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Asteroidea (Echinodermata) from shallow-waters of the remote oceanic archipelago Trindade and Martin Vaz, southeastern Atlantic, with taxonomic and zoogeographical notes

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Abstract

Trindade and Martin Vaz (TMV) is a highly isolated, oceanic volcanic archipelago located approximately 1200 km off the Brazilian coast and about 4200 km away from the nearest African coast. It has been almost 70 years since the first sea star, "*Astropecten* sp.", was recorded from Trindade in 1951. In the following years (1955–1971; 2006) six sea star species were added to the archipelago's fauna. After that period, however, research on shallow water echinoderms has not been conducted in TMV and no further sea star species have been recorded from there since. From 2012 to 2019, 263 daytime SCUBA diving and intertidal samplings conducted at TMV yielded 91 lots of sea stars in 7 species: *Linckia guildingi* Gray, 1840; *Oreaster reticulatus* (Linnaeus, 1758); *Astropecten* aff. *antillensis* Lütken, 1859; *Copidaster lymani* A. H. Clark, 1948; *Luidia alternata alternata* (Say, 1825); *Mithrodia clavigera* (Lamarck, 1816); and *Ophidiaster guildingi* Gray, 1840. The last five species in this list represent new records to the archipelago, with *C. lymani* also being the first record of the species in the southwestern Atlantic. Five shallow water species previously known from TMV have not been observed in the present survey: *Asterinides folium* (Lütken, 1860), *Astropecten brasiliensis* Müller & Troschel, 1842, *Astropecten cingulatus* Sladen, 1883, *Linckia nodosa* Perrier, 1875, and *Ophidiaster alexandri* Verrill, 1915. Twelve sea star species are currently known from shallow waters of TMV.

A list of all sea star species known from shallow waters (intertidal down to 100 meters) of the tropical southern-central Atlantic oceanic archipelagoes and islands (Ascension, Cape Verde, Fernando de Noronha, Gulf of Guinea, Rocas Atoll, Saint Helena, Trindade and Martin Vaz) with their gross distribution in the Atlantic Ocean was compiled in order to explore the existence of patterns of geographic distribution for the shallow water sea star species in the tropical southern-central Atlantic oceanic islands. It has been found that 44% of the species from TMV are of western Atlantic affinity, 33% amphi-Atlantic, and 22% circumtropical in distribution. No endemic sea star species are known from TMV to date. The even more remote Ascension (ASC) and Saint Helena (STH) are more of a mosaic than TMV. The ASC and STH fauna consist of 8 and 11 sea star species, respectively. Their endemic component totals to 25% and 27%, respectively. STH has more amphi-Atlantic and eastern Atlantic sea star species (27% each) than ASC (25% and 12.5%, respectively). Twenty-five percent of the sea star species in ASC are circumtropical in distribution, whereas no circumtropical species have been found in STH. The western Atlantic (WA) component comparatively to the eastern Atlantic (EA) one is of minor significance in STH (18% versus 27%, respectively), whereas the WA and EA components contribute equally to the taxonomic composition in ASC (12.5% each). However, patterns of faunal affinities in both islands are actually taxon-dependent.

Key words: Ascension, Brazil, Cape Verde, Gulf of Guinea, Rocas Atoll, Saint Helena, Seamounts

Introduction

Sea star research in the Trindade and Martin Vaz (TMV) oceanic archipelago dates back to 1951, when Oliveira (1951) recorded *Astropecten* sp. from the Trindade Island; and this specimen has never been identified down to species until the present date. In the following years some improvements were achieved with six additional sea star species recorded from TMV: *Asterinides folium* (Lütken, 1860); *Astropecten cingulatus* Sladen, 1883; *Linckia*

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guildingi Gray, 1840; *L. nodosa* Perrier, 1875; *Ophidiaster alexandri* Verrill, 1915; *Oreaster reticulatus* (Linnaeus, 1758) (Bernasconi, 1955; 1957a; 1957b; Brito, 1962; 1968; 1971; Ventura *et al*. 2006; 2007). After that period, however, research on shallow water echinoderms practically ceased to be conducted in TMV and hence no further sea star species have been recorded from there since (Table 1).

During an ongoing project coordinated by the second author (ProTrindade Research Program from CNPq – Brazilian National Research Council), eleven collecting campaigns aimed at inventorying the marine benthic invertebrates of TMV were conducted between 2012 and 2019, which resulted in about 650 lots of echinoderms (91 of which were sea stars), thus forming a solid base for taxonomic assessment of the shallow water echinoderm fauna of TMV (see previous results in Martins *et al*. 2016; Alitto *et al*. 2019). Here we report on the 12 shallow water sea star species known to date from TMV, five of which representing new records for TMV. The presence of *Copidaster lymani* A. H. Clark, 1948, in Trindade is the first record of that species in the southwestern Atlantic. A key to the species of TMV is provided.

Opportunity was taken to explore the existence of patterns of geographic distribution for the Asteroidea fauna of the tropical southern-central Atlantic oceanic islands.

TABLE 1. List of the Asteroidea associated with the south-central Atlantic oceanic islands, from the intertidal down to 100 m. ASC, Ascension; CVA, Cape Verde Archipelago; FN, Fernando de Noronha; GOG, Gulf of Guinea: São Tomé, Príncipe and Annobón; RA, Rocas Atoll; STH, St. Helena; TMV, Trindade and Martin Vaz Archipelago; VTSC, Vitória-Trindade Seamount Chain. Gross geographic distribution in the Atlantic Ocean: AA, anfiatlantic; CT, circumtropical; EA, eastern Atlantic; WA, western Atlantic; EN, Endemic. (*) Species first recorded from TMV; (**) doubtful records.

Species/Islands	ASC	CVA	FN	GOG	RA	STH	TMV	VTSC	
Astropectinidae									
Astropecten africanus Koehler, 1911	-	X	-	-	-	-	-	-	EA
Astropecten aff. *antillensis**	-	-	-	-	-	-	X	-	WA
Astropecten aranciacus (Linnaeus, 1758)	-	X	-	X	-	-	-	-	EA
Astropecten brasiliensis Müller & Troschel, 1842	-	-	X	-	-	-	X	-	WA
Astropecten cingulatus Sladen, 1883	-	-	-	-	-	-	X	X	WA
Astropecten ibericus Perrier, 1894	-	-	-	X	-	-	-	-	EA
Astropecten irregularis irregularis (Pennant, 1777)	-	X	-	-	-	-	-	-	EA
Astropecten sanctaehelenae Mortensen, 1933	-	-	-	-	-	X	-	-	EN
Astropecten variegatus Mortensen, 1933	X	-	-	-	-	X	-	-	EN
Psilaster andromeda andromeda (Müller & Troschel, 1842)	-	X	-	-	-	-	-	-	EA
Tethyaster vestitus magnificus (Bell, 1881)	X	-	-	-	-	X	-	-	EN
Tethyaster vestitus vestitus (Say, 1825)	-	-	-	-	-	-	-	X	WA
Luidiidae									
Luidia alternata alternata (Say, 1825)*	-	X	-	-	-	-	X	X	AA
Luidia alternata numidica Koehler, 1911	-	X	-	-	-	-	-	-	EA
Luidia atlantidea Madsen, 1950	-	X	-	-	-	-	-	-	EA
Luidia ciliaris (Philippi, 1837)	-	X	-	-	-	-	-	-	EA
Luidia clathrata (Say, 1825)	-	-	-	-	-	-	-	X	WA
Luidia sagamina aciculata Mortensen, 1933	-	-	-	-	-	X	-	-	AA

....Continued next page

TABLE 1. (Continued)

Species/Islands	ASC	CVA	FN	GOG	RA	STH	TMV	VTSC	
Luidia sarsii sarsii Duben & Koren, 1844	-	X	-	-	-	-	-	-	EA
Asterinidae									
Asterinides folium (Lutken, 1860)	-	-	-	-	-	-	X	X	WA
Asterinides pilosa (Perrier, 1881)**	-	-	-	-	-	-	-	X	WA
Parvulastra exigua (Lamarck, 1816)	-	-	-	-	-	X	-	-	EA
Chaetasteridae									
Chaetaster longipes (Bruzelius, 1805)	X	X	-	-	-	X	-	-	EA
Goniasteridae									
Goniaster tessellatus (Lamark, 1816)	-	X	-	-	-	-	-	-	AA
Nymphaster arenatus (Perrier, 1881)	-	X	-	-	-	-	-	-	AA
Pawsonaster parvus (Perrier, 1881)	-	X	-	-	-	-	-	-	AA
Plinthaster dentatus (Perrier, 1884)	-	X	-	X	-	-	-	-	AA
Mithrodiidae									
Mithrodia clavigera (Lamarck, 1816)*	X	-	X	-	-	-	X	X	CT
Ophidiasteridae									
Copidaster lymani A. H. Clark, 1948*	X	-	-	-	-	-	X	-	WA
Hacelia attenuata Gray, 1840	-	X	-	X	-	-	-	-	EA
Hacelia superba H. L. Clark, 1921	-	X	-	X	-	X	-	-	AA
Linckia guildingi Gray, 1840	X	X	-	-	X	-	X	-	CT
Linckia bouvieri Perrier,1875	-	X	-	X	-	-	-	-	EA
Linckia nodosa Perrier, 1875**	-	-	-	-	-	X	X	-	WA
Narcissia canariensis (d´Orbigny, 1839)	-	X	-	X	-	-	-	-	EA
Narcissia trigonaria Sladen, 1889	X	-	-	-	-	X	-	-	WA
Ophidiaster alexandri Verrill, 1915	-	-	-	-	-	-	X	X	WA
Ophidiaster guildingi Gray, 1840*	X	X	-	X	-	-	X	-	AA
Ophidiaster ophidianus (Lamarck, 1816)	-	X	-	X	-	X	-	-	EA
Oreasteridae									
Oreaster clavatus Müller & Troschel, 1842	-	X	-	X	-	-	-	-	EA
Oreaster reticulatus (Linnaeus, 1758)	-	-	-	-	-	-	X	-	WA
Echinasteridae									
Echinaster (*Echinaster*) *sepositus sepositus* (Retzius, 1783)	-	X	-	-	-	-	-	-	EA
Echinaster (*Othilia*) *brasiliensis* Müller & Troschel, 1842	-	-	-	-	-	-	-	X	WA
Brisingidae									
Hymenodiscus coronata (Sars, 1871)	-	X	-	-	-	-	-	-	EA
Asteriidae									
Coscinasterias tenuispina (Lamarck, 1816)	-	X	-	-	-	X	-	-	AA
Marthasterias glacialis (Linnaeus, 1758)	-	X	-	X	-	-	-	-	EA
	ASC	CVA	FN	GOG	RA	STH	TMV	VTSC	
Total	8	26	2	11	1	11	12	9	

Material and methods

Trindade (20°30'S, 29°20'W) and Martin Vaz (20°30'S, 28°51'W) are the aerial parts of the Vitória-Trindade submarine volcanic chain (Marques *et al.* 1999; Santos *et al.* 2002) (Fig. 1). The islands are as close as 49 km from each other, but remotely distant from the Brazilian and African coasts, about 1200 km and 4200 km away, respectively. Their nearest neighbor oceanic islands are Fernando de Noronha (1884 km), Rocas Atoll (1915 km), Ascension (2134 km), St. Peter and St. Paul Rocks (2387 km) and St. Helena (2546 km).

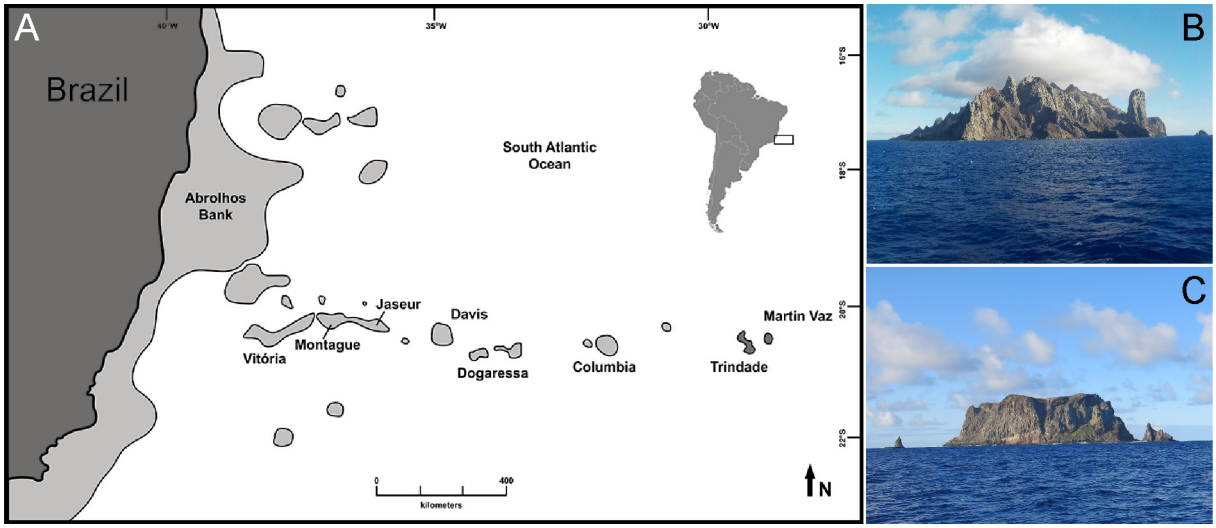

FIGURE 1. A. Diagrammatic East-West oriented cross-section of the volcanic Vitoria-Trindade Seamount Chain. Brazil's landmass in dark grey. **B, C.** Trindade and Martin Vaz islands, respectively. Photographs by J.B. Mendonça Jr.

