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The Echinoderm Fauna of the Azores (NE Atlantic Ocean)

PATRÍCIA MADEIRA[1,2,4], ANDREAS KROH[3], RICARDO CORDEIRO[1,2],
ANTÓNIO M. DE FRIAS MARTINS[2] & SÉRGIO P. ÁVILA[1,2]
[1]*CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Pólo dos Açores, Portugal*
[2]*Departamento de Biologia, Faculdade de Ciências e Tecnologia, Universidade dos Açores, Apartado 1422, 9501–801 Ponta Delgada, Açores, Portugal*
[3]*Naturhistorisches Museum Wien, Burgring 7, 1010 Wien, Austria*
[4]*Corresponding author. E-mail: tamissa@hotmail.com*

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Abstract

In more than 150 years of research in the waters surrounding the Azores, several publications on the fauna of echinoderms of the archipelago have been produced, in the form of papers, notes, reports, reviews, and monographs. This work attempts to summarize the present knowledge on this marine group in the Azorean exclusive economic zone (*i.e*., waters within 200 nautical miles of the archipelago's shores). A short review of the history of the species' taxonomy is given, with key references, geographical distribution, ecology, additional notes and, when possible, figures. We herein report 172 species of echinoderms (6 crinoids, 55 ophiuroids, 45 asteroids, 36 holothurians, and 30 echinoids) from the Azores Archipelago, most of them inhabiting deep waters (>200 m). Only 29 shallow-water species were recorded locally (≤50 m depth). In general, the echinoderm species present in the Azores are characterized by a wide geographical distribution in the Atlantic Ocean. Only nine taxa (all deep-water species, >840 m) appear to be restricted to the Azorean waters. Overall, the knowledge of the echinoderm fauna of the Azores is out-dated, with many species last collected in the archipelago over 100 years ago. A recent interest in the Azorean Mid-Atlantic waters has brought oceanographic cruises back to the archipelago, thus providing new opportunities for the renewal of 150 years of echinoderm studies in the area.

Key words: Echinodermata

Introduction

The echinoderms (phylum Echinodermata) are a conspicuous presence throughout all oceans and seas, at all latitudes and depths, from coastal areas down to the abyssal plains to approximately 6,000 m (Mironov 1978), and they occur in virtually all marine habitats, including coral reefs, mangroves, and rocky, sandy, and muddy substrates. They are a diverse group of generally strictly marine animals that includes the brittle stars (class Ophiuroidea, 2,064 species), sea stars (class Asteroidea, 1,900 species), sea cucumbers (class Holothuroidea, 1,400 species), sea urchins (class Echinoidea, 1,012 species), and sea lilies and feather stars (class Crinoidea, 623 species) (Pawson 2007; Appeltans *et al*. 2012; Mah & Blake 2012; Stöhr *et al*. 2012; Kroh & Mooi 2018).

In over 150 years of echinoderm studies in the Azores, a total of 150 publications include at least one specimen collected in the archipelago (Fig. 1). The focus of the research on the Azorean echinoderm fauna changed through time, with the first studies in the late 1800's resulting from small expeditions, which aimed to identify the main elements of the shallow-water echinoderm fauna. Drouët (1861), followed by Barrois (1888), and Simroth (1888), concluded that the Azorean shallow-water echinoderm fauna seemed to be derived exclusively from European waters, particularly from the Mediterranean Sea, with no elements endemic to the area. In the late 19th century during the 'Golden Age' of oceanographic surveys, the ocean floor around the Azores was extensively surveyed and new material unknown to science was retrieved from deep waters. Most of what we know about the deep-water echinoderm fauna of the archipelago derives from reports based on the material collected by these cruises (Table 1) such as by the research vessels H.M.S. *Challenger, Princesse Alice*, and *Talisman* (*e.g*. Perrier 1898; Koehler 1909; Hérouard 1923). However, by mid-20th century, interest in the Azorean echinoderm fauna faded away and, from the late 1920's onward, publications focused primarily on the re-examination of museum specimens collected during the former cruises (*e.g*., H.L. Clark 1925; Deichmann 1930; Mortensen 1935), though some studies also dealt with shallow-water biota collected by mostly small expeditions (Nobre 1924; Cadenat 1938; Chapman 1955; Marques 1983). Three exceptions are the publications based on the material collected by *Atlantis* (A.H. Clark 1948, 1949), *Jean Charcot* (Cherbonnier & Guille 1972; Cherbonnier & Sibuet 1972; Sibuet 1976, 1977), and by the French bathyscaphe *Archimède* (Sibuet 1972). From the 1980's onward, the studies shifted to a more integrated analysis of the shallow-water fauna, and Marques (1984) published the first ecological study on the Azorean echinoderms. In the 21st century, the first field guides were issued that included underwater photographs of animals in the Azores (*e.g.,* Wirtz & Debelius 2003).

In more recent years, a renewed interest on the complex geological processes shaping the ocean floor led to the return of the oceanographic cruises to Azorean deep waters, especially to areas surrounding the Mid-Atlantic Ridge (*e.g., G.O. Sars*) and to the extreme environments of the deep-water chemosynthetic hydrothermal vents (*e.g.,* Lucky Strike, Menez Gwen, Rainbow). The use of modern capture techniques, such as Remote Operated Vehicles (ROVs) together with more traditional collecting forms (*e.g.,* dredge, trawl or sledge) added several new species to the archipelago's deep-water echinoderm fauna, some of which proved to be new to science (*e.g.,* Stöhr & Segonzac 2005; Dilman 2008; Gebruk 2008; Martynov & Litvinova 2008). By the 2010's, phylogeographic and taxonomic studies using genetic tools started to readdress the shallow-water echinoderm fauna of the Northeast Atlantic, including the Azores (*e.g.,* Borrero-Pérez *et al*. 2011; Kroh *et al*. 2011; Wangensteen *et al*. 2012; Micael *et al*. 2014). Also, during the last decade, local faunal lists were produced on the shallow-water echinoderm fauna that summed up the first attempts to understand the overall biodiversity of this diverse animal group in the Azores (Micael & Costa 2010; Micael *et al*. 2012). In addition, the fossil echinoderm fauna from the early Pliocene and Pleistocene of the oldest island, Santa Maria, was addressed during this decade (*e.g.,* Madeira *et al*. 2011; Ávila *et al*. 2015a, b; Santos *et al*. 2015).

In sum, throughout 150 years of research, the echinoderm fauna of the Azores has been the subject of several studies, which are dispersed among papers, notes, reports, reviews, and monographs. The present work attempts to summarize the present knowledge about this invertebrate group in the Azores area.

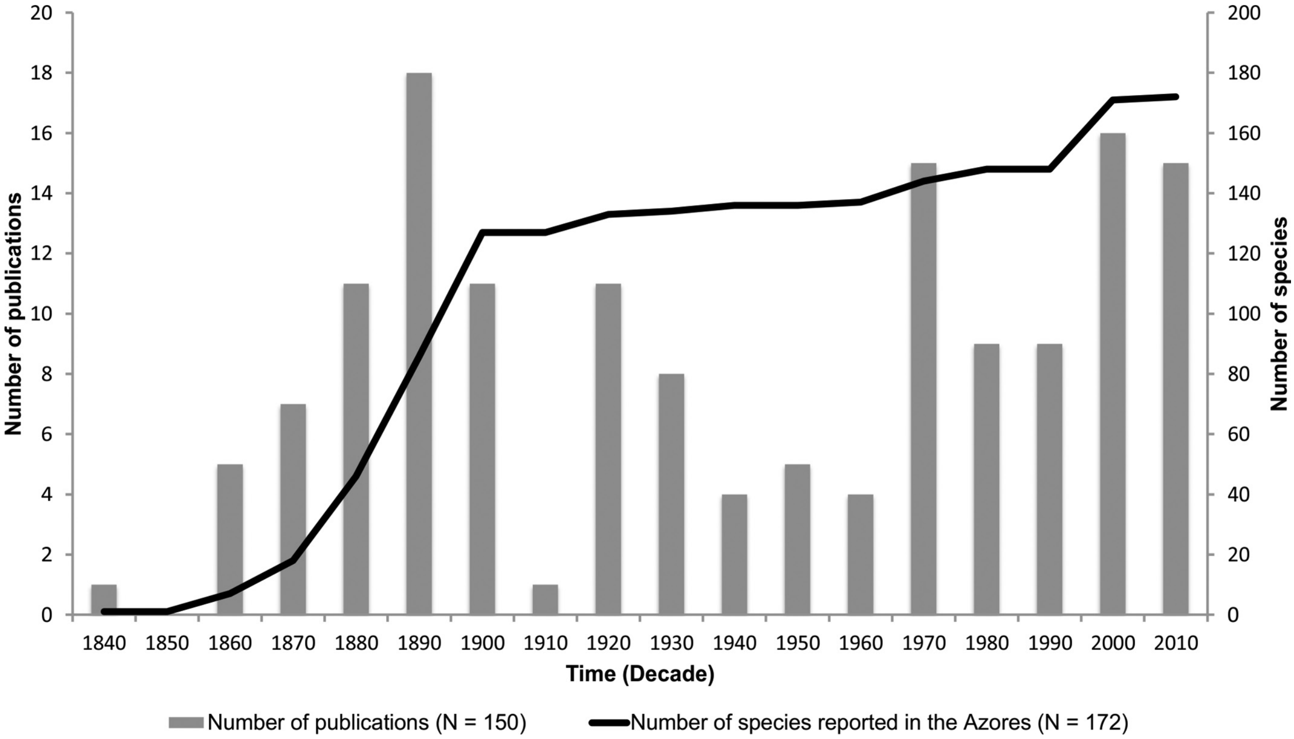

FIGURE 1. Number of echinoderm species reported for the Azores (black line; N = 172) and related literature through time (grey bars; N = 150).

Study area

The Azores is one of the most isolated archipelagos in the Atlantic Ocean. It is composed of nine volcanic oceanic islands and several islets, spread over 600 km in a SW–NE direction, between 36°55’N and 39°43’N and 24°46’W and 31°16’W, almost halfway between Europe and America (Fig. 2), some 1370 km from the nearest European continental shores and about 842 km from the Madeira Archipelago, the closest insular system (Morton *et al*. 1998). The Azorean waters are consigned by an Exclusive Economic Zone (EEZ) defined by a 200-nautical-mile radius around the islands (Fig. 2), enclosing almost one million square kilometres, with 94–97% of its area characterized by depths exceeding 1,000 m (da Silva & Pinho 2007).

The insular shelf of the islands is narrow, and the marine topography is characterized by a steep slope beyond the shelf break (Morton *et al.* 1998; Wallenstein & Neto 2006). The Azores’ extremely rugged coastline is approximately 930 km long (Instituto Hidrográfico 2000) and is exposed to medium/high levels of wave action (Wallenstein & Neto 2006; Wallenstein *et al*. 2010). The morphology of the littoral varies from island to island, though in general terms it is characterized mostly by rocky shores (Morton *et al.* 1998). Sandy beaches are rare, generally enclosed in small bays that are mostly of volcanic origin. The sand in many of the beaches is frequently seasonal, as winter storms carry the sand offshore, leaving behind the underlining basalt cobblestones (Morton *et al.* 1998). The tidal range is small (<2 m), and therefore extensive bedrock platforms that favour the occurrence of rock-pools are scarce and heterogeneous (Wallenstein & Neto 2006; Wallenstein 2010).

The Azores lie at the northern edge of the North Atlantic Subtropical Gyre, with the main sea-surface currents flowing from west to east. The Gulf Stream transports warmer waters of equatorial and tropical origin to the colder northern Atlantic (Johnson & Stevens 2000; Bashmachnikov *et al*. 2015). The average sea-surface temperatures in the archipelago range from 15–16°C in the winter to 22–24°C during summer (Bashmachnikov *et al*. 2004).

Material and methods

The echinoderm fauna compiled and revised herein considers all the species present in the Azores as reported in the literature over the last 150 years. Table 1 lists the main cruises made in Azorean waters and the resulting publications. Other important bibliographic sources referring to material collected in the area include: Drouët (1861), Lyman (1865), Agassiz (1863), Selenka (1867), Agassiz (1872–1874), Lovén (1874), Barrois (1888), Nobre (1924, 1930), Grieg (1932), Chapman (1955), Tortonese (1965), Marques (1983), Wirtz & Martins (1993), Morton *et al.* (1998), Wirtz & Debelius (2003), Stöhr & Segonzac (2005), Wirtz (2009), and Wisshak *et al.* (2009a, 2010). Taxonomic reviews, in which specimens collected in the area were re-examined (many producing re-descriptions and re-identifications), are also included (*e.g.,* Mortensen 1935; A.H. Clark & A.M. Clark 1967; Hansen 1975; Paterson 1985; A.M. Clark & Downey 1992; Gebruk *et al.* 2012). Compiled faunal lists for the area were also critically reviewed and used as additional sources: Pereira (1997), García-Diez *et al.* (2005), Micael & Costa (2010), and Micael *et al.* (2012).

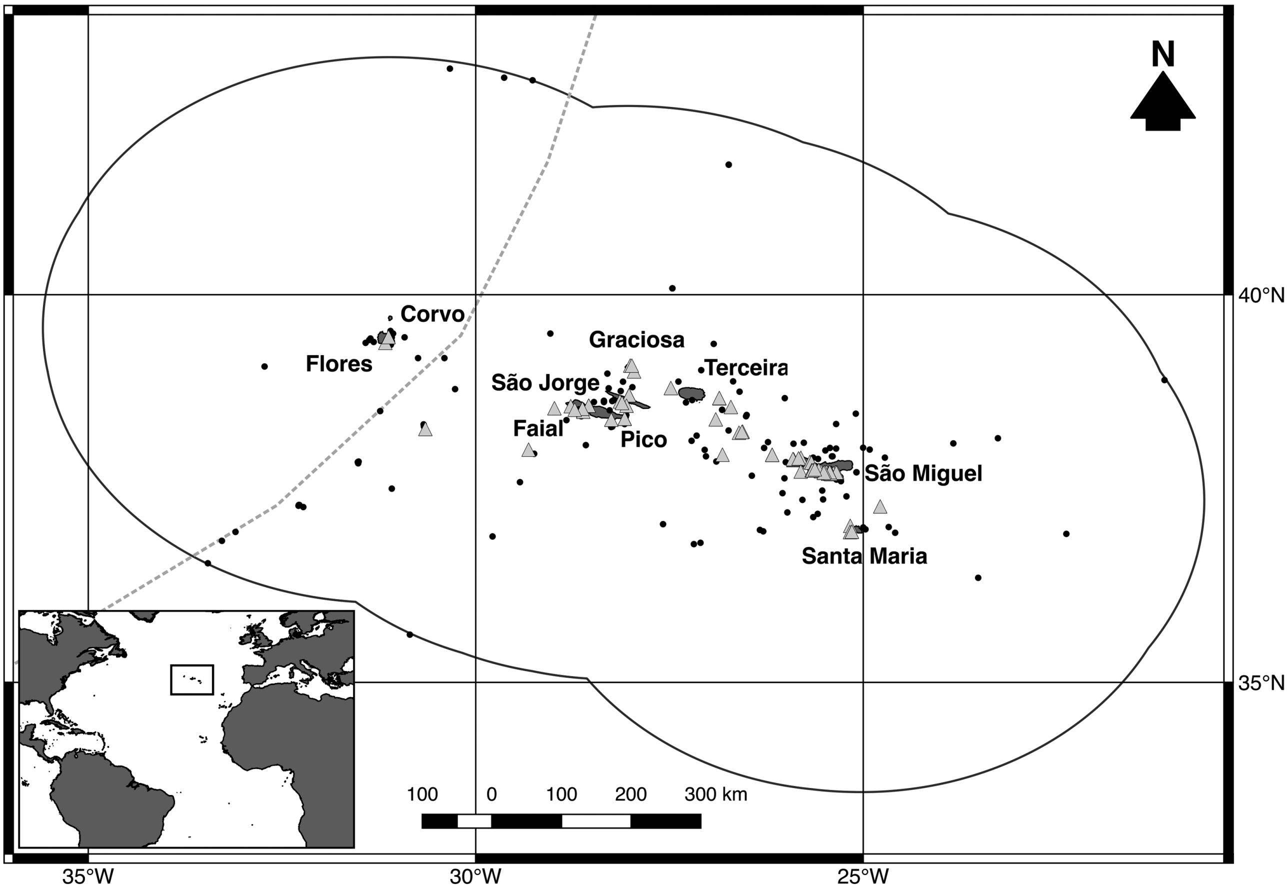

FIGURE 2. Azores Archipelago and the area defined by the 200 miles Economic Exclusive Zone (ZEE; solid line), Mid-Atlantic Ridge (hatched line), sample stations of the main historical oceanographic cruises (black circles; for references see Table 1) and the material examined herein (grey triangles).

Species were only considered as native to the archipelago if at least one record in the Azores was documented (*i.e.,* material collected by a cruise or belonging to a zoological collection). For this purpose, a list of references was assembled referring only to publications in which the Azores are included in the geographical distribution of the species. Synonymies of included species are not comprehensive but are restricted to works in which Azorean echinoderms were studied or mentioned by the authors. Works in which the records were based on actual specimens (collected, examined or observed) from the Azores are preceded by a superscript dollar sign ($^{\$}$) in the synonymies, whereas other studies only mentioning the Azores in faunal lists or species distributions are simply listed. All uncertain records for the area are preceded by a question mark (?). Records originally based on mixed lots are preceded by 'p.p.'. If the species' name is followed by a question mark (?) in the title, its presence in the Azores is considered questionable in this review, since its record was based either on unsound historical identifications, dubious reports (*e.g.,* possible mislabelling), or on possible vagrant animals with no evidence of an established local population (*e.g.,* shallow-water tropical species).

For a complete assessment of the Azorean echinoderm fauna, an additional list is also provided that includes all species erroneously considered as native to the Azores (*e.g.,* out-dated synonymy, misprints, mislabelling) that persist in the bibliography (*i.e.* all species we have considered that should be excluded from the Azorean checklist of echinoderms). Locations listed in the historical reports of *Princesse Alice*, *Talisman* and *Hirondelle* cruises, which were measured with reference to the Paris meridian were corrected to the Greenwich meridian by subtracting 2°20’14” from the longitude, except for Koehler (1909) and Hérouard (1923), which were already reported using the English meridian.

TABLE I. Main oceanographic cruises in the Azores and resulting main literature for each echinoderm classes.

Cruise (RV)	**References**	**Echinoderm Classes**
H.M.S. Challenger	Carpenter (1883b, 1884)	Crinoidea
	Lyman (1878a, 1979, 1882)	Ophiuroidea
	Sladen (1883, 1889)	Asteroidea
	Agassiz (1879, 1881)	Echinoidea
	Théel (1886a)	Holothuroidea
Josephine	Ljungman (1872)	Ophiuroidea
	Lovén (1871, 1874)	Echinoidea
Hirondelle	Koehler (1895a, 1896b, 1897b, 1898, 1921a)	Ophiuroidea, Echinoidea,
Hirondelle II	Perrier (1891, 1896a)	Asteroidea
	Hérouard (1923), Marenzeller (1892, 1893)	Holothuroidea
Princesse-Alice Princesse-Alice II	Koehler (1895b, 1896c, 1901, 1907b, 1909, 1921a)	Crinoidea, Ophiuroidea, Asteroidea, Echinoidea, Holothuroidea,
	Hérouard (1896, 1899, 1902, 1912, 1923)	Holothuroidea
Talisman	Koehler (1906a, b)	Ophiuroidea
	Perrier (1885b, c, d, 1894)	Asteroidea
	Mortensen (1903, 1927b)	Echinoidea
	Perrier (1896b, 1899, 1902)	Holothuroidea
Président Théodore-Tissier	Cadenat (1938)	Asteroidea, Echinoidea, Ophiuroidea,
Atlantis	Clark (1848)	Asteroidea, Ophiuroidea
	Clark (1949)	Asteroidea, Ophiuroidea, Crinoidea, Echinoidea
	Serafy (1974)	Echinoidea
Jean Charcot (Noratlante, BIAçores)	Cherbonnier & Guille (1972), Roux (1985), Améziane *et al*. (1999)	Crinoidea
	Cherbonnier & Sibuet (1972)	Asteroidea, Ophiuroidea
	Sibuet (1976, 1977),	Asteroidea
	Mironov (2006	Echinoidea
Archimède (Bathyscaphe)	Sibuet (1972), Pérès (1992)	Asteroidea, Echinoidea, Crinoidea, Ophiuroidea, Echinoidea, Holothuroidea
Knorr	Roux (1980, Famous)	Crinoidea
Tydeman (CANCAP-V)	Améziane *et al.* (1999)	Crinoidea
G.O. Sars (MAR-ECO)	Dilman (2008)	Asteroidea,
	Martynov & Litvinova (2008)	Ophiuroidea,
	Gebruk (2008)	Holothuroidea

The five echinoderm classes are treated in the following order: Crinoidea, Ophiuroidea, Asteroidea, Echinoidea, and Holothuroidea. The species are ordered alphabetically, from class downwards. The World Register of Marine Species database (WoRMS Editorial Board 2017) was used as a reference for the latest taxonomic status of Azorean species, though a bibliographical confirmation was always favoured (*e.g.,* Mortensen 1928; A.H. Clark & A.M. Clark 1967; Hansen 1975; Paterson 1985; A.M. Clark & Downey 1992; Martynov 2010, O'Hara *et al*. 2017, 2018).

The type locality for each species is given whenever possible. The paragraph ‘See’ encloses relevant literature that references the synonymy and comprehensive descriptions of each species. The geographical distribution outside of the Atlantic area is outlined only in general terms. The global depth range for each species is followed by the bathymetric distribution documented in Azorean waters (AZO). Reported habitat information together with other known ecological data are placed under the paragraph 'Habitat'. Data on the mode of larval development for the listed species is also provided.

Santa Maria, the oldest and southernmost island of the archipelago, is the only one with documented fossiliferous outcrops, mostly marine and early Pliocene, but also late Pleistocene (MIS 5e, *i.e.* Last Interglacial) in age (see Ávila *et al.* 2018). The paragraph 'Fossil record' briefly summarizes the extant echinoid species reported from the fossil record of Santa Maria Island.

Many echinoderm species (mainly holothurians and echinoids) are traditionally or commercially harvested. They are used directly for human consumption or as additives in pharmaceutical, nutraceutical, and cosmetic products. They are also used as ornamental species in aquarium trade and souvenir memorabilia (Micael *et al.* 2009). Most markets are concentrated in Asia, but several European species have been reported as being commercially harvested with potential economic importance for future fisheries. Though no echinoderm species from the archipelago have been traditionally consumed or commercially harvested in the islands, we have enclosed in the paragraph 'Commercial value' information regarding if the species is harvested for food consumption elsewhere.

The rich material collected over the years from Azorean waters is housed in zoological collections in numerous institutions throughout Europe and the USA. For instance, H.M.S. *Challenger* specimens are currently housed in several zoological collections, such as the Natural History Museum (London) and Museum of Comparative Zoology (Harvard University). The material collected by *Princesse Alice* is part of the zoological collections of the Muséum National d'Histoire Naturelle (Paris) and the Musée Océanographique de Monaco (Monaco). These two examples demonstrate how difficult it is to track and examine specimens reported in the literature, a task far more time-consuming and costlier than possible for this paper. Thus, to achieve a comprehensive revision of the echinoderm fauna of the Azores in a timely manner, we have relied on the published literature and local collections. 'Material examined' lists the studied specimens from the following Portuguese zoological collections: Department of Biology of the University of the Azores (DBUA-ECH, Ponta Delgada, São Miguel Island, Azores), Museu Carlos Machado (MCM, Ponta Delgada, São Miguel Island, Azores), Museu Bocage—Natural History Museum (MB–NMHN, Lisbon, Portugal), Department of Oceanography and Fisheries (DOP, Horta, Faial Island, Azores), and *Estrutura de Missão para a Extensão da Plataforma Continental Portuguesa* (EMEPC, Paço de Arcos, Portugal).

The material was collected using a variety of methods, including dredging, grab sampling or direct sampling by hand on the shore, SCUBA diving or by ROV (*Luso*, EMEPC 2009). Additional material from the Gorringe Seamount (W of Portugal, NE Atlantic) was also included for comparison. The depths at which the specimens were collected ranged from 0 to 1,201 m. Most specimens were preserved in 70–96% ethanol or dried, though some of the oldest material may have been temporarily immersed in a solution of buffered formalin as a fixation agent. All measurements were made on preserved animals either directly with a digital calliper or by using an eyepiece reticule on a binocular microscope. Observation of calcareous ossicles (*e.g.,* pedicellaria) was made with an optical microscope after a brief immersion in common household bleach. The paragraph 'Description' contains a brief diagnostic description based on the specimens found in the zoological collections mentioned above. The terminology used herein was mainly adapted from A.M. Clark & Rowe (1971), but also from Roux (2002; crinoids), Stöhr *et al.* (2012; ophiuroids), A.M. Clark & Downey (1992; asteroids), Kroh & Smith (2010; echinoids), and Purcell *et al*. (2012; holothurians). The paragraph 'Remarks' includes a brief review of the history of species records and taxonomy in the region. Whenever available, we included photographs or footage frames showing echinoderms *in situ* taken by the authors (shallow-water species) or by the ROV *Luso* (EMEPC, 2009) (deep-water species).

Abbreviations and acronyms used in the text. Institutions and Zoological Collections: DBUA-ECH—Recent echinoid reference collection of the Department of Biology of the University of the Azores; DBUA-F—Reference fossil collection of the Department of Biology of the University of the Azores; DOP—Recent reference collection of the Department of Oceanography and Fisheries of the University of the Azores; EMEPC—Portuguese expeditions *Estrutura de Missão para a Extensão da Plataforma Continental Portuguesa*; LUSO—Remotely operated underwater vehicle operated by EMEPC; MB–NMHN—Museu Bocage, Natural History Museum; **Measurements:** AL—Arm length (Crinoidea); D—Diameter; DD—Disk diameter (Ophiuroidea); P—Pinnules (Crinoidea); R—Major radius, from the centre to the arm tip (Asteroidea); r—Minor radius, from the centre to the interradius (Asteroidea); TL—Total length (test length in echinoids and holothurians); **Localities:** AZO—Azores; FAY—Faial Island; FLS—Flores Island; FRM—Formigas Islet; GRA—Graciosa Island; PIX—Pico Island; SJG—São Jorge

Island; SMA—Santa Maria Island; SMG—São Miguel Island; TER—Terceira Island; **Other:** $^{\$}$—Record based on specimens from the Azores; ?—Doubtful record or species in the Azores; bt(s)—Bare test(s) (Echinoidea); p.p.—record based on mixed material, containing at least two different species; ROV—Remotely operated underwater vehicle; Sta(s)—Station(s); spm(s)—Specimen(s).

Results

The extant echinoderm fauna of the Azores encompasses a total of 172 species: 6 crinoids (distributed among 3 orders, 6 families and 6 genera), 55 ophiuroids (6 orders, 18 families and 29 genera), 45 asteroids (6 orders, 18 families and 32 genera), 36 holothurians (6 orders, 12 families and 20 genera), and 30 echinoids (9 orders, 17 families, 25 genera). Twenty-nine additional species might also prove native to the archipelago, but their presence needs confirmation and their status must be currently considered as dubious in the area. Another 51 species reported for the Azores in the bibliography proved to be erroneous, mostly a direct result of misidentifications, out-dated synonymy, misprints, or incorrect indirect references. Nonetheless, a more recent interest in the Mid-Atlantic waters of the Azores and their echinoderm inhabitants resulted not only in the confirmation of the presence of 38 species (7 species herein) recorded in the historical bibliography, but also in the addition of 24 new taxa to the Azores (*e.g.,* Stöhr & Segonzac 2005; Dilman 2008; Gebruk 2008; Martynov & Litvinova 2008). The echinoderm fauna in the Azores consists of 126 Atlantic species (including 36 species that also occur in the Mediterranean), 37 cosmopolitan taxa, and only nine endemic deep-water species (Fig. 3). However, it is necessary to note that six of the endemic species are known only from the type material collected more than 100 years ago and one was last recorded 80 years ago.

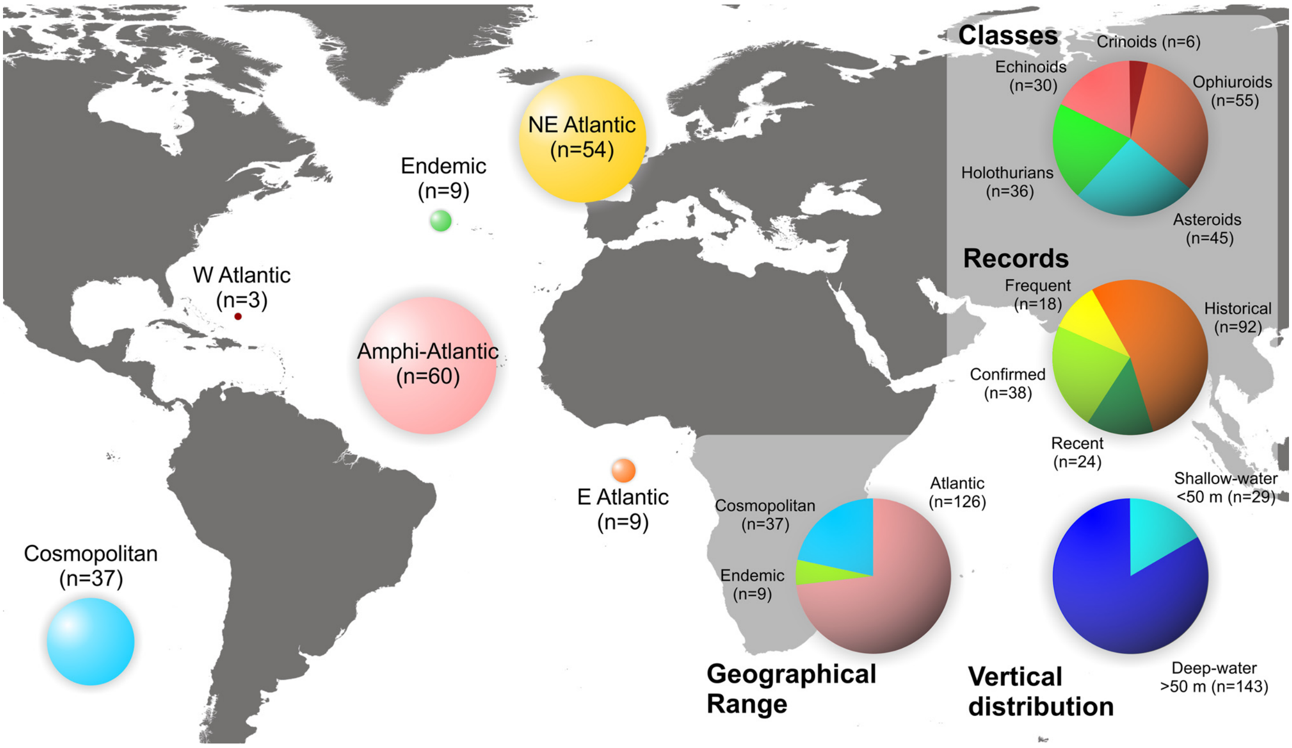

FIGURE 3. Echinoderms from the Azores per class, number of records in the literature, vertical distribution and geographical range.

Our results indicate that out of 172 species only 29 echinoderm species occur at shallow depths in the Azores (≤50 m: 1 crinoid, 6 ophiuroids, 8 sea stars, 5 holothurians, and 9 echinoids). Most consists of species restricted to the eastern side of the Atlantic, and most occur in the Mediterranean Sea (28 species). Exceptionally, six species also occur in West Atlantic shallow waters, and two have also widespread distributions outside the Atlantic, the heart urchin *Echinocardium cordatum* (Pennant, 1777) and the brittle star *Amphipholis squamata* (Delle Chiaje, 1828). However, these two species may represent cryptic species complexes. In contrast, the deep-water fauna is characterized by species with a wide geographical distribution in the Atlantic (with just 42 species restricted to the east side of the Atlantic) and 35 species also occurring in other oceans. Additionally, Azorean deep waters also support three species found elsewhere only in the West Atlantic.

The shallow water echinoderm fauna appears to be mainly associated with rocky shores, though nine species appear to be restricted to soft bottoms. In contrast, the deep-water fauna is mainly composed by species found in association with sediments. Interestingly, among the 36 holothurian species reported from the archipelago, 31 are considered deep-water species, and at least half of these are benthopelagic (14 to 17 species).

