16.xii.2001.

Geographic Distribution. Known only from the type locality.

Remarks. *Opalia revizee* new species is similar to and may be confused with *O. eolis* and *O. fortunata* Bouchet and Warén, 1986, due to the presence of a varix.

Opalia revizee and *O. eolis* are similar in the presence of a thickened outer lip, numerous microscopic pits, and a varix on the teleoconch. *Opalia revizee* is distinguished from *O. eolis* by the absence of a crenulated suture, spiral sculpture, axial threads, and ribs. *Opalia eolis* displays a crenulated suture, heavy axial ribs, and strong spiral cords [6, 37, 49].

Opalia fortunata (northeastern Atlantic) is the species most closely related to *O. revizee*. Both have a similar outline of the shell, 3 whorls on the protoconch, about 5 whorls on the teleoconch, whorls regularly convex and sculptured with microscopic pits, a prosocline varix, a regularly convex base, a thickened and complete peristome, and the absence of a basal ridge or basal disk. *Opalia revizee* differs from *O. fortunata* by exhibiting an ovate aperture, surface covered with intritacalx densely sculptured with spiral rows of microscopic pits and no axial ribs or crenulated suture. *Opalia fortunata* has a rounded aperture, whorls covered by a smooth, finely pitted intritacalx, weak axial ribs, and suture weakly crenulated [16].

Gregorioiscala Cossmann, 1912.

Gregorioiscala pimentai n. sp. (Figures 10(a)–10(d)).

Type Material. Holotype, 1 shell (MNRJ 18.306), Alagoas (Brazil, REVIZEE/NE: "Natureza," 10°06'35"S, 35°46'41"W, 720 m, 16.xii.2001).

Description. Shell whitish, small, strong, thick, conical (Figure 10(a)). Protoconch with about 2 moderately convex whorls, sculptured with microscopic pits (Figure 10(c)). Spire moderately high (Figure 10(a)). Suture moderately deep (Figures 10(a)–10(c)). Teleoconch with about 6 constricted whorls; whorls strongly convex, irregular in outline (Figure 10(a)); surface covered by intritacalx densely sculptured with microscopic pits in square pattern (Figure 10(b)). Axial sculpture with strong, thick, high, rounded, prosocline, widely spaced ribs that do not form crenulations in subsutural region (Figures 10(a) and 10(b)). Last whorl sculptured with 10 to 14 axial ribs, faint on basal ridge, weakly invading basal disc (Figure 10(d)). Base delimited posteriorly by prominent ridge keel (Figure 10(d)). Basal disc strongly flattened, large, sculptured with microscopic pits, weak ribs; prominent spiral rib at periphery of inner lip, with nodules in intersection of axial ornamentation (Figure 10(d)). Aperture rounded (Figures 10(a) and 10(d)); peristome thickened (Figure 10(d)); umbilicus very narrow and chinked (Figure 10(d)).