Samples were taken mainly during day time hours and consisted of 263 SCUBA diving surveys conducted between 2012 and 2019 in various habitats down to about 30 m, as well as numerous snorkeling dives and intertidal collecting (Fig. 2). Study details including sampling methods have been explained in previous works (Anker *et al.* 2016; Martins *et al.* 2016; Tavares *et al*. 2017; Alitto *et al*. 2019).

All specimens were preserved in 70% ethanol, some of which were photographed alive prior to preservation. Whenever possible, specimens from TMV were compared with conspecific specimens from the western Atlantic continental shelf.

A checklist of all shallow water (intertidal down to 100 meters) sea star species recorded from the tropical southern-central Atlantic oceanic islands (Ascension, Cape Verde, Fernando de Noronha, Gulf of Guinea, Rocas Atoll, Saint Helena, Trindade and Martin Vaz) with their gross distribution in the Atlantic Ocean is given in Table 1. That checklist was used to look for the existence of patterns of geographic distribution for the Asteroidea fauna of the tropical southern-central Atlantic oceanic islands. The exclusively deep-water *Mediaster pedicellaris* (Perrier, 1881) (from 197 to 576 m. See Clark & Downey, 1992) was included in the key to the species of Asteroidea from the Brazilian oceanic islands, but was not considered further.

The general terminology for Asteroidea morphology follows Clark & Downey (1992) and Mah (2019). For explanations of terminology see glossary in Clark & Downey (1992). Synonymies are limited to the original reference and some additional references published after 1992; previous to that year the relevant synonyms can be found in Clark & Downey (1992).

Photographs of preserved material were taken with a Zeiss stereomicroscope (AxioVision V4.8 software). Pedicellariae and plates were dried and mounted on metal stubs with double-sided tape, coated with gold and observed with a LEO 440 Scanning Electron Microscope (SEM). Measurements of asteroids were obtained from ethanol fixed specimens, and they are in millimeters (mm).

As it has been generally poorly documented, the morphology of the skeletal plates at the SEM level is difficult to compare across recent sea star species. Yet, photomicrographs of the carinal, abactinal, dorsolateral, adradial, superomarginal, inferomarginal, actinal, ambulacral, adambulacral and oral plates, and of the pedicellariae, spines, stereom and paxillae are provided, since it is thought to be of value to document their morphology in the studied species.

The spelling of the geographical names follows the National Geographic Atlas of the World, 8th edition, Washington DC. The dates are written in the format day.month.year, with months in lower-case Roman numerals.

The specimens studied herein have been deposited in the collections of the UF (Florida Museum of Natural History), MCZ (Museum of Comparative Zoology, Harvard University, Cambridge), MZUSP (Museu de Zoologia, Universidade de São Paulo), UFPB (Universidade Federal da Paraiba, Brazil), USNM (National Museum of Natural History, Smithsonian Institution, Washington, DC) and ZMUC (Zoological Museum, University of Copenhagen). Other abbreviations and acronyms include: AA, anfiatlantic; ASC, Ascension Island; coll., collector; COS, cosmopolitan; CT, circumtropical; EA, eastern Atlantic; EN, endemic; EP, eastern Pacific; km, kilometers; m, meters; MED, Mediterranean Sea; NWP, Northwestern Pacific; spm, specimen; stn, station; s. str., *sensu stricto*; STH, Saint Helena Island; WA, western Atlantic.

FIGURE 2. A–F. Trindade Island. **A.** Rocky beach and tide pool. **B–F.** Sublittoral habitats at water depths of less than 30 m: **B.** Calcareous reefs and rhodolith beds. **C.** Rocky and calcareous boulders of various sizes. **D.** Sand bottom with patches of calcareous reefs. **E.** Mixed sand, gravel, rocky bottoms with patches of sponges and macro algae. **F.** Calcareous reefs with algal mats.

Taxonomic account

Valvatida Perrier, 1884

Ophidiasteridae Verrill, 1870

Copidaster A. H. Clark, 1948

Copidaster lymani A. H. Clark, 1948

Figures 3, 4A

Copidaster lymani A. H. Clark, 1948: 55, pl. 2, figs. 1–2 [type locality: Key Largo, Florida, viz. Clark & Downey, 1992]; Hendler *et al.*, 1995: 76, fig. 19; Fernádez, 2001: 134.

Trindade specimens. Brazil, Espírito Santo, Trindade Island, Enseada das Orelhas, 20°29'40.2"S, 29°20'32.9"W, 27.vii.2015, 10.5 m: 1 spm R=112, r=11 (MZUSP 1547); 12.xi.2014, 6.9 m: 1 spm R=113, r=9 (MZUSP 1548); 13.xi.2014, 14.4 m: 3 spms R=107, r=11; R=122, r=10; R=160, r=10 (MZUSP 1550); 24.x.2014, 15.4 m: 1spm R=138, r-11 (MZUSP 1551). Ponta Noroeste, 20°29'46.4"S, 29°20'35.4"W, 7.iv.2012, 11.6 m: 1 spm R=124, r=9 (MZUSP 1546). Enseada do Lixo, 20°31'29.8"S, 29°19'43.9"W, 7.ii.2012, 25 m: 1 spm R=115, r=9 (MZUSP 1549).

Comparative material. *Copidaster lymani* A. H. Clark, 1948: U.S.A., Gulf of Mexico, Florida, Dry Tortugas, 24°47'35.52"N, 83°52'50.27"W, 29.iv.1997, 95 m: 1 spm R=62, r=7 (UF–3372). *Copidaster schismochilus* (H.L. Clark, 1922): Bermuda, Challenger Bank, 32°00'N, 65°00'W, 1.viii.1903, 56 m: holotype, R=98, r=10 (MCZ AST–2758).

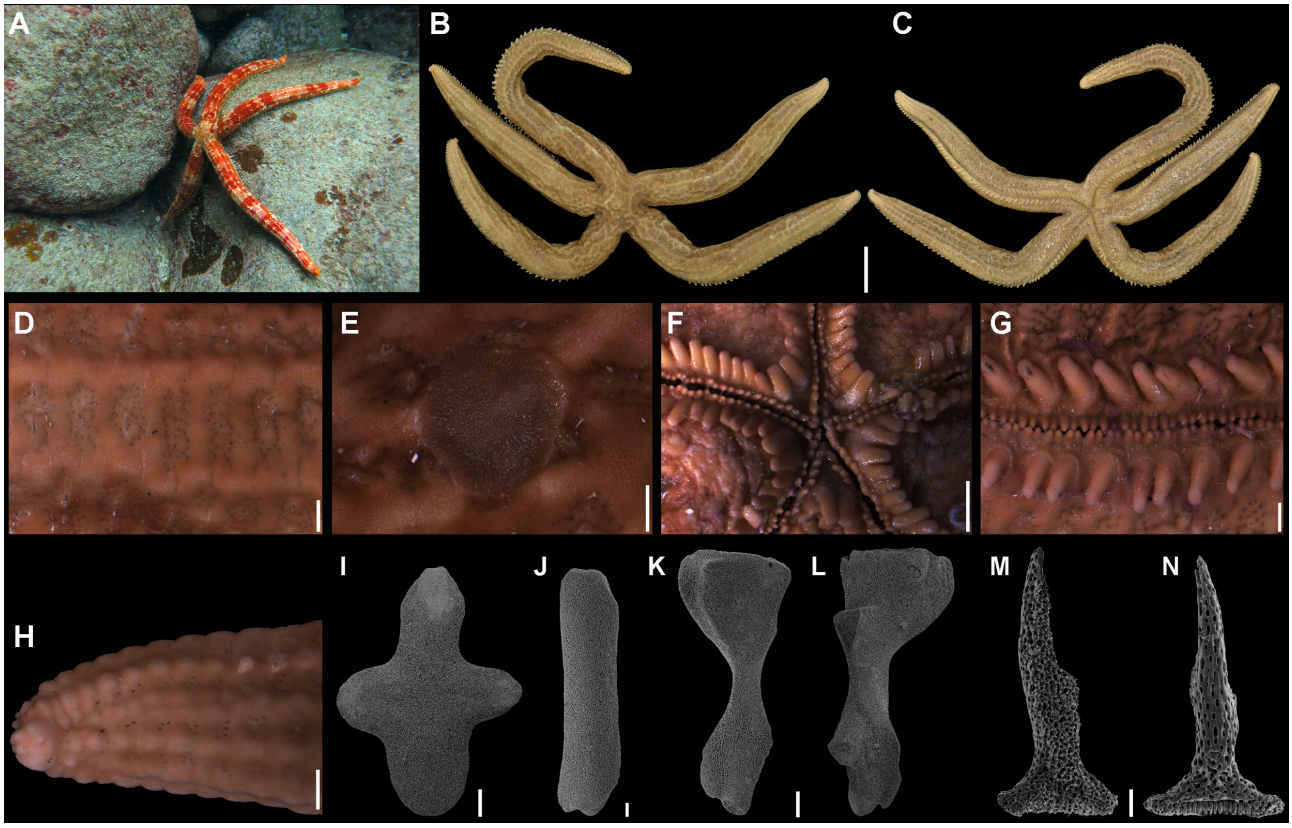

FIGURE 3. *Copidaster lymani* A. H. Clark, 1948. **A–N.** MZUSP 1550: **A.** Specimen from Trindade Island photographed *in situ*. **B, C.** Abactinal and actinal views. **D.** Abactinal plates and papulae. **E.** Detail of the madreporite. **F.** Mouth. **G.** Ambulacral spines. **H.** Tip of the arm, abactinal view. **I–N.** Scanning electron microscope. **I, J.** Abactinal plates. **K, L.** Ambulacral plates. **M, N.** Valves of the abactinal pedicellariae. Scale bars: B–C, 20 mm; D–H, 2 mm; I, K–L, 400 µm; J, 200 µm; M–N, 40 µm.

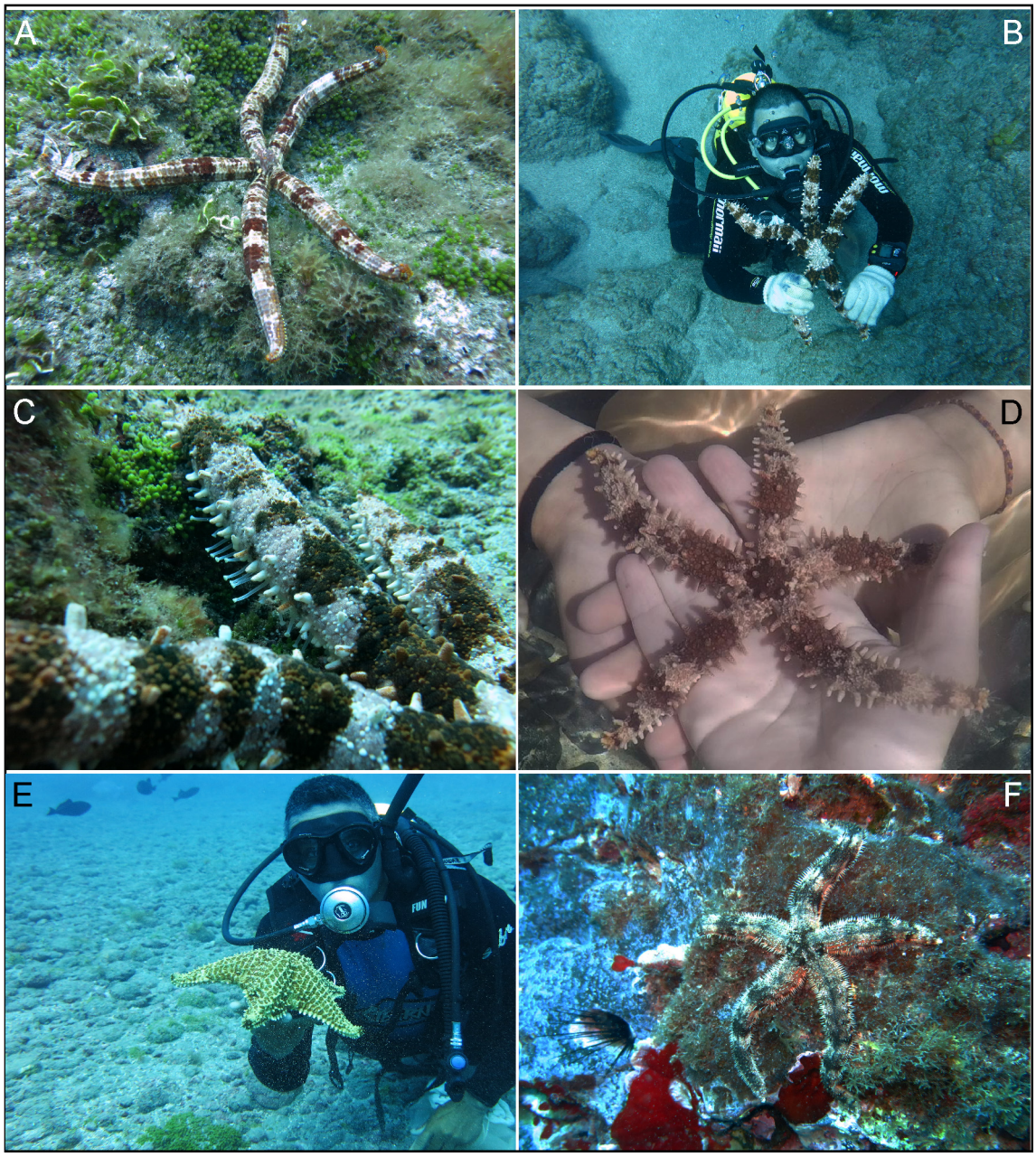

FIGURE 4. A. *Copidaster lymani* A. H. Clark, 1948, Trindade Island, Enseada das Orelhas. **B–D.** *Mithrodia clavigera* (Lamarck, 1816). **B, C.** Trindade Island, Príncipe beach. **D.** Fernando de Noronha, tide pool at Boldró beach. Photograph by Gabriela C. Zeineddine. **E.** *Oreaster reticulatus* (Linnaeus, 1758), Trindade Island, Enseada dos Portugueses, Farol. **F.** *Luidia alternata alternata* (Say, 1825) Trindade Island, Ponta da Calheta.