We have included Table S1 as Supplementary Material, containing a synopsis of all the species referred to the Azores, together with information about geographical and bathymetric ranges, habitat, type area, status, and first report for the archipelago.

List of Species

Phylum Echinodermata Bruguière, 1791

Class Crinoidea Miller, 1821

Order Comatulida A.H. Clark, 1908

Family Antedonidae Norman, 1865

Genus *Antedon* de Fréminville, 1811

Species *Antedon bifida* (Pennant, 1777)

Antedon bifida moroccana (A.H. Clark, 1914)

(Fig. 4)

Reports for the Azores:

Antedon sp.—$^{\$}$Simroth 1888: 231;
Antedon rosacea Norman, 1865—$^{\$}$Barrois 1888: 32, 33, 115; ?$^{\$}$Koehler 1898: 3;
Antedon bifida (Pennant, 1777)—A.H. Clark 1911: 38–39; $^{\$}$Chapman 1955: 338; Tortonese 1965: 27; Nichols 1994: 113–134; Pereira 1997: 332; $^{\$}$Morton *et al*. 1998: 150, fig. 7.5C; Micael & Costa 2010: 321; Micael *et al*. 2012: 3;
Antedon moroccana A.H. Clark, 1914: 307; Mortensen 1927a: 27;
Antedon bifida moroccana (A.H. Clark, 1914) —$^{\$}$A.H. Clark & A.M. Clark 1967: 226–234, fig. 13c; $^{\$}$Marques 1983: 1.

Type locality: Tangier, Morocco.

See: A.H. Clark & A.M. Clark (1967); Domenico *et al*. (2009).

Occurrence: Northeast Atlantic and Mediterranean Sea, from Morocco to west of Sierra Leone and Liberia, including the Azores, Madeira and Canaries (A.H. Clark & A.M. Clark 1967); the subspecies *A. bifida bifida* (Pennant, 1777) is distributed further north in the Northeast Atlantic, from Portugal northwards to the British Islands (A.H. Clark & A.M. Clark 1967).

Depth: 0–200 m (A.H. Clark & A.M. Clark 1967); AZO: 3–60 (?130) m (Koehler 1898, Marques 1983).

Habitat: present in waters with strong tidal currents and related upwelling phenomena (Domenico *et al*. 2009); in shallow waters, it lives in relatively protected areas, clinging to rocks, algae or other sessile fauna (Mortensen 1927a, Nichols 1994, Morton *et al*. 1998).

Larval stage: the females *Antedon bifida* brood the eggs, which produced a doliolaria larvae (non-feeding pelagic larvae, *c.* 5 days; Lahaye & Jangoux 1988; Nichols 1994).

Material examined: DBUA-ECH 071 (Piscina da Lagoa, Lagoa, SMG, AZO, *c.* 37°44’29”N, 25°34’27”W, 1996.07.25, 12 m; 9 spms, AL = 46–74 mm); DBUA-ECH 072 (Baixa do Ouro, Caloura, SMG, AZO, *c.* 37°43’32”N, 25°32’47”W, 1996.12.05, 15 m; 3 spms, AL = 37–64 mm).

Description: disc naked, with ten slim pinnate arms about 37–74 mm in length; centrodorsal discoidal, bearing crowded and irregular cirrus sockets in two or three more or less alternating rows; cirri XXV–XXXIV, 13–16, from 7 to 11 mm long; in lateral view the cirri are twice as broad distally as proximally with the distal half strongly recurved; the cirrals in the outer part of the cirri are almost as broad as long dorsally, becoming terminally slightly longer, about one third again as long as broad; overall cirral outline not centrally constricted or appressed but strongly compressed laterally; conspicuous group of perisomic interradials in each interradius; division series short and well separated laterally; first pinnule (P1) composed for the most part of elongated segments, though a few of the basal segments may be shorter; P1 composed of 25–31 segments (*c.* 12 mm long) to about 19–20 segments (*c.* about 6–7 mm) in smaller specimens (arm length ≤ 46 mm); P1 is at least twice as long as the second pinnule (P2), which is similar in size to the third pinnule (P3), the first genital pinnule; gonads absent from the first two pinnules (P1 and P2) and confined to proximal half of the pinnule; the production of the distal ends of the segments of the proximal pinnules is marked; in ethanol, the anterior side is more or less cream colour with ambulacral grooves and pinnules dark reddish-brown or dark purple; posterior side uniformly light cream.

Remarks: the *Antedon* species present in the Atlantic show a great morphological variation resulting in somewhat overlapping interspecific diagnosing characters, which historically have puzzled taxonomists. A.H. Clark (1914) believed that the overall variation was essentially a result of different environmental settings. Later, A.H. Clark & A.M. Clark (1967) again questioned if the several forms of *Antedon*, from the west and east tropical Atlantic waters (*A. duebeni* Böhlsche, 1866 and *A. hupferi* Hartlaub, 1890, respectively) and from the temperate and boreal Northeast Atlantic waters [*A. bifida* subspecies and *A. petasus* (Düben & Koren, 1846), respectively] could be all conspecific, a matter still to be settled.

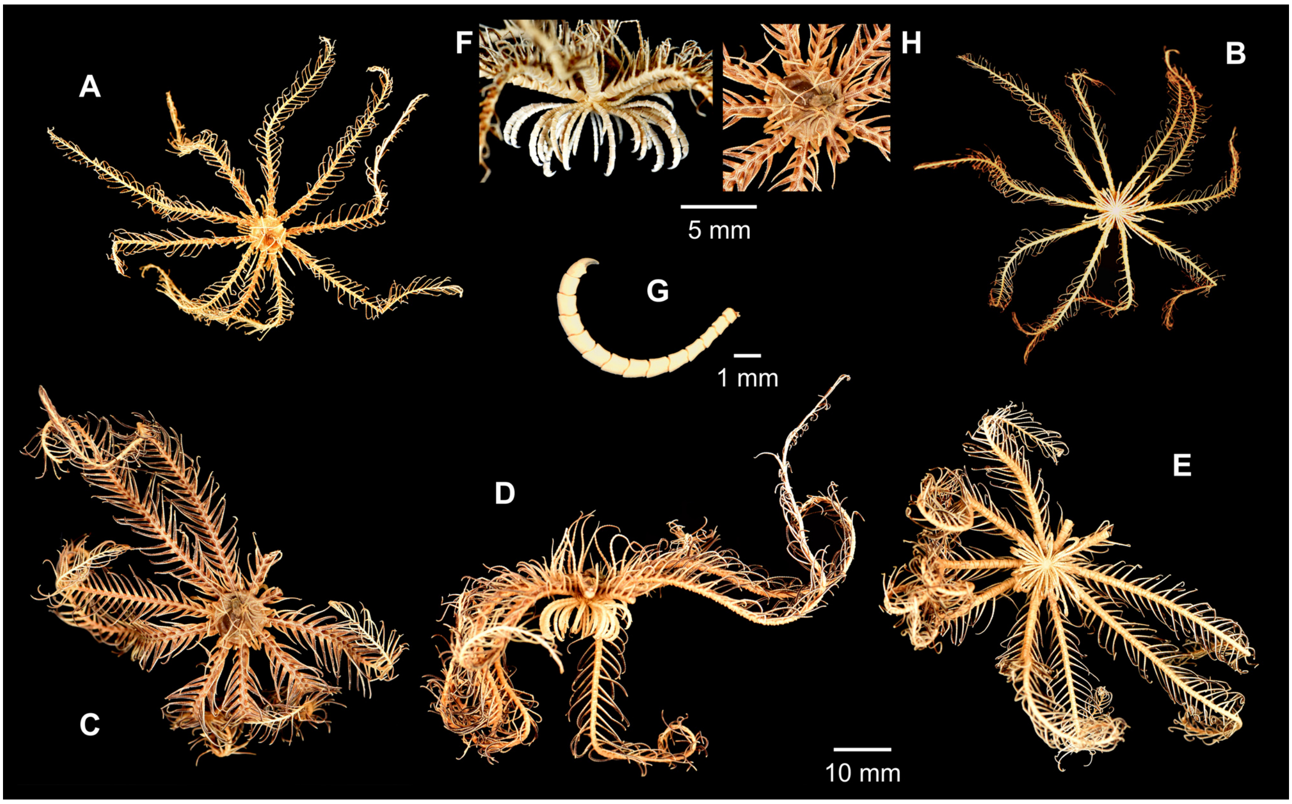

FIGURE 4. *Antedon bifida moroccana* (Clark, 1914) (DBUA-ECH 071). Dorsal view (A, C); ventral view (B, E); lateral view (D); detail of the disc, dorsal view (H), lateral view (E) and cirri (G).

The first report of an *Antedon* to the archipelago was made by Barrois (1888) under the name *Antedon rosacea*, a known synonymy of the European *A. bifida*. Simroth (1888) also listed an *Antedon* among the Azorean echinoderm fauna, but failed to assign it to a particular species. Koehler (1898) examined a very small and damaged specimen collected in the archipelago by *Hirondelle* at 130 m and commented that he could not ascertain if it belonged to *Antedon rosacea*. Chapman (1955) remarked that the animals from the Azores differ slightly from the typical *A. bifida* by having fewer segments in the first pinnule. A.H. Clark & A.M. Clark (1967) examined material from the Azores and concluded that the *Antedon bifida* present in the archipelago belonged to the subspecies *moroccana*. This subspecies differs essentially from the typical form by the overall aspect of the cirri segments. The first two pinnules (P1 and P2) seem also slightly smaller with fewer segments in *A. b. moroccana.* The overall cirrus shape exhibited by the Azorean material examined herein agrees with descriptions and illustrations of the *moroccana* form presented by A.H. Clark & A.M. Clark (1967) and by de Domenico *et al*. (2009). Nevertheless, smaller specimens showed slightly smaller P1 and P2, with fewer segments, similar to what was presented by A.H. Clark & A.M. Clark (1967) for *Antedon bifida moroccana*. These discrepancies were dismissed as size-related individual variations in view of the overall similarity with *A. bifida* particularly with the subspecies *moroccana*.

Genus *Leptometra* A.H. Clark, 1908

Leptometra celtica? (M'Andrew & Barrett, 1857)

Reports for the Azores:
non *Antedon phalangium* (Müller, 1841)—Koehler 1909: 269;
non *Leptometra phalangium* (Müller, 1841)—Grieg 1932: 43;
Leptometra celtica (M'Andrew & Barrett, 1857)—Marques 1980: 98;
Leptometra sp.—?$^{\$}$Pérès 1992: 252.

Type locality: Sound of Skye, Scotland.

See: A.H. Clark & A.M. Clark (1967: 564–573, figs. 32c–g); A.M. Clark (1980: 193–195, fig. 2).

Occurrence: East Atlantic, from Faeroe channel to off Sierra Leone including the archipelagos of Madeira, Canaries, and the seamounts Seine and Gorringe (A.H. Clark & A.M. Clark 1967; A.M. Clark 1980).

Depth: 46–1,279 m (A.H. Clark & A.M. Clark 1967); AZO: ?700 m (Pérès 1992).

Habitat: mud, or sand, or gravel with mud (rarely on hard bottoms) (A.H. Clark & A.M. Clark 1967); can form dense beds (Fonseca *et al*. 2014).

Remarks: Koehler (1909) included the Azores in the geographical distribution of *Leptometra phalangium* (Müller, 1841), a species regarded as endemic to the Mediterranean Sea (Tortonese 1965). All reports of *Leptometra phalangium* from the Atlantic were a result of confusion with *L. celtica*, the only *Leptometra* species known to occur in the Atlantic (A.H. Clark & A.M. Clark 1967). Regardless, the citation for the Azores by Koehler (1909) and later reproduced by Grieg (1932) and Marques (1980) is likely erroneous, as to best of our knowledge no material belonging to either *L. celtica* or *L. phalangium* was ever collected in the archipelago.

In 1992, Pérès claimed to have observed a *Leptometra* crinoid during a dive by the bathyscaphe *Archimède* west of Santa Maria Island at a depth of 700 m. It is possible that Pérès might be referring to *L. celtica*, considering this species' geographic and bathymetrical wide range. On the other hand, on stating a 'crinoid of *Leptometra* type', he could have been simply referring to a comatulid (an unstalked form), which in this case *Pentametrocrinus atlanticus* (Perrier, 1883a) should be also considered, a species known to occur in the Azorean deep waters (see below).

Family Pentametrocrinidae A.H. Clark, 1908

Genus *Pentametrocrinus* A.H. Clark, 1908

Pentametrocrinus atlanticus (Perrier, 1883a)

Reports for the Azores:
Eudiocrinus atlanticus Perrier, 1883a—$^{\$}$Koehler 1909: 271–274, pl. 32, figs. 15–18;
Pentametrocrinus atlanticus (Perrier, 1883a)—$^{\$}$A.H. Clark & A.M. Clark 1967: 790–794; $^{\$}$Messing 1978: 699–708, figs. 1–18; A.M. Clark 1980: 203–204; Messing & Dearborn 1990: 26, fig. 6; García-Diez *et al*. 2005: 46;

Type locality: North of Spain (44°01'20"N, 7°04'45"W).

See: Perrier (1883a); Koehler (1909); Messing (1978).

Occurrence: North Atlantic; in the western Atlantic reported from Florida and the Caribbean islands (Messing 1978); in the eastern Atlantic recorded from the Porcupine Bank (SW of Ireland) and from the Bay of Biscay south to Western Sahara, including the Azores and Canaries (A.H. Clark & A.M. Clark 1967; A.M. Clark 1980).

Depth: 374–2,115 m (Messing & Dearborn 1990); AZO: 1,165 m (Koehler 1909).

Habitat: soft substrates, fine sand to mud (A.H. Clark & A.M. Clark 1967); it can be found together with sponges, alcyonarians and azooxanthellate colonial scleractinians (Messing & Dearborn 1990).

Remarks: Koehler (1909) reported a single specimen belonging to *Pentametrocrinus atlanticus* (= *Eudiocrinus atlanticus*) among the material collected in the Azores by *Princesse Alice* (sta 578: 38°26'00"N, 26°30'45"W, 1,165 m). Later, A.H. Clark & A.M. Clark (1967) and Messing (1978) re-examined the animal from the Azores and confirmed the historical identification by Koehler. It is possible that the crinoid observed by Pérès (1992) during a dive by the bathyscaphe *Archimède* west of Santa Maria at 700 m depth, and described by the author as 'crinoid of *Leptometra* type' may have been this species (see remarks above under *Leptometra celtica*).

Family Bourgueticrinidae Loriol, 1882

Genus *Democrinus* Perrier, 1883b

Democrinus parfaiti Perrier, 1883b

Reports for the Azores:

non *Rhizocrinus rawsoni* Pourtalès, 1874—$Carpenter 1883b: 173–175, 1884: 262–269, pl. 9, figs. 3–5, pl. 10, figs. 3–20, pl. 53, figs. 7–8 [misidentification]; $Koehler 1909: 255–256 [misidentification]; ?$Pérès 1992: 256;

Democrinus parfaiti (Perrier, 1883b)—Mortensen 1927a: 20, fig. 8; $A.M. Clark 1977: 172–177, fig. 3; A.M. Clark 1980: 205, fig. 1; $Roux 1985: 480–481; Harvey *et al*. 1988: 157; Mironov *et al*. 2014: 116;

non *Democrinus rawsonii* (Pourtalès, 1874)—García-Diez *et al*. 2005: 46 [based on Koehler 1909].

Type locality: Cape Blanc, NW Africa.

See: Perrier (1883b); A.M. Clark (1977); Harvey *et al*. (1988).

Occurrence: Northeast Atlantic, from the Azores eastwards between 24°N and 50°N including the archipelagos of Madeira and Canaries, as well as the Ormond Seamount (Roux 1985, Mironov *et al*. 2014).

Depth: 870(?650)–4,260 m (A.M. Clark 1977; Mironov 2014); AZO: 1,550–1,919(?2,950) m (Koehler 1909, Pérès 1992).

Habitat: pteropod or *Globigerina* ooze, mud, gravel to rocky bottoms (A.M. Clark 1977).

Remarks: almost as soon as it was described by Perrier (1883b) *Democrinus parfaiti* was considered by Carpenter (1883a, 1884) as conspecific with the Caribbean *Rhizocrinus rawsonii* (= *Democrinus rawsonii* Pourtalès, 1874), based on inaccurate figures exchanged by the two authors (A.M. Clark 1977). The latter species was reported for the first time to the Azores by Carpenter (1883b, 1884) based on the material collected by H.M.S. *Challenger* (sta 76: 38°11'N, 27°09'W, 1,645 m). At the time, Carpenter (1883b) attributed deviations from the typical *R. rawsonii* observed in the Azorean material to water temperature differences. Following the previous author, Koehler (1909) identified *Princesse Alice*'s material from the Azores as *R. rawsonii*, though observing that the cruise material was quite close to the specimens described by Perrier (1883b) as *D. parfaiti*. On the redescription of the later species, A.M. Clark (1977) re-examined the material from the Azores collected by H.M.S. *Challenger* and placed it under *D. parfaiti* (an East Atlantic species). Without material of the Caribbean species for comparison and based on the historical bibliography, A.M. Clark concluded that *D. parfaiti* was distinguished by the conical shape of the calyx, by the indistinct or faint sutures between the ossicles in the calyx and by the presence of an abrupt constriction across the radials. Recently, Mironov *et al*. (2014) remarked that Carpenter (1884) could have been correct in considering the species conspecific, but unfortunately did not give any further details. Regardless, the reports of *D. rawsonii* to the archipelago were based on the assumption that this species was conspecific with *D. parfaiti*, thus are considered herein to be erroneous. Additionally, during two dives made by the bathyscaphe *Archimède* north of São Miguel and West of Santa Maria, Pérès (1992) observed stalked crinoids that he believed to be *D. rawsonii* (= *Rhizocrinus rawsoni*), which were quite abundant at depths 2,630 and 2,950 m.

Family Bathycrinidae Bather, 1899

Genus *Bathycrinus* Thomson, 1872a

Bathycrinus gracilis Thomson, 1872a

Reports for the Azores:

Bathycrinus gracilis Thomson, 1872a—$^{\$}$Koehler 1909: 254–255; A.M. Clark 1977: 164–167, figs. 1a–f; A.M. Clark 1980: 206–207, fig. 5; Mironov *et al*. 2014: 115.

Type locality: off West coast of France (47°38'N, 12°08'W).

See: Carpenter (1884); A.M. Clark (1977).

Occurrence: Northeast Atlantic, from SW of Ireland to Cape Finisterre (NW Spain) and the Azores (A.M. Clark 1977, 1980).

Depth: 2,880–5,275 m (Mironov *et al*. 2014); AZO: 5,005 m (Koehler 1909).

Habitat: soft bottoms, on *Globigerina* ooze (Koehler 1909).

Remarks: *Bathycrinus gracilis* is known from relatively few specimens, none of which was recovered complete, including the immature type material (presumably lost; Carpenter 1884; Koehler 1909; A.M. Clark 1977, 1980). Moreover, the only known record from Azorean waters is based on a single animal collected by *Princesse Alice* (sta 749: 38°54'00"N, 21°06'45"W, 5,005 m), only slightly larger than the type material (A.M. Clark 1977). Nevertheless, the paucity of available specimens can be explained by the great depths at which this species lives. Additionally, the West Atlantic species *B. aldrichianus* Thomson, 1876 is closely related to *B. gracilis* and Mironov *et al*. (2014) suggested that it might prove to be conspecific.

Order Cyrtocrinida Sieverts-Doreck, *in* Moore *et al*., 1952

Suborder Holopodina Arendt, 1974

Family Holopodidae Zittel, 1879

Genus *Cyathidium* Steenstrup, 1847

Cyathidium foresti Cherbonnier & Guille, 1972

Reports for the Azores:

Cyathidium foresti $^{\$}$Cherbonnier & Guille, 1972: 2193–2196, pl. 1, figs. A–I; A.M. Clark 1980: 209; $^{\$}$Heinzeller *et al*. 1997: 11–21, figs. 1–7; $^{\$}$Améziane *et al*. 1999: 441–448, figs. 1–3; $^{\$}$Wisshak *et al*. 2009a: 77–83, figs. 1–4, 2010: 2382.

Type locality: Azores (39°23'30″N, 31°19'00″W).

See: Cherbonnier & Guille (1972); Heinzeller & Fechter (1995, as *Cyathidium meteorensis*); Améziane *et al*. (1999).

Occurrence: Northeast Atlantic, known only from the Azores and the Great Meteor Seamount (Améziane *et al*. 1999).

Depth: 380–900 (?1,140) m (AZO; Cherbonnier & Guille 1972, Wisshak *et al*. 2009a).

Habitat: attached on hard substrata (*e.g.,* basalt) or skeletal remains, such as deep-water oysters (*Neopycnodonte zibrowii* Gofas *et al*., *in* Wisshak *et al*., 2009b) (Cherbonnier & Guille 1972; Wisshak *et al*. 2009a).

Larval stage: direct, produces a 'cyathidula' type of larvae (Heinzeller *et al*. 1997).

Remarks: Cherbonnier & Guille (1972) described a new enigmatic echinoderm species found among the material collected by *Jean-Charcot* in the Azores (39°30'N–36°54'N, 31°15'W–25°09'W, 380–900 m). Overall, this species resemble more a barnacle than a crinoid, with no stalk, permanently attached to the hard substrata via an expanded aboral base of the calyx. The body is reduced to a rounded cone, with the first brachial series forming a pentagonal vault enclosing reduced arms when coiled inwards. Cherbonnier & Guille (1972) concluded that the affinity of their new species lay within *Cyathidium* Steenstrup, 1847. At the time, this genus was composed exclusively of fossil species, most thought to be extinct by the end of the Cretaceous. Since the publication by Cherbonnier & Guille (1972), three more extant species were described for the genus, although *C. meteorensis* described by Fechter (1973) from the Great Meteor Seamount was later found to be identical with *C. foresti* (A.M. Clark 1980, Heinzeller *et al*. 1997, Améziane *et al*. 1999). Additionally, *in situ* observations of *C. foresti* in the channel between

Faial and Pico islands (420–500 m depth) by Wisshak *et al*. (2009a) gave further insight on this species' ecology and associated 'living fossil community'.

Order Hyocrinida Rasmussen, 1978

Family Hyocrinidae Carpenter, 1884

Genus *Anachalypsicrinus* A.M. Clark, 1973

Anachalypsicrinus nefertiti A.M. Clark, 1973

Reports for the Azores:

Anachalypsicrinus nefertiti (A.M. Clark, 1973)—$Roux 1980: 191, pl. 1, figs. 1–3; Roux 1985: 481–482, figs. 2–3; Tyler & Zibrowius 1992: 222, figs. 3h, 5 b–c, g; Mironov *et al*. 2014: 117.

Type locality: off W Ireland (53°11'12"N–53°11'36"N, 20°05'06"W–20°03'54"W).

See: A.M. Clark (1973: 269–270, figs. 1a–e, 2, pl. 1, figs. a–d).

Occurrence: Northeast Atlantic, from off S–SW Ireland south to the Azores and east to the Bay of Biscay and off Morocco (Tyler & Zibrowius 1992).

Depth: 2,000–2,810 m (Mironov *et al*. 2014); AZO: 2,200–2,810 m (Roux 1980).

Habitat: hard substrata (Tyler & Zibrowius 1992).

Remarks: Roux (1980) identified *Anachalypsicrinus nefertiti* in deep-sea photographs taken by the project *Famous* in the south of the Azores (36°49'36"N–36°57'30"N, 33°05′W–33°16'30"W, 2,220–2,810 m). The abyssal depths and the type of substrata may account for the paucity of reports throughout its known geographical distribution.

Class Ophiuroidea Gray, 1840

Order Amphilepidida O'Hara *et al*. 2017

Family Amphiuridae Ljungman, 1867

Genus *Amphipholis* Ljungman, 1866

Amphipholis squamata (Delle Chiaje, 1828)

(Fig. 5)

Reports for the Azores:

Amphipholis squamata (Delle Chiaje, 1828)—Ljungman 1872: 633–634; Barrois 1888: 32; $Chapman 1955: 400; Tortonese 1965: 231–234, fig. 107; Marques 1980: 100; $Marques 1983: 3, fig. 2; Pereira: 332; García-Diez *et al*. 2005: 48;
Amphipholis lineata $Ljungman, 1872: 634; Barrois 1888: 32, 115;
Amphiura squamata Lütken, 1859—$Barrois 1888: 73;
Amphiura squamata (Delle Chiaje, 1828)—Barrois 1888: 115; $Koehler 1898: 53;
Amphiura tenuispina Ljungman, 1865—$Koehler 1898: 53–55, pl. 6, figs. 22–23, 1909: 180.

Type locality: Mediterranean Sea.

See: Mortensen (1927a: 221–222, fig. 125; 1936: 292–293); Paterson (1985: 91, fig. 36).

Occurrence: present in all seas, cosmopolitan (absent in the polar areas; Tortonese 1965).

Depth: 0–1,962 m (Hernández-Herrejon *et al*. 2008); AZO: 0–1,229 m (Koehler 1909, herein).

Habitat: soft to hard substrates, common among algae and under rocks during low tide (Mortensen 1927a); found also on the roots of floating *Macrocystis* (Mortensen 1936); in the Azores they are also a common presence among algae (Marques 1983).

Larval stage: brooding hermaphrodite species (Mortensen 1927a); reproduces also through self-fertilisation (Boissin *et al*. 2008a).

Material examined: DBUA-ECH 241 (Baixa do Porto, Lajes, FLS, AZO, *c*. 39°22'50"N, 31°10'00"W, 1990.10.29; 1 spm, DD = 1 mm); DBUA-ECH 267 (São Roque, SMG, AZO, *c*. 37°44'37"N, 25°38'19"W, 2012.11.16, intertidal; 5 spms, DD = 2 mm); DBUA-ECH 277 (FRM, AZO, *c*. 37°16'14"N, 24°46'52"W, 1990.06.08, 6–8 m; 1 spm, DD = 3 mm); DBUA-ECH 284 (Gorringe Bank, NE Atlantic, *c*. 36°40'N, 11°12'W, 2006; 1 spm, DD = 2 mm); DBUA-ECH 308 (Baixa do Porto, Lajes, FLS, AZO, *c*. 39°22'50"N, 31°10'00"W, 1990.10.27; 4 spms, DD = 1–2 mm); DBUA-ECH 312 (Lajes, PIX, AZO, *c*. 38°23'22"N, 28°15'04"W, 1994.08.07, 1 m; 4 spms, DD = 2–3 mm); DBUA-ECH 314 (off Ribeira das Tainhas, SMG, AZO, 37°42'04"N, 25°25'02"W, 2006.07.24, 45–117 m; 1 spm, DD = 1 mm); DBUA-ECH 353 (Poços, SMG, AZO, *c*. 37°50'06"N, 25°40'10"W, 1996.07.08, intertidal; 5 spms, DD = 1–2 mm); DBUA-ECH 354 (Vila Franca do Campo, SMG, AZO, 37°41'39"N, 25°27'11"W, 2006.07.21, 95–121 m; 1 spm, DD = 2 mm); DBUA-ECH 417 (Mosteiros, SMG, AZO, 37°53'52"N, 25°48'19"W, 2011.07.06, 10 m; 1 spm, DD = 1 mm).

Description: disc round to subpentagonal, covered on both sides by coarse and imbricated scales. Centrodorsal and surrounding primary plates distinct. Radial shields small, between 1/3 and 1/2 of the disc radius (length > breadth), contiguous throughout their whole length. Sharp limit between the scales of the dorsal and ventral side near the edge of the disc. Ventral interradial plates imbricate and slightly smaller than the dorsal plates. Two oral papillae on each side of the jaw forming a continuous series with the blunt block-like to conical infradental papillae; the distalmost oral papilla very broad. Oral shields rounded to triangular in small specimens, becoming more rhombic (produced inwards) in larger animals. Arms about three or four times the DD. Tentacle pores small, with two tentacle scales proximally decreasing to one on the distal part of arms. Dorsal arm plates separated, proximally fan-shaped (length < breadth), with round distal edge, becoming more square-like on distal arm (length ≥ breadth). Ventral plates with slight indentation in the distal edge, contiguous only on the proximal part of the arm. Large lateral arm plates, meeting along the longitudinal mid-line, both dorsally and ventrally. Four, further out three, short, conical arm spines. One specimen (DBUA-ECH 354) with a juvenile's arm sticking out from a bursal slit. Colour in ethanol uniformly white.

Remarks: the specimens herein examined diverge slightly from what is described for the typical *Amphipholis squamata*, particularly regarding the shape and size of disc plates on the dorsal side. For example, the coarser plating, a well-defined central rosette and relatively larger radial shields are all features that agree with the description of *A. tenuispina* by Koehler (1898) based on animals collected by *Hirondelle* in the Azores (sta 198: 38°26'25"N, 28°38'56"W, 800 m). Mortensen (1927a) remarked on the existence of transitional stages that hardly support the maintenance of *tenuispina* as a separate variety of *A. squamata* even less as a separate species. In turn, Paterson (1985) stated that the primary plates are indistinguishable, except in smaller specimens. Future works will have to address the specific significance of *A. squamata* morphological variation throughout its geographical range. Molecular studies on *A. squamata* populations in New Zealand (Sponer & Roy 2002) and in French Mediterranean coast (Boissin *et al*. 2008b) indicate that *A. squamata* represents a cryptic species complex.

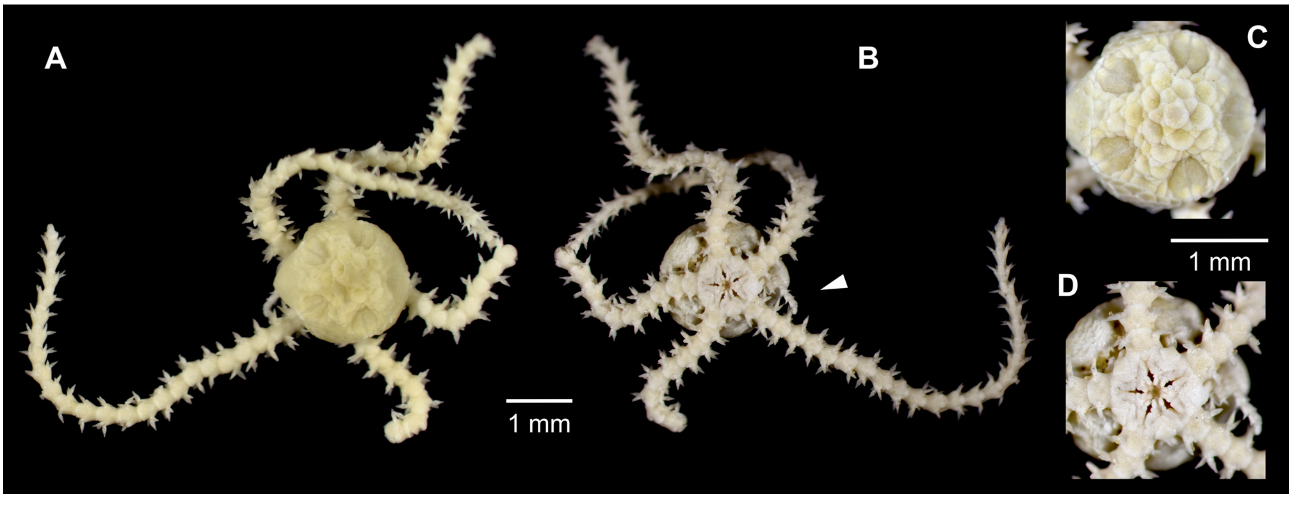

FIGURE 5. *Amphipholis squamata* (Delle Chiaje, 1828) (DBUA-ECH 354). Dorsal view (A); ventral view (B); detail of the disc and arm, dorsal view (C) and ventral view (D); arm of a young (indicated by white arrowhead) out of the adult bursae.

Genus *Amphiura* Forbes, 1843

Amphiura otteri Ljungman, 1872

Reports for the Azores:

Amphiura otteri Ljungman, 1872—$Lyman 1882: 128; $H.L. Clark 1915: 230; Mortensen 1927a: 209; Paterson 1985: 86–87, fig. 33; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 200;

Amphiura grandis Koehler, 1906b: 277–278; $Koehler 1909: 175–177, pl. 27, figs. 3–4; Mortensen 1927a: 208–209.

Type locality: Portugal.

See: Ljungman (1872: 631–632); Paterson (1985); Benavides-Serrato *et al*. (2011: 291).

