

New records and range extensions of azooxanthellate scleractinians (Cnidaria: Anthozoa) from Brazil

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*Based on specimens deposited in the scientific collections of the Reef Environment Laboratory of the Federal Rural University of Pernambuco, National Museum/Federal University of Rio de Janeiro, and Oceanography Department of the Federal University of Pernambuco, the first occurrences of the azooxanthellate scleractinians *Polycyathus senegalensis* and *Eguchipsammia cornucopia* from Brazilian waters are reported. In addition, latitudinal and/or bathymetric range extensions are reported for *Caryophyllia ambrosia caribbeana*, *Caryophyllia antillarum*, *Premocyathus cornuformis*, *Deltocyathus calcar*, *Paracyathus pulchellus*, *Flabellum apertum*, *Sphenotrochus auritus*, *Madracis asperula* and *Astrangia solitaria*.*

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INTRODUCTION

Some marine invertebrates, including most shallow-water scleractinian corals, have a symbiotic relationship with photosynthetic dinoflagellates (Boschma, 1925; Fitt *et al.*, 1993; Trench, 1997; Costa *et al.*, 2008) and, consequently, are restricted to shallow-waters. However, almost half of the extant scleractinians do not present this symbiosis (Cairns, 2007) and are able to inhabit aphotic zones and live heterotrophically (Kitahara, 2006; Roberts *et al.*, 2009). Therefore, with no taxonomic validity, scleractinian corals can be grouped on the presence or absence of these symbionts, and are commonly referred to as zooxanthellate or azooxanthellate corals, respectively (Cairns, 1977; Schuhmacher & Zibrowius, 1985; Capitoli & Bemvenuti, 2004; Cairns *et al.*, 2005; Cairns, 2007).

To date, the number of azooxanthellate scleractinians from Brazil has a 4:1 ratio in relation to the number of zooxanthellate species (Pires, 2007). Due to their ecological constraints and following a worldwide tendency, the distributional records of both groups in Brazilian waters show a much broader latitudinal/depth range for azooxanthellate species than that of zooxanthellate corals. Most of our knowledge about the Brazilian azooxanthellate coral fauna was acquired during or with the specimens collected through oceanographic expeditions carried out in the 18th Century (Pires, 2007; Kitahara, 2009). However, some regions with potentially diverse azooxanthellate coral fauna are still poorly sampled,

especially those from the north-eastern and northern Brazilian coast.

Despite the scarce scientific campaigns aspiring to collect deep-water organisms in Brazil, 63 scleractinian species are reported for the Brazilian Exclusive Economic Zone (EEZ) (Cairns, 1979, 2000; Kitahara, 2007; Pires, 2007; Neves & Johnsson, 2009). However, due to the low sampling efforts related to the scarce financial and logistical investments (Lindner & Kitahara, 2007), it is believed that the species richness of azooxanthellate scleractinians from the Brazilian EEZ is still underestimated (see Kitahara, 2007). Aiming to contribute to the knowledge about azooxanthellate scleractinians from Brazil, the present study reports the first occurrence of *Polycyathus senegalensis* Chevalier, 1966 and *Eguchipsammia cornucopia* (Pourtales, 1871), and expands the latitudinal and/or bathymetric ranges of the other nine species previously reported from this region.

MATERIALS AND METHODS

The specimens examined herein were collected by SCUBA diving or by bottom trawling throughout the Brazilian coast (Figure 1; Table 1). Vouchers were deposited at the scientific collections of the Reef Environment Laboratory of the Federal Rural University of Pernambuco (LAR/UFRPE); National Museum/Federal University of Rio de Janeiro (MNRJ); and/or Oceanographic Museum of the Pernambuco Federal University (MOUFPE).

Morphometrics and meristics followed Vaughan & Wells (1943), Wells (1972), Cairns (2000) and Kitahara (2007).

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Fig. 1. Map of the collection stations in Brazil.

Abbreviations

Morphological terms: GCD, greater calicular diameter; LCD, lesser calicular diameter; PD, pedicel diameter. Locations: ASPSP: St Peter and St Paul Archipelago ($00^{\circ}55'N$ $29^{\circ}20'W$); FN, Fernando de Noronha ($03^{\circ}55'S$ $32^{\circ}38'W$).