Distribution. U.S.A. (Florida), Mexico, Cuba, Belize, Panama, Brazil (Trindade Island, present study), Ascension Island (Hendler *et al*., 1995; Fernádez, 2001; Alvarado & Solis-Marin, 2013). Depth range: 0–95 m (Clark & Downey, 1992; present study)**.**

Recognition characters. Five long, cylindrical arms, up to 10 times longer than length of disc, constricted at bases. Abactinal plates flattened, T-shaped, imbricated. Second, long, abactinal plate bar-like connecting anterior plates laterally. Skeleton covered with gelatinous membrane**.** Carinal and adradial series of plates connected to each other by single internal plate at proximal half of ray. Acute subambulacral spines very close to each other, not embedded in dense integument of body wall. Pedicellariae between ambulacral and subambulacral spines, abundant (Miller, 1984; Clark & Downey, 1992; Solis-Marin & Laguarda-Figueras, 2010; Kogure & Kohtsuka, 2014; present study).

Color in life. Reddish tan or orange, with darker red mottling or banding, Figure 3A (see also Clark & Downey, 1992). Subambulacral spines and furrow spines white proximally and distally, orange medially. Pedicellariae and madreporite white, conspicuously contrasted by darker surrounding skin (Miller, 1984). Yellowish cream in ethanol (Figure 3B, C).

Habitats. *Copidaster lymani* inhabits both hard (coral reefs, rock, rubbles, and calcareous algae) and soft-mixed bottoms (mud, sand) (Miller, 1984; Fernádez, 2001; Alvarado & Solis-Marin, 2013). The specimens from Trindade were found sheltered in rocky and calcareous bottoms or among calcareous algae (Figures 3A, 4A) between 6.9 and 25 meters. In aquarium captivity, *C. lymani* concealed itself under rocks and remained motionless for long periods of time (Fernádez, 2001). Miller (1984) reported the co-occurrence of *C. lymani* and *Linckia guildingi* Gray, 1840 (as *Ophidiaster guildingi*), in the same area at Carrie Bow Cay (Belize). Similarly, the two species co-occurred in Trindade.

Comments. *Copidaster* A. H. Clark, 1948 (sensu Miller, 1984, and Clark & Downey, 1992) consists of four species: *C. cavernicola* Solis-Marin & Laguarda-Figueras, 2010 (WA); *C. japonicus* Kogure & Kohtsuka, 2014 (NWP); *C. lymani* A. H. Clark, 1948 (WA), and *C. schismochilus* (H. L. Clark, 1922) (WA). The specimens from Trindade are confidently assigned to *C. lymani*. *Copidaster lymani* can be immediately separated from *C. cavernicola* in having pedicellariae between the ambulacral and subambulacral spines (whereas these areas are naked in *C. cavernicola*). Clark & Downey (1992), while accepting both *C. schismochilus* and *C. lymani* as valid species, admitted that *C. schismochilus* might be "simply a large, possibly senescent, specimen of [*C.*] *lymani*". We concur with Clark & Downey's (1992) observation that the number of papulae is higher in the holotype of *C. schismochilus* than in *C. lymani*. However, this characteristic should not be used to separate between the two species. In the Trindade specimens (R= 105–160) the number of papulae varies with the size of the specimen as well as with the papular region considered (see also Miller (1984)). Near the disc and in the distal region of the arm, the amount of papulae is always smaller (8–12) relative to the rest of the arm (18–32) (Fig. 3D). We agree with Miller (1984) that *C. lymani* actually stands apart from *C. schismochilus* in that its carinal and adradial series of plates (Fig. 3I) are connected to each other by a single internal plate (Fig. 3J) in the proximal half of the ray (Fig. 3D), whereas 2–3 dorsolateral plates connect the carinal and adradial series of plates in *C. schismochilus*. *Copidaster lymani* can be separated outright from *C. japonicus* in having acute subambulacral spines very close to each other, not embedded in the dense integument of the body wall (Fig. 3G) (*versus* clavate subambulacral spines apart from each other, embedded in body wall with only the thick tip protruding in *C. japonicus*).

The presence of *C. lymani* in Trindade constitutes the first record of the species from the southwestern Atlantic.

Linckia Nardo, 1834

Linckia guildingi Gray, 1840

Figure 5

Linckia guildingii Gray, 1840: 285 [type locality: San Vicente, Caribbean Sea, viz. Clark & Downey, 1992]; Hendler *et al.*, 1995: 76, figs. 20–21; Benavides-Serrato *et al*., 2011: 174; Fernandes *et al*. 2002: 422; Gondim *et al*. 2008: 154.

Linckia guildingi – Pérez-Ruzafa *et al*. 1999: 47; Williams, 2000; Entrambasaguas, 2008: 63; Miranda *et al*. 2012: 144; Gondim *et al*. 2014: 32, figs. 10a–e, 12d.

Trindade and Martin Vaz specimens. Brazil, Espírito Santo, Trindade Island, Enseada das Orelhas, 20°29'40.2"S, 29°20'32.9"W, 6.vii.2013, 14 m: 1 spm R=83, r=10 (MZUSP 1591); 18.iv.2014, 12.1 m: 1 spm R=127, r=13 (MZUSP 1604); 15.vi.2012, 9.7 m: 1 spm R=100, r=12 (MZUSP 1608). Praia das Cabritas, 20°29'41"S, 29°19'39"W, 5.xi.2014, 13.7 m: 1 spm R=93, r=11 (MZUSP 1590). Ponta Noroeste, 20°29'46.4"S, 29°20'35.4"W, 9.vii.2012, 17.7 m: 1 spm R=170 , r=13 (MZUSP 1594). Praia da Calheta, 20°30'26"S, 29°18'44"W, 24.vi.2012, 4 m: 4 spms, R=93, r=13; R=95, r=10; R=100 , r=10; R=110, r=10 (MZUSP 1593); 14.vii.2013, 4 m: 2 spms, R=70, r=9; R=113, r=12 (MZUSP 1599); 26.vi.2012, 14.3 m: 1 spm, R=120, r=10 (MZUSP 1606); 18.vi.2012, 12 m: 1 spm, R=100, r=8 (MZUSP 1602); 10.iv.2014, 15 m: 1 spm, R=95, r=9 (MZUSP 1605); 24.iv.2012, 4 m: 2 spms, R=77, r=8; R=97, r=8 (MZUSP 1610). Parcel das Tartarugas, 20°30'37.6"S, 29°18'28.1"W, 28.vi.2012, 0 m: 1 spm R=90, r=8 (MZUSP 1592). Enseada dos Portugueses, Farol, 20°30'52"S, 29°19'15"W, 17.iv.2014, 13.3 m: 1 spm R=97, r=9 (MZUSP 1589); 15.vii.2013, 12 m: 1 spm R=83, r=10 (MZUSP 1598). Enseada dos Portugueses, 20°30'52.3"S,

29°19’15.6”W, 8.vii.2015, 11.6 m: 1 spm R=43, r=5 (MZUSP 1585); 31.vii.2015, 0 m: 1 spm R=105, r=11 (MZUSP 1586); 18.iv.2014, 10.2 m: 3 spms R=47, r=6; R=53, r=11; R=60, r=7 (MZUSP 1588); 10.vii.2012, 14.6 m: 1 spm R=43, r=4 (MZUSP 1613). Enseada das Tartarugas, 20°30’56.7”S, 29°18’08.7”W, 5.vii.2013, 0 m: 5 spms, R=27, r=4; R=34, r=6; R=44, r=6; R=47, r=5; R=82, r=9 (MZUSP 1583); 2.ii.2012, 15.2 m: 1 spm R=108, r=11 (MZUSP 1595); 3.viii.2013, 12 m: 3 spms R=93, r=12; R=110, r=13; R=120, r=12 (MZUSP 1597); 17.vii.2013, 9.9 m: 1 spm R=100 , r=10 (MZUSP 1601); 26.vi.2012, 9.5 m: 1 spm R=113, r=11 (MZUSP 1607). Praia das Tartarugas, 20°31’03.89”S, 29°18’08.4”W, 12.iv.2014, 0 m: 1 spm R=48, r=6 (MZUSP 1587). Enseada das Cachoeiras, Farrilhões, 20°31’22”S, 29°19’52”W, 9.vii.2013, 10.4 m: 1 spm R=165, r=13 (MZUSP 1596). Enseada do Lixo, 20°31’33.9”S, 29°19’33.6”W, 24.vi.2012, 23.5 m: 3 spms R=170, r=13; R=230, r=15; R=260, r=10 (MZUSP 1603). Martin Vaz Island, 20°30’45.7”S, 29°18’21.9”W, 24.vii.2013, 12.3 m: 1 spm R=90, r=14 (MZUSP 1600).

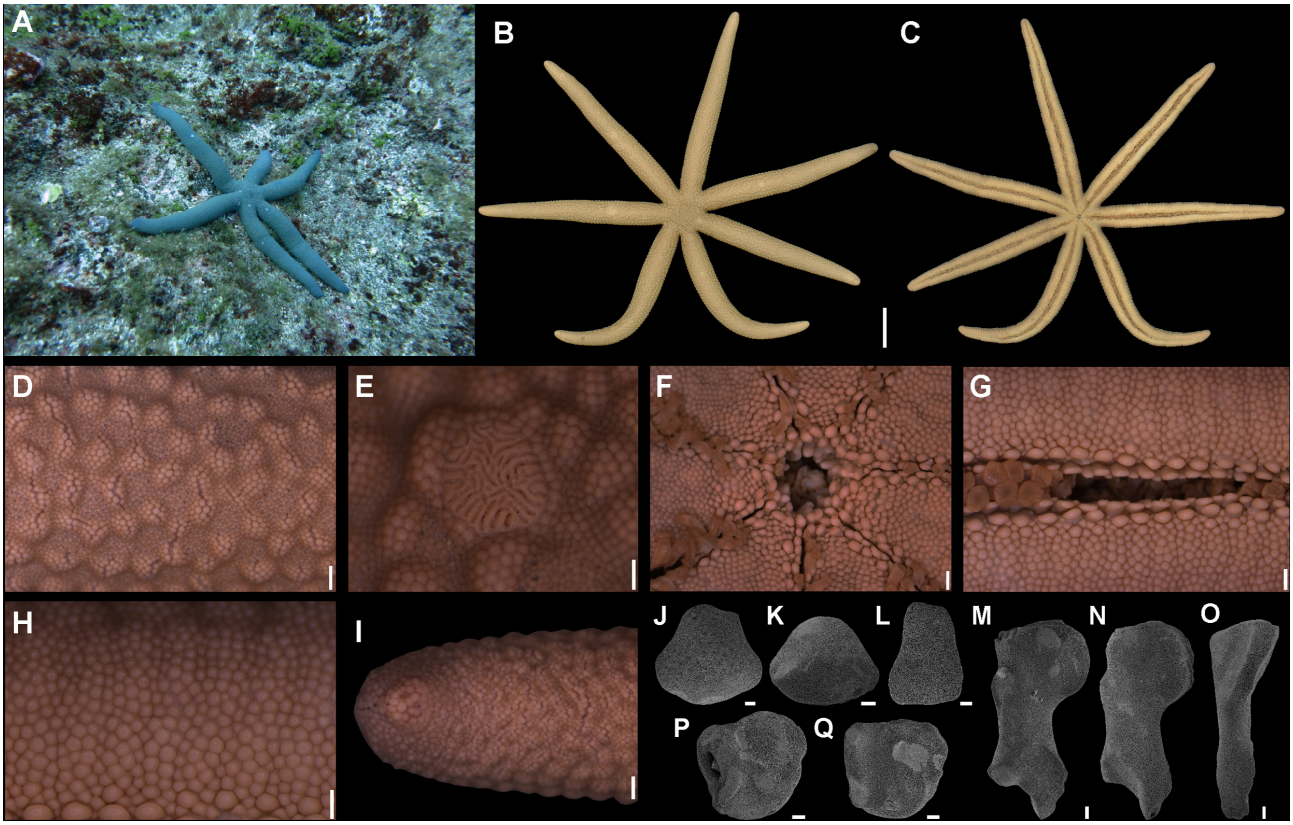

FIGURE 5. *Linckia guildingi* Gray, 1840. **A.** Specimen from Trindade Island photographed *in situ* (MZUSP 2015). **B–I.** MZUSP 1595: **B, C.** Abactinal and actinal views. **D.** Abactinal plates and papulae. **E.** Detail of the madreporite. **F.** Mouth. **G.** Ambulacral spines. **H.** Actinal granules. **I.** Tip of the arm, abactinal view. **J–Q.** Scanning electron microscope (MZUSP 1591). **J–L.** Abactinal plates. **M–O.** Ambulacral plates. **P, Q.** Adambulacral plates. Scale bars: B–C, 20 mm; D–I, 1 mm; J–Q, 200 µm.