Occurrence: North Atlantic, in the west from Labrador Basin to Caribbean Sea (Paterson 1985) and in the east from Iceland (Mortensen 1933a) to the West African coasts, including the Azores (Koehler 1906b, 1909).

Depth: 198–3,200 m (Smirnov *et al*. 2014); AZO: 1,647–1,900 m (Lyman 1882, Koehler 1909).

Habitat: soft sediments, mud to ooze (Lyman 1882).

Remarks: in the first report of *Amphiura otteri* from the archipelago, Lyman (1882) regarded this species as doubtful. H.L. Clark (1915) re-examined Lyman's specimens and confirmed his identification. Koehler (1896b, 1909) described *Amphiura grandis*, based on specimens collected by *Princesse Alice* in the Bay of Biscay and in the Azores (sta 1334: 39°30'N, 29°02'15"W), a species later synonymised with *A. otteri* by Paterson (1985). Additionally, *A. otteri* was reported also from the archipelagos of Canary Islands and Cape Verde (*e.g.,* Koehler 1909; Mortensen 1927a; Paterson 1985). However, these reports seem to be based directly or indirectly on the material collected by *Talisman*. At the time, Koehler (1906b, as *Amphiura grandis*) recorded the location of the stations using a system of coordinates based on the Paris Meridian. When converting the longitudes to the Greenwich Meridian, it is clear that the reported material came from waters off the coast of NW of Africa, outside the Canaries and Cape Verde waters.

Amphiura richardi Koehler, 1896b

Reports for the Azores:

Amphiura richardi $Koehler, 1896b: 245–246, 1909: 178–179, pl. 27, figs. 1–2; Mortensen 1927a: 209; García-Diez *et al*. 2005: 49.

Type locality: Azores (38°26'00"N, 26°30'45"W).

See: Koehler (1909); Paterson (1985: 88).

Occurrence: Northeast Atlantic; a rare species known from the Bay of Biscay (Cherbonnier 1970) to the Azores (Koehler 1909) and ?Canary Islands (Paterson 1985).

Depth: 850–1,494 m (Koehler 1909, Cherbonnier 1970); AZO: 1,165–1,494 m (Koehler 1909).

Habitat: soft to hard substrate (Koehler 1909).

Remarks: based on *Talisman* and *Travailleur* historical reports (*e.g*. Koehler 1906b, Perrier 1894), Paterson (1985) record of *A. richardi* from the Moroccan waters is erroneous, likely due to mislabelling. We believe that Paterson examined the same specimen reported by Koehler (1896b) from Bay of Biscay (*Travailleur*, sta 39, 1881: 44°05'N, 7°05'26"W). In contrast, we could not trace the original material on which Paterson (1985) based his record from the Canaries.

Amphiura sarsi Ljungman, 1872

(Fig. 6)

Reports for the Azores:

Amphiura (*Ophiopelte*) *sarsi* $Ljungman, 1872: 630;

Amphiura sarsi Ljungman, 1872—Lyman 1882: 124, 144; Barrois 1888: 32; Simroth 1888: 231; $H.L. Clark 1915: 231, pl. 5, figs. 8–9; Mortensen 1927a: 209; $Downey 1969: 37; $A.M. Clark 1970: 13, figs. 3l–m; Pereira 1997: 332; Morton & Britton 2000: 59.

Type locality: Azores.

See: Lyman (1882); H.L. Clark (1915); A.M. Clark (1970).

Occurrence: Northeast Atlantic, known only from the Bay of Biscay (Cherbonnier 1970), the Azores, Madeira and Josephine Seamount (Ljungman 1872, Jesus & Abreu 1998).

Depth: 55–1,098 m (AZO; Ljungman 1872).

Habitat: soft bottom with shells (Ljungman 1872) or inside crevices on large rocky boulders (herein).

Material examined: EMEPC G3D2 Ma001 (Southeast of TER, AZO, 38°33'11"N, 26°42'30"W, 2007.05.18, 350–744 m; 1 spm, DD = 3 mm).

Description: disc almost star-shaped, depressed in the interradial areas, covered dorsally by fine scales; central rosette and primary plates distinct. Radial shields almost parallel, separated proximally by a few scales, about 30% DD long. Ventral side of disc partially naked. Two conical infradental oral papillae and one blunt adoral shield spine on either side of the jaw. Mouth shields rounded triangular (length < breadth). No tentacle scales. Five long arms about six times the DD. Four or five short, finely serrated spines, decreasing to three distally; the second from below slightly thicker, its tip is somewhat blunt with two horizontal small thorns at each side (axe shaped). Dorsal arm plates transversally oval, separated. Ventral arm plates almost square-shaped, contiguous. Colour (alive): yellow arms with light yellowish orange bands; ventral side of disc same colour as arms; dorsal surface brown; interior of mouth red. Colour (in ethanol): white.

Remarks: the genus *Amphiura* is one of the largest ophiuroid genera (Stöhr & Segonzac 2005), comprising almost 200 valid species, 50 of them known from the Atlantic. The specimen herein documented agrees for the most part with the type description by Ljungman (1872), which is unique among the other *Amphiura* species reported from the Azores by the absence of tentacle scales. Also, it conforms well to the illustrations by A.M. Clark (1970), based on the syntypes collected in the Azores. However, our specimens presented four or five arm spines in the proximal part of the arms decreasing to three distally, a number slightly lower than the five or six reported by Ljungman. Surprisingly, Lyman (1882) in his *Amphiura* key mentioned just four spines for this species. H.L. Clark (1915) published the only known picture of *A. sarsi*, the Ljungman syntype. The animal appears to be slightly larger than ours, about 4 mm in DD. The size difference may account for the difference in the number of arm spines, as was observed in other *Amphiura* species (*e.g.,* Mortensen 1933b).

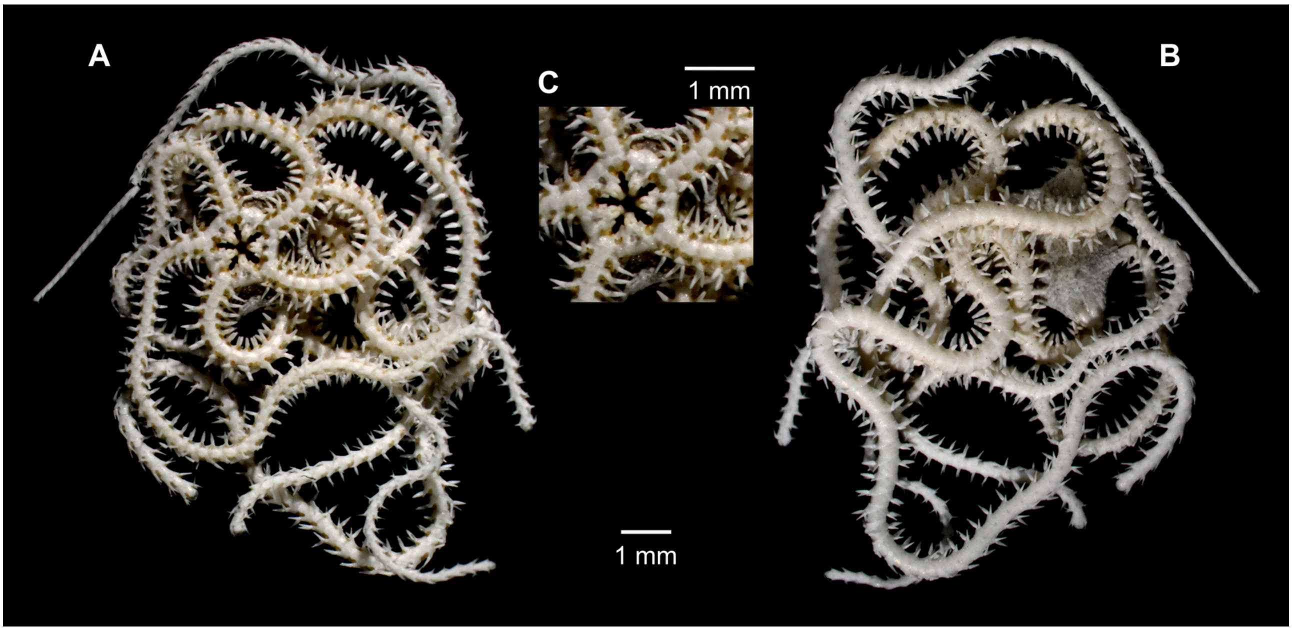

FIGURE 6. *Amphiura sarsi* Ljungman, 1872 (EMEPC G3D2 Ma001). Dorsal view (A); ventral view (B); detail of the disc, ventral view (C).

Among the *Amphiura* with no tentacle scales known from the Atlantic, the specimen herein examined also closely resembles *Amphiura filiformis* (Müller, 1776), known from the Mediterranean Sea and the Northeast Atlantic south to Angolan waters (Madsen 1970). These two species are distinguished primarily by the arrangement of the disc scales. The scales on the dorsal side of the disc are finer in *A. sarsi* than in *A. filiformis*, the central rosette is also relatively distinct in the former and indistinct in the latter. On the ventral side, *A. sarsi* possess few scales and in *A. filiformis* tends to be completely naked. In the original description of *A. sarsi*, Ljungman (1872) suggested that this species may be a form of *A. filiformis*. The subject was never revisited. Madsen (1970) also considered the possibility of his *A. senegalensis* being a juvenile of *A. sarsi* that had not yet developed axe-shaped spines. The specimen studied herein is about the same size as the type material of *A. senegalensis* and has already axe-shaped spines. This suggests that some of the characters used to diagnose *A. sarsi* (*e.g.,* arrangement of disc scales, number and shape of the arm spines) are subject to ontogenetic or individual variation in other *Amphiura* species (Mortensen 1933b; Madsen 1970). Additionally, *Amphiura sarsi* was regarded as the only endemic species of the Azores (*e.g.,* Pereira 1997; Morton & Britton 2000). However, this seems to be a consequence of misinterpretation of the original report. Ljungman (1872) used material from the *Josephine* expedition to describe his new species, listing specimens collected both from the Azores and from the Josephine Seamount.

Subgenus *Amphiura* (*Amphiura*) Forbes, 1843

Amphiura (*Amphiura*) *grandisquama* Lyman, 1869

Reports for the Azores:

Amphiura longispina $^{\$}$Koehler, 1896a: 211–212, 1898: 52–53, pl. 9, figs. 45–46;

Amphiura grandisquama Lyman, 1869—$^{\$}$Koehler 1907b: 301, 1909: 177–178; Koehler 1914b: 190–191; Mortensen 1927a: 209; Madsen 1970: 177–178, fig. 12; Paterson 1985: 87, fig. 33; García-Diez *et al*. 2005: 48.

Type locality: off Tennessee Reef (Florida Strait).

See: Lyman (1869: 334–337); Madsen (1970); Paterson (1985).

Occurrence: cosmopolitan, in the Atlantic, Pacific, Indian Oceans and in the ?Mediterranean Sea; in the west Atlantic from South Carolina to the Caribbean (Koehler 1914a), including Tristan da Cunha (Mortensen 1936); in the east Atlantic from Iceland to the Gulf of Guinea (Mortensen 1936), including the Azores (Koehler 1909), Madeira (Jesus & Abreu 1998), Canaries, Cape Verde (Koehler 1906b), Saint Helena (Mortensen 1933c), Meteor and Josephine seamounts (Bartsch 2008). The subspecies *A. grandisquama natalensis* Mortensen 1933b is restricted to southern Africa (Alva & Vadon 1989).

Depth: (?2)18–2,870 m (Mortensen 1936, Cherbonnier & Sibuet 1972); AZO: 599–880 m (Koehler 1909).

Habitat: soft to hard substrates (Koehler 1909).

Larval stage: brooder (embryos are kept in the bursae until the juvenile stage is reached; Bartsch 2008).

Remarks: Koehler (1896a, 1898) described *Amphiura longispina* based on a single specimen collected by *Hirondelle* in the Azores (sta 242: 38°48'30"N, 27°58'46"W, 861 m). On the re-examination of *A. grandisquama* from the Caribbean, Koehler (1907b) confirmed both are conspecific. Additionally, the species *Monamphiura apicula* from the Mediterranean Sea (Tortonese 1965; Koukouras *et al*. 2007) has been considered conspecific with *A. grandisquama* by some authors (*e.g.,* Madsen 1970; Paterson 1985; Bartsch 2008). If this is the case, the distribution range of the latter should be extended to the Mediterranean Sea and to depths as shallow as 2 m (Koukouras *et al*. 2007).

Family Ophiactidae Matsumoto, 1915

Genus *Ophiactis* Lütken, 1856

Ophiactis abyssicola (Sars, 1861)

Reports for the Azores:

Ophiactis corallicola Koehler, 1895—$^{\$}$Koehler 1896a: 208, 1898: 46, 1906b: 272–273, 1909: 170, pl. 1, fig. 11, pl. 7, figs. 4–5, 1921a: 3;

Ophiactis abyssicola (Sars, 1861)—$^{\$}$Koehler 1896a: 208, 1896b: 243, 1898: 46–48, pl. 5, fig. 17, pl. 6, fig. 18, 1909: 169; Mortensen 1927a: 202–203, fig. 114; Grieg 1932: 36–37; Marques 1980: 101; García-Diez *et al*. 2005: 48; $^{\$}$Stöhr & Segonzac 2005: 386;$^{\$}$Martynov & Litvinova 2008: 102–104, figs. 17C–E;

Ophiactis echinata $^{\$}$Koehler, 1898: 48–49, pl. 5, figs. 15–16; Mortensen 1927a: 199; Cherbonnier & Sibuet 1972: 402.

Type locality: Norway.

See: Sars (1861: 18–20, pl. 2, figs. 7–12, as *Amphiura abyssicola*); Paterson (1985: 76–78, fig. 32).

Occurrence: cosmopolitan, present in both Pacific and Atlantic Oceans; in the Atlantic from the Davis Strait, off Iceland and Scandinavian waters to Southern Africa (Mortensen 1933a, b), including the archipelagos of the Azores, Canaries and Cape Verde; reported elsewhere off Tristan da Cunha (Lyman 1882).

Depth: 118–4,721 m (Martynov & Litvinova 2008); AZO: 726–1,998 m (Koehler 1909, Stöhr & Segonzac 2005).

Habitat: soft bottoms, ooze, fine sand, gravel and shells to rock, among sponges, gorgonians and other sessile fauna (Farran 1913, Stöhr & Segonzac 2005).

Remarks: *Ophiactis abyssicola* is a highly variable species which is reflected by its numerous synonyms. In the Azores alone, this species was reported under three different names. For example, Koehler (1898) described *O. echinata* based on a single specimen collected by *Hirondelle* in the Azores (sta 198: 38°26’25”N, 28°38’56”W, 800 m). Later authors such as H.L. Clark (1918) and Mortensen (1927a, 1933a) believed that this species was a juvenile of *O. abyssicola*. See also remarks under *O. canotia* Lyman, 1879 and *O. nidarosiensis* Mortensen, 1920.

Ophiactis canotia Lyman, 1879

Reports for the Azores:

Ophiactis canotia $Lyman, 1879: 40–41, pl. 13, figs. 353–355, 1882: 119–120, pl. 19, figs. 16–18; $H.L. Clark 1915: 260; H.L. Clark 1918: 305; Mortensen 1927a: 199, 1933a: 48–49, fig. 29; $Downey 1969: 84.

Type locality: Azores (38°30’N, 31°14’W).

See: Lyman (1882).

Occurrence: known only from the type material collected in the Azores (Lyman 1882).

Depth: 1,830 m (AZO; Lyman 1882).

Habitat: soft bottoms (*Globigerina* ooze; Lyman 1882).

Remarks: *Ophiactis canotia* is only known from two specimens described by Lyman (1879) collected at one station in the Azores (H.M.S. *Challenger*, sta 73). This species is quite close to another deep-water species native to the Azores, *O. abyssicola* (only distinguished on the basis of dorsal plates outline) and might prove to be conspecific (Mortensen 1933a).

Ophiactis plana? Lyman, 1869

Reports for the Azores:

non *Ophiactis profundi* Lütken & Mortensen, 1829—?$Koehler 1909: 173 [misidentification]; Mortensen 1927a: 199, 200 [based on Koehler 1909]; García-Diez *et al*. 2005: 48 [based on Koehler 1909];

Ophiactis plana Lyman, 1869—H.L. Clark 1918: 301–302 [based on Koehler 1909].

Type locality: off Carysfort Reef, Florida.

See: Lyman (1869: 330–331); A.M. Clark (1974: 464–465); Stöhr & Segonzac (2004: 16).

Occurrence: Atlantic, in the west from North Carolina to the Caribbean waters and the Gulf of Mexico (H.L. Clark 1915); in the east from Namibia to South Africa (Alva & Vadon 1989), including the archipelagos of the ?Azores and ?Madeira (Jesus & Abreu 1998).

Depth: 18–412 m (H.L. Clark 1918, A.M. Clark 1974); ?AZO: 650–914 m (Koehler 1909).

Habitat: soft sediments, also on sponges and on corals (Lyman *in* Koehler 1914b, Alva & Vadon 1989).

Larval stage: unknown; also reproduces asexually through fission (Alva & Vadon 1989).

Remarks: Koehler (1909) reported *Ophiactis profundi* from the Azores based on two specimens collected by *Princesse Alice* (sta 2214: 39°26’10”N, 31°21’30”W, 650–914 m), a deep-water species believed to be restricted to the Pacific (Stöhr & Segonzac 2004). Later Koehler (1922) commented that the material collected by *Princesse Alice* in the Atlantic was either *O. profundi* or ‘a form extremely close to it’ (see as well Lütken & Mortensen 1899). H.L. Clark (1918) synonymised *O. profundi* with *O. plana* based on a comparison of the type material of both species, and included *Princesse Alice* records from the Azores under the geographical distribution of *O. plana*.

Mortensen (1924, 1936) agreed that *O. plana* and *O. profundi* could be conspecific, but stated further studies were necessary. The matter is still unresolved pending future revision (see Stöhr & Segonzac 2004). In spite of the great depths at which *Princesse Alice* specimens were collected we believe they most probably belong to the Atlantic form *O. plana*. The same can be assumed for the Madeira record by Jesus & Abreu (1998).

Ophiactis nidarosiensis? Mortensen, 1920

Reports for the Azores:
non *Ophiactis hirta* Lyman, 1879—?$Koehler 1909: 171 [misidentification].

Type locality: Trondhjemfjord, Norway.

See: Mortensen (1920: 60–63, fig. 5; 1933b: 346–347, fig. 58a).

Occurrence: recorded from the Scandinavia, Iceland, southern Africa, off Gough Island (Tristan da Cunha, S Atlantic) and ?Azores (Mortensen 1920, 1933a, 1936).

Depth: 102–560 m (Mortensen 1933a, 1936); AZO: ?1,095 m (Koehler 1909).

Habitat: ?volcanic sand (AZO; Koehler 1909).

Larval stage: unknown; also reproduces asexually through fission (Mortensen 1920).

Remarks: Koehler (1909) described a small six-armed specimen collected by *Princesse Alice* in Azorean waters (sta 1344: 38°45'30"N, 28°7'45"W, 1,095 m) as distinct from the type material of *Ophiactis hirta* collected by Lyman (1879, H.M.S. *Challenger*) in the Pacific, but not enough to consider it a different species. H.L. Clark (1918) suggested this specimen might represent a juvenile stage of *Ophiactis abyssicola*, a cosmopolitan deep-water species. Mortensen (1920, 1927) believed this specimen was actually *O. nidarosiensis*. Unfortunately, the specimen collected by *Princesse Alice* was lost (Mortensen 1920), and until new material is retrieved, the presence of either species in the archipelago should be considered as doubtful.

Ophiactis tyleri Stöhr & Segonzac, 2005

Reports for the Azores:
Ophiactis tyleri $Stöhr & Segonzac, 2005: 397–398, fig. 9; $Desbruyères *et al*. 2006: 482, figs. 1–3.

Type locality: Mid-Atlantic Ridge, Azores (38°18'58"N, 30°40'32"W).

See: Stöhr & Segonzac (2005); Desbruyères *et al*. (2006).

Occurrence: known only from Azorean waters, namely the Menez Gwen hydrothermal fields (Stöhr & Segonzac 2005).

Depth: 842–844 m (AZO; Stöhr & Segonzac 2005).

Habitat: hard substrates; can be found at hydrothermal vents (Stöhr & Segonzac 2005).

Larval stage: unknown; also reproduces asexually fission (Desbruyères *et al*. 2006).

Remarks: *Ophiactis tyleri* is relatively recently described species known only from two specimens collected at two stations in the Azores deep waters by *DIVANAUT 1* cruise. Though not restricted chemosynthetic environments, *O. tyleri* is the first *Ophiactis* species to be recorded from hydrothermal vents (Stöhr & Segonzac 2005; see remarks under *Ophioctenella acies*).

Ophiactis virens (Sars, 1859)

Reports from the Azores:
Ophiactis sp.—?$Simroth 1888: 231;
Ophiactis virens (Sars, 1859)—Koehler 1924: 194–197; Mortensen 1927a: 199; Tortonese 1965: 238–239, fig. 110; Marques 1980: 102; $Castro & Viegas 1983: 24; $Marques 1983: 3; Pereira 1997: 332; Jesus & Abreu 1998: 65; Micael & Costa 2010: 322; Micael *et al.* 2012: 3.

Type locality: Mediterranean Sea.

See: Tortonese (1965).

Occurrence: Northeast Atlantic and Mediterranean Sea; along the Western African coast to ?Cape Verde (Koehler 1924, Tortonese 1965) including the archipelagos of the Azores (Marques 1983), Madeira (Jesus & Abreu 1998) and Canaries (Bacallado *et al*. 1985).

Depth: 0–90 m (Tortonese 1965); a littoral species in the Azores (Marques 1983).

Habitat: rocky shores, coralligenous concretions, under stones and among algae and bryozoans; can form large aggregations (Tortonese 1965).

Larval stage: unknown; also reproduces asexually through fission (Tortonese 1965).

Remarks: Koehler (1924) listed the Azores and Cape Verde in the geographical distribution of *Ophiactis virens*. We do not know the original observation on which he based these records. In the echinoderm fauna of the Azores, Simroth (1888) reported an *Ophiactis* sp., which may represent the first record of *O. virens* to the archipelago since is the only *Ophiactis* species ever reported in Azorean shallow waters. Regardless, Castro & Viegas (1983) and Marques (1983) reported having collected *O. virens* throughout the Azorean archipelago, thus confirming the presence of this species in the Azores. Both studies indicate that locally *O. virens* lives among algae, but Marques added that this species was far less abundant compared to *Amphipholis squamata*. We do not know where Castro & Viegas have deposited their material and we could not find Marques' material at the Museu Bocage, Natural History Museum (Lisbon). The zoological collection of the Department of Biology of the University of the Azores houses a large number of samples derived from rocky shore algae scrapings collected over a time period of twenty years. Among those, we found numerous specimens of *A. squamata*, yet we have failed to find a single specimen of *O. virens*. The presence in the collection of numerous specimens belonging to a species does not necessarily imply a high local abundance (biased sampling), but its absence on the other hand may reflect its rare status at present. It is possible that local populations of this fissiparous six-armed species have simply declined since the publications by Castro & Viegas or Marques in the 1980s.

Family Ophiolepididae Ljungman, 1867

Genus *Ophiotypa* Koehler, 1897a

Ophiotypa simplex Koehler, 1897a

Reports for the Azores:

Ophiotypa simplex Koehler, 1897a—$^{\$}$Cherbonnier & Sibuet 1972t: 416; Paterson 1985: 144–145, fig. 55; Jesus & Fonseca 1999: 347, fig. 3; Martynov & Litvinova 2008: 81–82, fig. 2F; Smirnov *et al*. 2014: 204.

Type locality: Gulf of Bengal, Indian Ocean.

See: Koehler (1897a: 281–283, pl. 5, figs. 1–3); Paterson (1985); Martynov & Litvinova (2008).

Occurrence: cosmopolitan, present in the Atlantic, Pacific and Indian deep waters; from the Venezuelan Basin in the Caribbean (Paterson 1985) eastwards to the Azores (Cherbonnier & Sibuet 1972) and ?Portugal (Jesus & Fonseca 1999), south to waters between Cape Verde and NW Africa (Koehler 1906b); also recorded from the Reykjanes Ridge (S of Iceland; Martynov & Litvinova (2008).

Depth: (?27 m) 1,670–4,412 m (Jesus & Fonseca 1999, Paterson 1985, Martynov & Litvinova 2008); AZO: 3,665 m (Cherbonnier & Sibuet 1972).

Habitat: soft substrates (Koehler 1909).

Remarks: historically, *Ophiotypa simplex* has been recorded at several locations between the Azores and Iberian waters (*e.g.,* Koehler 1906b, 1909). Cherbonnier & Sibuet (1972) published the only report of this species

inside the archipelago waters based on the material collected by Jean Charcot (*Noratlante* cruise, sta P63 E8: 36°48'05"N, 27°06W', 3,665 m). The report from Portugal by Jesus & Fonseca (1999) may represent a different species since it was collected at 27 m, far too shallow for this abyssal species.

Family Ophionereididae Ljungman, 1867

Genus *Ophiochiton* Lyman, 1878

Ophiochiton ternispinus Lyman, 1883

Reports for the Azores:

Ophiochiton solutum $^{\$}$Koehler, 1906a: 16–17, pl. 2, figs. 22–23, 1906b: 269–271, pl. 20, figs. 39–40;
Ophiochiton solutus Koehler, 1906a—Mortensen 1927a: 224;
Ophiochiton ternispinus Lyman, 1883—Paterson 1985: 96–98, fig. 39; Alva & Vadon 1989: 840; Martynov & Litvinova 2008: 104–107, fig. 17H; Benavides-Serrato *et al*. 2011: 331–332; Smirnov *et al*. 2014: 208.

Type locality: southwest of Ireland.

See: Lyman (1883: 255); Paterson (1985); Borges & Amaral (2007: 858); Benavides-Serrato *et al*. (2011).

Occurrence: Atlantic Ocean, in the west from the Davis Strait (Mortensen 1933a) south through the NE American coasts to Brazil (Borges & Amaral 2007), including the Gulf of Mexico and Caribbean Sea and in east from SE of Iceland (Mortensen 1933a) to Namibia (Alva & Vadon 1989), including the Azores (Koehler, 1906b).

Depth: 256–2,220 m (Koehler, 1906b, Alva & Vadon 1989); AZO: 2,155–2,220 m (Koehler, 1906b).

Habitat: soft substrates (Borges & Amaral 2007).

Remarks: Koehler (1906a, b) described *Ophiochiton solutus* (= *O. solutum*) based on the specimens collected by *Talisman* at the NW African coast (type locality) and the Azores (sta 129, 1883: 38°00'N, 27°02'46"W, 2,155–2,220 m). Later, Paterson (1985) found this species to be identical with *O. ternispinus* and established the synonymy.

Genus *Ophionereis* Lütken, 1859

Ophionereis reticulata? (Say, 1825)

Reports for the Azores:

Ophionereis reticulata Lütken, 1859—$^{\$}$Koehler 1906b: 271, 1909: 181; Mortensen 1927a: 224; Pereira 1997: 332;
Ophionereis reticulata (Say, 1825)—García-Diez *et al*. 2005: 50.

Type locality: Florida Keys, USA.

See: Say (1825: 148, as *Ophiura reticulata*); A.M. Clark (1953); Thomas (1973: 586–588, figs. 1, 5A).

Occurrence: tropical Western Atlantic, from North Carolina (Pearse & Williams 1951) and Bermuda (A.M. Clark 1953), through the Caribbean coast to Brazil (Thomas 1973); possibly reaching the archipelagos of ?Cape Verde and ?Azores.

Depth: 0–200(?560) m (A.M. Clark 1953); ?AZO: 98–560 m (Koehler 1909).

Habitat: sediment-rocky shore interface (Yokoyama *et al.* 2011).

Larval stage: lecithotrophic (Yokoyama *et al.* 2008).

Remarks: the tropical West Atlantic shallow-water species *Ophionereis reticulata* was reported from the Azores by Koehler (1906b, 1909). Unfortunately, he fails to give any kind of description aside from the small size of the specimens (<5 mm, whereas a normal adult reaches 13 mm; Hernández-Herrejon *et al*. 2008). The presence of this species in Azorean waters might represent an occasional vagrant, a case similar to *Eucidaris tribuloides*. In Brazil, *O. reticulata* spawns in the summer when the waters can reach average temperatures as high as 27°C. Yokoyama *et al*. (2008, 2011) concluded that the rise in water temperatures plays a major factor in the reproduction of this species. Thus, like tropical *E. tribuloides*, it is hard to believe that this tropical brittle star could sustain a viable population in the significantly cooler Azorean waters, particularly if we consider the depth at which the material was recorded by *Talisman* (sta 123, 1883: 38°23'N, 28°49'46"W, 560 m) and *Princesse Alice* (sta 882: 38°3'40"N, 28°34'45"W, 98 m). On the other hand, A.M. Clark (1953: 65) commented that 'the chief trouble in differentiating the species of *Ophionereis* as with other genera, is to distinguish between the really characteristic features and those which are contingent upon the particular ontogenetic stage reached'. The only known material of *O. reticulata* in the east side of the Atlantic was all identified and reported by Koehler (1906b, 1909). In addition to the Azorean records, Koehler (1906b) also reported five specimens belonging to *O. reticulata* collected by *Talisman* in the Cape Verde waters, between 103 and 225 m depth. While the specimen from 560 m depth may in reality not be a member of the shallow-water genus *Ophionereis*, the remainder of Koehler's material could prove to belong to the only *Ophionereis* species known from the East Atlantic, *O. sexradia* Mortensen, 1936. This brittle star was first described from the Gulf of Guinea, and later reported from the Canaries (A.M. Clark 1953) and Madeira (Jesus & Abreu 1998). Regardless, whether the reports for the Azores originated either by a misidentification or by an occasional vagrant, the presence of *Ophionereis* in the northern latitudes of the Azores should be dismissed as doubtful until new material is collected.

Family Ophiopholidae O'Hara *et al.* 2018

Genus *Ophiopholis* Müller & Troschel, 1842

Ophiopholis aculeata? (Linnaeus, 1767)

Reports for the Azores:
Ophiopholis bellis (Fleming, 1828)—?$Lyman 1865: 14, 96–99, pl. 1, figs. 4–6;
Ophiopholis aculeata (Linnaeus, 1767)—?$H.L. Clark 1915: 267.

See: Mortensen (1927a: 204–206, figs. 88.5, 116); Serafy (1971); Picton (1993: 44).

Occurrence: circumboreal Arctic; in the Atlantic, from the arctic waters southwards to Cape Hatteras in the West Atlantic and to the English Channel in the east (Serafy 1971).

Depth: 0–300 m, exceptionally 1,000 m (Serafy 1971); AZO: ?.

Habitat: eurytopic; frequently found in crevices and borings in the rock or in association with sponges (Tyler *et al*. 2005).

Larval stage: planktotrophic (Mortensen 1927a).

Remarks: Lyman (1865) remarked that he identified a specimen of *Ophiopholis aculeata* (= *Ophiopholis bellis*) from Faial Island in the collection of the Museum of Comparative Zoology (Harvard University). However, when he presented the specimens list (p. 99) he added a question mark after 'Fayal', as if he had some doubts about the provenance of the material or his identification. Unfortunately, Lyman did not give any further details about its origin, omitting the depth, collector or date. Later, H.L. Clark (1915) listed the material present in the Harvard collection, including the material from the Azores previously analysed by Lyman, yet did not express any concerns, nor gave any further details. This circumpolar cold-water species was never (re)collected in the archipelago waters, and thus the inclusion of this species in the Azorean fauna should be considered with caution.

Family Ophiothamnidae O'Hara *et al.* 2018

Genus *Histampica* A.M. Clark, 1970

Histampica duplicata (Lyman, 1875)

Reports for the Azores:
Amphiura duplicata Lyman, 1875—$Koehler 1896a: 208, 1896b: 244, 1898: 49–50; Grieg 1932: 37;
Ophiactis duplicata, (Lyman, 1875)—$Koehler 1909: 171;
Amphiactis duplicata (Lyman, 1875)—Mortensen 1927a: 198;
Histampica duplicata (Lyman, 1875)—García-Diez *et al*. 2005: 48.

Type locality: Barbados, Caribbean.