RESULTS

SYSTEMATICS

Order SCLERACTINIA Bourne, 1900
 Family CARYOPHYLLIIDAE Dana, 1846
 Genus *Polycyathus* Duncan, 1876
Polycyathus senegalensis Chevalier, 1966
 (Figure 2A, B)

Polycyathus senegalensis Chevalier, 1966: 971–974, Pl. 4, figures 7–8. Best, 1968: 72. Patrity, 1970: 83–84. Zibrowius, 1980: 94. Hubbard & Wells, 1986: 133–134, figures 21–22. Verheij & Best, 1987: 153. Cairns *et al.*, 1994: 7. Cairns, 2000: 83–86, figures 17 & 92–95. Reyes *et al.*, 2010: 95, three figures.

Polycyathus mullerae: Hubbard & Wells, 1986: 134, figures 23–24. (Not *Polycyathus muellerae* (Abel, 1959).)

Paracyathus pulchellus: Cairns, 1979: 88–90, Pl. 16, figure 5 (in part). Hubbard & Wells, 1986. (Not *Cyathina pulchellus* Philippi, 1842.)

Polycyathus sp.: Edwards & Lubbock, 1983a: 62. Amaral *et al.*, 2002: 569. Amaral *et al.*, 2006: 72, figure 6.4.

TYPE LOCALITY

Dakar Region (Senegal), depth unknown.

MATERIAL EXAMINED

LAR/UFRPE 399 (ASPSP), 18 m (2 colonies); LAR/UFRPE 401 (ASPSP), 30 m (1 colony); MNRJ 8189 (ASPSP), 20 m (1 colony); MNRJ 8191 (ASPSP), 19 m (1 colony).

DIAGNOSIS

Colonies phaceloid and firmly attached to substrate. Coenosteum conspicuous, smooth (sparsely granulated), thick and continuous. Collected colonies have an average of five corallites per cm^2 . Intercorallite distance between 1 and 4 mm. Corallite cylindrical and up to 20 mm in

Table 1. List of collection stations.

Station	Expedition/research vessel	Depth (m)	Location	Collection
1	—	13–30	00°56'N, 29°22'W (St Peter and St Paul Archipelago)	SCUBA diving
2	REVIZEE-NE II/Antares-H40	70	01°54'S 37°49'W	Bottom-trawl
3	?	?	Potiguar Basin, north-east Brazil	Bottom-trawl
4	?	380	03°55'S 32°38'W (off Fernando de Noronha Archipelago)	Bottom-trawl
5	?	250	Off Recife (~8°S)	By-catch
6	REVIZEE-NE I/Antares-H40	166	North-east Brazil	Bottom-trawl
7	RV Akaroa	560	09°01'S 34°51'W	Bottom-trawl
8	PAVASAS-South II/Saldanha	171	23°40'S 42°33'W	Bottom-trawl
9	PAVASAS-South I/Saldanha	141	25°16'S 45°08'W	Bottom-trawl

height. Calice slightly elliptical (up to 10 mm in GCD). Septotheca costate. Costae extend from calice to half distance to pedicel. Septa hexamerally arranged in four complete cycles ($6S_1 > 6S_2 > 24S_4 \geq 12S_3$). S_5 sometimes present. S_1 most exserted (0.5 to 1.5 mm) and largest septa. S_2 about 2/3 width and only slightly less exsert than S_1 . S_3 least developed septa. Pairs of S_4 fused to adjacent S_{1-2} near calicular edge forming small rectangular lancets. Pali present in two crowns before all but last cycle ($P_3 > P_{1-2}$). P_3 bilobate or trilobate. Columella papillose (0.8 to 2.5 mm in diameter) consisting of 6 (young corallites) to 16 small elements.

REMARKS

In Brazilian waters, the genus *Polycyathus* has been previously reported from St Peter and St Paul Archipelago (Edwards & Lubbock, 1983b; Amaral *et al.*, 2002; 2006). However, the specimens examined are the first identified to species level, and therefore, represent the first record of *P. senegalensis* for Brazil.

Among azooxanthellate scleractinians reported from Brazil, *P. senegalensis* is most similar to *Paracyathus pulchellus* (Philippi, 1842). However, it is distinguished by forming true colonies (Cairns, 2000). The well-developed coenosteum and/or stoloniferous connection between corallites differentiate *P. senegalensis* from rhizangids reported from Brazil like *Astrangia solitaria* (Lesueur, 1817) (Cairns, 2000).

DISTRIBUTION

Western Atlantic: Gulf of Paria; from Venezuela to French Guiana; Cape Canaveral, FL; off James Island, SC/GA; Cape Lookout, NC (Cairns, 2000); Brazil, ASPSP (Present study). Eastern Atlantic: Senegal and Morocco (Cairns, 1999a; 2000). Bathymetric range: 12 to 150 m (Edwards & Lubbock, 1983b; Reyes, 2000; Reyes *et al.*, 2010).