Comparative material. Brazil, Alagoas, Barra de Camaragibe, 9°20’19”S, 35°26’10”W, 29.x.2011: 1 spm R=57, r=6 (MZUSP 1949). Bahia, Boipeba Island, Praia de Tassimirim, 13°34.882’S, 38°54.821’W, 15.viii.2011: 2 spms R=55, r=7; R=46, r=4 (MZUSP 1950); Praia de Bainema, 13°38.274’S, 38°53.546’W, 19.viii.2011: 2 spms R=90, r=8; R=95, r=8 (MZUSP 1951); Porto Seguro, Ponta Grande, 16°22.641’S, 39°00.342’W, 16.xi.2010, 0.6 m: 6 spms, R=26, r=5; R=60, r=6; R=60, r=7; R=61, r=7; R=62, r=6; R=63, r=6 (MZUSP 1952). Rio de Janeiro, Angra dos Reis, Ponta do Bananal, 23°04’23”S, 44°09’49”W, 20.i.2000: 1 spm, R=88, r=11 (MZUSP 1953); Ilha Grande, Grumixama, 23°05’16”S, 44°14’14”W, 23.vii.1966: 1 spm, R=62, r=8 (MZUSP 1954); Jorge Grego Island, 23°13’06”S, 44°13’65”W, 9.viii.2009: 1 spm, R=110, r=11 (MZUSP 1955).

Distribution. Circumtropical (Clark & Downey, 1992; Alvarado & Solis-Marin, 2013; Gondim *et al*. 2014). Brazil: Paraíba, Pernambuco, Alagoas, Bahia, Trindade and Martin Vaz Archipelago, Rio de Janeiro and São Paulo (Verril, 1868; Rathbun, 1879; Verril, 1915; Brito, 1960, 1968; Tommasi, 1970; Clark & Downey, 1992; Ventura *et al*., 2006; Gondim *et al*., 2014). Depth range: 0–298 m (Clark & Downey, 1992).

Recognition characters. Small disk in relation to total body size. Five (4–6) long, narrow, cylindrical arms. Abactinal plates tumid, polygonal, tessellate, irregularly arranged in a reticulate pattern**.** Primary plates on abactinal

surface without secondary plates between them. Many large papular areas between abactinal plates, with 18–30 pores per area. Lowermost papular area above inferomarginal plates. Two rows of subambulacral spines, innermost consisting of large, granuliform, more rounded spines; one subambulacral spine for each two ambulacral spines. Pedicellariae absent (Clark & Rowe, 1971; Clark & Downey, 1992).

Color in life. Strongly variable. Adults have been reported to be reddish-brown, yellowish-brown, brownish or violet, whereas juveniles can be red, brown, violet or with purple spots (Hendler *et al*. 1995). Clark & Downey (1992) referred to "usually mottled grey". The Trindade were blue gray in color with scattered light spots (Figure 5A). H. L. Clark (1933) suggested that changes in color pattern in this species might be related to habitat, but recently, Entrambasaguas (2008) found no evidence of changes in color pattern induced by habitat in *L. guildingi*. Genetic differentiation has been found between blue and orange morphs of *L. laevigata* across the Indian and Pacific oceans (Magsino *et al*. 2002). However, Williams (2000) recovered two clades within *L. guildingi* based on COI sequences, none of which referable to color or geographic distribution patterns.

Habitats. Commonly encountered on coral reefs (Williams, 2000), this is the most frequently encountered species in Trindade, where it can be found on corals, algae or rocky bottoms, between the tide zone and 23.5 m (Figure 5A).

Comments. Nine species of *Linckia* are currently accepted, three of which have been recorded from the Atlantic Ocean: *L. bouvieri* Perrier, 1875 (EA); *L. nodosa* Perrier, 1875 (WA; also Saint Helena), and *L. guildingi* Gray, 1840 (CT, including Ascension). The specimens from Trindade and Martin Vaz are confidently assigned to *L. guildingi* on the basis of it having many large papular areas between the abactinal plates, primary plates on abactinal surface without secondary plates between them, and no large, raised hemispherical abactinal plates (Fig. 5D), whereas *L. bouvieri* and *L. nodosa* display smaller papular areas, secondary plates between the primary ones, and have large, raised hemispherical abactinal plates. A single specimen, confidently referred to *L. guildingi* by Pawson (1978), is known from Ascension. Although Downey (1973) considered *L. nodosa* [as *L. bouvieri*] (R=134; R=144) the largest western Atlantic Ophidiasteridae, some Trindade specimens of *L. guildingi* are actually larger (R=165, MZUSP 1596; R=170, MZUSP 1594; MZUSP 1603; R=230 and R=260, MZUSP 1603).

Linckia nodosa Perrier, 1875

Linckia nodosa Perrier, 1875: 153, 417 [type locality: unknown, viz. Clark & Downey, 1992].

Distribution. United States (North Carolina), Mexico, Cuba, Antilles, Venezuela, Brazil (Pará and Maranhão (present study), Trindade Island, Rio de Janeiro, Rio Grande do Sul), Saint Helena island, Canary Islands, Cape Verde (Downey, 1968; Tommasi, 1970; Brito, 1971; Tommasi & Oliveira, 1976; Carrera-Rodriguez & Tommasi, 1977; Clark & Downey, 1992; Alvarado & Solis-Marin, 2013). Depth range: 35–475 m (Clark & Downey, 1992).

Color in life. Dorsal plates cream-yellow, spaces between plates reddish-orange, pale tan underneath. Color in formalin: light purple (Mortensen, 1933; Moore, 1960).

Habitats. Inhabits hard and soft substrates including coral reefs, rocky and sandy bottoms (Pawson *et al*. 2009; Alvarado & Solis-Marin, 2013).

Comments. *Linckia nodosa* was recorded only once from Trindade (Praia dos Portugueses) based on a single specimen (R= 45) (Brito, 1971). Brito (1971) referred the Trindade specimen to *L. nodosa* in that it had 5 arms (versus 6–7 arms of different sizes in *L. guildingi*) and larger spines in the first row of ambulacral spines. Additionally, the surface of the arms and disc appeared more "coarse" and the actinal surface more flatter in *L. guildingi*. However, as currently accepted (Clark & Downey,1992), *L. nodosa* is best recognized by the presence of small plates (secondary plates) between the larger primary plates of the abactinal surface, and large, raised hemispherical abactinal plates (*versus* absence of small plates between the larger primary plates and large, raised hemispherical abactinal plates in *L. guildingi*). Because we have not been able to locate Brito's specimen, confirmation as to whether the occurrence of *L. nodosa* in Trindade comes from confusion with *L. guildingi* cannot be ascertained here.

According to Clark & Downey (1992) *L. nodosa* and *L. bouvieri* are restricted to the western and eastern sides of the Atlantic, respectively. Recently, however, this purported distribution pattern has been confused by the record of *L. bouvieri* from the Mexican and Cuban coasts (Alvarado & Solis-Marin, 2013), and the record of the *L. nodosa* to Cape Verde (Downey, 1968). The morphological distinctness between *L. nodosa* and *L. bouvieri* needs further elaboration before any pattern of distribution is recognizable.

Ophidiaster L. Agassiz, 1836

Ophidiaster alexandri Verrill, 1915

Ophidiaster alexandri Verrill, 1915: 91, pl. 13, figs. 3–3b, pl. 25, fig. 2 [type locality: off Georgia, viz. Clark & Downey, 1992]; Alvarado & Solis-Marin, 2013: 612.

Distribution. Georgia, Florida, Gulf of Mexico, Cuba, Windward Islands, Brazil (Vitória-Trindade Seamount Chain, Martin Vaz Archipelago, Rio Grande do Sul) (Verrill, 1915; Clark, 1954; Tommasi, 1970; Carrera-Rodriguez & Tommasi, 1977; Clark & Downey, 1992; Ventura *et al*., 2006; Alvarado & Solis-Marin, 2013). Depth range: 52–585 m (Alvarado & Solis-Marin, 2013).

Color in life. Brown with darker spots (Tommasi, 1970).

Habitats. Coral sand, and shells (Verrill, 1915) and sand bottom (Carrera-Rodriguez & Tommasi, 1977).

Comments. Ventura et al. (2006) listed *O. alexandri* for Martin Vaz among the echinoderms amassed during the REVIZEE-Central Program (Evaluation of the Living Resources in the Brazilian Economic Exclusive Zone, sampling station C5-48R, 23°53'S–45°26'W, 52 m. See also Lavrado, 2006). Surprisingly enough, *O. alexandri* was not integrated into the atlas of the fauna caught during the REVIZEE-Central Program. In Martin Vaz, that species occurred well beyond the depths of our typical SCUBA diving survey.

Ophidiaster guildingi Gray, 1840

Figure 6

Ophidiaster guildingii Gray, 1840: 284 [type locality: St Thomas, Virgin Islands, viz. Clark & Downey, 1992]; Hendler *et al.*, 1995: 79, fig. 22.
Ophidiaster guildingi—Benavides-Serrato *et al*., 2011: 176.

Trindade specimens. Brazil, Espírito Santo, Trindade Island, Ponta Norte, 20°29'18.7"S, 29°20'18.3"W, 17.vii.2013, 12.8 m: 1 spm R=32, r=5 (MZUSP 1578); 4.i.2014, 0 m: 1 spm R=17, r=2 (MZUSP 1554). Enseada das Orelhas, 20°29'40.2"S, 29°20'32.9"W, 30.vi.2012, 14.4 m: 1 spm R=30, r=4 (MZUSP 1571); 7.vi.2013, 14 m: 1 spm R=12, r=3 (MZUSP 1553); 5.v.2014, 14.7 m: 1 spm R=37, r=5 (MZUSP 1572); 8.i.2015, 8.9 m: 1 spm R=62, r=5 (MZUSP 1570). Ponta do Monumento, 20°30'10.3"S, 29°20'36.1"W, 16.vi.2012, 12.1 m: 1 spm R=33, r=4 (MZUSP 1556); 13.vii.2012, 8.1 m: 1 spm R=37, r=4 (MZUSP 1557). SECON-ECIT, 20°30'20"S, 29°18'43"W, 18.vii.2013, 12.2 m: 1 spm R=29, r=5 (MZUSP 1565); 14.v.2014, 10 m: 1 spm R=38, r=5 (MZUSP 1564). Praia da Calheta, 20°30'26"S, 29°18'44"W, 18.vi.2012, 12 m: 1 spm R=12, r=2 (MZUSP 1567); 14.vii.2013, 4 m: 1 spm R=54, r=4 (MZUSP 1566). Racha Island, 29°30'26.5"S, 29°20'48"W, 22.vi.2012, 27.1 m: 1 spm R=36, r=4 (MZUSP 1568); 16.vii.2012, 24.9 m: 1 spm R=38, r=5 (MZUSP 1569). Praia do Andrada, 20°30'45.7"S, 29°18'21.9"W, 21.vii.2013, 0 m: 1 spm R=16, r=2 (MZUSP 1552). Enseada dos Portugueses, 20°30'52.3"S, 29°19'15.6"W, 15.vii.2013, 12 m: 1 spm R=24, r=4 (MZUSP 1562); 15.vii.2013, 12 m: 5 spms R=32, r=5; R=40, r=6; R=35, r=4; R=13, r=2; R=9, r=2 (MZUSP 1563); 22.iv.2014, 13.7 m: 1 spm R=34, r=5 (MZUSP 1575); 20.v.2014, 13.1 m: 1 spm R=27, r=3 (MZUSP 1573); 23.x.2014, 12.5 m: 1 spm R=12, r=3 (MZUSP 1574); Farol, 20°30'52"S, 29°19'15"W, 22.iv.2014, 13.7 m: 1 spm R=40, r=6 (MZUSP 1560); 7.vi.2015, 12.6 m: 1 spm R=42, r=5 (MZUSP 1561). Enseada da Cachoeira, Praia do M, 20°30'53.8"S, 29°20'19.2"W, 7.viii.2013, 15 m: 2 spms R=30, r=3; R=25, r=4 (MZUSP 1558); Farrilhões, 20°31'22.4"S, 29°19'52"W, 16.ix.2012, 11.9 m: 1 spm R=46, r=5 (MZUSP 1555); 20.vi.2012, 11.8 m: 1 spm R=19, r=3 (MZUSP 1559). Sul Island, 20°31'32"S, 29°19'28"W, 21.x.2014, 17.8 m: 1 spm R=46, r=6 (MZUSP 1579). Enseada do Lixo, 20°31'33.9"S, 29°19'33.6"W, 22.iv.2014, 14.5 m: 1 spm R=31, r=5 (MZUSP 1577). Enseada do Príncipe, Pedra da Garoupa, 20°31'36"S, 29°18'94"W, 16.vii.2013, 10.4 m: 1 spm R=25, r=3 (MZUSP 1576).

Comparative material. United States: Florida, Monroe County, Tennessee Reef, 24°45'54"N, 80°45'14.4"W, 3.v.2010, 6 m: 1 spm R=26, r=4 (UF–10265). Lesser Antilles, Guadeloupe Island, Malendure, 16°10'27.12"N, 61°46'46.92"W, 7.v.2012, 1 m: 1 spm R=7, r=2 (UF–13618).

Distribution. Circumtropical (Pawson, 1978; Clark & Downey, 1992; Alvarado & Solis-Marin, 2013). Brazil: Bahia, Trindade Island (present study) and Rio Grande do Sul (Tommasi, 1970; Carrera-Rodriguez & Tommasi, 1977; Tommasi & Aron, 1988). Depth range: 0–330 m (Clark & Downey, 1992).