See: Lyman (1875: 19–20, fig. 87, pl. 5, fig. 78, as *Amphiura duplicata*); Paterson (1985: 79, 80, fig. 32); Benavides-Serrato *et al*. (2011: 313–314).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian Oceans; in the west Atlantic, from Bermuda (Lyman 1882) and Caribbean to Brazil (Downey 1969); in the East Atlantic, from the Faeroe Plateau (Tyler *et al*. 2005) and Reykjanes Ridge (South of Iceland; Martynov & Litvinova 2008) to North Africa (Paterson 1985) including the Azores and Cape Verde archipelagos (Koehler 1909).

Depth: 125–2,870 m (Paterson 1985); AZO: 1,095–2,178 m (Koehler 1909).

Habitat: hard to soft (sand or mud) substrates; can be found in association with azooxanthellate corals (Benavides-Serrato *et al*. 2011).

Remarks: Despite being known in the archipelago only by historical reports, *Histampica duplicata* appears to be common in the Azorean deep-waters as Koehler (1898, 1909) recorded this species at numerous *Hirondelle* and *Princesse Alice* stations, from depths around 1000 m to 2000 m.

Family Ophiotrichidae Ljungman, 1867

Genus *Ophiothrix* Müller & Troschel, 1840a

Ophiothrix fragilis (Abildgaard, *in* Müller, 1789)

(Fig. 7)

Reports for the Azores:

Ophiothrix rubra [$]Ljungman, 1872: 624–625; [$]Lyman 1874: 248; Barrois 1888: 32;

Ophiothrix lusitanica Ljungman, 1872—[$]Barrois 1888: 32, 72;

Ophiothrix fragilis (Abildgaard, *in* Müller, 1789)—[$]Koehler 1898: 58–59, 1909: 200; [$]Nobre 1924: 89; [$]Mortensen 1927a: 174–175, fig. 98; [$]Nobre 1930: 69; [$]Nobre 1938: 65–68, figs. 34–35; [$]Chapman 1955: 400; Marques 1980: 103; [$]Marques 1983: 3, fig. 3; Pereira 1997: 332; [$]Morton *et al*. 1998: 76, 169, fig. 4.2L; [$]Wirtz & Debelius 2003: 271; García-Diez *et al*. 2005: 48; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

See: Koehler (1921b: 74–77, figs. 48–49); Mortensen (1927a); Stöhr (2005: 269, figs. 16A-N).

Occurrence: Mediterranean Sea and East Atlantic, from Iceland to South Africa (Tortonese 1965, A.M. Clark 1974), including the Azores, Madeira (Nobre 1938), Canaries and Cape Verde (Madsen 1970).

Depth: 0–509 m (Tortonese 1965, Cherbonnier 1970); AZO: 0–150 m (herein).

Habitat: on hard bottom, among algae, shells, serpulids, under stones, etc. (Mortensen 1927a, Tortonese 1965); predated specially by *Luidia ciliaris* (Philippi, 1837) (Mortensen 1927a).

Larval stage: planktotrophic (26 days; MacBride 1907).

Material examined: DBUA-ECH 064 (Islet of Vila Franca do Campo, SMG, AZO, *c*. 37°42’21”N, 25°26’34”W, 1997.03.03; 1 spm, DD = 8 mm); DBUA-ECH 121 (São Roque, SMG, AZO, *c*. 37°44’37”N, 25°38’19”W, 2012.11.16, intertidal; 9 spms, DD = 2–4 mm); DBUA-ECH 125 (Poços de São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.17, 8 m; 2 spms, DD = 3–6 mm); DBUA-ECH 126 (Poços de São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.03, 10 m; 2 spms, DD = 3–6 mm); DBUA-ECH 127 (Poços de São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.17, 10 m; 8 spms, DD = 4–8 mm); DBUA-ECH 133 (Baixa da Caloura, SMG, AZO, *c*. 37°42’20”N, 25°30’30”W, 1996.12.05, 15 m; 3 spms, DD = 2–5 mm); DBUA-ECH 195 (FRM, AZO, *c*. 37°16’14”N, 24°46’52”W, 1996–06–07; 2 spms, DD = 3–4 mm); DBUA-ECH 254 (PIX, AZO; 1 spm, DD = 5 mm); DBUA-ECH 342 (Sabrina Bank, SMG, AZO, 37°52’09”N, 25°54’08”W, 2011.07.07, 150 m; 1 spm, DD = 5 mm); DBUA-ECH 395 (Horta harbour, FAY, AZO, *c*. 38°31’51”N, 28°37’23”W, 2011.03.10, 6 m; 1 spm, DD = 3 mm); DBUA 416 (Sabrina seamount, SMG, AZO, *c*. 37°52’35”N, 25°53’50”W, 2011.07.07, 34 m; 1 spm, DD = 4 mm).

Description: disc subpentagonal covered more or less evenly by short stumps, terminating in a crown of very small sharp and thin spines, typical three in number but occasionally more (this is particularly true in the largest specimen, DD = 8 mm, DBUA-ECH 064). Radial shields about 19–24% DD, naked with a few scattered stumps (most individuals) to almost entirely covered. No spines present on the dorsal surface of the disc. Stumps also present on the ventral surface of the disc. Mouth shields somewhat triangular (length < breadth). A hole is present at the base of each jaw. No oral papilla. Numerous crowded tooth papillae. One small tentacle scale; arms about three to four times the DD; the largest specimen (DD = 8 mm, DBUA-ECH 064) with four of the five arms showing evidence of predation with varying degrees of regeneration. Dorsal plates of arms naked with longitudinal keel, protruding distally to form a faint elevated knob. Ventral arm plates almost rectangular with a concave outer edge. Seven thorny arm spines, increasing gradually in length from very small lowermost to the fifth or sixth arm spine, then decreasing in size again; distally lowermost arm spine hooked-shaped. Colour: disc uniform light brown, green, greyish-green to purple or pink; the disc colour was frequently lighter towards the centre to almost white or light pink; some specimens had a deep green circular spot in the centre of the disc; others presented as well small brown to dark green specks; radial shields sometimes almost totally white or having a white distal part (also the base of the arms), mid-way deep green, proximally pink as the rest of the disc arms green to greyish green with stripes (darker brown, greyish green or pink); some individuals had a conspicuous white spot on the dorsal plates; arm spines as the arms; exceptionally, oral surface of the disc orange becoming somewhat darker pinkish in the centre and arms banded yellow and orange with the dorsal plates presenting dark lines forming an irregular pattern (DBUA-ECH 342). Colour (in ethanol): many individuals had lost all colour, presenting a uniform cream colour, though some showed a conspicuous white circular spot in the centre of the dorsal surface of the disc.

Remarks: *Ophiothrix fragilis* is a highly polymorphic species, a fact reflected by the numerous synonyms and varieties described (Tortonese 1965), which is mirrored by the history of this species in the Azores. Ljungman (1872) based *Ophiothrix rubra* an animal collected in the Azores. Lyman (1874) re-examined Ljungman's type specimen and concluded that *O. rubra* was conspecific with *Ophiothrix lusitanica*, whereas Ljungman believed that it was closely related to the *Ophiothrix echinata*. Barrois (1888) agreed with Lyman and commented that *Ophiothrix lusitanica* seemed rather common on the shores of all Azorean islands. Conversely, Koehler (1898, 1909) identified material collected in the Azores by *Hirondelle* at 130 m depth and by *Princesse Alice* between 54 and 98 m depth as '*pentaphyllum*' and 'common' forms, respectively. Later, Koehler (1921b) reduced the forms previously described as independent species or varieties to four basic subspecies: '*echinata*', '*lusitanica*', '*pentaphyllum*' and '*abildgaardi*'. Mortensen (1927a) found Ljungman's type material to be identical with *O. fragilis*, confirming unambiguously the synonymy (though without commenting which variety it was most closely related to). Among later authors working with material from the Azores, only Chapman (1955) ventured to identify a specimen collected in archipelago as *O. fragilis* var. *lusitanica*.

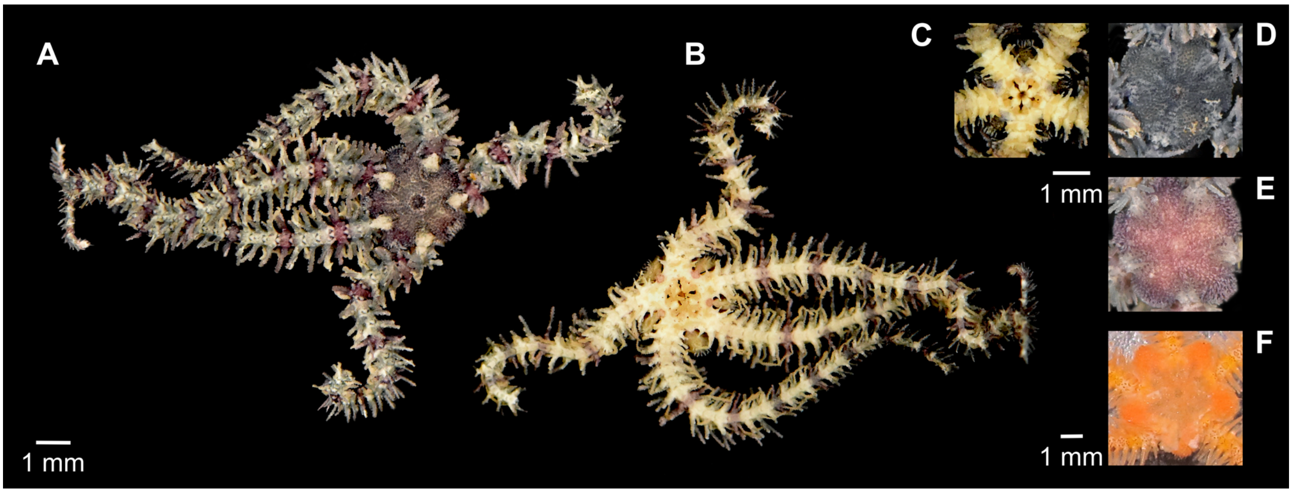

FIGURE 7. *Ophiothrix fragilis* (Abildgaard, *in* Müller, 1789) (juveniles; DBUA-ECH 121: A–C; DBUA-ECH 342: F). Dorsal view (A); ventral view (B); detail of the disc, ventral view (C); dorsal view (D–F).

Historically, many authors commented that diagnosis of *O. fragilis* subspecies was quite difficult since they are linked by intermediary forms (*e.g.,* Mortensen 1927a; Nobre 1938; Tortonese 1965; A.M. Clark 1974). Among the littoral subspecies, '*lusitanica*' is viewed as the southern form from the Atlantic French coasts south to NW Africa, '*echinata*' is viewed as a typical Mediterranean form, the form '*triglochis*' is thought to be restricted to Southern Africa and '*nuda*' to Cape Verde (Koehler 1921b; Cadenat 1938; Nobre 1938; Tortonese 1965; Madsen 1970; A.M. Clark 1974). Nevertheless, it is known that these subspecies can co-occur sympatrically (*e.g*., Cadenat 1938, Alva & Vadon 1989). Comparing the description of *O. rubra* type specimen by Ljungman (1872) and Lyman (1874) with our own specimens, the most striking commonality is the presence of thorny spinelets on the radial shields. This morphological feature is normally associated with *O. alopecurus*, which Koehler (1921b) synonymised as a rare form of '*echinata*'. However, in this subspecies the disc stumps have only up to three terminal spines ('trifid stumps'). This contrasts with the occasional presence of stumps terminating in up to five thorns in our material, which is more characteristic of the subspecies '*lusitanica*'. Another typical feature of this subspecies, shared with our specimens, is the absence of disc spines, and even and regular distribution and size of disc spinelets. Interestingly, A.M. Clark (1974) observed the same intermediary characteristics between '*echinata*' and '*lusitanica*' in specimens from South Africa previously identified as *Ophiothrix triglochis* (= *Ophiothrix fragilis*). The choice, in which subspecies the Azorean specimens should be placed is even less clear considering the colour pattern alone (see Figs. 7A–E). For example, some specimens had a conspicuous white or lighter coloured spot on the dorsal plates, which is characteristic of '*echinata*'. In contrast, other specimens presented a uniform green colour which places them in the range of '*lusitanica*' variety. The specimen from deeper waters (150 m; DBUA-ECH 342) presented an overall structure similar to the shallow-water material. However, the animal presented a brightly yellow/orange colour pattern typical of the deeper water variety '*pentaphyllum*' (Fig. 7F). Overall, the material of *O. fragilis* housed in the DBUA-ECH collection presented features intermediary to the varieties '*echinata*' and '*lusitanica*'. Whether these subspecies reflect environmental differences (*e.g.,* differences in temperature and depth) or underlying genetic differences between populations is not clear, but recent genetic studies on the European varieties by Muths and co-authors (2009) suggest that *O. fragilis* represents a single, but plastic, species.

Madsen (1970) synonymized *Ophiothrix indigna* Koehler, 1906a (from Madeira and Gulf of Cadiz) with *O. cotteaui* (de Loriol, 1900) as it merely represented adults of the latter species. However, Madsen erroneously placed *O. indigna*'s type locality in the Azores. *Ophiothrix fragilis* can be easily distinguished from *O. cotteaui* or even from *O. luetkeni* Thomson, 1873 (see below) by its naked dorsal arm plates with a more or less produced distal edge.

Ophiothrix luetkeni Thomson, 1873

Reports for the Azores:

Ophiothrix luetkeni Thomson, 1873—?$Lyman 1879: 54, 1882: 218, 286; Bell 1892: 133; $Koehler 1909: 201–202, pl. 29, figs. 8–10; Koehler 1924: 254–257; Mortensen 1927a: 176–177, fig. 99; Pereira 1997: 332; García-Diez *et al*. 2005: 48; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

Type locality: SW Ireland.

See: Thomson (1873: 100); Koehler (1921b: 71–72, fig. 46); Mortensen (1927a).

Occurrence: Northeast Atlantic from the British Islands to Cape Verde (Mortensen 1927a), including the Azores Archipelago and Josephine Seamount (Koehler 1909).

Depth: 130–838 (?932) m (Thomson 1873, Koehler 1909); AZO: ?54–165 (?823) m (Lyman 1882, Koehler 1909).

Habitat: soft bottom (rarely on hard substrates), sand, gravel and shelly substrates (Koehler 1909, 1921b).

Remarks: the first report of *O. luetkeni* in the Azores was by Lyman (1879), though he remarked that the specimen was too young and left the identification tentative. The depth of 823 m (H.M.S. *Challenger*, sta 75: 38°37'N, 28°30'W) reported by Lyman seems a result of mislabelling. We believe that the station's depth might be much shallower, 92–165 m (see remarks under *Astropecten hermatophilus* Sladen, 1883). In contrast, Koehler (1909) recorded this species in the Azores at 54 m, a surprisingly shallow depth since this species generally tends to occur below 100 m (see Koehler 1921b). In spite of the small size of *Princesse Alice* individuals (DD: 5–8 mm), it is hard to believe that Koehler (1909), who was familiar with the morphological variability of both *O. fragilis* and *O. luetkeni*, could have misidentified the specimens. Thus, we believe that a possible mislabelling occurred in the depth values of the stations.

Order Euryalida Lamarck, 1816

Family Asteronychidae Verrill, 1899

Genus *Astrodia* Verrill, 1899

Astrodia tenuispina (Verrill, 1884)

Reports for the Azores:

Astrodia tenuispina (Verrill, 1884)—$Sibuet 1972: 121–122; Pérès 1992: 254.

Type locality: off Nantucket Shoals.

See: Verrill (1884: 219, as *Asteronyx tenuispina*); Okanishi & Fujita (2014: 198–200, figs. 10–11).

Occurrence: cosmopolitan, in the Pacific and Atlantic Oceans; in the Atlantic, from off Nantucket Island to Brazil including the Caribbean and Gulf of Mexico deep waters, eastwards from Rockall Trough south to the Iberian Peninsula, including the Canary Islands and the Azores (Sibuet 1972; Okanishi & Fujita 2014).

Depth: 512–3,548 m (Okanishi & Fujita 2014); AZO: 2,480 m (Sibuet 1972).

Habitat: epizooic on other sedentary marine species, such as the pennatulid *Scleroptilum grandiflorum* Kölliker, 1880 on which the Azorean specimen was found (Sibuet 1972); probably planktivorous (Gage *et al*. 1983).

Larval stage: produces large yolky eggs, possibly indicative of a direct or lecithotrophic development (Gage *et al*. 1983).

Remarks: the record of the cosmopolitan *Astrodia tenuispina* in the archipelago was based on a single specimen collected by bathyscaphe *Archimède* in 1969, north of São Miguel Island, and later identified by Sibuet (1972). See also remarks below, under *Asteroschema inornatum* Koehler, 1906a.

Family Euryalidae Gray, 1840

Genus *Asteroschema* Oerstedt & Lütken, *in* Lütken, 1856

Asteroschema inornatum Koehler, 1906a

Reports for the Azores:

Asteroschema inornatum Koehler, 1906—$Koehler 1909: 205, pl. 7, fig. 1, 1921a: 2; A.H. Clark 1948: 78; Paterson 1985: 16, fig. 10; García–Diez *et al*. 2005: 48; $Stöhr & Segonzac 2005: 386; Martynov & Litvinova 2008: 78–79, fig. 1B; Smirnov *et al*. 2014: 194.

Type locality: Bay of Biscay.

See: Koehler (1906a: 30–31, pl. 3, figs. 45, 47; 1921a); Paterson (1985).

Occurrence: North Atlantic deep waters, from off Nova Scotia and the Reykjanes Ridge (S of Iceland) on the Mid-Atlantic Ridge, south of the Charlie-Gibbs Fracture Zone to the Azores and from the Rockall Trough south of the Bay of Biscay to Madeira (Koehler 1921a, Martynov & Litvinova 2008).

Depth: 1,300–2,300 m (Stöhr & Segonzac 2005, Martynov & Litvinova 2008); AZO: 1,478–2,300 m (Koehler 1909, Stöhr & Segonzac 2005).

Habitat: found in association with gorgonians (Gage *et al*. 1983).

Remarks: Simroth (1888) reported a small young euryalid collected in the Azores. Only two species belonging to the order Euryalida are known from the archipelago, *Astroschema inornatum* and *Astrodia tenuispina*, both known from Azorean waters well below 1,000 m. Aside from the small size of the specimen, Simroth (1888) presented no further details and we have no knowledge where this animal could be housed. Nevertheless, Koehler (1909, 1921a) and more recently Stöhr & Segonzac (2005) collected material belonging to *Asteroschema inornatum* in the archipelago, thus confirming this species' presence in the Azores.

Order Ophiacanthida O'Hara *et al*., 2017

Family Ophiacanthidae Ljungman, 1867

Genus *Ophiacantha* Müller & Troschel, 1842

Ophiacantha abyssicola Sars, 1872

Reports for the Azores:

Ophiacantha abyssicola Sars, 1872—$Koehler 1909: 182; Farran 1913: 38–39, fig. 9d; Mortensen 1927a: 194, figs. 105.5–6; Grieg 1932: 37; García-Diez *et al*. 2005: 49.

Type locality: Norway.

See: Sars (1872: 8–10); Paterson (1985: 47–48, fig. 20).

Occurrence: North Atlantic, Northeast American coast, north of Cape Hatteras to Greenland and Iceland, eastwards to Scandinavia, southwards to the Western Sahara (Paterson (1985), including the Azores (Koehler 1909), Madeira (Jesus & Abreu (1998), Canaries (Madsen 1970), and the Atlantis Seamount (A.H. Clark 1949).

Depth: 35–3,500 m (Mortensen (1927a), an upper bathyal species that may occur in shallow waters at higher latitudes, such as the Norwegian Sea (Gage *et al*. 1983); AZO: 880 m (Koehler 1909).

Habitat: rock, coral, mud to gravel and detritic substrates (Farran 1913; Cherbonnier 1969, 1970); it can form dense beds (Metaxas & Giffin 2004).

Remarks: the record of *Ophiacantha abyssicola* in the Azores is based on a single small specimen collected by *Princesse Alice* (sta 837: 37°55'N, 25°24'15"W, 880 m) and identified by Koehler (1909).

Ophiacantha aculeata Verrill, 1885a

Reports for the Azores:

Ophiacantha aculeata Verrill, 1885—$Martynov & Litvinova 2008: 90–91, figs. 7A, 10.

Type locality: off Virginia, USA (37°50'00"N, 73°03'50"W).

See: Verrill (1885a: 153; 1885b: 443–444); Koehler (1914a: 74–77, pl. 11, figs. 1–2); Martynov & Litvinova (2008).

Occurrence: North Atlantic deep waters, from off Virginia to New England, eastwards to Rockall Trough, the Bay of Biscay to Iberian Basin, including in the Mid-Atlantic Ridge, from Reykjanes Ridge to the north of the Azores (Martynov & Litvinova 2008).

Depth: 1,650–3,584 m (AZO: 2,954–2,968 m; Martynov & Litvinova 2008).

Habitat: soft sediments (*Globigerina* ooze; Verrill 1885a).

Remarks: *Ophiacantha aculeata* was recently identified by Martynov & Litvinova (2008) among the material collected by *G.O. Sars* (*MAR–ECO* expedition) at a station located at the northern border of the Azorean waters (sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m). This species has been historically confused with *O. fraterna* Verrill, 1885c (Martynov & Litvinova 2008), a species also considered at one point conspecific or a variety of *O. bidentata* (Bruzelius, 1805). See remarks under the latter species.

Ophiacantha aristata Koehler, 1895c

Reports for the Azores:

Ophiacantha aristata Koehler, 1895c—$Koehler 1896a: 212, 1898: 55, 1906b: 288–289, 1909: 183, pl. 26, figs. 5–6, 1921a: 2; Mortensen 1927a: 191, 193–194, fig. 107; Grieg 1932: 38; Nobre 1938: 76–77; García-Diez *et al*. 2005: 49.

Type locality: Bay of Biscay.

See: Koehler (1896c: 81–86, figs. 43, 44); Rodrigues *et al*. (2011: 7, fig. 2).

Occurrence: Northeast Atlantic, from the Reykjanes Ridge (S of Iceland; Copley *et al*. 1996) and British Isles to NW Africa (Paterson 1985), including the Azores and Canaries (Koehler 1909).

Depth: 658–1,805 m (Copley *et al*. 1996); AZO: 1,095–1,740 m (Koehler 1909, 1921a).

Habitat: soft bottoms, mud to sand (Koehler 1909) and on corals (Rodrigues *et al*. 2011).

Remarks: Koehler (1896a, 1898, 1906b, 1909, 1921a) recorded *Ophiacantha aristata* among the material collected by the main oceanographic cruises crossing the Azorean archipelago waters at the time (*Hirondelle*, *Talisman*, *Princesse Alice*). This species is only known in the archipelago from Koehler's historical reports.

Ophiacantha bidentata? (Bruzelius, 1805)

Reports for the Azores:

Ophiacantha bidentata (Bruzelius, 1805)—?$^{\$}$Koehler 1898: 55; Koehler 1924: 244–246; Mortensen 1927a: 196, figs. 105.1–2; Nobre 1938: 72; Paterson 1985: 34–36, fig. 15; García-Diez *et al*. 2005: 49; Micael & Costa 2010: 322; Benavides-Serrato *et al*. 2011: 244–245; Micael *et al*. 2012: 3; Smirnov *et al*. 2014: 195.

Type locality: Norway.

See: Bruzelius (1805: 33, as *Asterias bidentata*); Mortensen (1933a: 20–22, figs. 6–8); Martynov & Litvinova (2008).

Occurrence: Arctic (circumpolar) and North Atlantic, from the eastern coast of USA to Greenland and in the eastern Atlantic from South of Iceland to Cape Blanc (Paterson 1985), including the archipelagos of the ?Azores (Koehler 1898), Madeira (Jesus & Abreu 1998), Canaries (Koehler 1906b) and ?Cape Verde (Mortensen 1927a).

Depth: 10–?4,730 m (Smirnov *et al*. 2014); ?AZO: ?1,287 m (Koehler 1898).

Remarks: when describing *Ophiacantha fraterna*, Verrill (1885c) cautioned that this species had previously been confused with *O. bidentata*, including some of the H.M.S. *Challenger* material identified by Lyman (1882). Verrill (1885b) also added that *O. bidentata* unlike *O. fraterna* occurs at moderate depths. Later authors consider *O. fraterna* as a junior synonym of *O. bidentata*, or a variety of the latter (*e.g.,* Mortensen 1933a; Paterson 1985). As a result, it is difficult to understand the true geographical and depth range of *O. bidentata* (see discussion by Martynov & Litvinova 2008). In view of this and considering that the report of *Ophiacantha bidentata* in the archipelago is based on a single poorly preserved specimen collected at a depth of 1,287 m (Koehler 1898; *Hirondelle*, sta 112: 38°48'30"N, 28°06'16"W), the inclusion of this species in the Azorean faunal list should be considered with caution.

Mortensen (1927a) included Cape Verde in the geographical distribution of *O. bidentata*. To the best of our knowledge no animal belonging to this species was ever collected in the archipelago. In an earlier report, Koehler (1906b) recorded this species at *Talisman* deep-water stations located between off NW African coast and Canaries. It is possible that Mortensen (1927a) mistook Koehler's records, which was repeated by subsequent references (*e.g.*, Mortensen 1933a, Nobre 1938, Madsen 1947).

Ophiacantha crassidens Verrill, 1885a

Reports for the Azores:

Ophiacantha crassidens Verrill, 1885a—$^{\$}$Koehler 1909: 185–186, pl. 26, figs. 9–11; Farran 1913: 42–43, figs. 9c, 14; Mortensen 1927a: 192–193, fig. 106; Grieg 1932: 38; $^{\$}$Paterson 1985: 40–41, fig. 17; García-Diez *et al*. 2005: 49; $^{\$}$Stöhr & Segonzac 2005: 386; Smirnov *et al*. 2014: 194;

Ophiacantha decipiens $^{\$}$Koehler, 1906a: 22–23, pl. 2, figs. 26–27, 1906b: 283–284, pl. 20, figs. 31–32; Mortensen 1927a: 188; Nobre 1938: 73.

Type locality: off Cape Hatteras, USA.

See: Verrill (1885a: 152–153); Paterson (1985).

Occurrence: North Atlantic; it is known from west of Cape Hatteras and off Virginia in the West Atlantic and from the British waters to south of the Azores in the East Atlantic (Paterson 1985).

Depth: 970–3,120 m (Smirnov *et al*. 2014); AZO: 1,095–2,200 m (Koehler 1909, Stöhr & Segonzac 2005).

Habitat: soft sediments, sand to mud (Koehler 1909; Grieg 1932).

Remarks: Koehler (1906a, b) described *Ophiacantha decipiens* from a specimen collected by *Talisman* in the Azores (sta 127, 1883: 38°38'N, 28°20'46"W, 1,257 m). Koehler (1906a) believed that this species was a close ally of *O. smitti* Ljungman, 1872, a species reported from the archipelago by Stöhr & Segonzac (2005). Koehler (1909) also reported *O. crassidens* from the Azores, based on material collected by *Princesse Alice* (sta 703: 39°21'20"N, 31°05'45"W, 1,360 m; sta 1344: 38°45'30"N, 28°07'45"W, 1,095 m). Later, Paterson (1985) compared the type material of *O. decipiens* with specimens belonging to *O. crassidens* and found them to be conspecific. More recently, Stöhr & Segonzac (2005) reported an animal belonging to this species from Mount Saldanha, in the southwesternmost waters of the Azores (*SEAHMA–1*, sta PL181–3: 36°33'38"N, 33°24'49"W, 2,200 m).

Ophiacantha lineata Koehler, 1896b

Reports for the Azores:

Ophiacantha lineata $Koehler, 1896b: 247–249, 1909: 187–188, pl. 25, figs. 6–8, 1921a: 2, 4; Mortensen 1927a: 188; Cherbonnier & Sibuet 1972: 398; $Paterson 1985: 42–44, fig. 19; García-Diez *et al*. 2005: 49.

Type locality: Azores (38°26'N, 26°30'45"W).

See: Koehler (1896b); Bartsch (1987: 122–123, figs. 20–21); Paterson (1985).

Occurrence: North Atlantic, from Florida eastwards from Rockall to Western Sahara, including the Azores (Paterson 1985).

Depth: 500–3,175 m (Koehler 1914a, Cherbonnier & Sibuet 1972); AZO: 1,165–1,378 m (Koehler 1909, 1921a).

Habitat: soft sediments, sand with coral and shells (Koehler 1914a).

Remarks: Koehler (1896b, 1909) described *Ophiacantha lineata* based on specimens collected in the Azores by *Princesse Alice* (sta 578: 38°26'N, 26°30'45"W, 1,165 m). Koehler (1921a) found further material from the archipelago on a later expedition by *Hirondelle II* (sta 3140: 37°38'N, 26°01'W, 1,378 m). No other material is known from the archipelago.

Ophiacantha mesembria H.L. Clark, 1915

Reports for the Azores:

Ophiacantha pentagona armata $Koehler, 1898: 55–56;
Ophiacantha mesembria H.L. Clark, 1915—Koehler 1922: 60–61; Mortensen 1927a: 188.

Type locality: off Santa Cruz (Virgin Islands, Caribbean).

See: H.L. Clark (1915: 201–202); Benavides-Serrato *et al*. (2011: 248–249).

Occurrence: Northwest Atlantic, known from the Caribbean islands and Gulf of Mexico (Benavides-Serrato *et al*. 2011) eastwards to the Azores (Koehler 1922) and ?Madeira (Jesus & Abreu 1998).

Depth: 256–2,870 m (H.L. Clark 1915, Koeheler 1898); AZO: 2,870 m (Koeheler 1898).

Habitat: soft sediments (clayish sand; Koehler 1898).

Remarks: Koehler (1898) examined two specimens collected by *Hirondelle* in Azorean waters, which he placed in a variety *armata* of *O. pentagona*, a species described from the Pacific Ocean. Later, Koehler (1922) changed his previous identification of the *Hirondelle* material, and placed them under the Caribbean *O. mesembria*, extending its geographical distribution to the Mid-Atlantic and its vertical distribution from 1,143 m to 2,870 m. This species may also occur at Madeira Archipelago (Jesus & Abreu 1998, as *Ophiacantha* cf. *mesembria*).

Ophiacantha notata Koehler, 1906a

Reports for the Azores:

Ophiacantha notata Koehler, 1906a—$Stöhr & Segonzac 2005: 386.

Type locality: Bay of Biscay (45°05'00"N, 7°00'26"W).

See: Koehler (1906a: 23–24, pl. 2, figs. 28–30; 1906b: 284–286. pl. 20, figs. 36–38); Paterson (1985: 44, fig. 19).

Occurrence: only known from the Bay of Biscay (Koehler 1906a) and near Menez Gwen, in Azores (Stöhr & Segonzac 2005).

Depth: 850–1,226 m (AZO: 850 m; Koehler 1906a, Stöhr & Segonzac 2005).

Remarks: until recently, *Ophiacantha notata* was known only from the type material collected by *Travailleur* and *Talisman* expeditions in the Bay of Biscay. Stöhr & Segonzac reported this rare species from the waters in the vicinity of Menez Gwen, in the southwest of the Azores (*SEAHMA–1*, DR01: 37°50'32"N, 31°31'16"W, 850 m).

Ophiacantha setosa (Bruzelius, 1805)

Reports for the Azores:
Ophiacantha setosa Müller & Troschel, 1842—?Koehler 1898: 57–58, pl. 8, figs. 37–38; $Nobre 1938: 74, fig. 34.2;
Ophiacantha setosa (Bruzelius, 1805)—$Koehler 1906b: 291–292; Tortonese 1965: 218–220, fig. 102.

See: Tortonese (1965); Paterson (1985: 37–38, fig. 16).

Occurrence: Mediterranean Sea and East Atlantic, from the Bay of Biscay along West African coast as far as Angola (Paterson 1985), including the archipelagos of the Azores (Koehler 1906b), Canaries (Bacallado *et al*. 1985) and Cape Verde (Rochebrune 1881).

Depth: 5–1,480 m (Koukouras *et al*. 2007); AZO: ?139–1,257 m (Koehler 1898, 1906b).

Habitat: abundant in detritic substrates and a frequent epibiont on gorgonians (Tortonese 1965).