Family DENDROPHYLLIIDAE Gray, 1847

Genus *Eguchipsammia* Cairns, 1994

Eguchipsammia cornucopia (Pourtales, 1871)

(Figure 2C–E)

Dendrophyllia cornucopia Pourtales, 1871: 45, Pl. 5, figures 7 & 8. Cairns, 1978: 11, Table 1. Cairns, 1979: 179–181, Pl. 36, figures 1–4, Map 54. Zibrowius, 1980: 175–176, pl. 88, figures A–L. Not Hubbard & Wells, 1986: 139, figures 33–35 (*Rhizopsammia goesi*). Viada & Cairns, 1987: 32. Cairns & Wells, 1987: 43, Pl. 11, figures 14–17. Cairns, 1999b: Table 1.

Balanophyllia [sic] *cornucopia*. Cairns *et al.*, 1994: 5.

Eguchipsammia cornucopia. Cairns, 1994: 85. Cairns, 2000: 169–170, figure 198. Reveillaud *et al.*, 2008: 322. Reyes *et al.*, 2010: 120.

TYPE LOCALITY

Off Key West, Florida, 220–229 m.

MATERIAL EXAMINED

MNRJ 8190, 03°54,9'00"S 32°37,8'00"W (FN), 380 m (5 specimens); LAR/UFRPE 876, 03°54,9'00"S 32°37,8'00"W (FN), 380 m (40 specimens). All collected by RV 'Natureza'.

DIAGNOSIS

Corallum cylindrical to vermiform, and free. Calice elliptical. Largest specimen examined (MNRJ 8190) 14.6 mm in calicular diameter, 4.2 mm in PD, and 113.0 mm in height. Theca porous bearing up to 27 asexual buds or bud scars. Epithecium present on lower part of corallum. Costae flat, marked by conspicuous striae (larger in young specimens). Septa hexamerally arranged in five incomplete cycles. Larger specimens display up to 66 septa. S_1 is the only independent septa. Septal margins often beaded, and those of S_4 lacinate. Pali absent. Fossa shallow, containing a well-developed, elliptical, and convex columella.

REMARKS

According to Cairns (2000), *E. cornucopia* reproduces asexually through thecal buds. However, some specimens examined herein (also mentioned in specimens from the Caribbean (Cairns, 2000)), have settled on skeletons. This is consistent with the concept that this species also reproduces sexually by larval dispersal.

The genus *Eguchipsammia* had already been recorded in Brazilian waters, more specifically from the ASPSP, through *E. gaditana* (Duncan, 1873) (Cairns, 2000). The coral *E. cornucopia* is distinguished from the only Brazilian congener in having a larger corallum, a deeper fossa and a better developed columella (see also Cairns, 2000).

DISTRIBUTION

Western Atlantic: Florida; Bahamas; Yucatan Channel; Gulf of Mexico; Cuba; south-western Caribbean; from the Gulf of Venezuela to Barbados; Colombia; northeastern Brazil (Cairns, 1979, 2000; Zibrowius, 1980; Viada & Cairns, 1987; Reyes *et al.*, 2010; present study). Eastern Atlantic: Celtic Sea (Zibrowius, 1980); Bay of Biscay (Reveillaud *et al.*, 2008); Gulf of Gascony. Bathymetric range: 91 to 960 m.