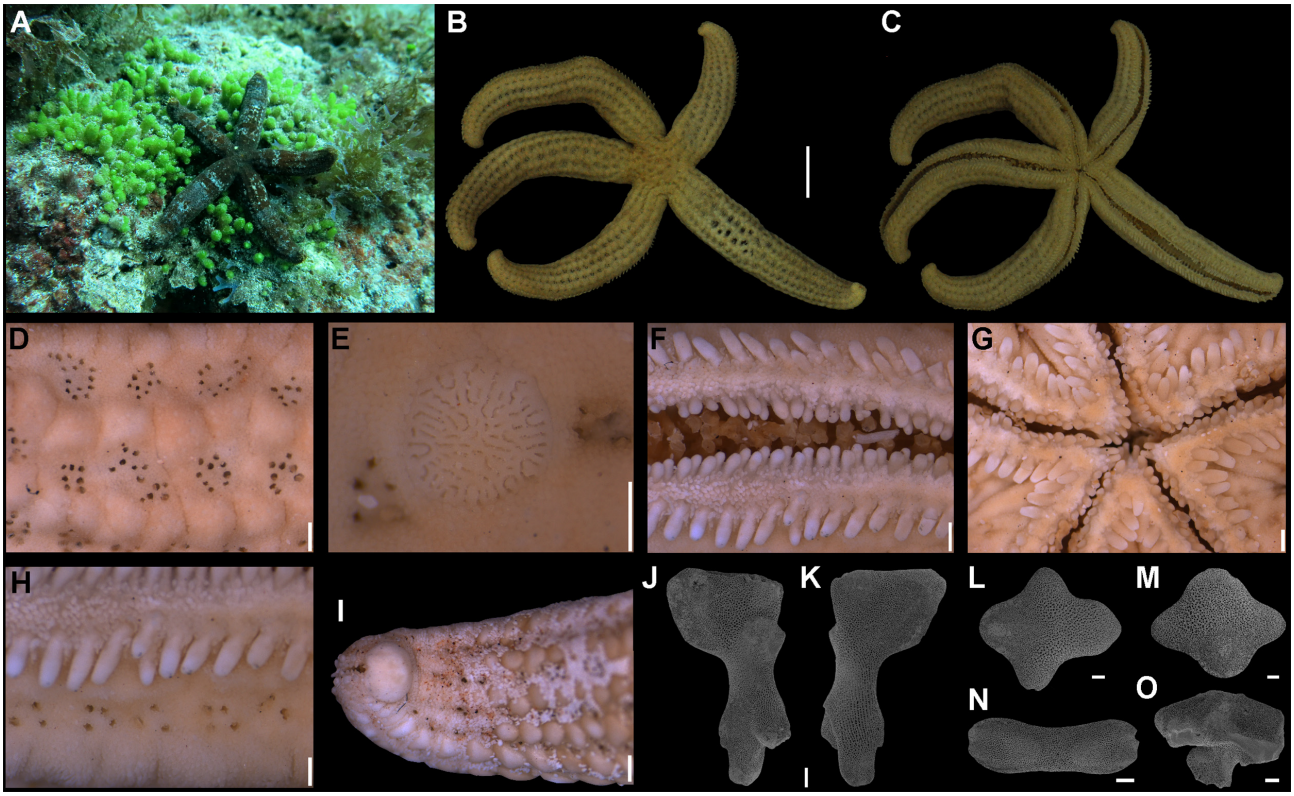

FIGURE 6. *Ophidiaster guildingi* Gray, 1840. **A.** Specimen from Trindade Island photographed *in situ* (MZUSP 1560). **B–I.** MZUSP 1580: **B, C.** Abactinal and actinal views. **D.** Abactinal plates and papulae. **E.** Detail of the madreporite. **F.** Mouth. **G.** Ambulacral spines. **H.** Tip of the arm, abactinal view. **J–O.** Scanning electron microscope (MZUSP 1570). **J, K.** Ambulacral plates. **L–N.** Abactinal plates. **O.** Oral plate. Scale bars: B–C, 10 mm; D–I, 1 mm; J–O, 200 μm.

Recognition characters. Small disk in relation to total body size. Five, sometimes four, long, cylindrical arms, constricted at base. Abactinal plates cruciform, imbricated, arranged in regular rows. 5–15 papulae per papular area (Fig. 6D). Lowermost papular area below inferomarginal plates. One row of actinal plates (Fig. 6H). One row of subambulacral spines (Fig. 6F). Space between ambulacral and subambulacral spines covered by large flattened granules. Pedicellariae rare (Clark & Rowe, 1971; Clark & Downey, 1992).

Color in life. Variable over ontogeny. Juveniles are purple, whilst mature specimens range from light yellow to scarlet or reddish brown, more or less stained with blue, purple, brown or coffee (Hendler *et al*., 1995). The color recorded for the Trindade specimens (Figure 6A) conform to the description of Pawson (1978) for three specimens from Ascension, all mottled light and dark orange-brown.

Habitats. In Trindade, *O. guildingi* was found between 0 and 24.9 meters depth, frequently found under rocks and, sometimes, along with the sea urchin *Eucidaris tribuloides* (Lamarck, 1816) (see Martins *et al*. 2016). Pawson (1978) reported that most of the specimens collected in Ascension Island were on underside of rocks or exposed in the intertidal zone. Many of the Trindade specimens presented arms with autotomy and/or in the process of regeneration.

Comments. *Ophidiaster* accounts for six Atlantic species: *O. alexandri* Verrill, 1915 (WA); *O. bayeri* A. H. Clark, 1948 (WA); *O. bullisi* (Downey, 1970) (WA); *O. guildingi* Gray, 1840 (WA, EA; also Ascension); *O. ophidianus* (Lamarck, 1816) (EA, MED; also Saint Helena), and *O. reyssi* Sibuet, 1977 (MED, EA) (Clark & Downey, 1992; Mah & Hansson, 2008).

Ophidiaster guildingi has been previously known in the southwestern Atlantic only from Rio Grande do Sul (Tommasi, 1970) and Bahia (Tommasi & Aron, 1988). However, this later record has not been integrated into Gondim's *et al*. (2014) checklist.

Ophidiaster guildingi differs from *O. alexandri, O. bullisi* and *O. reyssi* in having only one row of actinal plates (Fig. 6H) (versus 3–5 rows in *O. alexandri*, two rows in *O. bullisi*, and four rows in *O. reyssi*). It stands apart from *O. bayeri* in the presence of only one row of subambulacral spines (Fig. 6F) (versus two rows in *O. bayeri*), and from

O. *ophidianus* in having 5–15 papulae per papular area (Fig. 6D), whereas in the latter species there are 20 papulae per papular area.

Clark & Downey (1992) stated that *O*. *guildingi* and *O*. *ophidianus* can be further differentiated by the shape of the subambulacral spines, and the number of pores per papular area (based on specimens with R=6–50 and R=175, *O*. *guildingi* and *O*. *ophidianus*, respectively). However, we have noticed that such characters vary with the size of the specimens and therefore are not suitable for differentiating between the two species.

Juveniles of *O. guildingi* and *L. guildingi* are likely to be confused with one another (Hendler *et al*. 1995). However, in *O. guildingi* the position of the lowermost papular areas is below the inferomarginal plates (Fig. 6B), whereas such areas are above the inferomarginal plates in *L. guildingi* (Clark & Rowe, 1971).

Clark & Downey (1992) reported that pedicellariae were rare in *O. guildingi*, only occasionally and in large specimens (R>50); no such structures were found in the Trindade specimens.

Mithrodiidae Viguier, 1878

***Mithrodia* Gray, 1840**

***Mithrodia clavigera* (Lamarck, 1816)**
Figures 4B–D, 7

Asterias clavigera Lamarck, 1816: 562 [type locality: unknown, viz. Clark & Downey, 1992]
Mithrodia clavigera – Verrill, 1870: 289; Gondim *et al*. 2014: 26, figs. 7f–i.

Trindade specimens. Brazil, Espírito Santo, Trindade Island, Enseada da Cachoeira, Farrilhões, 20°31’22.4”S, 29°19’52”W, 14.viii.2012, 10 m: 1 spm R=110, r=10 (MZUSP 1175); 4.vii.2012, 18 m: 1 spm R=160, r=15 (MZUSP 1176). Ilha do Sul, 20°31’32”S, 29°19’28”W, 21.x.2014, 18 m: 1 spm R=220, r=25 (MZUSP 1178). Enseada do Príncipe, 20°31’36”S, 29°18’94”W, 21.x.2014, 19 m: 1 spm R=240, r=20 (MZUSP 1177).

Comparative material. Brazil, Paraíba, Projeto Algas–PB, 7º04’S–38º41’W, 17.ii.1981, 26 m: 1 spm R=10, r=2 (UFPB.ECH.880).

Distribution. Circumtropical (Engel *et al*., 1948; Clark & Rowe, 1971; Marsh, 1977; Jangoux, 1984; Clark & Downey, 1992; Alvarado & Solis-Marin, 2013). Brazil: Paraiba, Fernando de Noronha and Trindade Islands (present study), and Vitoria Trindade Seamounts Chain (Vitoria Bank) (Bell, 1882; Tommasi, 1970; Gondim *et al*., 2014; present study). Depth range: 0–157 m (Clark & Downey, 1992; present study).

Recognition characters. Small disc (20–50 mm). Five long, cylindrical, flat arms, tapering terminally. Seven rows of prominent spines, occasionally five, distributed longitudinally around arm. Abactinal and marginal skeleton similar to each other, composed of well-spaced polygonal primary plates connected by elongate secondary plates arranged in a reticulum. Abactinal plates covered by granules. Papular areas large and triangular. Spines squamous other than ambulacral and oral ones. Actinal plates with row of robust spines reaching to terminal region of arm, forming clusters of 2–3 spines; papular areas between plates. Ambulacral spines seven, rounded tip, connected by membrane; central spine largest, remaining spines decreasing in size towards edge of plate. One row of subambulacral spines similar to actinal ones, but smaller and thinner. Pedicellariae rare (Clark & Downey, 1992; present study).

Color in life. Arms boldly banded dark brown or reddish and light, usually gray. Papular areas are brown to black (Clark & Downey, 1992; Marsh, 1977). Trindade specimens (Figures 4B–D, 7A).

Habitats. This species has been found to inhabit hard substrates, such as crevices, reefs gravel, rocky bottoms, and rhodolith banks (Abreu-Pérez *et al*. 2005; Gondim *et al*. 2014). More active during the night (Guille *et al*., 1986). One specimen was observed and photographed *in situ* by Gabriela C. Zeineddine in Fernando de Noronha (in a rocky tide pool at Boldró beach, ix.2019, figure 4D), but released after collection. In Trindade *M. clavigera* was found in rocky bottoms or sheltered in rocky cavities, between 10 and 19 m (Figures 4B–D, 7A).

Comments. *Mithrodia clavigera* is the only species of three in the genus to occur in the Atlantic Ocean. *Mithrodia victoriae* Bell, 1882, described from off the coast of southeastern Brazil (Vitoria Bank, Espírito Santo) has been placed by Clark & Downey (1992) under the synonymy of *M. clavigera*, who also called into question the status of *M*. *bradleyi* Verril, 1870 (EP) as a distinct species. Engel *et al*. (1948), warned that pedicellariae are not easily detected, described and illustrated the pedicellariae of *M. clavigera* based on specimens from Moluccas, Flores and

Java (Indonesia), and Haingsisi (Timor). However, pedicellariae have not been found neither in the specimen from Paraíba (northeastern Brazil) studied by Gondim *et al*. (2014), nor in the Trindade specimens (present study).

These are the first records of *M. clavigera* from the oceanic islands of Fernando de Noronha and Trindade. Previous to the oceanic insular waters, *M. clavigera* was known in the southwestern Atlantic from the northeastern Brazilian coast (Paraíba) and the Vitória Bank, Espírito Santo (Figure 1).