Remarks: the first report of *Ophiacantha setosa* from the Azores can be traced back to Koehler (1898). In the introduction and later in the discussion of the geographical distribution of this species (pages 32 and 58), Koehler remarked that he found this species in the Azores at a depth of 139 m, without giving any further details. However, Koehler (pp. 33, 57, 69) only listed a station sampled by *Hirondelle* located in the Bay of Biscay, at a depth of 135 m. Regardless, the same author (1906b) later identified a specimen belonging to *O. setosa* among the material collected by *Talisman* in the Azores (sta 127, 1883: 38°38'N, 28°20'46"W, 1,257 m), which appears to have been re-examined later by Nobre (1938).

Ophiacantha simulans Koehler, 1895c

Reports for the Azores:
non *Ophiacantha composita* Koehler, 1897a—$Koehler 1909: 185 [misidentification]; García-Diez *et al*. 2005: 49 [based on Koehler 1909];
Ophiacantha simulans Koehler, 1895c—Gage *et al*. 1983: 291; Paterson 1985: 39–40, fig. 17; Martynov & Litvinova 2008: 96, fig. 11B; Smirnov *et al*. 2014: 196.

Type locality: Bay of Biscay.

See: Koehler (1895c: 465–467; fig. 7; 1896c: 82–84); Mortensen (1933a: 26–29, figs. 11, 12, pl. 3, figs. 5–6); Paterson (1985).

Occurrence: North Atlantic, from off North Carolina eastwards to Iceland in the North (Gage *et al*. 1983), southwards to off Morocco (Bartsch 1987) including the archipelagos of the Azores and Canaries (Koehler 1909).

Depth: 1,480–3,018 m (Mortensen 1933a); AZO: 1,919–3,018 m (Koehler 1909).

Habitat: soft substrates, mud to muddy sand and corals (Koehler 1909).

Remarks: Koehler (1906b, 1909) reported small animals collected by the *Talisman*, *Travailleur* and *Princesse Alice* in the Bay of Biscay, Canaries and the Azores, which he believed to be *Ophiacantha composita*, a species he described for the Indian Ocean. Mortensen (1933a) disagreed with Koehler stating that the NE Atlantic animals were *O. simulans*. Paterson (1985) re-examined the material from the *Talisman* and *Travailleur* collected in the Bay of Biscay and agreed with Mortensen, assigning Koehler's *Ophiacantha composita* specimens from the Atlantic to *O. simulans*.

Ophiacantha smitti Ljungman, 1872

Reports for the Azores:
Ophiacantha smitti Ljungman, 1872—$Stöhr & Segonzac 2005: 286.

Type locality: Portugal (38°10'N, 9°25'W).

See: Ljungman (1872: 621–622); Paterson (1985: 46–47, fig. 20).

Occurrence: North Atlantic, from the Bay of Biscay south to off Western Sahara (Paterson 1985, Bartsch 1987), including the Azores (Stöhr & Segonzac 2005) and Madeira (Jesus & Abreu 1998); also off Bermuda (Lyman 1882).

Depth: 75–2,282 m (Jesus & Abreu 1998, Paterson 1985); AZO: 1,550 m (Stöhr & Segonzac 2005).

Habitat: soft bottoms, muddy sand (Jesus & Fonseca 1999) to grey ooze (Lyman 1882).

Remarks: *Ophiacantha smitti*, a species known from both sides of the Atlantic, is one of the more recent additions to the deep-water echinoderm fauna from the Azores, identify by Stöhr & Segonzac (2005) in a non-vent area near Lucky Strike (*L'Atalante*, *Victor 1ère* cruise, sta PL33: 37°15'45"N, 32°13'30"W, 1,550 m).

Ophiacantha veterna Koehler, 1907a

Reports for the Azores:

Ophiacantha veterna Koehler, 1907a—$Koehler 1921a: 2; Mortensen 1927a: 189; Martynov & Litvinova 2008: 96–97, fig. 11D;

Ophiacantha enopla veterna (Koehler, 1907a)—Paterson 1985: 37, fig. 16; García-Diez *et al*. 2005: 49; $Stöhr & Segonzac 2005: 386, 392;

Ophiacantha enopla Verrill, 1885—Smirnov *et al*. 2014: 196.

Type locality: North of the Azores.

See: Koehler (1907a: 41–43; 1909: 189–190, pl. 29, figs. 3, 4); Paterson (1985); Stöhr & Segonzac (2005).

Occurrence: Northeast Atlantic, from Reykjanes Ridge (Martynov & Litvinova 2008), eastwards from the Bay of Biscay to Western Sahara and Madeira, and southwards in the Mid-Atlantic Ridge to south of the Azores (Paterson 1985, Stöhr & Segonzac 2005).

Depth: 101–2,460 m (Koehler 1909, Paterson 1985); AZO: 1,330–2,300 m (Koehler 1921a; Stöhr & Segonzac 2005).

Habitat: soft substrates (Koehler 1909), found associated with diverse sessile fauna (*e.g.,* sponges, hydrozoans, gorgonians, colonial tunicates) and co-occurring with *Asteroschema inornatum* Koehler, 1906a (Stöhr & Segonzac 2005).

Remarks: *Ophiacantha veterna* was demoted to a subspecies of *O. enopla* Verrill, 1885a by Paterson (1985), a species previously known only from off NE America. This decision was later revoked by Martynov & Litvinova (2008) by reinstating the species status. Regardless, *O. veterna* is known from Azores deep waters by relatively few material: two specimens collected near Santa Maria Island (*Hirondelle II,* sta 3137: 37°00'N, 25°00'W, 1,330 m; Koehler 1921a) and further two individuals from the Mid-Atlantic Ridge area (*Marvel* cruise, sta PL1199–10: 36°32'16"N, 33°27'24"W, 2,300 m; Stöhr & Segonzac 2005).

Genus *Ophiochondrus* Lyman, 1869

Ophiochondrus armatus (Koehler, 1907a)

Reports for the Azores:

Ophioplus armatus $Koehler, 1907a: 46, 1909: 203–204, pl. 28, figs. 7–8; Koehler 1914a: 129–131, pl. 14, figs. 2–3, 6; Mortensen 1927a: 197–198, figs. 109–110; García-Diez *et al*. 2005: 49.

Type locality: Azores (38°35'30"N, 28°05'45"W).

See: Koehler (1909; 1914a); Mortensen (1927a).

Occurrence: a rare species known only from Florida (Koehler 1914a), Porcupine Seabight (SW of Ireland; Mortensen 1927a) and the Azores (Koehler 1909).

Depth: 287–1,250 m (AZO: 1,250 m; Koehler 1909, 1914a).

Habitat: sandy bottoms with corals and shells; epibiont on corals (Koehler 1914a).

Remarks: Koehler (1907a, 1909) described *Ophiochondrus armatus* (= *Ophioplus armatus*) based on two specimens collected by *Princesse Alice* in the Azores. No other material is known from the archipelago.

Genus *Ophiomitrella* Verrill, 1899

Ophiomitrella cordifera Koehler, 1896b

Reports for the Azores:

Ophiomitra cordifera $Koehler, 1896b: 250–251, 1909: 192–193, pl. 29, figs. 1–2; $Mortensen 1933a: 40–41; $Paterson 1985: 72–73, fig. 28;

non *Ophiomitrella clavigera* (Ljungman, 1865)—Mortensen 1927a: 186–187, fig. 103 [based on invalid synonymy]; Marques 1980: 102 [based on Mortensen 1927a]; Paterson 1985: 71, fig. 28 [based on Mortensen 1927a]; Harvey *et al*. 1988: 170 [based on Paterson 1985]; García-Diez *et al*. 2005: 49 [based on Mortensen 1927a].

Type locality: Azores (38°52'45"N, 28°06'00"W).

See: Koehler (1896b, 1909); Paterson (1985).

Occurrence: known only from the Azores and Canaries (Koehler 1909).

Depth: 1,143–1,530 m (AZO: 1,143 m; Koehler 1909).

Habitat: soft bottoms (mud and sand; Koehler 1909).

Remarks: Mortensen (1920, 1927a) believed that *Ophiomitrella cordifera* described by Koehler (1896b) from the Azores was conspecific with the *O. clavigera* (Ljungman, 1865). However, on re-examination of the type material, Mortensen (1933a) reinstated *O. cordifera* as a valid species. Paterson (1985) agreed, but for some unknown reason kept the Azores under the geographical distribution of both species. We could not find any valid record of *O. clavigera* in the Azores, which led us to believe that Paterson's (1985) account for the archipelago was a mistake resulting from the historical synonymy of the two species.

Family Ophiodermatidae Ljungman, 1867

Genus *Ophioderma* Müller & Troschel, 1840a

Ophioderma longicauda? (Bruzelius, 1805)

Reports for the Azores:

Ophiura laevis $Lyman, 1865: 10, 26;

Ophioderma longicauda Linck, 1733—Koehler 1914b: 275, 1921b: 87–89, fig. 58;

Ophioderma longicaudum (Retzius, 1805)—$H.L. Clark 1915: 301; Tortonese 1965: 259–261, figs. 118–119;

Ophioderma longicauda (Bruzelius, 1805)—Mortensen 1927a: 226; Pérez-Ruzafa *et al*. 2002: 282; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

See: Tortonese (1965); Stöhr *et al*. (2009).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Brittany on the west coast of France to Congo (Tortonese 1965), including the archipelagos of the ?Azores, Madeira, Canaries (Koehler 1914b), Selvagens (Pérez-Ruzafa *et al*. 2002) and Cape Verde (Entrambasaguas 2008).

Depth: 0–70 m (Tortonese 1965), recorded at 120 m in the Gulf of Guinea (Cadenat 1938).

Habitat: hard to coralligenous and muddy substrates, also among algae, under rocks and in *Posidonia* and *Caulerpa* beds (Tortonese 1965).

Larval stage: lecithotrophic larvae, though brooding females were also observed in the Mediterranean Sea (Stöhr *et al*. 2009).

Remarks: the only known specimen from the Azores was reported by Lyman (1865, as *Ophiura lævis*) based on the collection of the Museum of Comparative Zoology (Harvard University). However, Lyman presented no data on its origin, depth, collector or date. Later, H.L. Clark (1915, as *Ophioderma longicaudum*) confirmed Lyman's identification, but added no further information. Though we have no doubts about the species identification, the lack of specimen background information requires to include this shallow water species in the dubious records list, until new material is found that could substantiate the historical records.

Family Ophiomyxidae Ljungman, 1867

Genus *Ophioconis* Lütken, 1869

Ophioconis forbesi (Heller, 1863)

Reports for the Azores:
Ophioconis forbesi Lütken, 1869—$Koehler 1896a: 213, 1898: 58;
Ophioconis forbesi (Heller, 1863)—$Koehler 1909: 141; Koehler 1921b: 89–90, fig. 59; Mortensen 1927a: 227; Tortonese 1965: 262–263, fig. 120; Pereira 1997: 332; García-Diez *et al*. 2005: 50; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

Type locality: Adriatic (Mediterranean Sea).

See: Heller (1863: 422–424, pl. 2, figs. 5–8) Koehler (1921b); Tortonese (1965).

Occurrence: Mediterranean Sea and Northeast Atlantic, from the Bay of Biscay to Moroccan coasts (Tortonese 1965), including the archipelagos of the Azores (Koehler 1909) and Canaries (Hernández *et al*. 2013), and the seamounts of Josephine, Seine and Gettysburg (Koehler 1909).

Depth: 20–230 m (Koehler 1921b, Cherbonnier & Sibuet 1972); AZO: 98–130 m (Koehler 1898, 1909).

Habitat: sand, gravel and shells to rock; also among coralligenous algae; found in association with *Ophiura albida* Forbes, 1939 (Koehler 1921b).

Remarks: Koehler (1896a, 1898, 1909) identified the only two specimens of *Ophioconis forbesi* known from the Azores, collected by *Hirondelle* (sta 226: 38°31'19"N, 28°34'31"W, 130 m) and *Princesse Alice* (sta 882: 38°03'40"N, 28°34'45"W, 98 m).

Genus *Ophiomyxa* Müller & Troschel, 1840a

Ophiomyxa serpentaria Lyman, 1883

Reports for the Azores:
Ophiodera serpentina (Lyman, 1883)—$Koehler 1909: 203;
Ophiomyxa serpentaria Lyman, 1883—Mortensen 1927a: 168, fig. 94a, 1933a: 11–14, figs. 1–3; Paterson 1985: 18–20, fig. 11; Harvey *et al*. 1988: 168; García-Diez *et al*. 2005: 48; Smirnov *et al*. 2014: 194.

Type locality: Faeroe Channel (59°56'N, 6°27'W).

See: Lyman (1883: 274, pl. 8, figs. 114–116); Paterson (1985).

Occurrence: Northeast Atlantic, from the Denmark Strait and Iceland southwards to the northwest African coast, including the Azores (Mortensen 1933a, Paterson 1985).

Depth: 450–2,440 m (Paterson 1985); AZO: 599–1,095 m (Koehler 1909).

Habitat: sand (Koehler 1909), rock and coralligenous substrates (Cherbonnier 1969).

Larval stage: lecithotrophic (Mortensen 1933a).

Remarks: *Ophiomyxa serpentaria* is only known in the Azores from three poorly preserved specimens collected by *Princesse Alice* and reported by Koehler (1909) (sta 866: 38°52'50"N, 27°23'05"W, 599 m; sta 1344: 38°45'30"N, 28°07'45"W, 1,095 m).

Family Ophiotomidae Paterson, 1985

Genus *Ophiocomina* Koehler, *in* Mortensen, 1920

Ophiocomina nigra (Abildgaard, *in* Müller, 1789)

(Fig. 8)

Reports for the Azores:
Ophiocoma nigra (Müller & Troschel, 1842)—$Barrois 1888: 73–74;

Ophiocoma nigra (Abildgaard, *in* Müller, 1789)—$^{\$}$Koehler 1907b: 326;

Ophiocomina nigra (Abildgaard, *in* Müller, 1789)—$^{\$}$Koehler 1922: 314–318, pl. 75, figs. 1–5; Mortensen 1927a: 178–179, figs. 83, 100; Nobre 1938: 69–70, fig. 38; Fontaine 1962: 1–8; Tortonese 1965: 251–253, fig. 115; $^{\$}$Marques 1983: 3, fig. 4; Moyse & Tyler 1995: 674, fig. 12.6; Pereira 1997: 332; Pérez-Ruzafa *et al*. 2002: 283; $^{\$}$Cardigos *et al.* 2005: 165; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

See: Mortensen (1927a); Stöhr (2005: 569–572, figs. 17A–M).

Occurrence: East Atlantic and Mediterranean Sea, from Scandinavia to Portugal (Tortonese 1965) and in the Azores (Marques 1980), Madeira (Jesus & Abreu 1998), Selvagens and Canaries (Pérez-Ruzafa *et al*. 2002).

Depth: 0–400 m, though rare at depths greater than 100 m (Mortensen 1927a); AZO: 6–30 m (herein).

Habitat: gravel to rocky bottoms, usually on moderately sheltered areas (Pérez-Ruzafa *et al*. 2002); can form large aggregations with over 100 a^{ni}mals/m2 (Picton 1993).

Larval stage: planktotrophic (35–40 days; Narasimhamurti (1933).

Material examined: DBUA-ECH 070 (Baixa do Cerco, Caloura, SMG, AZO, *c.* 37°42'20"N, 25°30'30"W, 1996.12.5, 15–30 m, 5 spms, DD = 3–8 mm); DBUA-ECH 128 (FRM, AZO, *c.* 37°16'14"N, 24°46'52"W, 1990.06.08, 6–8 m, 1 spm, DD = 5 mm).

Description: disc round to pentagonal, covered by minute granules. Radial shields not visible; Mouth shields broader than long, triangular with rounded sides to almost diamond-shaped rounded middle angles, an obtuse proximal angle and the distal angle forms a small rounded lobe projecting into the interradial space. Adoral shields barely meeting within, extending around the lateral angle of the oral shield, separating it from the ventral arm plates. Two large blunt apical papillae flanked on each side by four oral papillae, inner oral papillae spiniform, pointed and outer papilla enlarged and scale-like. Five relatively long arms, about 4–5 times the DD. Five long slender arm spines; two ventral ones slightly smaller. Dorsal arm plates broad and contiguous with a slightly rounded distal margin; first proximal dorsal plates covered by granules. Ventral arm plates continuous, pentagonal with obtuse proximal edge and slightly concave distal margin; two tentacle scales over each pore reduced to one in the distal part of the arm; the outer scale slightly larger. Colour (in ethanol) is uniformly white or brown to dark brown on the dorsal side and white or pale brown on the ventral side.

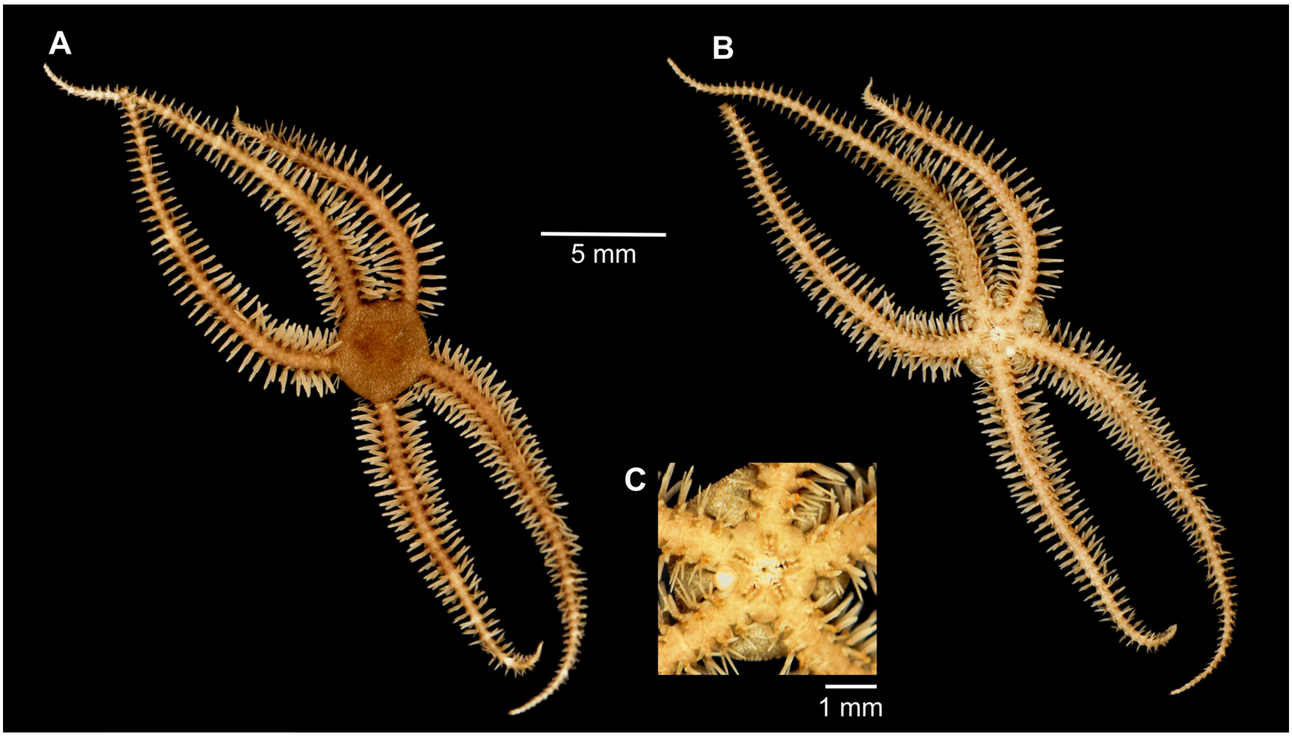

FIGURE 8. *Ophiocomina nigra* (Abildgaard, *in* Müller, 1789) (DBUA-ECH 070). Dorsal view (A); ventral view (B); detail of the disc, ventral view (C).

Remarks: among the shallow-water echinoderm fauna of the Azores, *Ophiocomina nigra* is quite unique in having a disc covered by small granules giving it an overall smooth appearance. Among the ophiuroids found in the Azores several species also have a disc covered with granules. *Ophiacantha bidentata* is known to occur in shallow waters but its disc covering is characterized by rather short stumps (Mortensen 1927a), clearly contrasting with the minute granulation presented by *O. nigra*. *Ophiothrix fragilis* is known to be found in association with *O. nigra* in the Azorean shallow waters (*e.g.,* Koehler 1909) and also has shorts stumps where the radial plates can be seen clearly (see also remarks under *O. fragilis*). Another unique character among shallow-water brittle stars of the Azores is the *O. nigra* typical dark brown or black colour. Unfortunately, it tends to fade in the preservation process.

Ophiocomina nigra is found on all sorts of substrate, though it prefers rocky bottoms (Mortensen 1927a). Nevertheless, Marques (1983) noted that in the Azores, *Ophiocomina nigra* seems particularly common in areas of strong sedimentation and rich in organic matter, such as ports, populated, and industrial areas. Cardigos *et al.* (2005) recorded this species in the area of Dom João de Castro Seamount (between Terceira and São Miguel islands), one of the rare examples in the Azores of a shallow-water hydrothermally active volcanic seamount (the top of the seamount lies at just 13 m depth; Cardigos *et al*. 2005).

Genus *Ophiotoma* Verrill, 1899

Ophiotoma alberti (Koehler, 1896b)

Reports for the Azores:

Ophiotrema alberti $^{\$}$Koehler, 1896b: 251–253, 1909: 196–198, pl. 28, figs. 1–2; Mortensen 1927a: 183; Gage *et al*. 1983: 288; Paterson 1985: 57–58, fig. 23; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 197.

Type locality: Azores (38°09'00"N, 23°15'45"W).

See: Paterson (1985); Martynov (2010: 97–103, figs. 66A–E, 67A–C, 68A–I).

Occurrence: Northeast Atlantic; recorded from several scattered locations in the Atlantic, including the Reykjanes Ridge area (*c.* 58°30'N, 31°29'W; Martynov 2010) and Rockall Trough, south to the Bay of Biscay and the Azores (Paterson 1985); it was also recorded in the Southern Hemisphere (51°07'S, 9°31'W; Mortensen 1927a).

Depth: 1,684–4,354 m (Paterson 1985, Martynov 2010); AZO: 4,020 m (Koehler 1909).

Habitat: soft substrates (Koehler 1906b).

Remarks: *Ophiotoma alberti* was described by Koehler (1896b, 1909; as *Ophiotrema alberti*) based on two specimens collected by *Princesse Alice* in the Azores (sta 527: 38°09'N, 23°15'45"W, 4,020 m), the only material known so far from the archipelago.

Ophiotoma coriacea? Lyman, 1883

Reports for the Azores:

non *Ophiopora bartletti* (Lyman, 1883)—?$^{\$}$Koehler 1909: 195 [misidentification]; García-Diez *et al*. 2005: 49 [based on Koehler 1909];

Ophiotoma coriacea Lyman, 1883—Mortensen 1927a: 187–188, fig. 104; Paterson 1985: 57, fig. 23; Harvey *et al*. 1988: 169–170; Smirnov *et al*. 2014: 197.

Type locality: off Cape Cod, USA (41°24'45"N, 65°35'30"W).

See: Lyman (1883: 268–269, pl. 2, figs. 1–3); Mortensen (1933a: 37–39); Paterson (1985); Martynov (2010: 97–103, figs. 66F–H).

Occurrence: North Atlantic; from off Cape Cod eastward to Iceland, south to the Bay of Biscay and ?Azores (Paterson 1985).

Depth: 1,605–4,106 m (Paterson 1985, Harvey *et al*. 1988); AZO: ?3,465 m (Koehler 1909).

Habitat: soft bottoms, from muddy sand to ooze (Koehler 1909, Farran 1913).

Remarks: Koehler (1909) reported the Caribbean species *Ophiotoma bartletti* (= *Ophiopora bartletti*) from the Azores, based on a single incomplete and deformed specimen, collected by *Princesse Alice* (sta 745: 38°05'00"N, 23°50’15”W) at a depth of 3,465 m, much deeper than what is believed to be the normal depth for the Caribbean species. H.L. Clark (1915) considered that the Caribbean species *O. bartletti* was conspecific with the East Atlantic *O. coriacea*, an opinion that subsequent authors did not agree with (*e.g.,* Koehler 1922; Mortensen 1933a). Paterson (1985) argued that since all that remains of the type material of the former species were fragments of the arms the synonymy could not be confirmed. We agree with Paterson (1985) that *O. bartletti* is restricted to the Caribbean and tentatively refer Koehler’s report of *O. bartletti* to the temperate species *O. coriacea* (see also Farran 1913), despite the fact that *O. coriacea* as such has not been reported from the Azores so far. Inclusion of this species in the Azorean echinoderm fauna should, nevertheless, be considered with caution, considering the poor state of the only known specimen recovered from the Azorean deep waters.

Genus *Ophiotreta* Verrill, 1899

Ophiotreta valenciennesi (Lyman, 1879)

(Fig. 9)

Reports for the Azores:

Ophiacantha rufescens $Koehler, 1896b: 249–250; H.L. Clark 1901: 250;

Ophiacantha valenciennesi Lyman, 1878—$Koehler 1906b: 292, 1909: 188–189, pl. 6, fig. 2; Mortensen 1927a: 189; $Mortensen 1933a: 35–37, figs. 19b, 21a–e; Nobre 1938: 77–78; Marques 1980: 101; García-Diez *et al*. 2005: 49;

Ophiotreta valenciennesi rufescens Koehler, 1896b—$Paterson 1985: 49–50, fig. 21; $Stöhr & Segonzac 2005: 386, 292; Mifsud *et al*. 2009: 67, fig. 2.

Type locality: off the Key-Islands**,** Indonesia (5°43’S, 132°25’W).

See: Lyman (1882: 183–184, pl. 26, figs. 7–8, as *Ophiacantha valenciennesi*); Mortensen (1933a); O’Hara & Stöhr (2006: 62–63, figs. 5A–D, 17P); Borrero-Pérez *et al*. (2008: 181, figs. 7D, E); Stöhr (2011: 20–21).

Occurrence: cosmopolitan, in the Pacific, Atlantic (O’Hara & Stöhr 2006) and the Mediterranean Sea (Mifsud *et al*. 2009); in the Atlantic from the Gulf of Mexico (Stöhr & Segonzac 2005) and Caribbean (Borrero-Pérez *et al*. 2008), eastwards in the Azores and on the West African waters to Angola (Paterson 1985).

Depth: 123–1,442 m (Koehler 1906b, 1914a); AZO: 711–1,442 m (Koehler 1906b, herein).

Habitat: soft to hard substrates (Koehler 1896b, 1914a); can be found near hydrothermal vents (Stöhr & Segonzac 2005) and on cold seeps and in association with *Lophelia* corals (Mifsud *et al*. 2009).

Material examined: EMEPC G3D4 Ma004 (South of TER, AZO, 38°23’36”N, 26°54’11”W, 2007.05.18, 711–790 m; 1 spm, DD = 9 mm); EMEPC G3D4 Ma018 (South of TER, Azores, 38°23’36”N, 26°54’11”W, 2007.05.18, 711–790 m; (SE of TER, AZO, 38°23’36”N, 26°54’11”W, 2007.05.18, 711–790 m; 1 spm, DD = 7 mm).

Description: disc round to sub-pentagonal, covered by thin small imbricating plates bearing low hemispherical rugose granules; only the distalmost tips of the radial shields are visible. Mouth shields arrow-head-shaped (length ≈ breadth), widest at the mid-distal area, with a lobed distal margin; adoral shields not meeting within, extending around the lateral angle of the oral shield, separating it from the ventral arm plates. Jaws about as wide as long. One or two apical papillae flanked by five oral papillae on each side; proximal oral papillae spiniform, pointed, distal papilla enlarged and scale-like. Dorsal arm plates bell-shaped, with slightly lobed distal margin, contiguous, not bearing small spines on the distal margin. Ventral arm plates wider than long, contiguous with an acute proximal angle and a convex distal margin. Arms mostly broken off at the base, carrying six arm spines, the uppermost longest (about three segments in length); two small oval tentacle scales over each pore, 1/2 as long as the ventral arm plate, inner scale slightly smaller. Colour brown with slightly darker bands on the arms.

Remarks: Koehler (1896b) described *Ophiacantha rufescens*, based on material collected by *Princesse Alice* in the Azores (sta 584: 38°31’N, 26°49’15”W, 845 m). On analysing the specimens collected by *Talisman* off NW Africa and in the Azores (sta 122, 1883: 37°35’N, 28°20’46”W, 1,440–1,442 m), Koehler (1906b) placed his species in the synonymy of the Pacific species, *O. valenciennesi*. Re-examining material from *Princesse Alice* and *Talisman*, Mortensen (1933a) believed that the Atlantic specimens belonged to a separate variety, retaining Koehler’s form *rufescens* as a subspecies of *O. valenciennesi*. More recently, Stöhr & Segonzac (2005) recorded an animal belonging to this Atlantic subspecies on a block recovered in the area of the hydrothermal vents of Menez Gwen (*DIVANAUT 1*, sta PL906–14: 37°49’36”N, 31°31’01”W, 848 m). On a study on the New Caledonia brittle stars, Stöhr (2011) revoked the subspecific status of '*rufuscens*', as the diagnostic morphological features were not exclusive of the Atlantic material.

The specimens documented herein agree with the original descriptions presented by Koehler (1896b) under the name of *Ophiacantha rufescens*. For the most part, the Azorean material is also in accordance with the observations by O'Hara & Stöhr (2006) on *O. valenciennesi*. The only conspicuous difference is the presence of small spines at the distal margin of the dorsal arm plates in the Indo-Pacific material. Koehler (1914a) commented that some of the specimens of *O. valenciennesi* collected by *Albatross* in Cuban waters also presented this feature. Still, as a rule, the form *rufescens* documented in the Atlantic or Mediterranean Sea presents a smooth distal edge of the dorsal plates (*e.g.,* Paterson 1985; Mifsud *et al*. 2009; Borrero-Pérez *et al*. 2008), which agrees with our material. In contrast, Paterson (1985) reported that this subspecies has seven to eight arm spines, which clearly contrasts with our observations and with Koehler's (1896b) original description, placing the Azorean material somewhat closer to the typical *valenciennesi*. A reduced number of arms spines was also reported in the Columbian specimens by Borrero-Pérez *et al*. (2008).

Ophiotreta valenciennesi was also reported from the archipelago of Cape Verde (*e.g.*, Koehler 1909; Mortensen 1927a; Nobre 1938). However, such records seem to be based directly or indirectly on the material collected by *Talisman*. At the time, Koehler (1906b) reported the location of the stations using a system of coordinates based on the Paris Meridian. On converting the longitudes to the Greenwich Meridian, it is clear that the reported material came from waters off the coast of NW Africa, outside Cape Verde waters. We also believe that Peterson (1985) account of 'off Madeira' as the NE Atlantic geographical limit of *O. valenciennesi* is a result of a misprint. He probably wanted to refer to the archipelago of the Azores.

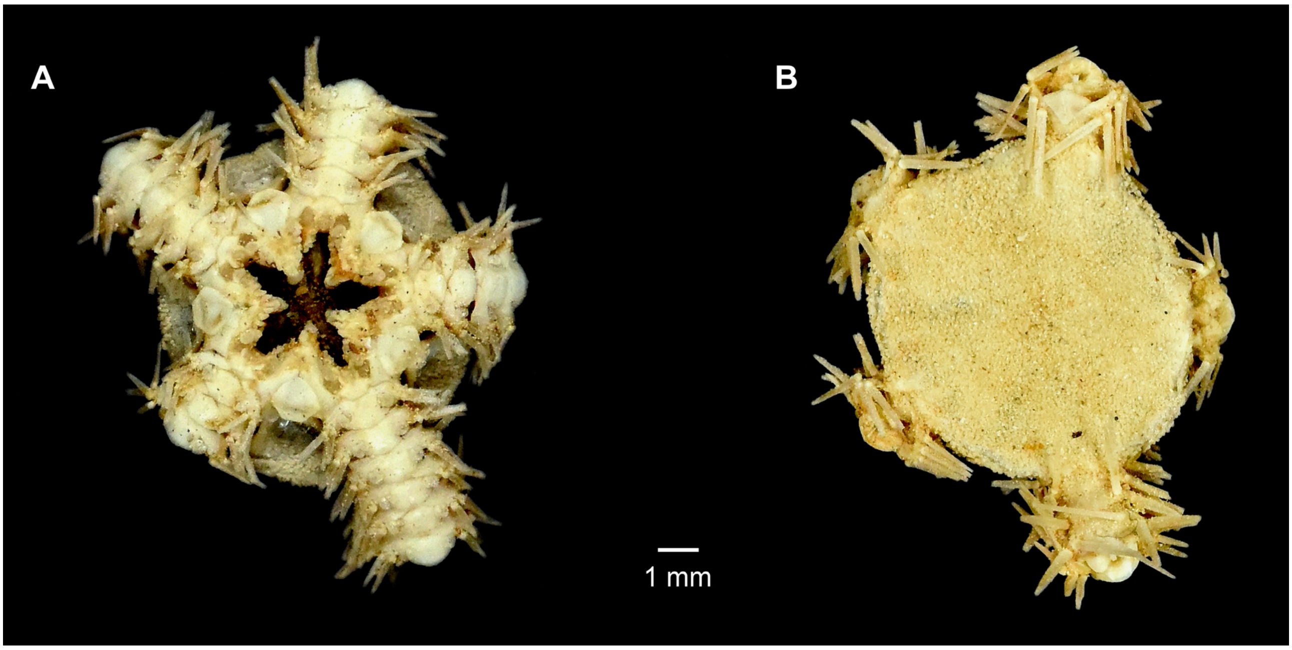

FIGURE 9. *Ophiotreta valenciennesi* (Lyman, 1879) (EMEPC G3D4Ma004). Dorsal view (A); ventral view (B).