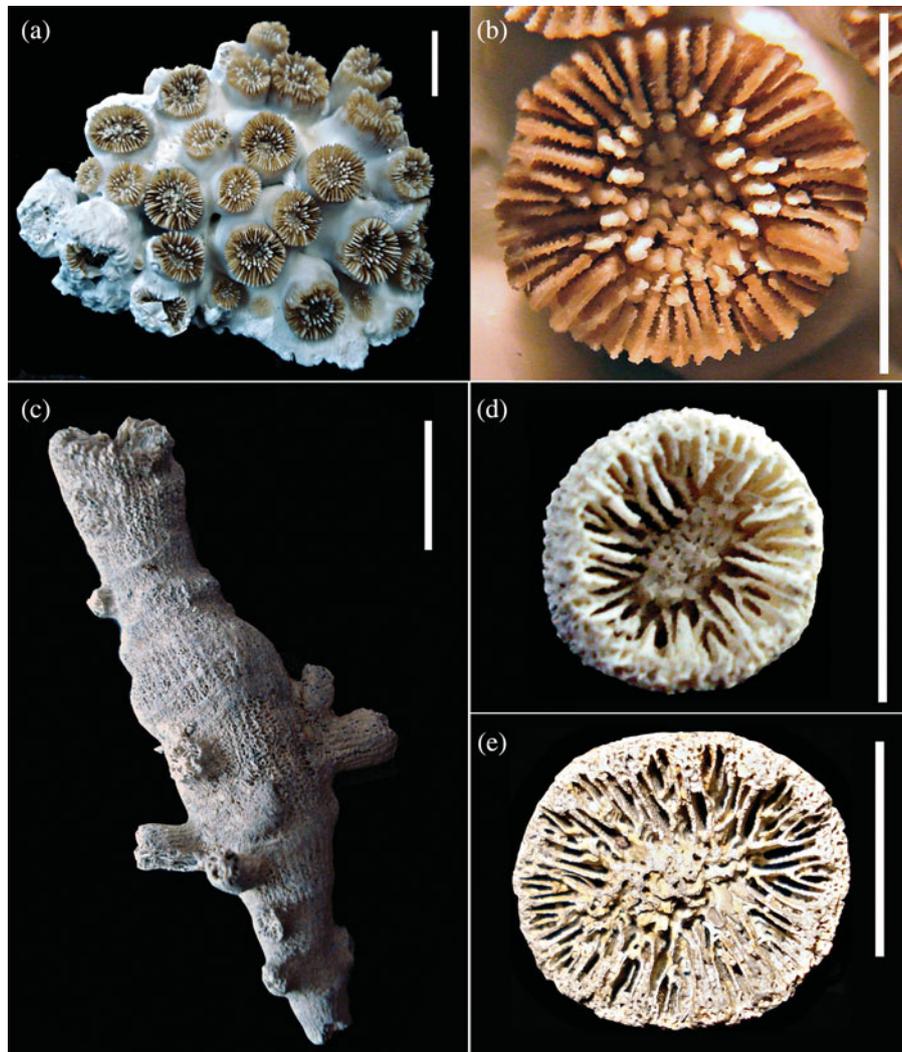


Fig. 2. (A, B) *Polycyathus senegalensis*: (A) colony view (MNRJ 8189); (B) calcicular view (LAR/UFRPE 399). (c–e) *Eguchipsammia cornucopia*: (C) lateral view (LAR/UFRPE 650); (D) (juvenile); (E) (adult) calcicular views (MNRJ 8190). Scale bar = 10 mm.

RANGE EXTENSIONS

Additionally to the report of *P. senegalensis* and *E. cornucopia*, the present study also expands the Brazilian occurrence of nine species previously recorded in Brazil (Table 2).

DISCUSSION

According to Kitahara (2007), the Brazilian coast can be considered as a transition region between the Caribbean and sub-Antarctic azooxanthellate coral fauna. However, among

Table 2. Brazilian azooxanthellate scleractinians with range extensions in Brazilian waters. *, geographical or bathymetric range extensions.

Species	Material examined	Latitudinal range in Brazil	Depth range in Brazil (m)
<i>Sphenotrochus auritus</i> Pourtalès, 1874	MOUFPE–CNI 028, Station 8	1°12'S–34°35'S	15–171*
<i>Madracis asperula</i> Milne-Edwards & Haime, 1849	MOUFPE–CNI 011, Station 6; MOUFPE–CNI 003, Station 2	1°54'S* (off Ceará State)–22°40'S	45–166*
<i>Astrangia solitaria</i> (Lesueur, 1817)	LAR/UFRPE 402, Station 1; LAR/UFRPE 299, Station 1	Northern Brazil, including St Peter and St Paul Archipelago (0°56'N)*	0–51
<i>Caryophyllia antillarum</i> Pourtalès, 1874	MOUFPE–CNI 024, Station 9	?–25°16'S* (off São Paulo State)	141*–1000
<i>Caryophyllia ambrosia caribbeana</i> Cairns, 1979	LAR/UFRPE 875 Station 4	0°18'S–27°34'S, including Fernando de Noronha Archipelago*	274–1326
<i>Premocyathus cornuiformis</i> (Portalès, 1868)	MOUFPE–CNI 019, Station 3	~5°00'S* (Potiguar Basin, Rio Grande do Norte state)–31°14'S	46–600
<i>Deltocyathus calcar</i> Pourtalès, 1874	MOUFPE–CNI 013, Station 7	9°01'S* (off Alagoas State)–32°40'S	91–560*
<i>Paracyathus pulchellus</i> (Philippi, 1842)	LAR/UFRPE 878, Station 5	00°18'N–33°37'S, including Recife (~8°S)*	183–310
<i>Flabellum apertum</i> Moseley, 1876	MOUFPE–CNI 020, Station 3	~5°00'S* (Potiguar Basin, Rio Grande do Norte State)–34°36'S	400–900

Table 3. Summary of the azooxanthellate scleractinian distributional gaps in Brazilian waters.