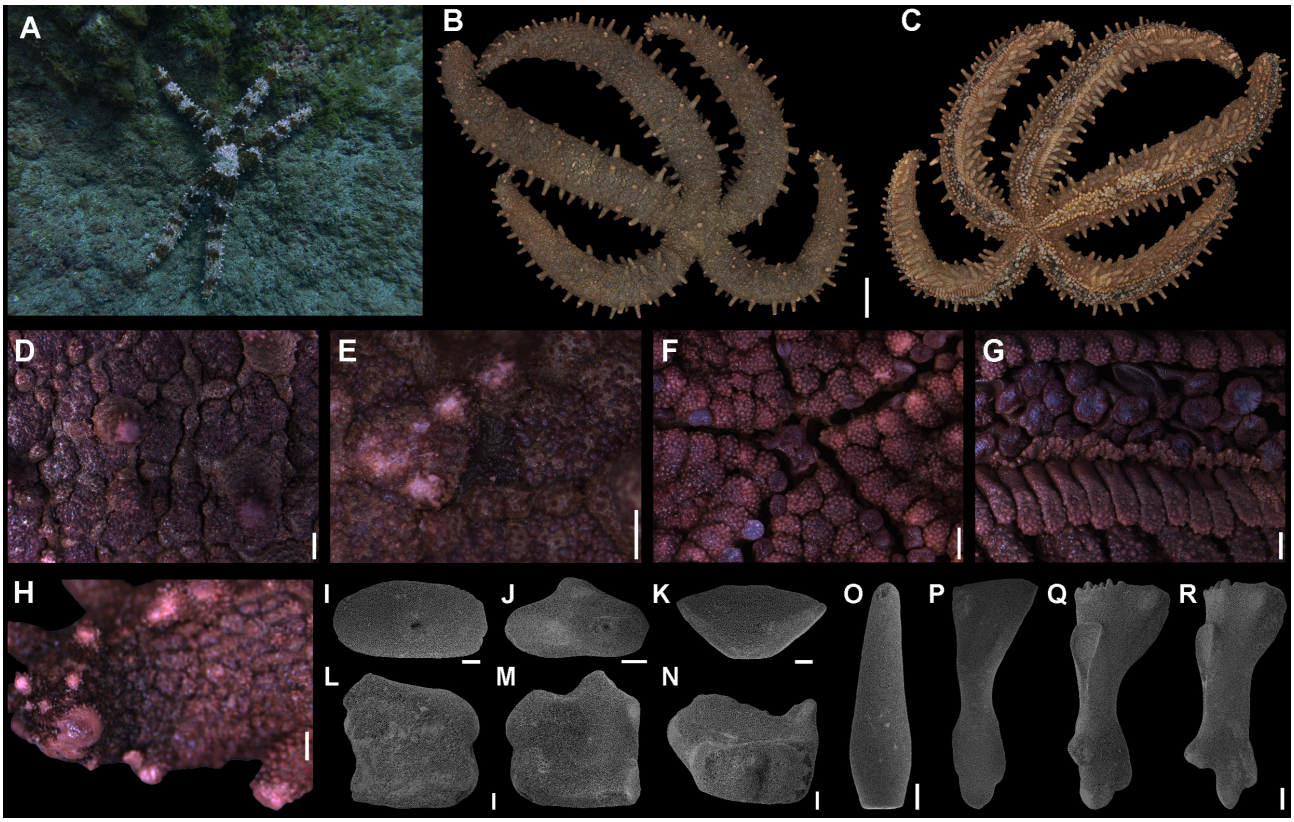

FIGURE 7. *Mithrodia clavigera* (Lamarck, 1816). **A.** Specimen from Trindade Island photographed *in situ* (MZUSP 1177). **B–H.** MZUSP 1631: **B, C.** Abactinal and actinal views. **D.** Abactinal plates and papulae. **E.** Detail of the madreporite. **F.** Mouth. **G.** Ambulacral spines. **H.** Tip of the arm, abactinal view. **I–R.** Scanning electron microscope (MZUSP 1175). **I–K.** Abactinal plates. **L–N.** Adambulacral plates. **O.** Abactinal spine. **P–R.** Ambulacral plates. Scale bars: B–C, 20 mm; D–H, 2 mm; I, K–N, 200 µm; J, P–R, 400 µm; O, 600 µm.

Oreasteridae Fisher, 1911

Oreaster Müller & Troschel, 1842

Oreaster reticulatus (Linnaeus, 1758)

Figures 4E, 8

Asterias reticulata Linnaeus, 1758: 661 [type locality: "Spanish West Indies", viz. Clark & Downey, 1992].
Oreaster reticulatus – Hendler *et al.*, 1995: 82, figs. 25–26; Fernandes *et al*. 2002: 422; Magalhães *et al*. 2005: 63; Ventura *et al*. 2007: 238; Manso *et al*. 2008: 185, fig. 8c–e; Xavier, 2010: 75; Alves & Dias, 2010: 157; Benavides-Serrato *et al*., 2011: 179–180. Miranda *et al*. 2012: 143–144; Gondim *et al*. 2014: fig. 8a–g, 12c.

Trindade specimens. Brazil, Espírito Santo, Trindade Island, Enseada dos Portugueses, Farol, 20°29'52.3"S, 29°19'15.6"W, 23.x.2014, 12.5 m: 1 spm, R=100, r=45 (MZUSP 1611); 6.vii.2015, 12.6 m: 1 spm, R=105, r=52 (MZUSP 1612).

Comparative material. Bermuda, Ferry Reach, 32º21'58"N, 64º41'56"W, iv.1939: 1 spm, R=170, r=90 (MCZ AST–3727). Brazil, São Paulo, São Sebastião, 23º47'55"S, 45º 23'45"W: 1 spm R=125, r=60 (MZUSP 1956); San-

tos, 23º57’39”S, 46º20’01”W, 1.vi.1999, 76 m: 2 spms R=130 cm, r=70; R=140, r=80 (MZUSP 1617).

Distribution. Mexico, Bahamas, Cuba, Belize, Haiti, Dominican Republic, Puerto Rico, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Venezuela, Guyana, Surinam, Brazil (Ceará, Paraíba, Pernambuco, Bahia, Trindade Island, Cabo Frio, São Paulo), Canary Islands, Cape Verde (Verrill, 1915; Caso, 1944; Tommasi, 1958; Brito, 1960; 1962; 1968; Walenkamp, 1976; Clark & Downey, 1992; Hendler *et al*. 1995; Guzman & Guevara, 2002; Ventura *et al*. 2007; Entrambasaguas, 2008; Alvarado & Solis-Marin, 2013; Hernandéz *et al*. 2013; Gondim *et al*. 2014). Depth range: 0–69 m (Clark & Downey, 1992).

Recognition characters. Highly inflated disc. Five (4–6) short arms, distally tapered. Abactinal plates with tubercles or spines, reticulated, attached by elongated, sometimes narrow, secondary plates (Fig. 8D). Adambulacral plate with seven spines, five unequal in size, smallest two positioned at extremities of plate. One large, heavy subambulacral spine. Actinal pedicellariae not in alveoli. Pedicellariae abundant (Clark & Downey, 1992; present study).

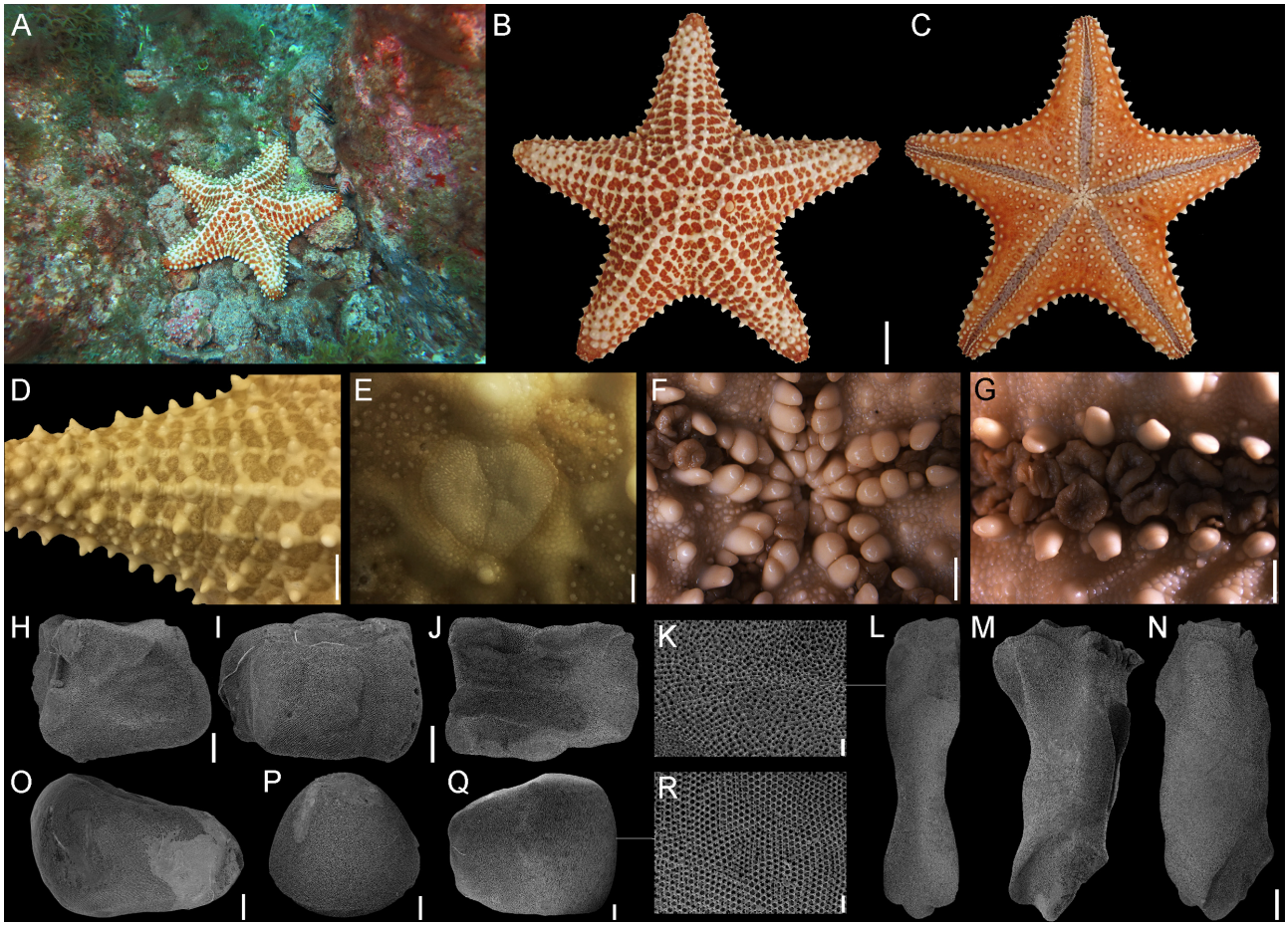

FIGURE 8. *Oreaster reticulatus* (Linnaeus, 1758). **A–R.** MZUSP 1611: **A.** specimen from Trindade Island photographed *in situ*. **B, C.** Abactinal and actinal views. **D.** Detail of the reticulate area. **E.** Madreporite. **F.** Mouth. **G.** Ambulacral spines. **H–R.** Scanning electron microscope. **H–J.** Adambulacral plates. **K.** Stereom, ambulacral plate. **L–N.** Ambulacral plates. **O.** Actinal plate. **P.** Marginal spine. **Q.** Superomarginal plate. **R.** Stereom, superomarginal plate. Scale bars: B–C, 20 mm; D, 10 mm; E, 1 mm; F–G, 3 mm. H–J, O, Q, 600 µm; K, R, 90 µm; L–N, 900 µm; P, 400 µm.

Color in life. Variable. In juveniles the abactinal surface is usually mottled with green, brown, beige and gray, whilst adults are yellow, brown, or orange on the abactinal surface. The actinal region is beige or yellowish in both, juveniles and adults (Ummels, 1963; Hendler *et al*. 1995). Trindade specimens (Figure 8A–C).

Habitats. Inhabits shallow, protected waters, such as calm reef waters, lagoons and mangrove canals. This is species has been found on coral reefs, mangroves, rocky bottom, sandy bottom, seagrass, and rubble bottom, where it feeds upon different benthic organisms (Scheibling, 1980; Alvarado & Solis-Marin, 2013). In Trindade *O. reticulatus* inhabits mixed bottoms of rhodolith beds, sand, gravel, and small rocks, between 12.5 m and 12.6 m (Figure 8A). This species is vulnerable to human exploitation (Hendler *et al*. 1995; Alves & Dias, 2010; Lawrence, 2013).

Comments. *Oreaster* consists of only two species in the Atlantic Ocean: *O. reticulatus* (Linnaeus, 1758) (WA) and *O. clavatus* Müller & Troschel, 1842 (EA). Clark & Downey (1992) differentiated the two species primarily based upon the presence, in *O. reticulatus*, of a highly inflated disc, abactinal plates with tubercle or spine (Fig. 8D), subambulacral spine large and heavy, and actinal pedicellariae not in alveoli (*versus* more or less flat disc, granules in the abactinal plates, slender and blunt subambulacral spine, and actinal pedicellariae in alveoli in *O. clavatus*).

However, the variation in shape, from pentagonal to stellate, and the differing degrees of swollenness of the disc make this an extremely variable species. Morphological variations appeared to have led H. L. Clark (1942) astray in describing one specimen from Bermuda as a new subspecies (*i.e*., *O. reticulatus* var. *bermudensis*). Downey (1973) found that the disc in small individuals of *O. reticulatus* was not inflated, and the marginal plates are relatively larger and more conspicuous than in the adults. One specimen from São Sebastião (R=125; MZUSP 1956) has a flattened disc, whereas the remaining studied specimens have strongly arched discs.

Ummels (1963) reported that most of the specimens of *O. reticulatus* from Saint Martin (Caribbean Sea) have a second subambulacral spine, which vary greatly in size. The Trindade specimens have only one spine in the subambulacral row (Fig. 8G) and the actinal granules are arranged in mosaics; whereas the coastal specimens from São Sebastião and Santos, São Paulo (see under comparative material) have two such spines, the smaller being positioned behind the larger one. In the specimens from Santos, the granules are more distant from one another and hence not forming a mosaic.

The spines in the center of the actinal plates are smaller in the specimens from Trindade comparatively to São Sebastião, which also have comparatively much larger spines in the interradial region near the mouth.

The Trindade specimens have seven ambulacral spines, being five larges and two very small spines. The smaller ones are not easily detected and this is, probably, why in most of the literature only five ambulacral spines have been recorded for this species. The coastal specimens studied have 5–7 spines.

The number of pedicellariae in the proximal interradial region and above the ambulacral furrow also vary between the Trindade and the coastal specimens (São Sebastião and Santos), in which the pedicellariae in the proximal interradial region and above the ambulacral furrow are much more numerous. The abactinal pedicellariae are abundant in the Santos specimens, whereas they were detected in only one specimen from Trindade, and they were not found in the specimens from São Sebastião. Furthermore, we have noticed that the number of pedicellariae increase with the size of the specimens.