Order Ophioleucida O'Hara *et al.* 2017

Family Ophiernidae O'Hara *et al.* 2017

Genus *Ophiernus* Lyman, 1878

Ophiernus vallincola Lyman, 1878

Reports for the Azores:

Ophiernus vallincola $^{\$}$Lyman, 1878: 122–123, pl. 6, figs. 170–175, 1882: 32–33, pl. 24, figs. 16–18, pl. 38, figs. 6–9; Mortensen 1927a: 228; Madsen 1977: 112–114, fig. 2; $^{\$}$Paterson 1985: 98–99, fig. 40; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 207–208;

Ophiernus abyssalis Koehler, 1896b: 242–243; $Koehler 1909: 143–145, pl. 28, figs. 3, 4; Mortensen 1927a: 228.

Type locality: Azores (37°24'N, 25°13'W).

See: Lyman (1878); Madsen (1977); Paterson (1985); Martynov & Litvinova (2008: 83, fig. 3D).

Occurrence: cosmopolitan, present in the Pacific, Indian, Atlantic and Southern (Antarctica) Oceans; in the Atlantic from the Reykjanes Ridge area (S of Iceland; Martynov & Litvinova 2008) and the British Isles to Southern African waters (Madsen 1977), including the archipelagos of the Azores and Madeira (Koehler 1909).

Depth: 840–4,065 m (Madsen 1977); AZO: 1,732–1,919 m (Koehler 1909).

Habitat: soft bottoms, muddy sand to ooze (Koehler 1909).

Remarks: Lyman (1878) described *Ophiernus vallincola* based on material collected by H.M.S. *Challenger* selecting a specimen taken in Azores waters as the type. The only other material of this species from the archipelago was reported by Koehler (1909, as *Ophiernus abyssalis*), collected by *Princesse Alice* at several stations.

Order Ophioscolecida O'Hara *et al*., 2017

Family Ophiohelidae Perrier, 1893

Genus *Ophiomyces* Lyman, 1869

Ophiomyces frutectosus Lyman, 1869

Reports for the Azores:
Ophiomyces frutectosus Lyman, 1869—$Ljungman 1872: 621; Barrois 1888: 32; Mortensen 1927a: 183.

Type locality: off Sand Key (Florida).

See: Lyman (1869: 345–347); Paterson (1985: 75, fig. 31).

Occurrence: Caribbean species (Paterson 1985), also reported from southern Brazil (Borges *et al*. 2002), Azores and Josephine Seamount (Ljungman 1872).

Depth: 50–1,098 m (AZO: 585–1,098 m; Borges *et al*. 2002, Ljugman 1872).

Habitat: soft substrates (Lyman 1883).

Remarks: on describing *Ophiomyces frutectosus*, Lyman (1869) remarked that he also found two specimens belonging to this species among the material collected by the *Josephine* cruise in the Josephine Seamount. Later, Ljungman (1872) reported material of this species collected in São Miguel Island (Azores) by *Josephine*, at depths (585–1,098 m) well below the species' normal bathymetrical range (141–527 m; Lyman 1869, 1883).

Family Ophioscolecidae Lütken, 1869

Genus *Ophiogeron* Lyman, 1878

Ophiogeron granulatus? (Lyman, 1883)

Reports for the Azores:
non *Ophiogeron edentulus* Lyman, 1878—?$Lyman 1882: 237, pl. 12, figs. 16–18 [misidentification];
Astrogeron supinus (Lyman, 1883)—?$Koehler 1909: 199, pl. 29, fig. 7; Mortensen 1927a: 167; García-Diez *et al*. 2005: 48.

Type locality: Martinique (Caribbean Sea).

See: Lyman (1883: 269–270, as *Ophiosciasma granulatum*); H.L. Clark (1941: 70–71).

Occurrence: West Atlantic; restricted to the Gulf of Mexico and Caribbean waters (Lyman 1883; Lyman *in* Koehler 1914a), but possibly extending to the Azores.

Depth: 95–511 m in the West Atlantic (Lyman *in* Koehler 1914a); ?AZO: 1,250–1,647 m (Lyman 1883, Koehler 1909).

Habitat: soft bottoms with coral and broken shells (Lyman 1883; Lyman *in* Koehler 1914a).

Remarks: Lyman (1878) described *Ophiogeron edentulus* based on the material collected by H.M.S. *Challenger* at a station located in South Pacific waters. Later, Lyman (1882) added material from another H.M.S. *Challenger* station to this species, now located in the Azores (sta 76: 38°11'N, 27°09'W, 1,647 m). Mortensen (1927a) believed that the material from this Atlantic station belonged most probably to the Caribbean species *O. granulatus* (= *Astrogeron supinus*). The report of this West Atlantic species in the Azores by Koehler (1909) appears to support this supposition. Furthermore, the present knowledge of *O. edentulus* is still limited to the type material. In view of this, we are inclined to agree with Mortensen and consider *O. edentulus* as restricted to the Pacific waters and thus, tentatively regard Lyman's record of *O. edentulus* as misidentification. On the other hand, the record of *Ophiogeron granulatus* (= *Astrogeron supinus*) in the Azores by Koehler (1909) was based on a small and poorly preserved specimen collected by *Princesse Alice* (sta 1349: 38°35'30"N, 28°05'45"W, 1,250 m) at a depth below the normal range for this species. Overall, both H.M.S. *Challenger* and *Princesse Alice* reports place *O. granulatus* outside its normal geographical and bathymetric range. Thus, the identity of the Azorean material with *Ophiogeron granulatus* should be viewed with caution until new material collected in area can confirm the historical reports.

Genus *Ophiophrura* H.L Clark, 1911

Ophiophrura tripapillata (Stöhr & Segonzac, 2005)

Reports for the Azores:
Ophioscolex tripapillatus $Stöhr & Segonzac, 2005: 385–388, fig. 3.

Type locality: Near Menez Gwen, Mid-Atlantic Ridge, Azores (37°50'56"N, 31°30'40"W).

See: Stöhr & Segonzac (2005).

Occurrence: Northeast Atlantic, known only from the Azores, the Bay of Biscay, and Iceland (Stöhr & Segonzac 2005).

Depth: 1,015–1,500 m (AZO: 1,015 m; Stöhr & Segonzac 2005).

Habitat: hard substrates (oxidized basalt), with other benthic fauna (*e.g.,* sponges, bryozoans, brachiopods and tunicates; Stöhr & Segonzac 2005).

Remarks: Stöhr & Segonzac (2005) described *Ophioscolex tripapillatus*, based on a specimen collected in the vicinity of Menez Gwen, southwest of the Azores. This species is known only from five specimens, collected from widely separated localities.

Order Ophiurida Müller & Troschel, 1840a *sensu* O'Hara *et al.*, 2017

Genus *Anthophiura* H.L. Clark, 1911

Anthophiura ingolfi? Fasmer, 1930

Reports for the Azores:
Ophioglypha minuta Lyman, 1878—?$Koehler 1896b: 242, 1909: 152–153 [possible misidentification];
Aspidophiura minuta (Lyman, 1878)—García-Diez *et al*. 2005: 49 [based on Koehler 1909].

Type locality: Between Greenland and Iceland (64°34'N, 31°12'W).

See: Fasmer (1930: 4–7, figs. 3–5); Vadon & Guille (1984: 593–595, figs. 1A–B, pl. 4, figs. 4–6); Paterson (1985: 140, fig. 53).

Occurrence: North Atlantic, between Greenland and Iceland south to the Bay of Biscay (Paterson 1985) and the ?Azores; reported also from Reunion Island (Indian Ocean; Vadon & Guille 1984) and New Caledonia (SW Pacific Ocean; Améziane 2007).

Depth: 1,175–2,862 (?4,020) m (Vadon & Guille 1984, Paterson 1985); AZO: ?4,020 m (Koehler 1909).

Habitat: soft bottoms (detrictic mud; Vadon & Guille 1984).

Remarks: Koehler (1909) identified two individuals collected by *Princesse Alice* in the Azores as *Anthophiura minuta* (= *Ophioglypha minuta*) (sta 527: 38°09'00"N, 23°15'45"W, 4,020 m). However, he added that the Azorean specimens were different from Lyman's (1878) type material collected by H.M.S. *Challenger* half way between the Antarctic and Australian waters, but identical to *Caudan* animals from the Bay of Biscay (Koehler 1895c, 1896c). Additionally, Koehler (1909) remarked on the very simple structure that characterises the material collected by H.M.S. *Challenger*, *Caudan* and *Princesse Alice*, possibly juveniles belonging to two different species. Later, Fasmer (1930) believed that these animals belonged to his newly described species, *Anthophiura ingolfi* based on the description of the disc scaling, an opinion shared by later authors (*e.g.,* Mortensen 1933a; Paterson 1985). However, Fasmer remarked Koehler's material was lost and without its re-examination the presence of *A. ingolfi* in the Azores and the Bay of Biscay could not be confirmed. Paterson (1985) was able to confidently expand the geographical range of Fasmer's species to the Bay of Biscay, based on the material collected by the oceanographic mission *Biogas*. Thus, and in spite of the absence of confirmed records, we have transferred the Azorean specimens from *A. minuta* (a strictly Pacific species) to *A. ingolfi*, following Fasmer (1930) and Paterson (1985).

Family Astrophiuridae Sladen, 1879

Genus *Ophiophycis* Koehler, 1901

Ophiophycis mirabilis Koehler, 1901

(Fig. 10)

Reports for the Azores:

Ophiophycis mirabilis $^{\$}$Koehler, 1901: 222–225, figs. 1, 2, 1909: 163–164, pl. 26, figs. 3–4; Mortensen 1927a: 229; Cherbonnier 1969: 348; Cherbonnier & Sibuet 1972: 419; Paterson 1985: 141–142, fig. 54; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 203.

Type locality: Azores (38°26'00"N, 26°30'45"W).

See: Koehler (1901); Paterson (1985).

Occurrence: Northeast Atlantic, from Reykjanes Ridge (South of Iceland) south in the Bay of Biscay and off Portugal, in the Josephine Bank area (Paterson 1985, Martynov & Litvinova 2008) to the Azores.

Depth: 810–2,150 (?2,871) m (Cherbonnier 1969, Tyler & Zibrowius 1992); AZO: 1,131–1,201 m (herein).

Habitat: hard substrate and on corals (Cherbonnier 1969).

Material examined: EMEPC G3D3A Ma004 (Southeast of TER, AZO, 37°56'15"N, 26°49'00"W, 2007.05.18, 1,131–1,201 m; 4 spms, DD = 4–5 mm)

Description: disc pentagonal, fringed spines (modified arm spines), dominated by a large star-shaped centrodorsal and primary radial plates; spines flat with tips of variable shape, from blunt almost square to more acute; a faint knob on the centrodorsal plate; radial shields somewhat tear-drop shaped (length > breadth), longer than half disc radius and contiguous along the mid-portion of the plate; a single row of two plates between each pair of radial shields, the proximal one rectangular and the distal one triangular to heart-shaped. One pointed mouth papilla flanked on each side by two to four contiguous block-like papillae. Adoral shields narrow, longer than broad. Mouth shields small (length <1/2 disc radius) and pentagonal. Ventral inter-radial scales rectangular, elongated from the edge of the oral shield to the margin of the disc. None of specimens presented complete arms, either broken at the base or at the first two or three segments. First two dorsal arm plates contiguous and trapezoidal. Ventral arm plates separated; first ventral arm plate is approximately rectangular; subsequent plate somewhat more pentagonal with a straight proximal edge and a slight obtuse distal angle. Tentacle pores including the second oral tentacle pore with one small, round to oval, slightly pointed tentacle scale. Two to three flattened arm spines. Colour (dry) uniformly white.

Remarks: for the most part, the specimens herein described are in accordance with the description by Koehler (1901, 1909) and Paterson (1985). Nevertheless, according to the latter author, the absence of knobs on the dorsal disc and arm plates in *O. mirabilis* is one of the main differences between this species and the closely resembling *Ophiomisidium pulchellum* (Thomson, 1877). Our specimens presented faint knobs on the centrodorsal plates identical to what was figured by Martynov & Litvinova (2008: 82, fig. 3A). Conversely, on a redescription of *O. pulchellum* by Borges & Campos (2011), no such knobs are described. Apparently, the presence of knobs on the centrodorsal plate is variable and thus not diagnostic. Notwithstanding, according to Paterson (1985) the plate shape and arrangement in the ventral interradial area can also be used to distinguish *Ophiophycis mirabilis* from *Ophiomisidium pulchellum* or *Ophiomisidium speciosum* Koehler, 1914a. In our material as in *O. mirabilis*, there is a single large rectangular plate between the edge of the disc and the mouth plate, which contrasts with the sub-trapezoidal elongate plate described for the *Ophiomisidium* species.

Koehler (1901, 1909) described *Ophiophycis mirabilis* based on two specimens collected by *Princesse Alice* in the Azores (sta 578: 38°26’00”N, 26°30’45”W, 1,165 m). Later, this deep-water ophiuroid was reported from the Bay of Biscay (Cherbonnier 1969; Cherbonnier & Sibuet 1972; Paterson 1985) expanding the species’ geographical range to the continental European waters. More recently, Martynov & Litvinova (2008) found *O. mirabilis* on the Reykjanes Ridge, south of Iceland. Tyler & Zibrowius (1992) observed this species on hard substrates (using fissures in the rock) in steep slopes of the Porcupine deep waters (SW Ireland) and they believed that this could be the reason why this species is rarely documented since this behaviour makes it very difficult to sample. Fortunately, our specimens were recovered among the rock samples collected during a geological survey in the Azores deep waters by EMEPC that helped to further confirm the presence of this species in the area.

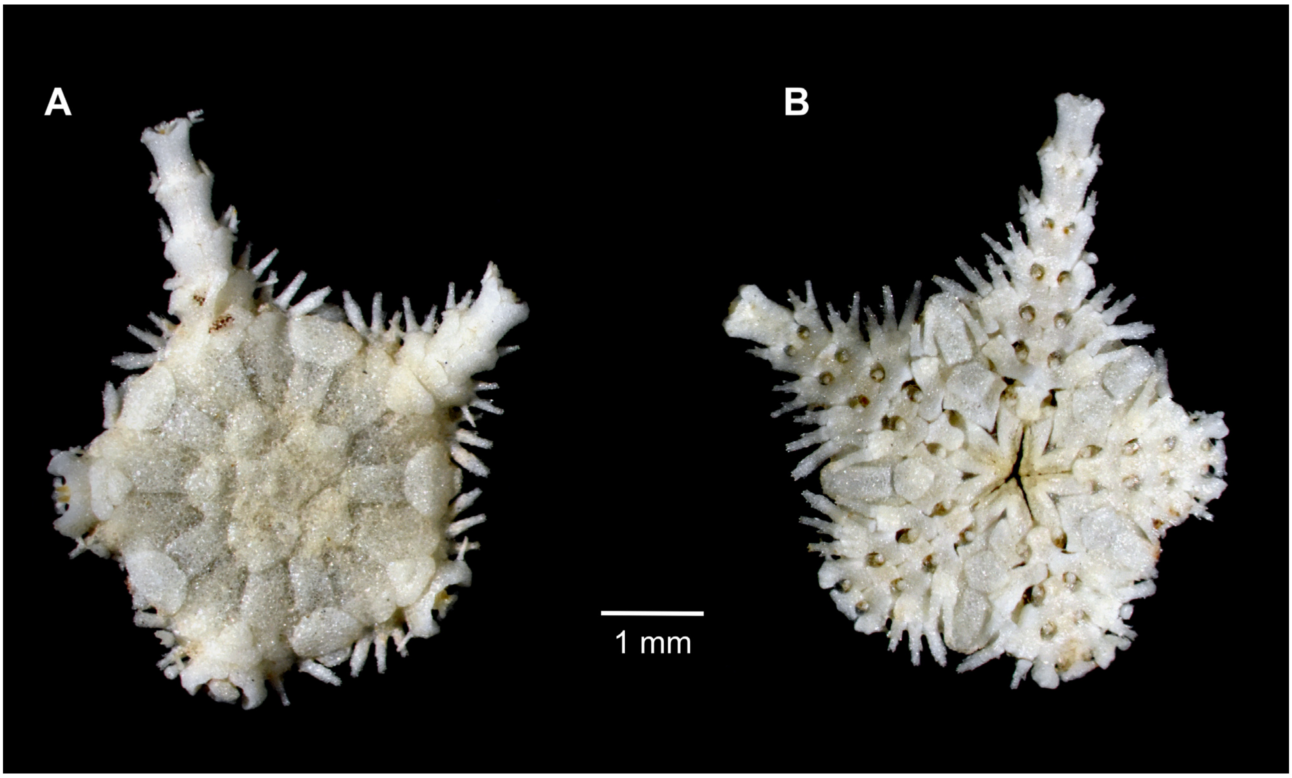

FIGURE 10. *Ophiophycis mirabilis* Koehler, 1901 (EMEPC G3D3A Ma004). Dorsal view (A); ventral view (B).

Family Ophiopyrgidae Perrier, 1893

Genus *Amphiophiura* Matsumoto, 1915

Amphiophiura convexa (Lyman, 1878)

Reports for the Azores:

Ophioglypha convexa (Lyman, 1878)—$Koehler 1909: 149–150, pl. 25, figs. 1–2;

Amphiophiura convexa (Lyman, 1878)—Mortensen 1927a: 231; $Cherbonnier & Sibuet 1972: 408; Martynov & Litvinova 2008: 81, fig. 2D;

Ophiura convexa (Lyman, 1878)—Grieg 1932: 32;

Amphiophiura bullata convexa (Lyman, 1878)—Paterson 1985: 132–133, fig. 51; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 201.

Type locality: E of Japan, Pacific.

See: Lyman (1878: 84, pl. 3, figs. 83–84, as *Ophioglypha convexa*); Paterson (1985).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian Oceans; in the west Atlantic from Labrador basin to off New England (Paterson 1985) and in the East Atlantic, from Reykjanes Ridge south to the Bay of Biscay (Martynov & Litvinova 2008), Azores, Canaries (Koehler 1909) and ?Madeira (Jesus & Abreu 1998); also reported from Vema Fracture zone, off Central African coast (24°02'S 14°41'W; Lyman 1882) and Demerara Abyssal Plain, off northern South America (Paterson 1985).

Depth: 1,950–6,810 m (Smirnov *et al*. 2014); AZO: 3,665–4,261 m (Koehler 1909, Cherbonnier & Sibuet 1972).

Habitat: soft bottoms (ooze; Koehler 1909).

Remarks: Koehler (1909, 1914a) remarked on the variability present in *Amphiophiura convexa* (= *Ophioglypha convexa*), which in certain aspects of its morphology resembles *A. bullata* (Thomson, 1877). Paterson (1985) based on the variability of the dorsal plating of the disc, assumed *A. convexa* to be a subspecies of *A. bullata*. Martynov & Litvinova (2008) disagreed and maintained the specific status, a view followed herein.

Jesus & Abreu (1998) reported an '*Amphiophiura* cf. *bullata convexa*' from Madeira shallow waters, between 20 and 100 m. In the North Atlantic, the genus *Amphiophiura* includes strictly deep-water species that tend to live well below 1,000 m (Paterson 1985; Smirnov 2014). In light of this, we doubt that the material reported by Jesus & Abreu (1998) belongs to *A. convexa* or even the genus *Amphiophiura*.

Genus *Ophiopleura* Duncan, 1878

Ophiopleura inermis (Lyman, 1878)

Reports for the Azores:

Ophiura aurantiaca (Verrill, 1882)—$^{\$}$Koehler 1921a: 5;

Ophiopleura aurantiaca (Verrill, 1882)—Mortensen 1927a: 251–252, fig. 137, 1933a: 92–94, fig. 50;

Ophiopleura inermis (Lyman, 1878)—Gage *et al*. 1983: 295; Paterson 1985: 128, fig. 48; Martynov & Litvinova 2008: 82–83, fig. 3B.

Type locality: Off Tristan da Cunha Island.

See: Lyman (1878: 95–96, pl. 5, figs. 123–125, as *Ophioglypha inermis*); Paterson (1985).

Occurrence: Atlantic species, known from Greenland and Iceland south to off Martha's Vineyard (Massachusetts) in the west and to the Bay of Biscay (Paterson 1985), the Azores (Koehler 1921a), Madeira (Jesus & Abreu 1998) and Canaries (Koehler 1909) in the east; also found in the south of the Charlie-Gibbs Fracture Zone (Martynov & Litvinova 2008) and off Tristan da Cunha (Lyman 1878).

Depth: 150–1,875 m (Gage *et al*. 1983, Paterson 1985); AZO: 1,740 m (Koehler 1921a).

Habitat: hard to soft sediments (Koehler 1909, Jesus & Fonseca 1999).

Remarks: Koehler (1921a) reported the only specimen of *Ophiopleura aurantiaca* (as *Ophiura aurantiaca*) known from the Azores waters (*Hirondelle II*, sta 3150: 38°01'N, 25°21'W, 1,740 m), a species later found to be conspecific with *Ophiopleura inermis* (Mortensen 1933a; Gage *et al*. 1983).

Genus *Ophioplinthus* Lyman, 1878

Ophioplinthus inornata (Lyman, 1878)

Reports for the Azores:

Ophioglypha inornata Lyman, 1878—$^{\$}$Koehler 1906b: 262–263;

Homalophiura inornata (Lyman, 1878)—Mortensen 1927a: 231;

Ophiura inornata (Lyman, 1878)—$^{\$}$A.H. Clark 1948: 78;

Ophiurolepis inornata (Lyman, 1878)—Paterson 1985: 138–139, fig. 53; Smirnov *et al*. 2014: 206.

Type locality: off S. Paulo Rocks (1°47'N, 24°26'W).

See: Lyman (1878: 97, pl. 2, figs. 26–27); Paterson (1985); Martynov & Litvinova (2008: 85–7, figs. 6G).

Occurrence: cosmopolitan, recorded in the Pacific, Indian and Atlantic; in the Atlantic from South America, Falkland Islands, Caribbean, Saint Paul Rocks, eastwards to off Cape Blanc (NW Africa), including the Azores (Paterson 1985).

Depth: 242–3,385 m (Lyman 1878, Mortensen 1936); AZO: 2,995–3,200 m (Koehler 1906b, A.H. Clark 1948).

Habitat: soft sediments (*Globigerina* ooze; Lyman 1878).

Larval stage: non-brooding, direct or lecithotrophic development (Mortensen 1936).

Remarks: the presence of *O. inornata* in the Azores was first reported by Koehler (1906b; *Talisman*, sta 131, 1883: 38°28'N, 25°05'46"W, 2995 m). Later, A. H. Clark (1948) also identified material belonging to this species from the Azores, but referred to it as from west of Gibraltar (*Atlantis* sta 15: 35°37'N, 30°51' W; 3,200 m).

Ophioplinthus pseudotessellata Martynov & Litvinova, 2008

Reports for the Azores:

Ophioplinthus pseudotessellata $Martynov & Litvinova, 2008: 89–90, figs. 4B, D, 5D–G.

Type locality: North of the Azores (42°55'N, 30°20'W).

See: Martynov & Litvinova (2008).

Occurrence: known only from the Mid-Atlantic Ridge north of the Azores (Martynov & Litvinova 2008).

Depth: 2,954–2,968 m (AZO; Martynov & Litvinova 2008).

Remarks: *Ophioplinthus pseudotessellata* is only known by type material collected at the north border of the Azorean waters.

Ophioplinthus tessellata (Verrill, 1894)

Reports for the Azores:

Ophioglypha tessellata Verrill, 1894—$Koehler 1896a: 203–204, 1898: 37–40, pl. 7, figs. 34, 36, 1909: 156–157, pl. 25, figs. 12–13, pl. 27, figs. 5–6;

Homalophiura tesselata (Verrill, 1894)—Mortensen 1927a: 231, 1933a: 91–92, pl. 3, fig. 17; $Cherbonnier & Sibuet 1972: 408–409;

Ophiura tessellata Verrill, 1894—Grieg 1932: 33;

Homophiura tessellata (Verrill, 1894)—Paterson 1985: 137–138, fig. 52; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 202;

Ophioplinthus tessellata (Verrill, 1894)—Martynov & Litvinova 2008: 83–88, figs. 4A, C, 5A–C.

Type locality: east coast of North America, between 39°35'N and 41°47'N.

See: Verrill (1894: 290–293, as *Ophioglypha tessellata*); Paterson (1985); Martynov & Litvinova (2008).

Occurrence: North Atlantic, from Greenland (Cherbonnier & Sibuet 1972) to south of Block Island (off the coast of Rhode Island; Paterson 1985), eastwards from south of Iceland (Mortensen 1933a), in European waters south to Cape Verde, and along the Mid-Atlantic Ridge south to the Azores (Koehler 1909, Martynov & Litvinova 2008).

Depth: 433–4,706 m (Smirnov *et al*. 2014); AZO: 1,919–2,870 m (Koehler 1896b, 1909).

Habitat: soft substrates (Koehler 1909).

Larval stage: lecithotrophic (Kasyanov *et al*. 1998).

Remarks: Koehler (1906b, 1909) reported *O. tessellata* in the Azores (*Talisman*, sta 248: 41°40'41"N, 26°44'09"W, 2870 m; *Princesse Alice*, sta 738: 37°40'N, 26°26'15"W, 1919 m). Later, Cherbonnier & Sibuet (1977) also recorded this relatively large species in the area (*Noratlante*, sta P65B10: 36°58'02"N, 26°20'W, 2870 m). No other material was reported in the Azores.

Family Ophiosphalmidae O'Hara *et al*. 2018

Genus *Ophiomusium* Lyman, 1869

Ophiomusium lymani Thomson, 1873

Reports for the Azores:

Ophiomusium lymani Thomson, 1873—$^{\$}$Lyman 1878: 113, 1882: 90; $^{\$}$Koehler 1896a: 204, 1898: 42, 1906b: 264–265, 1909: 161, pl. 3, fig. 4, pl. 4, fig. 1, 1921a: 3;$^{\$}$Sibuet 1972: 122; $^{\$}$Paterson 1985: 147–148, fig. 58; Pérès 1992: 254, 255, 257, 258; García-Diez *et al*. 2005: 49.

Type locality: Rockall Trough, off SW of Ireland.

See: Paterson (1985).

Occurrence: cosmopolitan, recorded in the Atlantic, Pacific and Indian Oceans (Paterson 1985); in the Atlantic from the Davis Strait (Mortensen 1933a) to Caribbean waters (Koehler 1914a), eastwards from Iceland (Mortensen 1933a) to southern Namibia (Alva & Vadon 1989), including the Azores, Canaries and Tristan da Cunha (Lyman 1882, Koehler 1906b).

Depth: 651–4,829 m (Paterson 1985); AZO: 1,384–3,300 m (Koehler 1898, Pérès 1992).

Habitat: soft sediments, clay, mud to ooze (Lyman 1882, Koehler 1909); an opportunistic scavenger or carnivore that moves over or nestles into the sediment surface without burrowing (Gage *et al*. 1983).

Larval stage: lecithotrophic (Gage & Tyler 1982).

Remarks: *Ophiomusium lymani* was reported by almost every historical oceanographic expedition made in the Azores waters (*e.g*., H.M.S. *Challenger*, *Hirondelle*, *Princesse Alice*). Pérès (1992) commented that this species appears to be quite abundant in the Azores at depths between 2,000 and 3,300 m.

Genus *Ophiosphalma* H.L. Clark, 1941

***Ophiosphalma armigerum* (Lyman, 1878)**

Reports for the Azores:

Ophiomusium planum Lyman, 1878—$^{\$}$Koehler 1896b: 242, 1906b: 265–266, 1909: 162, pl. 29, figs. 11; Mortensen 1927a: 252; Grieg 1932: 36; Nobre 1938: 145; García-Diez *et al*. 2005: 49;

Ophiomusium armigerum Lyman, 1878—$^{\$}$A.H. Clark 1948: 78; $^{\$}$Cherbonnier & Sibuet 1972: 416.

Type locality: between Tristan da Cunha and South American continent (37°29'S, 27°31'W).

See: Lyman (1878: 108, 109–110, pl. 1, figs. 21–22, as *Ophiomusium armigerum*); Paterson (1985: 149, fig. 58).

Occurrence: Atlantic, East coast of United States from off Virginia to the Caribbean Sea (Koehler 1914a) and Gulf of Mexico (Lyman 1883), south to off South America (Lyman 1882), in the East Atlantic known from the Bay of Biscay (Cherbonnier & Sibuet 1972) to NW Africa (Koehler 1906b), including the Azores (Koehler 1909), Madeira (Lyman 1882) and Canaries (Paterson 1985).

Depth: 260–5,110 m (Lyman *in* Koehler 1914a, Cherbonnier & Sibuet 1972), mainly found from 3,000–5,000 m (Paterson 1985); AZO: 2,870–5,005 m (Koehler 1909, Cherbonnier & Sibuet 1972).

Habitat: soft sediments, clay, mud to ooze (Lyman 1882, Koehler 1909).

Remarks: *Ophiomusium planum* was reported from the Azores by Koehler (1896b, 1906b, 1909) and Cherbonnier & Sibuet (1972), based on material collected by *Princesse Alice*, *Talisman* and *Noratlante*. A.H. Clark (1948) reported *Ophiomusium armigerum* collected by *Atlantis* in the archipelago. Later, Paterson (1985) found these species to be conspecific and established the synonymy.

Family Ophiuridae Müller & Troschel, 1840a

Genus *Ophiocten* Lütken, 1855

Ophiocten affinis? (Lütken, 1858)

Reports for the Azores:
Ophioglypha affinis Lyman—?$Simroth 1888: 231;
Ophiura affinis (Lütken 1858)—Pereira 1997: 333;
Ophiocten affinis (Lütken, 1858)—Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

Type locality: Norway.

See: Lütken (1858: 45–46, pl. 2, figs. 10a–b, as *Ophiura affinis*); Mortensen (1927a: 244–245, figs. 132, as *Ophiura affinis*); Sumida *et al*. (1998: 282–285, 295–297, fig. 9).

Occurrence: North Atlantic, from Nova Scotia and Newfoundland (Theroux & Wigley 1998), eastwards from Iceland, Faroe, Scandinavian and British waters (Mortensen (1927a, 1933a), along the European Shelf (Cherbonnier 1969) south to Cape Bojador (Grieg 1932), the ?Azores (Simroth 1888) and Madeira (Jesus & Abreu 1998); the subspecies *O. affinis simulans* can be found in South Africa (Mortensen 1936).

Depth: 8–550 m (Mortensen 1927a).

Habitat: soft substrates, silt, sand, shingle to silt covered rocks (Grieg 1932, Picton 1993).

Larval stage: lecithotrophic (Fell 1945).

Remarks: the presence of *Ophiocten affinis* in the Azores is based on a single record by Simroth (1888). However, no additional information was given by the author and there is no trace where the specimen could be housed (or later reviewed). The presence of this species in the archipelago should be considered with caution, until new material collected in the area can corroborate this historical record.

Ophiocten centobi Paterson *et al.*, 1982

Reports for the Azores:
Ophiocten centobi Paterson *et al*., 1982—$Stöhr & Segonzac 2005: 286, 394–395.

Type locality: Bay of Biscay (47°44'N, 08°21'W).

See: Paterson *et al*. (1982: 119–121, figs. 6–7); Stöhr & Segonzac (2005).