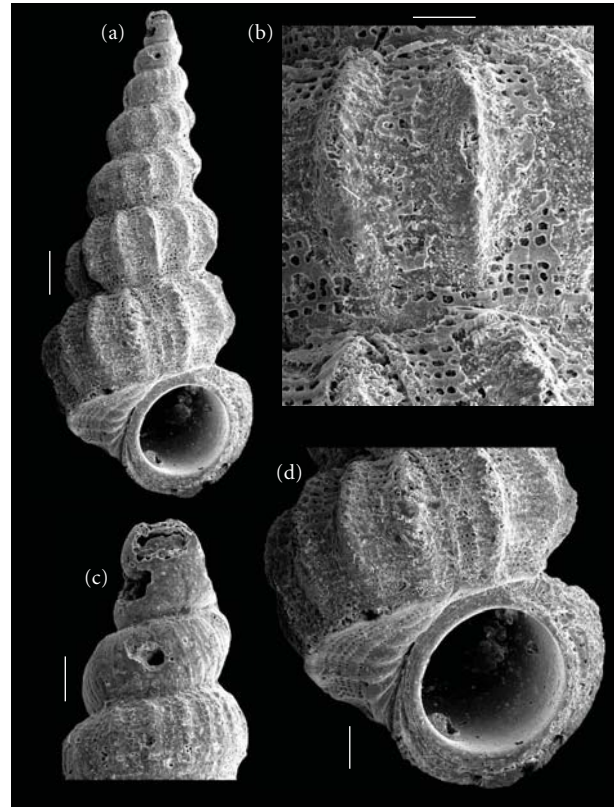


FIGURE 10: (a–d) *Gregorioiscala pimentai* new species (holotype—MNRJ 18.306); (a) ventral view, (b) detail of teleoconch ornamentation, (c) protoconch, and (d) view of last whorl. Scale bars: (a) 300 μ m, (b), (c) 100 μ m, and (d) 200 μ m.

Etymology. In homage to Dr. Alexandre Dias Pimenta (MNRJ) for his initiative in reviewing the epitoniids and nys-tiellids of the Brazilian coast.

Type Locality. State of Alagoas ("Natureza," 10°06'35"S, 35°46'41"W), at a depth of 720 meters, muddy bottom, 16.xii.2001.

Geographic Distribution. Known only from the type locality.

Remarks. The taxon *Gregorioiscala* Cossmann, 1912, was erected to include deep-water epitoniid species with non-crenulated sutures, a relatively wide basal disk and a strongly defined basal ridge, thickened outer lip, thick pitted intritacalx, and strong axial ribs, some of which may form varices [16, 58]. About 14 *Gregorioiscala* species are currently known in seas worldwide [16, 55, 58]. *Gregorioiscala pachya* (Locard, 1897) is the only deep sea congener reported for the western Atlantic (Gulf of Mexico) [55].

Gregorioiscala pimentai resembles *G. pachya* in presenting a teleoconch with constricted whorls; whorls irregular in outline; strong, thick, prosocline, widely spaced axial ribs, axial ribs of subsequent whorls not aligned in a row, suture

moderately deep, and peristome thickened. *Gregorioiscala pimentai* is distinguished from *G. pachya* by the presence of a conical, less solid shell, teleoconch with 6 whorls, columellar axis not curved, teleoconch whorls not developing a shoulder, lacking varices, basal disc sculptured with weak axial ribs and a spiral rib present at the periphery of inner lip, forming nodules in the intersections with axial ribs. *Gregorioiscala pachya* is recognized by the turrillate, very solid, heavy shell, teleoconch with about 12 whorls, curved columellar axis, shouldered teleoconch whorls, some axial ribs forming varices and basal disc not sculptured with ribs [16].

4. Discussion

The present paper permits an extended analysis of the biodiversity and distribution of the genera studied in the Atlantic Ocean, with an emphasis on the taxa reported for South America. A review of the literature and together with the database offered by the present study resulted in records of three *Alora*, including *A. sp.* [9, 16], about four *Amaea* [6, 9, 22, 57, 59], one *Cycloscala* [33, 49, 55], about four *Gregorioiscala*, including *G. pimentai* n. sp. [9, 16], fourteen *Opalia*, including *O. revizee* n. sp. [6, 9, 16, 22, 37, 39, 42, 49], and about eighty *Epitonium* species [7, 9, 16, 22, 32, 37, 39, 42, 43, 49, 54] reported for the Atlantic Ocean. Information on the geographic and bathymetric distribution of *Alora* and *Cycloscala* was presented previously.

The genera *Amaea* and *Gregorioiscala* are among the most poorly represented epitoniids on both Atlantic coasts and species richness values therefore have little comparative meaning between regions. The two *Amaea* species from the western Atlantic are spread over a broad geographic area [6, 9, 22, 37, 39, 55, 57], but only *A. retifera* has been recognized as significantly expanding the area of occurrence of the group to the Atlantic coast of South America and apparently beyond the continental shelf [22]. Other species have been found in the eastern Atlantic off West Africa (*A. africana* Bouchet and Tillier, 1978; *A. guineensis* Bouchet and Tillier, 1978) [9, 42, 59].