Despite Clark & Downey's (1992) assertion that the two species are separated by an east and west Atlantic distribution, the species *O. reticulatus* is also recorded from the Cape Verde Islands (Caso, 1944; Hendler *et al*. 1995; Guzman & Guevara, 2002; Entrambasaguas, 2008), and Canary Island (Hernandéz *et al*. 2013), however in this last record the authors did not provide any morphological information.

Asterinidae Gray, 1840

Asterinides Verrill, 1913

Asterinides folium (Lütken, 1860)

Asteriscus folium Lütken, 1860: 60, 61 [type locality: Saint Thomas, Virgin Islands, viz. O'Loughlin 2002]
Asterina folium – Clark & Downey, 1992: 182.
Asterinides folium – Oliveira *et al*. 2010: 3, fig. 2a; Benavides-Serrato *et al*. 2011: 150; Gondim *et al*. 2014: 24, figs. 7a–e.

Distribution. Bermudas, Florida, Mexico, Bahamas, Belize, Panama, Puerto Rico, Colombia, Venezuela and Brazil (Paraíba, Bahia, Vitória-Trindade Seamount Chain, Trindade Island and Rio de Janeiro) (Verrill, 1915; Brito, 1962; 1968, 1971; Clark & Downey, 1992; Hendler *et al*. 1995; Alvarado *et al*. 2008; Oliveira *et al*. 2010; Benavides-Serrato *et al*. 2011; Alvarado & Solis-Marin, 2013; Gondim *et al*. 2014). Depth range: 0–15 m (Clark & Downey, 1992).

Color in life. Color varies with size. Clark & Downey (1992) reported small specimens to be are nearly white, turning "cream to yellow to reddish yellow or more often greenish", whilst large specimens were "olive- or bluish-green to blue". The specimens recorded from Trinidad Island by Brito (1968) were dark grayish-blue.

Habitat. Coral reefs, rocky, sandy and rubble bottoms (Pawson *et al*. 2009; Alvarado & Solis-Marin, 2013);

commonly found under rocks or corals of the reef flat (Brito, 1971; Hendler *et al*. 1995). The Trindade specimens were found under rocks (Brito, 1968; 1971).

Comments. Brito (1962; 1968; 1971) briefly reported on 25 specimens of *A. folium* (radio up to 8 mm) amassed by H. Rodrigues da Costa in Trindade at the Enseada dos Portugueses, most certainly in the intertidal zone. Curiously enough, despite its very small size and intertidal habits, *A. folium* has never been reported from Trindade again since, nor has it been collected by us there.

Paxillosida Perrier, 1884

Luidiidae Sladen, 1889

Luidia Forbes, 1839

Luidia alternata alternata (Say, 1825)

Figure 4F

Asterias alternata Say, 1825: 144–145 [type locality: Dry Tortugas, Florida Keys, Florida, viz. Clark & Downey, 1992].

Luidia alternata alternata – Hendler *et al*., 1995: 66-67, fig. 13; Pérez-Ruzafa *et al*. 1999: 45; Entrambasaguas, 2003: 68–71, fig. 1; Entrambasaguas, 2008: 41; Pawson *et al*., 2009: 1188; Alvarado & Solis-Marin, 2013: 607; Gondim *et al*., 2014: 7, figs. 3a–d.

Distribution. United States (North Carolina, Bahamas, Florida, Gulf of Mexico), Mexico, Cuba, Honduras, Dominican Republic, Puerto Rico, Panama, Colombia, Venezuela, Suriname, Brazil (Paraíba, Alagoas, Bahia, Trindade Island (present study), Rio de Janeiro, São Paulo), Uruguay, Argentina and Cape Verde (Verrill, 1915; Brito 1962, 1968; Tommasi, 1970; Downey, 1973; Walenkamp, 1976; Clark & Downey, 1992; Hendler *et al*. 1995; Pérez-Ruzafa *et al*. 1999; Entrambasaguas, 2003; Magalhães *et al*. 2005; Ventura *et al*. 2007; Entrambasaguas, 2008; Pawson *et al*., 2009; Miranda *et al*. 2012; Alvarado & Solis-Marin, 2013; Gondim *et al*., 2014). Depth range: 1–200 m (Clark & Downey, 1992).

Recognition characters. Five long arms, tapering distally. One prominent spine at center of some paxillae from abactinal region. One row of adambulacral curved spines. Three unequal subambulacral spines, arranged irregularly. Pedicellariae with four valves on actinal surface (Clark & Downey, 1992; Hendler *et al*., 1995).

Color in life. The Trindade specimen (Figure 4F) mostly matches the color description given by Clark & Downey (1992): upper parts boldly patterned, with a "dark pentagon on the disc and 3–5 transverse dark bands, brown, black, greenish or purple on each arm, otherwise yellow, white, cream or pink".

Habitats. Sandy mud and muddy bottoms near mangroves (Clark & Downey, 1992). The specimen from Trindade Island was found on the top of a calcareous reef (Figure 4F).

Comments. This is the first record of *L. alternata alternata* from Trindade. One specimen was observed and photographed *in situ* in Trindade (Ponta da Calheta, 31.vii.2018, at a depth of about 15 m), but escaped after collection. However, its distinctive color pattern, number of arms, and more importantly, the presence of a prominent spine in the center of some paxillae of the abactinal region lead us to identify the Trindade specimen as *L. alternata alternata*.

Astropectinidae Gray, 1840

Astropecten Gray, 1840

Astropecten aff. *antillensis* Lütken, 1859

Figure 9

Astropecten antillensis Lütken, 1859: 47 [type locality: St. Thomas, Virgin Islands, viz. Clark & Downey, 1992]; Benavides-Serrato et al. 2011: 114; Alvarado & Solis-Marin, 2013: 605.

Trindade specimens. Brazil, Espírito Santo, Trindade Island, Ponta da Calheta, 20°30'20.29"S, 29°18'32.86"W, 10.viii.2018, 30 m: 1 spm R=40, r=5 (MZUSP 2090).

Comparative material. *Astropecten brasiliensis* Müller & Troschel, 1842: Brazil, Rio de Janeiro, Ilha Grande, Ponta do Aripeba, 23º 07'05"S, 44º16'53"W, 21.i.2000, 1 spm R=65, r=11 (MZUSP 2095). São Paulo, Ubatuba, 23°31'S, 45°02'W, 25.ix.2002, 9 m: 1 spm R=110, r=15 (MZUSP 2099). Caraguatatuba, 23°45'S, 45°13'W, 16.x.2001, 1 spm R=60, r=15 (MZUSP 116); 19 m: 1 spm R=65, r=15 (MZUSP 2098). São Sebastião Island, 23°53'S, 45°26'W, 13.ii.2001: 4 spms R=55, r=8; R=53, r=8; R=32, r=6; R=19, r=4 (MZUSP 118); xii.1915: 3 topotypes R=125, r=20; R=105, r=20; R=65, r=13 (MZUSP 2096); 14.xii.2001, 20.3 m: 1 spm R=55, r=10 (MZUSP 2097). *Astropecten marginatus* Gray, 1840: Brazil, São Paulo, Ubatuba, 23º31'S, 45º09'W, 16.iv.2002, 14 m: 2 spms R=36, r=24; R=18, r=12 (MZUSP 00002).

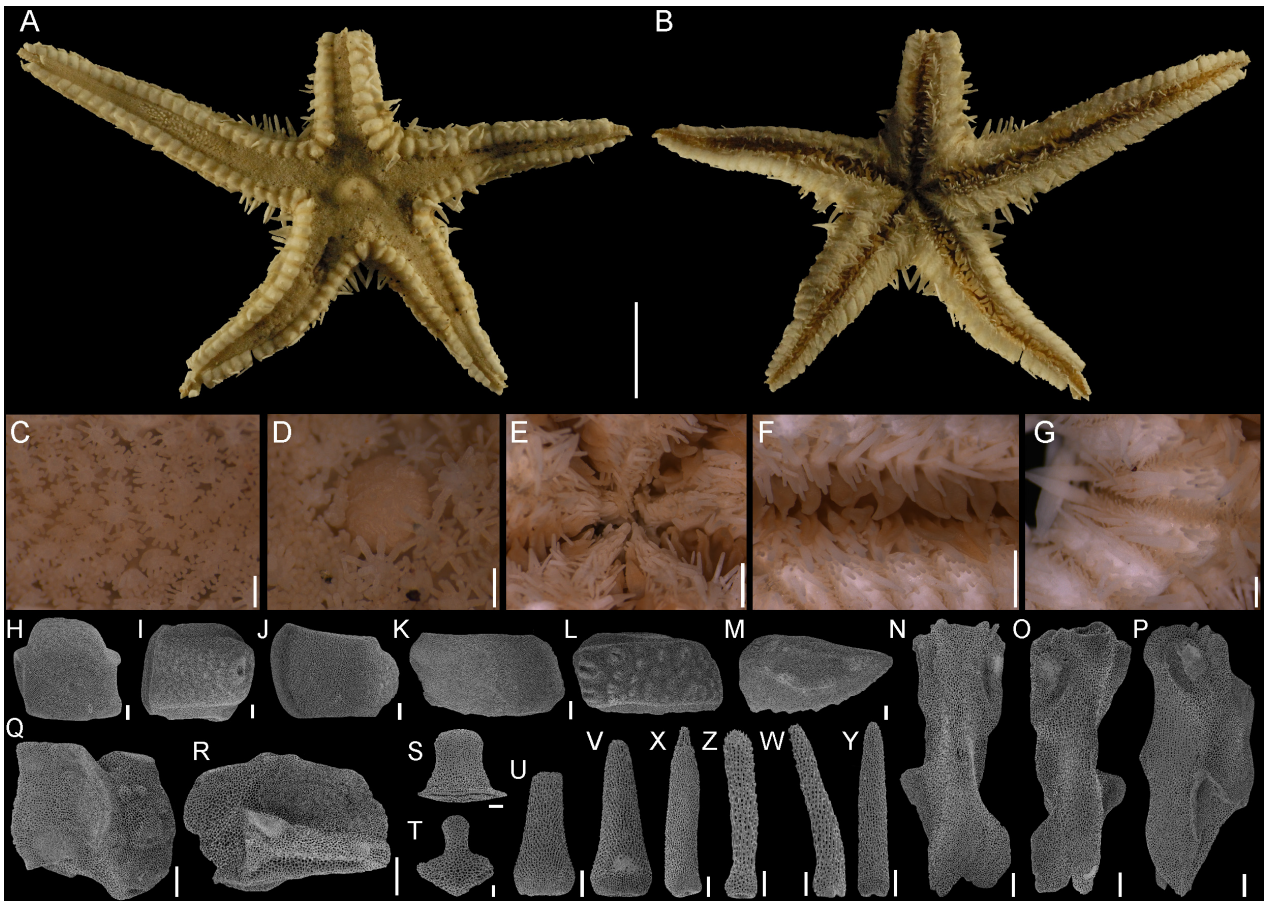

FIGURE 9. *Astropecten* aff. *antillensis* Lütken, 1859. **A–Y.** MZUSP 2090: **A, B.** Abactinal and actinal views. **C.** Paxillae. **D.** Madreporite. **E.** Mouth. **F.** Ambulacral spines. **G.** Squamules and spines, inferomarginal plate. **H–Y.** Scanning electron microscope. **H–J.** Superomarginal plates. **K–M.** Inferomarginal plates. **N–P.** Ambulacral plates. **Q, R.** Adambulacral plates. **S, T.** Haste, paxillae. **U.** Superomarginal spine. **V, X.** Inferomarginal spines. **Z–Y.** Furrow spines. Scale bars: A–B, 10 mm; C–D, G, 1 mm; E–F, 2 mm; H–J, N–R, U–X, Y, 200 µm; K–M, 300 µm; S, Z–W, 100 µm; T, 60 µm.

Distribution. *Astropecten antillensis* s. str., has been reported from Gulf of Mexico, Greater and Lesser Antilles, Colombia (Sladen, 1889; Bayer et al., 1970; Clark & Downey, 1992; Abreu-Pérez et al., 2005; Alvarado & Solis-Marin, 2013). Brazil: Bahia (John, 1948). Depth range: 3–278 m (Clark & Downey, 1992).

Recognition characters. Two prominent spines in first pair of superomarginal plates, spines decreasing in size distally in remaining plates. Inferomarginal plates projecting beyond superomarginal ones. Inferomarginal spines broad, opaque. Two rows of subambulacral spines. First subambulacral row with three spines; middle spine wider and longer than proximal and distal ones, longer than furrow spines. Conspicuous bare area at center of actinal surface of inferomarginal plate. No pedicellariae (Clark & Downey, 1992; Benevides-Serrato et al., 2011; Cobb et al., 2019; present study).

Color in life. Pale yellow (Lütken, 1859). The specimen in the photograph given by Benevides-Serrato *et al*. (2011) had orange body, with darker midline along each arm, and bright-red bands at the base of the inferomarginal fringe spines and superomarginal spines. The Trindade specimen was not photographed alive prior to preservation.

Habitats. The Trindade specimen was found on a whitish sandy bottom, around 30 meters depth.

Comments. The species in *Astropecten* can be separated into two groups according to the presence or absence of superomarginal spines. Among the eight species so far recorded from the Brazilian coasts, only *A. cingulatus* Sladen, 1833 and *A. marginatus* Gray, 1840, are devoid of superomarginal spines. The six species with superomarginal spines are as follow: *A. acutiradiatus* Tortonese, 1956, *A. alligator* Perrier, 1881, *A. antillensis* Lütken, 1859, *A. articulatus* (Say, 1825), *A. brasiliensis* Müller & Troschel, 1842, and *A. duplicatus* Gray, 1840.