Occurrence: known only from the Bay of Biscay (Paterson *et al*. 1982) and in the vicinity of the deep-water hydrothermal systems on the Mid-Atlantic Ridge south of the Azores, such as Lucky Strike and Rainbow (Stöhr & Segonzac 2005).

Depth: 1,680–2,837 m (AZO; Stöhr & Segonzac 2005).

Habitat: coral and gravel detritic substrates (non-vent environments); also among mytilid bivalves, pteropod shells and *Cynachira* sponges (Stöhr & Segonzac 2005).

Remarks: *Ophiocten centobi* was only known from the type material from the Bay of Biscay until Stöhr & Segonzac (2005) reported it from the vicinity of deep-sea hydrothermal vent fields in the Mid-Atlantic Ridge, south of the Azores.

Ophiocten hastatum Lyman, 1878

Reports for the Azores:
Ophiocten hastatum $Lyman, 1878: 103, pl. 5, figs. 133–134, 1882: 82–83, pl. 9, figs. 10–11; $Koehler 1898: 42–44, 73, pl. 7, figs. 32, 33, 1909: 165; Mortensen 1927a: 246; $Paterson *et al*. 1982: 117–119, fig. 5; Paterson 1985: 129, fig. 49; Gage *et al*. 2004: 849–864, figs. 1–84; García-Diez *et al*. 2005: 49; $Martynov & Litvinova 2008: 83, fig. 3C; Smirnov *et al*. 2014: 202–203;
Ophiocten longispinum $Koehler, 1896a: 204–205;
Ophiura hastata (Lyman, 1878)—Guille 1982: 80, figs. 5, 6, 7a–b.

Type locality: off Marion Island, Southern Ocean (46°46'S, 45° 31'E).

See: Lyman (1878); Paterson *et al*. (1982); Guille (1982); Martynov & Litvinova (2008).

Occurrence: cosmopolitan, found in the Atlantic, Southern, and Pacific Oceans (Guille 1982); in the Atlantic from Labrador basin east in the Rockall Trough south to the Bay of Biscay (Paterson 1985), including the Mid-Atlantic Ridge from Reykjanes Ridge south to the Azores (Martynov & Litvinova 2008); with exception of the reports for the Labrador Basin, all other records from the West Atlantic are misidentifications of *O. gracilis* (Paterson *et al*. 1982).

Depth: 843–4,700 m (Grieg 1932, Guille 1982); AZO: 1,830–2,107 m (Lyman 1878, Martynov & Litvinova 2008).

Habitat: soft bottoms, muddy sand to ooze (Koehler 1909); opportunistic (Gage *et al*. 2004).

Larval stage: planktotrophic (Gage *et al*. 2004).

Remarks: Lyman (1878, 1882) described *Ophiocten hastatum* on the basis of material taken by H.M.S. *Challenger* in Southern Ocean deep waters. Lyman (1878, 1882) also found two specimens of this species among the material collected by the same cruise in Azorean waters (sta 78: 37°24'N, 25°13'W, 1,830 m). Koehler (1896a) described a new species *Ophiocten longispinum* from the material collected by *Hirondelle* in the Azores (sta 184: 40°05'N, 27°27'46"W, 1,850 m). Later, Koehler (1898) recanted his previous identification, changing it to *O. hastatum* and completed Lyman's original description of this species using *Hirondelle* material from the archipelago. Koehler (1909) also identified this species at several *Princesse Alice* stations located inside Azorean waters. More recently, Martynov & Litvinova (2008) identified this species in Azorean northern waters (*G.O. Sars, MAR–ECO* cruise, sta 42/368: 42°48'N, 29°38'W, 2,063–2,107 m).

Genus *Ophioctenella* Tyler *et al*., 1995

Ophioctenella acies Tyler *et al*., 1995

Reports for the Azores:
Ophioctenella acies Tyler *et al*. 1995—$Stöhr & Segonzac 2005: 395–396, figs. 2, 7.

Type locality: Mid-Atlantic Ridge.

See: Tyler *et al*. (1995); Stöhr & Segonzac (2005); Desbruyères *et al*. (2006: 483, figs. 1–3).

Occurrence: Atlantic, along the Mid-Atlantic Ridge from Lucky Strike (SW Azores, *c*. 37°17'N, 32°16'W) south to Snake Pit (23°22'N, 44°56'W), westwards from Blake Plateau and Florida Escarpment to south of Barbados.

Depth: 1,626–3,650 m (Desbruyères *et al*. 2006), though it seems to reach higher densities at depths greater than 3,000 m (Stöhr & Segonzac 2005); AZO: 1,626–1,727 m (Stöhr & Segonzac 2005).

Habitat: restricted to chemosynthetic areas, found at hydrothermal vents and methane cold seeps, usually in association with deep-sea mytilid beds (Stöhr & Segonzac 2005).

Larval stage: probable planktotrophic (Stöhr & Segonzac 2005).

Remarks: *Ophioctenella acies* appears to be the only echinoderm species restricted to active vent sites known to occur in the Azores. In one of the few echinoderm studies from deep-sea reducing environments in the North Atlantic, Stöhr & Segonzac (2005) identify several animals of *O. acies* from Lucky Strike, but found this species conspicuously absent from hydrothermal vents of Menez Gwen.

Genus *Ophiura* Lamarck, 1801

Ophiura albida Forbes, 1839

Reports for the Azores:
Ophioglypha albida (Forbes, 1839)—$Lyman 1869: 319; $Ljungman 1872: 620; $Barrois 1888: 72, 133;
Ophiura albida Forbes, 1839—$H.L. Clark 1915: 318; Mortensen 1927a: 239–240, figs. 128.5–6; Nobre 1938: 91; Tortonese 1965: 272–274, figs. 99B, 125; Moyse & Tyler 1995: 673, fig. 12.6; Pereira 1997: 332–333; Micael & Costa 2010: 322; Micael *et al.* 2012: 3.

Type locality: Irish waters.

See: Forbes (1839: 125–126, pl. 4, figs. 5–6); Mortensen (1927a); Paterson (1985: 118, Table 3).

Occurrence: Mediterranean Sea and Northeast Atlantic; from Iceland to Portugal, including the Azores (Tortonese 1965).

Depth: 2–1,030 m (Tyler *et al*. 2005, Koukouras *et al*. 2007); AZO: 20–458 m (Ljungman 1872, Barrois 1888).

Habitat: gravel, muddy sand or on silty areas between rocks (Tyler *et al*. 2005, Koukouras *et al*. 2007).

Larval stage: planktotrophic (Mortensen 1927a).

Remarks: historically, *O. albida* is known in the Azores by relatively few records. It was first collected by *Josephine* expedition in Ponta Delgada (São Miguel Island) at 274–458 m depth. This material was examined by Lyman (1869), Ljungman (1872) and later by H.L. Clark (1915). Barrois (1888) also reported this species in the same area, but at much shallower depths, about 20 to 25 m. The scarcity of records could be explained by the species preferred habitat in the archipelago. This ophiuroid appears to live mainly on soft bottoms at depths between 20 and 458 m. Soft-bottom environments were extensively sampled by oceanographic cruises in the archipelago, but rarely at depths shallower than 500 m.

Ophiura imprudens (Koehler, 1906a)

Reports for the Azores:

Ophioglypha imprudens $Koehler, 1906a: 8–10, pl. 1, figs. 7–8, 1906b: 256–257, pl. 18, figs. 9–10;

Ophiura imprudens (Koehler, 1906)—Mortensen 1927a: 234; Gage *et al*. 1983: 298; $Paterson 1985: 117–118, fig. 42; Jesus & Abreu 1998: 63.

Type locality: Azores (38°23’00”N, 28°49’46”W).

See: Koehler (1906a, b); Paterson (1985).

Occurrence: Northeast Atlantic, known for the Azores (Koehler 1906b), Madeira (Jesus & Abreu 1998), Rockall Bank (Gage *et al*. 1983) and Portuguese mainland (Jesus & Fonseca 1999).

Depth: 75–560 m (Koehler 1906b, Jesus & Abreu 1998); AZO: 560 m (Koehler, 1906b).

Habitat: soft bottoms, sandy gravel to muddy sediments (Koehler 1906b, Jesus & Fonseca 1999).

Remarks: *Ophiura imprudens* is only known from the archipelago by the type specimen. See also remarks under *O. carnea* Lütken, 1858.

Ophiura ljungmani (Lyman, 1878)

Reports for the Azores:

Ophioglypha lepida $Lyman, 1878: 70–71, pl. 3, figs. 71–73, 1882: 43–44, pl. 4, figs. 1–3;

Ophioglypha ljungmanni Lyman, 1878—$Koehler 1909: 152, 1921a: 3;

Ophioglypha thouleti Koehler, 1895c—$Koehler 1909: 158–159, pl. 6, fig. 6; pl. 26, figs. 1–2;

Ophiura ljungmani (Lyman, 1878)—Mortensen 1927a: 240–242, fig. 130; $Paterson 1985: 118–120, fig. 44; Borges *et al*. 2002: 27–31, figs. 15a–c, 16a–f, 17a–d, 18a–c; García-Diez *et al*. 2005: 49; $Stöhr & Segonzac 2005: 386; Hernández-Herrejon *et al*. 2008: 101–102, figs. 3E–F; $Martynov & Litvinova 2008: 80, fig. 1D; Smirnov *et al*. 2014: 205;

Ophiura lepida (Lyman, 1878)—Mortensen 1927a: 234.

Type locality: Brazil (09°07’S, 34°50’W).

See: Mortensen (1933a: 83–84); Paterson (1985); Borges *et al*. (2002).

Occurrence: Atlantic, from Labrador Basin to Brazil, eastwards from Iceland to southern Africa (Paterson 1985), including the Azores, Madeira (Koehler 1909), Canaries (Koehler 1906b) and Ascension Island (Lyman 1882).

Depth: 101–6,398 m (Smirnov *et al*. 2014); AZO: 789–2,968 m (Stöhr & Segonzac 2005, Martynov & Litvinova 2008).

Habitat: mainly soft bottoms, coralligenous sand, mud to ooze (Koehler 1909, Lyman 1883); can form large aggregations (Borges *et al*. 2002).

Larval stage: planktotrophic (Schoener 1972).

Remarks: *Ophiura ljungmani* was reported from the Azorean waters under three different names: *Ophioglypha* *lepida* by Lyman (1878, 1882; H.M.S. *Challenger*), *Ophioglypha ljungmanni* and *Ophioglypha thouleti* both by Koehler (1909, 1921a; *Princesse Alice*). Later, Koehler (1914a) found O. *thouleti* to be identical with Lyman's *O. ljungmanni*. In turn, Mortensen (1933a) found the diagnosing characters that separate *O. lepida* from *O. ljungmani* mostly size related and established the synonymy.

Ophiura saurura (Verrill, 1894)

Reports for the Azores:

Ophiura saurura (Verrill, 1894)—$^{\$}$Martynov & Litvinova 2008: 80–81, figs. 2A–C.

Type locality: off Georges Bank, NE America.

See: Verrill (1894: 288–290, as *Ophioglypha saurura*); Paterson (1985: 134–135, fig. 50, as *Amphiophiura saurura*); Martynov & Litvinova (2008).

Occurrence: North Atlantic, off Nantucket and Newfoundland, eastwards from south of Iceland to the Bay of Biscay (Paterson 1985); reported also from the Reykjanes Ridge and from the Mid-Atlantic Ridge from the Charlie-Gibbs Fracture Zone to the North of the Azores (Martynov & Litvinova 2008).

Depth: 844–2,979 m (Martynov & Litvinova 2008); AZO: 2,063–2,968 m (Martynov & Litvinova 2008).

Habitat: soft bottoms (Koehler 1898).

Remarks: *Ophiura saurura* was recently reported by Martynov & Litvinova (2008) from the material collected by *G.O. Sars* (*MAR–ECO* expedition) at two stations located in the extreme north of the Azorean waters (42°55'N–42°48'N, 30°20'W–29°38'W, 2,063–2,968 m), the species' southernmost known record.

Subgenus *Ophiura* (*Dictenophiura*) H.L. Clark, 1923

Species *Ophiura* (*Dictenophiura*) *carnea carnea* Lütken, 1858

Ophiura (*Dictenophiura*) *carnea carnea* Lütken, 1858

(Fig. 11)

Reports for the Azores:

Ophioglypha carnea (Lütken, 1858)—$^{\$}$Koehler 1909: 147–148;
Ophiura carnea Lütken, 1858—Farran 1913: 29–30, figs. 2–3; Koehler 1923: 14, 1924: 314–315; García-Diez *et al*. 2005: 49;
Dictenophiura carnea (Lütken, 1858)—Tortonese 1965: 267;
Ophiura carnea Sars, 1861—Mortensen 1927a: 243, figs. 131.3–4

Type locality: Bergen, Norway.

See: Lütken (1858: 41, pl. 1, figs. 6a–b); Farran (1913); Madsen (1970: 233–234, fig. 46); Paterson (1985: 117, fig. 42).

Occurrence: Northeast Atlantic and Mediterranean Sea, from Reykjanes Ridge (south of Iceland; Copley *et al*. 1996), Scandinavia and Faeroe Islands to Senegal, including the Azores and ?Cape Verde archipelagos (Koehler 1923, Mortensen 1927a, 1933a) and Gorringe Seamount (Pérès 1964); the subspecies O. *carnea skoogi* (Koehler, 1923) is known from tropical West Africa, from Dakar to Angola (Madsen 1970).

Depth: 14–2,857 m (Paterson 1985, herein); AZO: 14–599 m (Koehler 1909, herein).

Habitat: soft (mud, sand, gravel, detritic) to hard substrates (Cherbonnier 1969, 1970).

Larval stage: planktotrophic (McEdward & Miner 2001).

Material examined: DBUA-ECH 065 (Vila Franca do Campo, SMG, AZO, *c.* 37°42'50"N, 25°25'58"W, 1991.08.03, 70–80 m; 4 spms, DD = 5–6 mm); DBUA-ECH 066 (Água d'Alto, SMG, AZO, *c.* 37°42'55"N, 25°28'27"W, 1991.07.30; 4 spms, DD = 5 mm); DBUA-ECH 068 (off Ribeira das Tainhas, Vila Franca do Campo, SMG, AZO, 37°42'16"N, 25°24'45"W, 2006.07.21, 72 m; 2 spms, DD = 3–4 mm); DBUA-ECH 134 (Vila Franca do Campo, SMG, AZO, 37°42'43"N, 25°21'33"W, 2006.07.26, 38 m; 4 spms, DD = 3–5 mm); DBUA-ECH 135 (Vila Franca do Campo, SMG, AZO, 37°41'39"N. 25°27'11"W, 2006.07.21, 95–121 m; 1 spm, DD = 4 mm); DBUA-ECH 136 (off Praia de Água d'Alto, SMG, AZO, 37°42'24"N, 25°28'59"W, 2006.07.26, 66 m; 2 spms, DD

= 4–5 mm); DBUA-ECH 137 (off Ribeira das Tainhas, SMG, AZO, 37°41’57”N, 25°25’08”W, 2006.07.24, 144–198 m; 1 spm, DD = 6 mm); DBUA-ECH 332 (off Praia da Vinha da Areia, SMG, AZO, 37°42’15”N, 25°24’28”W, 2006.07.21, 14 m; 1 spm, DD = 4 mm); DBUA-ECH 333 (off Ponta Garça, SMG, AZO, 37°42’01”N, 25°23’07”W, 2006.09.05, 318 m; 1 spm, DD = 4 mm); DBUA-ECH 335 (off Vila Franca do Campo, SMG, AZO, 37°41’52”N, 25°23’13”W, 2006.07.21, 46–47 m; 1 spm, DD = 3 mm).

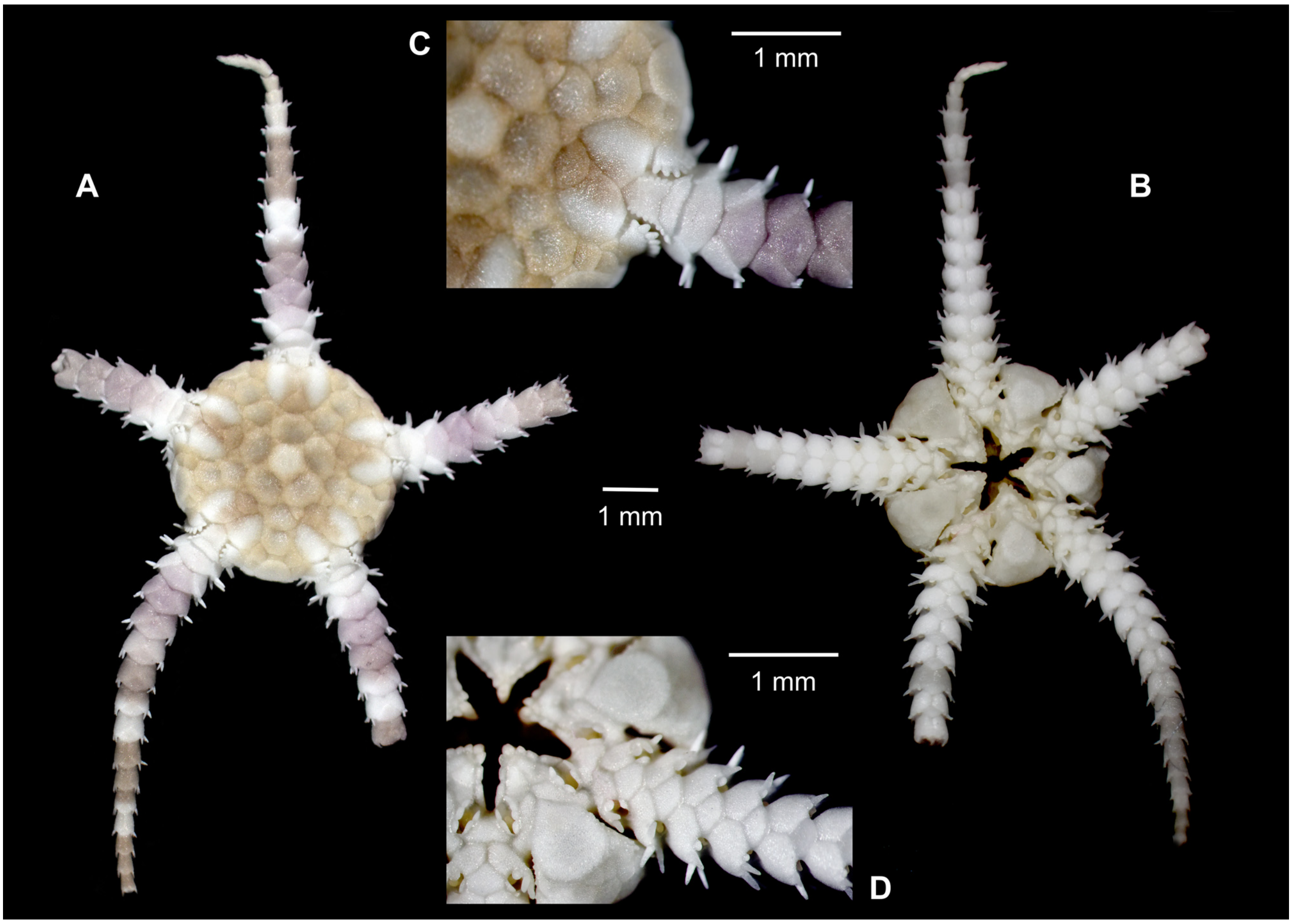

FIGURE 11. *Ophiura* (*Dictenophiura*) *carnea carnea* Lütken, 1858 (DBUA-ECH 332). Dorsal view (A); ventral view (B); detail of the disc and arm, dorsal view (C) and ventral view (D).

Description: disc round to subpentagonal, high with almost vertical sides; five short arms mostly broken off at the tip, about twice the DD; disc scales rather coarse and naked, with distinct centrodorsal and primary plates. Radial shields rounded to almost teardrop-shaped in larger specimens (length > breadth), contiguous distally, about one third of the disc radius in length. Arm combs prominent, almost vertical, extending up towards the dorsal surface of the disc; outer comb with about 10 to 12 conical and slightly rounded spinelets; inner comb with smaller and pointed spinelets. Innermost dorsal plate with a distinct groove. One pointed apical papilla flanked on each side by one triangular and two block-like oral papillae. Adoral shields narrow, slightly curved in appearance. Oral shields rounded pentagonal somewhat elongated (length > breadth) about one third to one half of the disc radius, with an obtuse proximal angle and a convex distal edge. Genital papillae small, pointed. Second oral tentacle slit, with three to four rounded tentacle scales on each side increasing to five to six in the larger specimens (DD = 6 mm). Dorsal arm plates fan-shaped, distal edge with a weak point, contiguous only on the first 2–3 proximal arm segments and swollen in profile. First ventral arm plate triangular to trapezoidal; subsequent plates become more rounded with an obtuse proximal angle and a rounded distal edge; they are separated from one another. First proximal tentacle pores large with one larger rounded tentacle scale opposing one to two smaller ones; in largest specimens (DD = 6 mm), one to two extra scales are also present, summing the total tentacle scales per pore to 4–5; the number of tentacle scales is reduced to one by the fourth proximal arm segment. Lateral arm plates swollen, with three relatively small arm spines of about the same size and evenly spaced, distally decreasing progressively in size. Colour (in ethanol):

most specimens presented a more or less uniform white colour pattern, with dorsal side of the disc slightly darker with clear white radial shields; the original colour seems better preserved in one specimen (DBUA-ECH 332, Fig. 11), having the dorsal surface of the disc light brown and the arms banded light pink, white and light brown; ventral surface uniformly white or cream.

Remarks: the examined specimens share many diagnosing characters of *O. carnea*, distinct from the close resembling *O. albida* and *O. imprudens*: a thick almost vertical disc; comparatively small arms; well developed almost vertical arm combs; a distinct longitudinal furrow in the inner-most dorsal arm-plate; arm plates with overall swollen appearance; small rounded radial shields and somewhat longer oral shields. The examined specimens did not present the arm spines arranged as described by Paterson (1985) in *O. carnea* (i.e., two adjacent to the tentacle pore and another towards the dorsal surface). However, this appears to be a variable character in this species, and animals of this species may present arm spines arranged in an evenly manner (*e.g.*, Koehler 1898, Mortensen 1927a, Glück *et al*. 2012). Previously, *O. carnea* was known in the Azores based on a single specimen collected by *Princesse Alice* (sta 866: 38°52’50”N, 27°23’05”W, 599 m; Koehler 1909).

H.L. Clark (1923: 361) selected *O. carnea* as the genotype of *Dictenophiura*, a genus characterised by a longitudinal furrow dividing the inner-most dorsal plate. Madsen (1970: 234) downgraded *Dictenophiura* to a subgenus of *Ophiura*, on the basis that this is not a constant character in *O. carnea*, occasionally absent in larger specimens (see also Mortensen 1933a: 82). In view of this, we agree with Paterson (1985: 118, table 3), that this species closely resembles *O. imprudens*. In the absence of a medium furrow in the inner-most dorsal plate, *O. carnea* differs only slightly from *O. imprudens*: by the shape/size of the radial and mouth plates. Also, the arm combs in *O. imprudens* appear not to be prominent as in *O. carnea*. The former species is known by very little material, a total of seven reported specimens (Koehler 1906a, Gage *et al*. 1985). As more material becomes available, it will be necessary to re-address *O. imprudens* specific status in relation to *O. carnea*. Additionally, the subspecies African *O. carnea skoogi* is distinguished from *O. carnea carnea* by relatively more swollen dorsal and lateral arm plates (Mortensen 1936). We believe that our material belongs to the NE Atlantic variety despite the remarks by Madsen (1970: 234), who observed that *O. carnea skoogi* can only be diagnosed with certainty in fully grown animals (6–7 mm disc diameter).

Koehler (1923) included Cape Verde in the geographical distribution of *O. carnea*, which was repeated by subsequent references (*e.g.*, Koehler 1924, Mortensen 1927a, 1936, Tortonese 1965, Madsen 1970). We could not trace the original material on which Koehler (1923) based his record, though the occurrence of this species in Cape Verde is not unlikely considering the wide distribution of *O. carnea* in East Atlantic waters.

Subgenus *Ophiura* (*Ophiura*) Lamarck, 1816

Ophiura (*Ophiura*) *mundata* (Koehler, 1906a)

Reports for the Azores:
non *Ophioglypha irrorata* Lyman, 1878—$^{\$}$Koehler 1896b: 241 [misidentification];
Ophioglypha mundata, Koehler, 1906a—$^{\$}$Koehler 1909: 153, pl. 27, figs. 7–8;
Ophiura (*Ophiuroglypha*) *mundata* (Koehler, 1906a)—Mortensen 1933a: 88–89, figs. 48d–e, pl. 3, figs. 11–12;
Ophiura (*Ophiura*) *mundata* (Koehler, 1906a)—Paterson 1985: 127–128, fig. 48; Smirnov *et al*. 2014: 205;
Ophiura mundata Koehler, 1906—García-Diez *et al*. 2005: 49.

Type locality: waters between Canaries and NW Africa.

See: Koehler (1906a: 10–11, pl. 1, figs. 4–6, as *Ophioglypha mundata*); Paterson (1985).

Occurrence: North Atlantic, from Labrador Basin eastwards to Iceland (Paterson 1985) and south from the Bay of Biscay to Morocco, including the Azores and Canaries (Koehler 1906b, 1909).

Depth: 1,674–4,315 m (Smirnov *et al*. 2014); AZO: 1,919–4,020 m (Koehler 1909).

Habitat: soft substrates (Koehler 1909).

Remarks: the great similarity between *Ophiura mundata* and *O. irrorata* (Lyman, 1878) has led to doubtful identifications (Koehler 1896b), and they have been considered conspecific (Koehler 1914a). A taxonomic revision is needed to clear up the confusion (Paterson 1985).

Subgenus *Ophiura* (*Ophiuroglypha*) Hertz, 1927

Ophiura (*Ophiuroglypha*) *concreta* (Koehler, 1901)

Reports for the Azores:
Ophioglypha concreta Koehler, 1901—$Koehler 1906b: 261;
Ophiura concreta (Koehler, 1901)—Mortensen 1927a: 233; Grieg 1932: 32; $Cherbonnier & Sibuet 1972: 414, 415.

Type locality: Cape Verde (14°47'N, 24°31'45"W).

See: Koehler (1901: 228–230, figs. 6–8, 1909: 148–149, pl. 25, figs. 3–5, as *Ophioglypha concreta*); Paterson (1985: 125, fig. 47, as *Ophiura irrorata concreta*).

Occurrence: East Atlantic, from the Bay of Biscay south to Cape Verde, and east to the Azores (Koehler 1906b, 1909, Cherbonnier & Sibuet 1972); reported as well off South African deep waters (Paterson 1985).

Depth: 1,885– 3,120 m (Grieg 1932, Cherbonnier & Sibuet 1972) AZO: 2,845–2,995 m (Koehler 1906b, Cherbonnier & Sibuet 1972).

Habitat: soft substrates (muddy sand; Koehler 1909, Grieg 1932).

Remarks: Paterson (1985) found *O. concreta* to be identical with *O. irrorata* in almost every aspect, ascribing no specific value to differences in the arrangement or number of arm spines. In view of this, Paterson proposed to demote this species to a subspecies of *O. irrorata*, restricted to the East Atlantic. Nevertheless, he also noted that the distinct characters of *O. concreta* were constant over a wide range of sizes and geographical areas. Martynov & Litvinova (2008) disputed the subspecific division of *O. irrorata*. According to them, several subspecies should not live syntopically as in the case of *O. i. irrorata* and *O. i. concreta*, both known from the Bay of Biscay. Another example of co-existence can be found in Grieg (1932), who identified both forms in the material collected by *Michael Sars* at a station located north of the Azores (sta 88: 45°26'N, 25°45'W, 3,120 m). However, Martynov & Litvinova (2008) were unsure if they represented two separate species or rather a single polymorphic species. In view of this, we have opted for a more conservative approach and maintain the historical species *O. concreta* separate from *O. irrorata*. Presently, *O. concreta* is known with certainty in the Azores only by historical records of Koehler (1906b; *Talisman* cruise) and Cherbonnier & Sibuet (1972; *Noratlante* cruise). See below remarks under *Ophiura irrorata*.

Ophiura (*Ophiuroglypha*) *irrorata*? (Lyman, 1878)

Reports for the Azores:
non *Ophioglypha irrorata* Lyman, 1878—Koehler 1896b: 241 [misidentify *O. concreta*];
non *Ophiura irrorata* (Lyman, 1878)—Grieg 1932: 32 [based Koehler 1896b];
Ophiura irrorata (Lyman, 1878)—?$Martynov & Litvinova 2008: 79–80, fig. 1C.

Type locality: off South Africa.

See: Lyman (1878: 73–74, pl. 4, figs. 106–108); Paterson (1985: 122–125, figs. 46–47).

Occurrence: cosmopolitan, in all oceans except Arctic; in the Atlantic from Cape Cod, eastwards from SW Iceland to NW Africa (Paterson 1985), including the Azores (Martynov & Litvinova 2008); reported elsewhere off South African deep waters (Lyman 1878).

Depth: 403–7,340 m, most common at depths over 2,000 m (?AZO: 3,005–3,050 m; Martynov & Litvinova 2008).

Habitat: soft substrates (*e.g.,* ooze; Lyman 1882).

Remarks: the first report of *O. irrorata* from the archipelago was made by Koehler (1896b, as *Ophioglypha irrorata*), later changed to *O. mundata*. The report of *O. irrorata* by Grieg (1932) from the Azores was either based on the first report by Koehler (1896b) or by Mortensen (1927a) who at the time believed both species were conspecific. More recently, Martynov & Litvinova (2008) identified a single specimen of *O. irrorata* in the north of the Azores (*G.O. Sars*, *MAR–ECO* cruise, sta 46/372: 42°46'N, 29°16'W, 3,005–3,050 m). As Martynov & Litvinova disputed the subspecific status of *O. concreta* as a subspecies of *O. irrorata*, it is not clear whether the individual belonged to the *O. irrorata sensu stricto* or to *O. concreta*. *Ophiura irrorata* is cosmopolitan species and thus, likely to occur in the Azores deepwaters. However, taking into account the taxonomical background of this species, we considered its presence in the Azores as uncertain (see above remarks under *O. concreta* and *O. mundata*).

Class Asteroidea de Blainville, 1830

Order Velatida Perrier, 1884

Family Myxasteridae Perrier, 1885b

Genus *Pythonaster* Sladen, *in* Thomson & Murray, 1885

Pythonaster atlantidis A.H. Clark, 1948

Reports for the Azores:

Pythonaster atlantidis $A.H. Clark 1948: 76–77; $A.M. Clark & Downey 1992: 339; $Mah *et al.* 2012: 60–61, figs. 3A–D; Dilman 2014: 37.

Type locality: Azores (35°37'N, 30°51'W).

See: A.M. Clark & Downey (1992); Mah *et al*. (2012).

Occurrence: North Atlantic, from Hudson Canyon (38°25'N, 70°52'W; Mah *et al*. 2012) east to the Porcupine Abyssal Plain (SW Ireland; Howell *et al*. 2002) and southern Azorean waters (A.H. Clark 1948).

Depth: 2,976–4,877 m (Mah *et al*. 2012); AZO: 3,200 m (A.H. Clark 1948).

Larval stage: possibly direct development (A.M. Clark & Downey 1992).

Remarks: currently, *P. atlantidis* is known from the Azores only from the type specimen collected by *Atlantis*, at the border between the Azorean and Meteor Seamount.

Family Pterasteridae Perrier, 1875

Genus *Calyptraster* Sladen, 1882

Calyptraster personatus (Perrier, 1885c)

Reports for the Azores:

Cryptaster personatus, $Perrier, 1885c: 70, 1894: 191, pl. 14, fig. 3; Mortensen 1927a: 101;

Calyptraster personatus (Perrier, 1885c)—Madsen 1947: 3–7, figs. 1–2; $Cherbonnier & Sibuet 1972: 383; $Clark & Downey 1992: 309–310, pl. 75, figs. C–D; Downey 1973: 80, pl. 35, figs. C, D; Sibuet 1975: 108; Dilman 2014: 34;

non *Calyptraster coa* Sladen, 1882—Walenkamp 1979: 64–72, figs. 19, 23–25, pl. 14 [fidé Cherbonnier & Sibuet 1972].

Type locality: Azores (38°38'00"N, 25°05'46"W).