At least eleven *Opalia* species have been reported for the western Atlantic, five of which (*O. crenata* (Linnaeus, 1758), *O. hotessieriana* (d'Orbigny, 1842), *O. pumilio* (Mörch, 1875), *O. eolis*, and *O. abbotti*) have distributions shared between the Gulf of Mexico, West Indies, and the Atlantic coast of South America (Table 2) [6, 9, 16, 22, 39, 42, 49, 55], extending the southern limit of distribution (except *O. pumilio*) to southeastern/southern Brazil [22]. *Opalia leeana* (Verrill, 1882) and *O. tortilis* (Watson, 1883) are only known from their type localities [43]. This genus is still very poorly studied in the eastern Atlantic, with four species known for Europe [9, 16, 42]. Despite the occurrence of *O. abbotti* on both sides of the Atlantic [7, 16], there are wide gaps between the reported localities, especially between the West Indies and the northeastern portion of South America (see [7, 22, 37]). Most known species of *Opalia* in the Atlantic Ocean occur on the continental shelf [6, 7, 9, 22, 37, 39, 49, 56], with the exception of *O. abbotti*, *O. aurifila* (Dall, 1889), *O. fortunata*

Bouchet and Warén, 1986, *O. leeana*, *O. tortilis*, and *O. revizee* n. sp., which have been recorded in deep waters (between depths of 200 and 713 m) [6, 9, 16, 18, 22, 37, 53, 60].

The genus *Epitonium* has the highest number of described epitoniids [7–9, 11, 14, 22, 23, 32, 37, 39], with about forty species on both sides of the Atlantic [42, 43]. Currently, the *Epitonium* fauna of the western Atlantic may be divided into six categories on the basis of their distribution: (A) amphi-Atlantic species (4.79%); (B) species widely distributed from the United States to the Caribbean Sea and the Atlantic coast of South America (38.09%); (C) species distributed from the United States to the Caribbean Sea (16.66%); (D) species known only for the coast of the United States (16.66%); (E) species known only for the Caribbean Sea (11.90%); (F) species restricted to the Atlantic coast of South America (11.90%).

The data reviewed here reveal that *Epitonium* fauna with the greatest similarity occur between the Caribbean Sea and the Brazilian coast, as nearly half the species have records in both regions [7, 22, 32, 37, 41, 43, 49]. In the western Atlantic, about 20 species (47.61%) are found at depths of less than 200 m, while the other half has also been collected from deep waters [43]. In South America, the vertical range of *Epitonium* as a whole extends from the sublittoral zone (15 species; 42.8%) to the bathyal zone (20 species; 57.2%) (Table 1).

The only studies documenting *Epitonium* species in subregions of the Atlantic coast of South America were carried out by Diaz and Puyana [39] for Colombia (at least 16 species) and Rios [19–22] for Brazil. Not surprisingly, the Brazilian coast has the greatest richness of *Epitonium* in South America, with at least 25 species (Table 1) [22, 23, 31, 32, 37, 41, 44]. However, this total is far from being considered satisfactory due to the vast areas with scarce or no information on Epitoniidae.

Abbreviations

IBUFRJ:	Laboratório de Malacologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil;
LMUFRPE:	Laboratório de Malacologia, Universidade Federal Rural de Pernambuco, Recife, Brazil;
MCZ:	Museum of Comparative Zoology, Cambridge, USA;
MNRJ:	Setor de Malacologia, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil;
MZSP:	Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil;
NHMUK:	The Natural History Museum, London, Great Britain;
SEM:	Scanning Electronic Microscope;
USNM:	National Museum of Natural History, Washington, USA.

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