Astropecten brasiliensis and *A. cingulatus* have both been previously recorded from Trindade (Brito, 1962; Ventura *et al*. 2006; 2007). However, the Trindade specimen can be immediately distinguished from *A. cingulatus* in having superomarginal spines (Fig. 9A, U), and stands apart from *A. brasiliensis* in presenting three spines in the first subambulacral row (Fig. 9F) (*versus* two spines in *A. brasiliensis*).

Astropecten aff. *antillensis* actually appears to be morphologically more closely related to *A. antillensis*, a species previously known from the Brazilian coasts only from Bahia (John, 1948). However, the insular specimen differs from *A. antillensis* s. str. (cf., Clark & Downey, 1992) in having two prominent spines on the inner edge of the first pair of superomarginal plates, and one row of spines decreasing in size distally in the other plates (Fig. 9A) (*versus* prominent spines present on the inner edge of first 5–6 superomarginal plates, and a much smaller spine on the outer edge of all superomarginals in *A. antillensis*); and two rows of subambulacral spines (Fig. 9F) (versus one row in *A. antillensis*). However, the syntype ZMUC-AST-4-22 (R=29 mm) of *A. antillensis* s. str. also shows a second row of subambulacral spines in some plates. The Trindade specimen and the Caribbean Colombian specimens assigned to *A. antillensis* by Benavides-Serrato *et al*. (2011) agree with one another in having inferomarginal plates projecting beyond the superomarginal ones. Conversely, in *A. antillensis* sensu Clark & Downey (1992), the inferomarginals plates do not project beyond the superomarginals. According to Lütken (1859), morphology greatly varies over ontogeny in *A. antillensis*.

Astropecten aff. *antillensis* differs from its Brazilian congeners with superomarginal spines in that it has a large spine in the first subambulacral row. That spine is wider and longer than the proximal and distal spines and longer than the furrow spines (Fig. 9F). It further stands apart in having long, narrow arms and narrow disk; the inferomarginal plates usually have two ambital fringe spines (sometimes a much smaller one in the proximal region) (Fig. 9A). The fringe spines are about equal in length, or the distal spine is slightly longer. Conspicuous bare area in the center of the actinal surface of the inferomarginal plate (Fig. 9G). Paxillae with 1–5 central and about 12 peripherals spinelets. Three ambulacral spines truncated, the middle one larger than the lateral ones. No pedicellariae.

Astropecten brasiliensis Müller & Troschel, 1842

Astropecten brasiliensis Müller & Troschel, 1842: 68 [type locality: São Sebastião Island, São Paulo, Brazil, viz. Clark & Downey, 1992]; Fernandes *et al*. 2002: 422; Netto, 2006: 25–26, pl. 2a, fig. 16a; Ventura *et al*. 2007: 230; Machado *et al*. 2008: 350; Lima & Fernandes, 2009: 58; Xavier, 2010: 75; Miranda *et al*. 2012: 143, 144; Gondim *et al*. 2014: 19.

Distribution. Caribbean Colombia, Venezuela, Brazil (Ceará, Rio Grande do Norte, Fernando de Noronha, Alagoas, Bahia, Trindade Island, Rio de Janeiro, Ubatuba, São Sebastião, Santa Catarina and Rio Grande do Sul), Uruguay and Argentina (Rathbun, 1879; Sladen, 1889; Verrill 1915; Tommasi, 1958, 1970; Brito, 1960, 1962, 1968; Lima-Verde, 1969; Walenkamp, 1976; Carrera-Rodriguez & Tommasi, 1977; Walenkamp, 1979; Clark & Downey, 1992; Fernandes *et al*., 2002; Netto *et al*., 2005; Ventura *et al*. 2007; Miranda *et al*., 2012; Alvarado & Solis-Marin, 2013; Gondim *et al*., 2014). Eastern Pacific: Peru (Alvarado & Solis-Marin, 2013). Depth range: 2–66 m (Alvarado & Solis-Marin, 2013).

Color in life. *In situ* abactinal region violet and marginals pink; actinal salmon. Fixed: light pink or whitish (Bernasconi, 1957a; Gondim *et al*. 2014).

Habitats. Soft bottoms, including sand-mud (Brogger *et al*. 2013).

Comments. Oliveira (1951) referred to a juvenile specimen of "*Astropecten* sp." from the Trindade Island, whose record was repeated by Brito (1962) in a preliminary catalog of the echinoderms of Brazil (as *Astropecten armatus brasiliensis*). However, this species was not included in the compilation prepared by Brito (1971) of the echinoderm species known at that time from Trindade, and we know of no subsequent records of *A. brasiliensis* from Trindade nor has it been collected by us there.

A note on the topotypes of *Astropecten brasiliensis*

Astropecten brasiliensis was described based on the material collected in "Brasilien" [Brazil] by the Austrian

naturalist and explorer Johann Natterer (1787–1843) (Müller & Troschel, 1842). Natterer extensively traveled in Brazil from 1817 throughout 1835, collecting natural history specimens for the Imperial Cabinet of Natural History in Vienna. Between the years 1817 and 1821, he made a number of field trips to a coastline strip comprised between Rio de Janeiro and Paraná, from where he probably obtained the specimens described later under the name *A. brasiliensis*. In 1848, a great fire destroyed the Imperial Cabinet along with parts of Natterer's collections from Brazil (Papavero, 1971). Clark & Downey (1992) considered the type of *A. brasiliensis* lost, and selected the neotype E 529 from the USNM collection. The neotype was collected along with three specimens in the São Sebastião Island, São Paulo, in December 1915, by Ernest Garbe (a professional collector working at that time for the MZUSP) and donated to the USNM. Three topotypes remain at the Museum of Zoology in São Paulo (MZUSP 2096).

Astropecten cingulatus Sladen, 1883

Astropecten cingulatus Sladen, 1883: 266 [type locality: Pernambuco, Brazil, viz. Clark & Downey, 1992); Ventura *et al*. 2007: 231; Xavier, 2010: 75; Gondim *et al*. 2014: 21, fig. 5e–h; Lawrence *et al*. 2018: 130, figs. 2–3, 6, 8–10, 12–14, 17.

Distribution. North Carolina, Bahamas, Gulf of Mexico, Mexico, Nicaragua, Costa Rica, Puerto Rico, Panama, Colombia, Venezuela, Brazil (Pernambuco, Vitória-Trindade Seamount Chain, Martin Vaz Archipelago, Trindade Island, Rio de Janeiro, Vitória Island-SP, São Paulo, Santa Catarina), Uruguay, Argentina, and Africa (Brito 1962; Tommasi, 1970, 1985; Carrera-Rodríguez & Tommasi, 1977; Tommasi & Aron, 1987; Manso, 1989; Clark & Downey, 1992; Ventura *et al*. 2007; Alvarado *et al*. 2008; Xavier, 2010; Alvarado & Solis-Marin, 2013). Depth range: 11 to 1350 m (Lawrence *et al*. 2018).

Color in life. Abactinal surface red or orange-red; actinal surface white (Bernasconi, 1957; Benavides-Serrato *et al*. 2011; Clark & Downey, 1992). Disk orange, fading to bright-pink arm tips. Fascioles of superomarginal plates dark red-brown (Cobb *et al*. 2019). Ventura *et al*. (2007) referred to Brazilian specimens with abactinal surface cream-color and actinal white (presumably based upon color in life individuals).

Habitats. Soft-bottom environments (Ventura *et al*. 2007). Muddy, sandy and rubble bottom (Alvarado & Solis-Marin, 2013).

Comments. Ventura *et al*. (2006) referred to a "Astropectinidae" from Martin Vaz in a list of echinoderms amassed during the REVIZEE-Central Program (Evaluation of the Living Resources in the Brazilian Economic Exclusive Zone, sampling station C5-48R, 23°53'S, 45°26'W, 52 m. See also Lavrado, 2006). Later on, Ventura *et al*. (2007) recorded *A. cingulatus* from the Trindade island [sic] on a distribution map without any further details. We had no access to this material and whether the records from Martin Vaz and Trindade are the same or not is yet to be determined.

Key to the species of Asteroidea from the Brazilian oceanic islands

1. Pointed tube feet; paxillae on abactinal region 2
   Tube feet with sucking disc; paxillae absent 5
2. Superomarginals similar in size to abactinals, not forming distinct dorsal facing frame; some paxillae with central enlarged spine . . . . . *Luidia alternata alternata*
   Superomarginal plates massive, block-like, forming distinct dorsal facing frame; paxillae without central enlarged spine . . . 3
3. Spines in the first row of subambulacral equal in length, three; no prominent spines in the first pair of superomarginal plates . . . . . *Astropecten cingulatus*
   Spines in the first row of subambulacral unequal in length, two or three; two prominent spines in the first pair of superomarginal plates 4
4. First row of subambulacral spines three, central larger; paxillae with 1–5 central spinelets . . . . . *Astropecten* aff. *antillensis*
   First row of subambulacral spines two, distal larger; paxillae with about 10 central spinelets . . . . . *Astropecten brasiliensis*
5. Arms not cylindrical, wide at base 6
   Arms cylindrical, narrow at base 8
6. Marginal plates inconspicuous; abactinal plates imbricate . . . . . *Asterinides folium*
   Marginal plates prominent; abactinal plates not imbricate 7
7. Marginal plates not conspicuous in aboral view; spines on abactinal plates present; tabulate plates absent .... *Oreaster reticulatus*
   Marginal plates conspicuous in aboral view; spines on abactinal plates absent; tabulate plates present . *Mediaster pedicellaris*

(exclusively deep water)

8. Spines on abactinal plates . . . . . *Mithrodia clavigera*
   No spines on abactinal plates 9
9. Body covered with gelatinous membrane; pedicellariae abundant . . . . . *Copidaster lymani*
   Gelatinous membrane absent; pedicellariae present or absent 10
10. Papulae confined to abactinal surface; papular areas in scattered groups 11
    Papulae in actinal as well as abactinal surface; papular areas in 8 longitudinal rows 12
11. Many pore areas with 18–30 pores per papular area; no secondary plates between larger primary plates on abactinal surface; large hemispherical plates absent . . . . . *Linckia guildingi*
    Few pore areas with 2–18 pores per papular area; secondary plates between larger primary plates on abactinal surface; large hemispherical plates present . . . . . *Linckia nodosa*
12. Actinal plates in 3–5 rows; pedicellariae present . . . . . *Ophidiaster alexandri*
    Actinal plates in one row; pedicellariae rare or absent . . . . . *Ophidiaster guildingi*

Zoogeographical notes

Seven species of Asteroidea have been so far recorded from shallow waters (intertidal down to 100 meters) of Trindade, namely *Asterinides folium*, *Astropecten brasiliensis*, *A. cingulatus*, *Linckia guildingi*, *L. nodosa*, *Ophidiaster alexandri*, and *Oreaster reticulatus* (Oliveira, 1951; Bernasconi, 1956; Brito, 1968; Brito, 1971; Ventura *et al*. 2006; 2007; Gondim *et al*. 2014). Five additional species were now discovered in shallow waters of Trindade and Martin Vaz: *Astropecten* aff. *antillensis*, *Copidaster lymani*, *Luidia alternata alternata*, *Mithrodia clavigera*, and *Ophidiaster guildingi*.

It becomes increasingly clear that the taxonomic composition of the benthic invertebrates of Trindade and Martin Vaz (TMV) is a mosaic of western Atlantic, eastern Atlantic, amphi-Atlantic, central Atlantic (insular), endemic and circumtropical species. However, the archipelago greatest faunal affinity is with the western Atlantic fauna (Anker *et al.* 2016; Martins *et al*. 2016; Tavares *et al.* 2017; Alitto *et al*. 2019).

Indeed, a little more of 44% of the TMV sea star species are also known from the western Atlantic coast, 33% are amphi-Atlantic, whereas 22% of the sea star species are circumtropical in distribution (Table 1). However, it might well be that the amphi-Atlantic and circumtropical patterns are overestimated by poor taxonomic resolution. The even more remote Ascension (ASC) and Saint Helena (STH) are more of a mosaic than TMV (Table 1). The ASC and STH fauna consist of 8 and 11 sea star species, respectively. Their endemic component totals to 25% and 27%, respectively. STH has more amphi-Atlantic and eastern Atlantic sea star species (27% each) than ASC (25% and 12.5%, respectively). Twenty-five percent of the sea star species in ASC are circumtropical in distribution, whereas no circumtropical species have been found in STH. The western Atlantic (WA) component comparatively to the eastern Atlantic (EA) one is of minor significance in STH (18% versus 27%, respectively), whereas the WA and EA components contribute equally to the taxonomic composition in ASC (12.5% each). However, patterns of faunal affinities in both islands are actually taxon-dependent.

The Cape Verde oceanic islands (CV) are about 672 km away from the African coast, and as much as 63% of its sea star species expectedly also occur in the eastern Atlantic coast; this figure increases to 96.3% when the amphi-Atlantic component (33.3%) is considered (Table 1). Only one circumtropical species is known to inhabit the Cape Verde islands, from where no WA species have been recorded so far. Similarly, the oceanic islands in the Gulf of Guinea (GOG), about 317 km distant from the African coast, share all its shallow water species with the eastern Atlantic Asteroidea coastal fauna. Only a little more than 33% of the GOG sea stars are amphi-Atlantic in distribution.

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