Species	Distributional gaps
<i>Astrangia rathbuni</i> Vaughan, 1906	Between Suriname (~6°N) and southern Bahia (~15°S) and between the states of Espírito Santo (~20°S) and Santa Catarina (~26°S)
<i>Caryophyllia antillarum</i> Pourtalès, 1874	Between Grenadine Islands (~12°40'N) and São Paulo State (~24°S)
<i>Caryophyllia berteriana</i> Duchassaing, 1850	Between Suriname (~6°N) and Espírito Santo State (~20°S)
<i>Caryophyllia paucipalata</i> Moseley, 1881	Between Lesser Antilles (~13°N) and Espírito Santo State (~20°S)
<i>Cladocora debilis</i> Milne-Edwards & Haime, 1849	Between Gulf of Paria, Venezuela (~11°N) and Espírito Santo State (~20°S)
<i>Cladopsammia manuelensis</i> (Chevalier, 1966)	Between Arrowsmith Bank, México (~21°N) and Santa Catarina State (~27°S)
<i>Coenocyathus parvulus</i> (Cairns, 1979)	Between Venezuela (~8°N) and southern Bahia (~17°S)
<i>Dendrophyllia alternata</i> Pourtalès, 1880	Between Gulf of Mexico (~25°N) and Rio de Janeiro State (~23°S)
<i>Deltocyathus eccentricus</i> Cairns, 1979	Between Amazonas river (~1°N) and centre of the Bahia State (~15°S)
<i>Deltocyathus moseleyi</i> Cairns, 1979	Between Bermuda (~32°N) and Espírito Santo State (~20°S)
<i>Deltocyathus pourtalesi</i> Cairns, 1979	Between Cuba (~21°N) and São Paulo State (~24°N)
<i>Desmophyllum dianthus</i> (Esper, 1794)	Between Lesser Antilles (~14°N) and Rio de Janeiro State (~22°S)
<i>Enallopsammia rostrata</i> (Portalès, 1878)	Between Nicarágua (~11°N) and Espírito Santo State (~20°S)
<i>Flabellum floridanum</i> Cairns, 1991	Between City of Panama (~9°N) and São Paulo State (~24°N)
<i>Javania cailletii</i> (Duchassaing & Michelotti, 1864)	Between Suriname (~6°N) and southern Bahia (~17°S)
<i>Polymyces fragilis</i> (Duchassaing & Michelotti, 1864)	Between Amazonas river (~1°N) and Rio de Janeiro State (~22°S)
<i>Rhizopsammia goesi</i> (Lindström, 1877)	Between Concepción, Bahamas (~23°N) and southern Bahia (~17°S)
<i>Schizocyathus fissilis</i> Pourtalès, 1874	Between Venezuela (~11°N) and centre of the Bahia State (~15°S)

the 63 azooxanthellate scleractinians recorded from the Brazilian EEZ, 16 have disjunct distribution (Table 3), with gaps particularly on the north-eastern Brazilian coast (see Cairns, 1979, 2000; Castro *et al.*, 2006; Kitahara, 2007; Pires, 2007). Apart from these species, *Deltocyathus eccentricus* Cairns, 1979 and *Polymyces fragilis* (Portalès, 1868) are considered to have disjunct distribution because they display more than 14° of latitudinal gap between the northernmost Brazilian record and their subsequent southern record (15°35'S and 29°20'S, respectively).

Apart from *Tubastraea coccinea* Lesson, 1829, an invasive species in Brazilian waters that most probably migrated through oil platforms (Paula & Creed, 2004), the disjunct distribution of all other azooxanthellate scleractinians in Brazilian waters is most probably due to low sampling efforts.

Beside the first record of 2 species of azooxanthellate scleractinians in the south-western Atlantic, the new distributional records reported herein are a step forward in our understanding of this poorly understood fauna. To summarize, the present study decreases the gap between the previous Brazilian records of *Caryophyllia ambrosia caribbeana* Cairns 1979, reporting this species from Fernando de Noronha Island, which indicates that this species probably has a continuous distribution along the Brazilian north-eastern coast. Furthermore, the new record of *Flabellum apertum* Moseley, 1876 from Potiguar Basin (northern Brazilian coast) is the northernmost record of this species thought to be restricted to temperate/sub-Antarctic waters.

With the addition of *Polycyathus senegalensis* Chevalier, 1966 and *Eguchipsammia cornucopia* (Portalès, 1871), the number of azooxanthellate scleractinians in Brazilian waters total 65. However, we believe that this number is still an underestimate for the species richness in this region.

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