See: Downey (1973); A.M. Clark & Downey (1992).

Occurrence: Atlantic, in the west recorded to the Gulf of Mexico and Caribbean waters (A.M. Clark & Downey 1992) and in the east from the Gulf of Cadiz (Madsen 1947) to the Gulf of Guinea (Sibuet 1975), including the Azores (Cherbonnier & Sibuet 1972).

Depth: 2,151–6,560 m (A.M. Clark & Downey 1992); AZO: 2,871– 2,995 m (Perrier, 1894, Cherbonnier & Sibuet 1972).

Habitat: soft sediments (Perrier 1894).

Remarks: Perrier (1894) described a monotypic genus *Cryptaster* to accommodate *C. personatus* from the Azores. Madsen (1947) believed that this species was conspecific with *Calyptraster coa* Sladen, 1882 from the south-east of Pernambuco (Brazil), distinguished only by a strongly musculated dorsal membrane. Madsen argued that the diagnosing characters selected by Sladen in the genus *Calyptraster* (which it was also monotypic at the time) had no generic value (and possible also no specific value) and established the synonymy with Perrier's genus

Cryptaster. Nonetheless, Madsen kept *C. coa* and *C. personatus* separated, as he believed that further studies should be conducted before considering these as geographic varieties of the same species. Walenkamp (1979) compared Sladen' syntypes and his own specimens from Guyana with *C. personatus* specimens from Bay of Cadiz (Madsen 1947) and from Gulf of Guinea (Sibuet 1975) and found all to be identical. Walenkamp also assumed that the material reported from the Azores by Cherbonnier & Sibuet (1972; *Jean Charcot*, *Noratlante* cruise, sta P. 65, B10: 36°58'2"N, 26°20'W, 2,871 m) belonged to *C. coa*. On the re-examination of the type material of *C. personatus*, A.M. Clark & Downey (1992: 308) found Perrier's original description of this species misleading and reinstated the species status. A.M. Clark & Downey (1992) also commented on the apparent bathymetric partition between these species, as *C. coa* occurs at depths shallower than 1,000 m whereas *C. personatus* occurs at depths below 2,000 m. Thus, the report of the western *C. coa* to the Azores is erroneous.

Genus *Hymenaster* Thomson, 1873

Hymenaster anomalus Sladen, 1882

Reports for the Azores:

Hymenaster anomalus Sladen, 1882—$Dilman 2008: 141.

Type locality: Mid-Atlantic Ridge, North of Tristan da Cunha (32°24'S, 13°05'W).

See: Sladen (1889: 512–514, pl. 89, figs. 3–4, pl. 91, figs. 4–6); Downey (1973: 75, pl. 32: figs. A–B); A.M. Clark & Downey (1992: 315–316, figs. 49a–c, pl. 76, figs. C–D).

Occurrence: Western Atlantic, known from Straits of Florida, Gulf of Mexico and Tristan da Cunha (Clark & Downey 1992), also from the Mid-Atlantic Ridge north of the Azores (Dilman 2008).

Depth: 1,984–3,050 m (Clark & Downey 1992, Dilman 2008); AZO: 2,954–3,050 m (Dilman 2008).

Habitat: soft sediments (pteropod ooze; Sladen 1889).

Remarks: the West Atlantic *Hymenaster anomalus* was recently recorded from northern Azorean waters by Dilman (2008), expanding its geographical range to the Mid-Atlantic Ridge northwest waters.

Hymenaster giboryi Perrier, 1894

Reports for the Azores:

Hymenaster giboryi Perrier, 1894—$Koehler 1909: 93, pl. 1, figs. 2–3; Mortensen 1927a: 106; Cherbonnier & Sibuet 1972: 381–382; Sibuet 1976: 298; A.M. Clark & Downey 1992: 316–317 figs. 51f–h; García-Diez *et al*. 2005: 47; Dilman 2014: 35.

Type locality: between the Azores and Portugal (42°19'00"N, 21°15'46"W).

See: Perrier (1894: 189–190, pl. 14, fig. 1); A.M. Clark & Downey (1992).

Occurrence: North Atlantic, from off Newfoundland (Cherbonnier & Sibuet 1972), southwards to off Jamaica (A.M. Clark & Downey 1992) and eastwards to Rockall Trough (Cherbonnier & Sibuet 1972) and to waters between Azores and Iberian Peninsula (Koehler 1909).

Depth: 1,919–4,275 m (AZO: 1,919–4,261 m; Koehler 1909).

Habitat: soft substrates, mud or *Globigerina* ooze (Koehler 1909).

Remarks: *Hymenaster giboryi* is known only from a few specimens collected at discrete locations throughout the North Atlantic.

Hymenaster pellucidus Thomson, 1873

Reports for the Azores:

Hymenaster pellucidus Thomson, 1873—$Perrier 1896a: 40; García-Diez *et al*. 2005: 47; $Dilman 2008: 142; Dilman 2014: 35.

Type locality: Faeroe Channel (60°21'N, 05°41'W).

See: Sladen (1889: 521–522, pl. 92, figs. 6–7, pl. 93, figs. 10–12); A.M. Clark & Downey (1992: 319–320, figs. 50a–b, pl. 77, figs. C–D).

Occurrence: circumboreal, in the Atlantic and Pacific Oceans (Clark & Downey 1992); in the Atlantic from the Arctic waters (Koehler 1909) south to northern South America (*c.* 7°N; Clark & Downey 1992) in the West Atlantic and south to Portugal in the East Atlantic, and in the Mid-Atlantic Ridge from the Reykjanes Ridge and the Charlie-Gibbs Fracture Zone to the Azores (Dilman 2008).

Depth: 13–3,240 m (Dilman 2008); AZO: 2,870–3,050 m (Perrier 1896a, Dilman 2008).

Habitat: soft (ooze, mud sand, shell-sand, gravel) to hard substrates (Perrier 1896a, Sneli 1999).

Larval stage: lecithotrophic (brachiolaria larvae), brooded internally until late juvenile stage is reached (approximately one month; Janies 1995).

Remarks: the first report of *Hymenaster pellucidus* from the Azores by Perrier (1896a; *Hirondelle*, sta 248: 41°40'41"N, 26°44'9"W, 2,870 m; specimens lost) was considered doubtful by later authors (*e.g.,* Koehler 1909, 1924; Mortensen 1927a; Grieg 1932) as it was generally considered an exclusively Arctic cold-water species. However, Dilman (2008) recently identified this species among the material collected from the Mid-Atlantic Ridge in northern Azorean waters (*G.O. Sars*, *MAR–ECO* cruise, sta 46/372: 42°46'N, 29°16'W, 3,005–3,050 m) thus substantiating the presence of this species in the archipelago.

Hymenaster roseus Koehler, 1907a

Reports for the Azores:

Hymenaster roseus $^{\$}$Koehler, 1907a.: 21–23, 1909: 94–95, pl. 20, figs. 1, 11; Mortensen 1927a: 106; ?$^{\$}$Sibuet 1976: 293–295, fig. 5A; $^{\$}$A.M. Clark & Downey 1992: 322–323, pl. 78, figs. E–F; García-Diez *et al*. 2005: 47; Dilman 2014: 36.

Type locality: Azores.

See: Koehler (1909); A.M. Clark & Downey (1992).

Occurrence: known only from the Azores (A.M. Clark & Downey 1992).

Depth: 1,846–2,102(?2,370) m (AZO; Koehler 1909, A.M. Clark & Downey 1992).

Habitat: soft substrates, muddy sand to *Globigerina* ooze (Koehler 1909).

Remarks: Koehler (1907a, 1909) described *Hymenaster roseus*, though clearly stating that the material collected by *Princesse Alice* in the Azores was in a very poor state. Sibuet (1976) found a specimen quite close to this species original description among the material collected south of São Miguel Island (*Jean Charcot*, *Biacores* cruise, sta 163BL: 37°26'30"N, 26°02'30"W, 2,370 m). However, Sibuet observed that the type material of *H. roseus* was in such deteriorate condition that any valid comparison was impossible. A.M. Clark & Downey (1992) re-examined Koehler's original material and reinforced this concern remarking that the state of preservation of the type material was such that rendered it useless. These authors considered the reasons for Koehler erecting a new species rather weak, as the diagnosing characters are shared with many *Hymenaster* species. Furthermore, they observed that Koehler's specimens are quite small. A.M. Clark & Downey (1992) stated that in the future *H. roseus* could prove to be an invalid species.

Hymenaster tenuispinus Sibuet, 1976

Reports for the Azores:

Hymenaster tenuispinus $^{\$}$Sibuet, 1976: 289–291, fig. 3.

Type locality: off Brittany, France (47°34'N, 8°38'W).

See: Sibuet (1976); A.M. Clark & Downey (1992: 323).

Occurrence: Northeast Atlantic, from west of Brittany (France) south to North of Galicia (Spain) in the Bay of Biscay west to the Azores (Sibuet 1976).

Depth: 2,120–2,245 m (AZO: 2,120 m; Sibuet 1976).

Remarks: the relatively unknown *Hymenaster tenuispinus* was described by Sibuet (1976) to encompass specimens collected in the Bay of Biscay. Sibuet also identified this species among the material taken in the southwest of Flores Island by the *Jean Charcot* during the expedition *Biacores* (sta 131BL: 39°04'30"N, 32°43'30"W, 2,120 m). Recently, Dilman (2013) noted that some of the specimens collected in the Charlie-Gibbs Fracture Zone north of the Azores shared characters with *H. tenuispinus* and the sub-Antarctic *H. coccinatus*. According to Dilman, these two species differ only by the number of adambulacral and oral spines, a character that appears to be size-related. *Hymenaster tenuispinus* may prove to be a junior synonym based on juveniles or subadults of *H. coccinatus*, a species previously thought to be restricted to the waters between Marion and the Crozet Islands.

Genus *Pteraster* Müller & Troschel, 1842

Pteraster personatus Sladen, 1891

Reports for the Azores:

Pteraster reductus Koehler 1907a—$Koehler 1909: 96–97, pl. 3, figs. 8–9, pl. 20, fig. 10; Mortensen 1927a: 102; Grieg 1932: 28–29, pl. 5, figs. 6–7; Cherbonnier & Sibuet 1972: 380; Gage *et al*. 1983: 282;

Pteraster personatus Sladen, 1891—Downey 1973: 76–77, pl. 32, figs. C–D; A.M. Clark & Downey 1992: 334, pl. 82, figs. A–B; García-Diez *et al*. 2005: 48; Benavides-Serrato *et al*. 2011: 187; Dilman 2014: 36.

Type locality: Porcupine Seabight, SW of Ireland (51°01'N, 11°50'W).

See: Downey (1973); A.M. Clark & Downey (1992); Benavides-Serrato *et al*. (2011).

Occurrence: North Atlantic, in the west reported from Labrador (Cherbonnier & Sibuet 1972) and the Gulf of Mexico (Downey 1973), in the east recorded from the Rockall Trough (Cherbonnier & Sibuet 1972) and SW of Ireland (Sladen 1881) to ?Mauritania (A.M. Clark & Downey 1992), including the Azores (Koehler 1909).

Depth: 480–2,870 m (Dilman 2014); AZO: 1,846–2,870 m (Koehler 1909).

Habitat: soft substrates, mud to muddy sand (Koehler 1909).

Remarks: Koehler (1909) described a new species *Pteraster reductus* based on small poorly preserved specimens collected by *Princesse Alice* at several stations located within the Azores waters. Later, Downey (1973) argued that *P. reductus* represents juveniles of *P. personatus* dismissing the diagnosing differences selected by Koehler as size-dependent. No other material is known from the archipelago.

Superorder Forcipulatacea Blake, 1987

Order Brisingida Fisher, 1928

Family Brisingidae Sars, 1875

Genus *Hymenodiscus* Perrier, 1884

Hymenodiscus coronata (Sars, 1872)

Reports for the Azores:

Brisinga coronata Sars, 1872—$Perrier 1896a: 20; $Koehler 1909: 122–123, 1921a: 2;

Brisingella coronata (Sars, 1872)—Mortensen 1927a: 127; Nobre 1938: 28–31, fig. 3; Gage *et al*. 1983: 285; Downey 1986: 13–15, fig. 6; A.M. Clark & Downey 1992: 468–469, figs. 67b, 70b, pl. 108, fig. F; García-Diez *et al*. 2005: 48;

Hymenodiscus coronata (G.O. Sars, 1872)—Dilman 2006: 183, 2014: 38.

Type locality: off Lofoten Island, Norway.

See: Downey (1986); A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Norway and Reykjanes Ridge (Dilman 2006) to off Banc d'Arguin (Mauritania; Perrier 1894) and ?Cape Verde (Mortensen 1927a), including the Azores and Canaries (Koehler 1909).

Depth: 100–2,904 m (Tortonese 1965); AZO: 919–2,870 m (Perrier 1894, Koehler 1921a).

Habitat: soft bottoms, sand, mud to *Globigerina* ooze (Koehler 1909); a suspension feeder (copepods) and a predator (Howell *et al*. 2003).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: from the Azores, *Hymenodiscus coronata* is only known from the historical reports by Perrier (1896a) and Koehler (1909, 1921a) based on material collected by *Talisman* and *Princesse Alice* at several stations. The southern-most record of this of species appears to be located off Banc d'Arguin, and not in Cape Verde as reported by the related literature (*e.g.*, Mortensen 1927a, Grieg 1932, Downey 1986, A.M. Clark & Downey 1992, Dilman 2014). The *Talisman* reports published the station locations using a French coordinate system (Paris Meridian). Later authors may not have been aware of this and might have placed Perrier (1894)'s record near the archipelago waters, instead of the continental NW African waters (sta 96, 1883: 19°19'00"N, 18°01'46"W).

Family Freyellidae Downey, 1986

Genus *Freyastera* Downey, 1986

Freyastera sexradiata (Perrier, 1885c)

Reports for the Azores:

Freyella sexradiata Perrier, 1885c—$^{\$}$Koehler 1909: 129–130, pl. 23, fig. 6; Mortensen 1927a: 122; Cherbonnier & Sibuet 1972: 388; Gage *et al.* 1983: 285;

Freyastera sexradiata (Perrier, 1885c)—Downey 1986: 40–41, fig. 20; A.M. Clark & Downey 1992: 481–482, figs. 74c–d; García-Diez *et al.* 2005: 48; Dilman 2014: 38–39.

Type locality: Between the Azores and Iberian Peninsula (42°19'00"N, 21°15'46"W).

See: Perrier (1894: 82, 89–90, pl. 3, fig. 2, as *Freyella sexradiata*); Downey (1986); A.M. Clark & Downey (1992).

Occurrence: North Atlantic deep waters, from the Porcupine Abyssal Plain (SW of Ireland) southwards to Gibraltar (Gage *et al.* 1983) and westwards to North America (A.M. Clark & Downey 1992) including the Azores (Koehler 1909).

Depth: 4,020–5,110 m (A.M. Clark & Downey 1992); AZO: 4,020 m (Koehler 1909).

Habitat: soft substrates, mud to *Globigerina* ooze (Koehler 1909, Grieg 1932).

Remarks: the only known record of *Freyastera sexradiata* in the Azores was made by Koehler (1909) based on two discs and several arm fragments collected by *Princesse Alice* (sta 527: 38°09'N, 23°15'45"W, 4,020 m). The scarcity of records in the Azores might be explained by the great depths at which this species lives and the frail structure that characterises this sea star, as *F. sexradiata* was never recovered intact (A.M. Clark & Downey 1992).

Genus *Freyella* Perrier, 1885d

Freyella elegans (Verrill, 1884)

Reports for the Azores:

Freyella spinosa Perrier, 1894—Grieg 1932: 31; $^{\$}$Cherbonnier & Sibuet 1972: 385; Gage *et al*. 1983: 285;.

Freyella elegans (Verrill, 1884)—$^{\$}$Dilman 2008: 148; Dilman 2013: 584, 2014: 39.

Type locality: off New England.

See: Downey (1986: 43–46, fig. 22); A.M. Clark & Downey (1992: 484–485, fig. 69f, pl. 113, figs. A, B).

Occurrence: Atlantic, from North Carolina northwards to Greenland (Downey 1986) and eastwards to Europe (Cherbonnier & Sibuet 1972), including the Porcupine Abyssal Plain (Gage *et al*. 1983), southwards along West Africa to Namibia (Sibuet 1975), including the Mid-Atlantic Azorean waters (Dilman 2008).

Depth: 1,600–4,849 m (AZO: 2,063–3,050 m; Dilman 2008).

Habitat: suspension feeder (copepods, crustacean remains, foraminiferans; Howell *et al*. 2003) on soft bottoms (Perrier 1894) or attached to the rock surface and dead gorgonians (Tyler & Zibrowius 1992).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: *Freyella elegans* is a highly variable species, widely distributed throughout the Atlantic deep waters.

Grieg (1932) placed the Azores as the western geographical limit known at the time for *F. spinosa*, a form now known to be conspecific with *F. elegans* (see Downey 1986). At the time, no material of either species was reported from Azorean waters but between the archipelago and the European continental shores by Perrier (1894, as *Freyella spinosa* var. *abyssicola*). Later, Cherbonnier & Sibuet (1972, as *Freyella spinosa*) identified two specimens collected within the Azorean waters (*Jean Charcot*, *Noratlante* cruise, sta P65B10: 36°58'02"N, 26°20'W, 2,871 m). Recently, Dilman (2008) identified material belonging to this species in the northern waters of the Azores, substantiating the presence of *F. elegans* in the archipelago.

Order Forcipulatida Perrier, 1884

Family Asteriidae Gray, 1840

Genus *Asterias* Linnaeus, 1758

Asterias rubens? Linnaeus, 1758

Reports for the Azores:

non *Asterias polaris*, Gray—$Perrier 1896a: 38 [juveniles of *A. rubens*];

non *Leptasterias polaris* (Müller & Troschel, 1842)—Pereira 1997: 336 [based on Perrier 1896a]; Micael & Costa 2010: 321 [based on Perrier 1896a];

non *Ctenodiscus crispatus* (Bruzelius, 1805)—García-Diez *et al*. 2005: 47 [inaccurate synonymy]; Micael & Costa 2010: 322 [inaccurate synonymy]; Micael *et al*. 2012: 5 [inaccurate synonymy];

Asterias rubens Linnaeus, 1758—$Koehler 1924: 10.

See: A.M. Clark & Downey (1992: 422–423, fig. 67c, pl. 100, figs. C–D).

Occurrence: North Atlantic, in the west from Labrador south to Carolinas (occasionally also Florida); and in the east White Sea and Iceland south to southern Portugal (Mortensen 1927a, A.M. Clark & Downey 1992) and ?Azores (Koehler 1924).

Depth: 0–900 m (A.M. Clark & Downey 1992); ?AZO: intertidal (Perrier 1896a).

Habitat: all sorts of substrates (Wirtz & Debelius 2003).

Larval stage: planktotrophic (McEdwards & Miner 2001).

Remarks: Perrier (1896a) reported a species '*Asterias polaris* Gray' (family Asteriidae, order Forcipulata) from the Azorean rocky intertidal (*Hirondelle*, sta 104, Bay of Porto Pim, Horta, Faial Island). The name as this author listed it is not present in Gray (1840, 1866). Fisher's review (1923, 1930) listed *Asterias polaris* under the synonymy of two (very different) Arctic species: the paxillosid *Ctenodiscus crispatus* (Bruzelius, 1805) (= *Asterias polaris* Sabine, 1824) and the forcipulatid *Leptasterias polaris* (Müller & Troschel, 1842) (= *Asteracanthion polaris* Müller & Troschel, 1842) (see also A.M. Clark & Downey 1992). In Azorean faunal lists one or both of these species are mentioned, however, none of the authors explained their choice, nor commented on the unusual presence of an Arctic species in the Azores. García-Diez *et al*. (2005) and Micael *et al*. (2012) selected the first species, *Ctenodiscus crispatus*. Pereira (1997) chose the latter species, *Leptasterias polaris* and Micael & Costa (2010) listed both. Notwithstanding, Perrier (1875) acknowledged Sabine's *Asterias polaris* as a junior synonym of *Ctenodiscus corniculatus* (= '*Astropecten polaris* Gray') now accepted as *C. crispatus*. In contrast, Perrier (1896a) grouped the Azorean *A. polaris* together with *A. rubens* (the genus' type species), as both members of the order Forcipulatida. Previously, Norman (1965) had disagreed with the replacement of the Linnaean genus *Asterias* by Müller & Troschel (1840b) not realising that with the suppression of *Asteracanthion*, two species would arise with the same name. The problematic taxonomical position of Müller & Troschel (1840b) species' was only resolved much later by Fisher (1923, 1930). Thus, it is apparent that Perrier was referring to *L. polaris* as described by Müller & Troschel (1842). Regardless, Koehler (1924: 102–103) stated in a small footnote that the two small specimens identified by Perrier (1896a) as *L. polaris* were in reality six-armed individuals of *A. rubens*. In contrast with arctic *L. polaris*, the geographical range of *A. rubens* extends to the southern latitudes of South Carolina (or Florida) and Portugal (A.M. Clark & Downey 1992), making it a more likely inhabitant of the Azores warmer waters. The unusual number of arms observed in the material from the Azores could be the reason for Perrier's misidentification.

Unlike the six-armed *L. polaris*, *A. rubens* is characterized by having typically five arms. Occasionally, abnormal animals may have as many as eight arms (Koehler 1924, Mortensen 1927a).

The material of *A. rubens* was collected in the rocky intertidal waters of Porto Pim Bay (c. 38°31'29"N, 28°37'38"W). The only other sea star species collected at this *Hirondelle* station was *Marthasterias glacialis*, making other common inhabitants of Azores conspicuously absent. Among these, *Coscinasterias tenuispina* (Lamarck, 1816) and *Luidia ciliaris* (Philippi, 1837) are the only non-pentamerous species. In view of this, it is possible that both Perrier and Koehler may have misidentified *Hirondelle* specimens with juveniles of the closely related *C. tenuispina* (see text below). However, this seems unlikely as Koehler was familiarized with these species. Nonetheless, Porto Pim Bay is located in Horta city, near the old installations of Department of Oceanography and Fisheries. This area of easy access is one of the most survey waters in the Azores. However, no new material belonging to *A. rubens* has ever been collected since *Hirondelle* cruise. These two small specimens of *A. rubens* may represent the arrival of this species in the Azores, but for some reason failed to settle in the archipelago. For the above reasons, we have considered the presence of this species in the archipelago shallow waters as doubtful.

Genus *Coscinasterias* Verrill, 1867

Coscinasterias tenuispina (Lamarck, 1816)

(Fig. 12)

Reports for the Azores:

Asterias tenuispina Lamarck, 1816—$Barrois 1888: 70; $Koehler 1909: 122; Koehler 1914b: 275; Mortensen 1921: 224;

Coscinasterias tenuispina (Lamarck, 1816)—Koehler 1921b: 26, fig. 19; $Nobre 1924: 88; Mortensen 1927a: 138; $Nobre 1930: 68, 1938: 36–37, figs. 10, 11; $Marques 1983: 2; A.M. Clark & Downey 1992: 427–428, figs. 63h, i, pl. 101, figs. A, B; Pereira 1997: 335; $Morton *et al*. 1998: 120, 169, figs. 6.2O, 8.8S; Pérez-Ruzafa *et al*. 2002: 280–281; Micael & Costa 2010: 321; Micael *et al*. 2012: 2, 3–4.

See: Verrill (1915: 19–20, pl. 26, figs. 2, pl. 17, fig. 4); A.M. Clark & Downey (1992).

Occurrence: on tropical-subtropical waters of the Mediterranean Sea and Atlantic Ocean; in the west, from North Carolina south to Brazil (A.M. Clark & Downey (1992) including Bermuda (H.L. Clark 1933), and in the east from the Bay of Biscay (Koehler 1921b) to Sierra Leone (Nataf & Cherbonnier 1975), including the Azores (Koehler 1909), Madeira (Augier 1985), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries (Bacallado *et al.* 1985), Cape Verde (Pérez-Ruzafa *et al*. 1999) and Saint Helena (Mortensen 1933c).

Depth: 0–165 m (A.M. Clark & Downey (1992); AZO: 0–12 m (herein).

Habitat: typical inhabitant of rocky shores; also found on biogenic detritus, sandy to silty sand substrates, under stones and in the meadows of *Zostera* and *Posidonia* (Koukouras *et al*. 2007).

Larval stage: probably planktotrophic (inferred from the genus); also reproduces asexually through fission (Waters & Roy 2003).

Material examined: DBUA-ECH 077 (FRM, AZO, *c.* 37°16’14”N, 24°46’52”W, 1990.06; 6 spms, R = 32–68 mm, r = 4–7 mm); DBUA-ECH 108 (FRM, AZO, *c.* 37°16’14”N, 24°46’52”W, 1990.06; 3 spms, R = 30–110 mm, r = 3–10 mm); DBUA-ECH 114 (Lajes, PIX, AZO, *c.* 38°23’22”N, 28°15’04”W, 2 m; 4 spms, R = 7–25 mm, r = 1–3 mm)**;** DBUA-ECH 122 (São Roque, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2012.11.16, intertidal; 1 spm, R = 3 mm, r = 1 mm); DBUA-ECH 184 (Poços, Capelas, SMG, AZO, *c.* 37°50’06”N, 25°40’10”W, 1996.07.18, 12 m; 1 spm, R = 3 mm, r = 1 mm); DBUA-ECH 407 (Marina, Vila do Porto, SMA, AZO, 36°56’42”N, 25°08’50”W, 2016.07.5, 1 m; 1 spm, R = 76 mm, r = 8 mm).

Description: disc small, with six to nine arms, rather long and slender, slightly angular and of unequal size, being larger of one side relative to the other. Most specimens with two to three madreporites; exceptionally three specimens exhibited a single madreporite, but also signs of recent self-division (shape of the disc half circumference; smallest arms less than a quarter the size of the remaining arms) (DBUA-ECH 077c, 114c, 184). Abactinal skeleton strong, with three regular longitudinal series of primary plates, each carrying a single aciculate spine encircled by a large wreath of crossed pedicellaria; only one dorsal (carinate) series in the smaller specimens (R < 7 mm). Spines in the disc irregularly distributed not forming a pentagon. Superomarginal plates with an irregular patch of fine crystal bodies; alternating plates bear single aciculate spines encircled by large wreath of crossed pedicellaria.

Inferomarginals bear two oblique spines somewhat flattened, with similar sizes as superomarginals; marginal spine with crossed pedicellaria surrounding only the outer side; larger specimens (R > 40 mm) occasionally presented a third (interactinal) spine in the proximal area between the inferomarginal and the adambulacral plates, about the same size and shape as the nearest inferomarginal; the presence or position along the arms of this additional spine was not constant between specimens or between arms of the same specimen. Adambulacral plates generally bearing one long flattened spine with no attached pedicellaria (monocanthid); in larger specimens (R > 7 mm), a second spine was occasionally present, though its presence was irregular, normally restricted to the proximal area of the arms; in the largest specimen (DBUA-ECH 108; R = 110 mm) this additional spine was observed to about two thirds from the arm base. Crossed pedicellaria with enlarged terminal teeth larger than the median terminal teeth; lanceolate straight pedicellaria long and scattered throughout surface, particularly numerous between the arms. Colour (alive): dorsal side brown or purplish-blue with darker and lighter specks; crossed pedicellaria and tube feet bright orange; ventrally cream; colour (in ethanol) from uniform whitish to cream. Shells of the marine gastropod *Anachis avaroides* Nordsieck, 1975 were found in the stomach of the specimen DBUA-ECH 407.

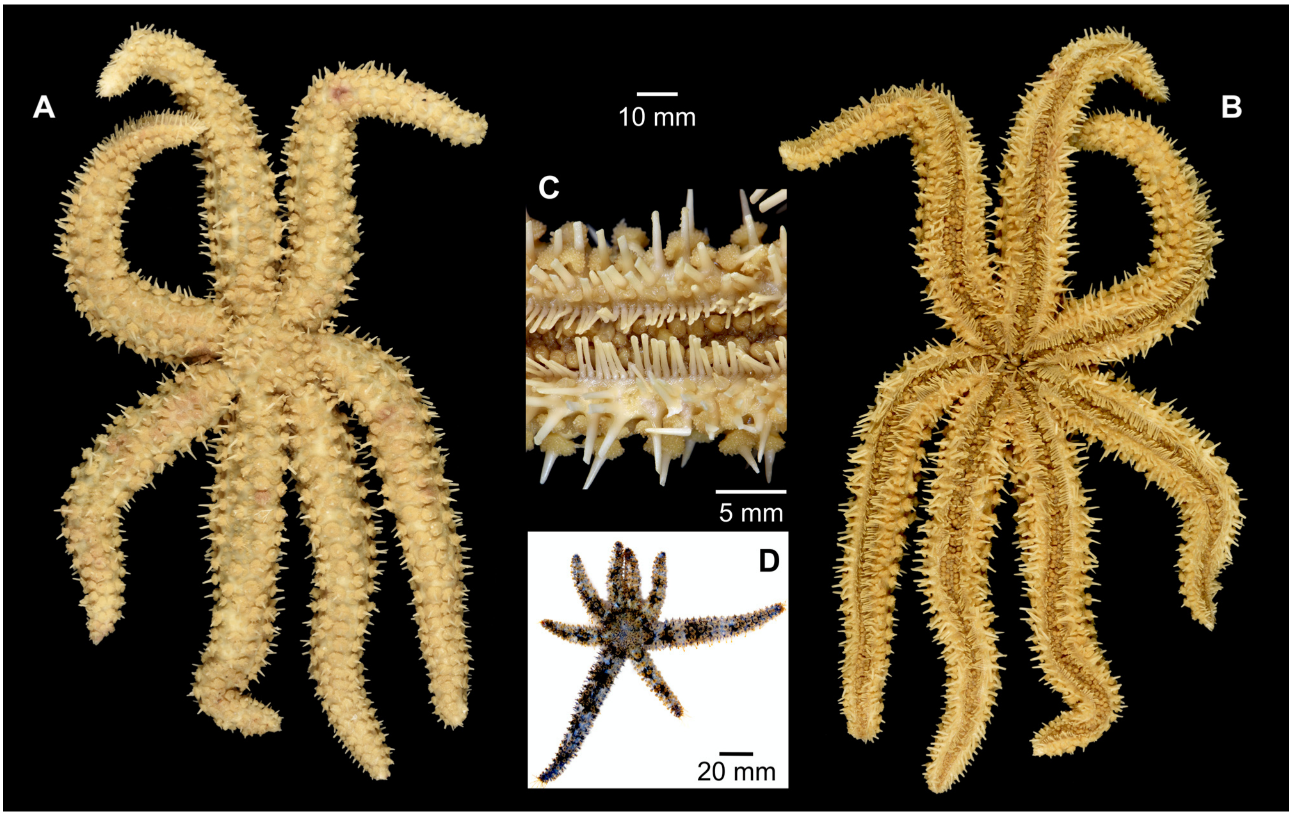

FIGURE 12. *Coscinasterias tenuispina* (Lamarck, 1816) (DBUA-ECH 357: A–C; DBUA-ECH 407: D). Dorsal view (A); ventral view (B); detail of the arm, ventral view (C); blue colour morph (D).

Remarks: among species belonging to the genus *Coscinasterias*, *C. tenuispina* closely resembles *C. calamaria* a species known from South African and Australian waters. These two species differ only by the shape of the pedicellaria, as in *C. tenuispina* the crossed pedicellaria present an enlarged tooth and the straight pedicellaria present short stubs at the tips. A.M. Clark & Downey (1992) remarked that the separation between the two species should eventually be downgraded to a subspecific level, as *C. tenuispina* from Brazil seemed to present somewhat intermediary characteristics. More recently, Waters & Roy (2003) conducted a phylogenetic analysis on the genus, and their findings contradicted the previous authors' hypothesis and pointed to a closer relationship between *C. calamaria* and *C. acutispina*, a north Pacific species. On the other hand, Waters & Roy support a subspecific separation of *C. tenuispina* populations from the Brazil. Nevertheless, these authors cautioned that further studies should be conducted on Brazilian animals since the differences observed by A.M. Clark & Downey were based on juvenile specimens, thus inconclusive from a morphological point of view. In a study on the asteroids from northeastern Brazil, Gondim *et al*. (2014) appear to support the Waters & Roy's contention as their own observations fail to support any clear morphological separation. The colour pattern was also present by A.M. Clark & Downey

(1992) as a possible source of variation among populations through the geographic range of *C. tenuispina*. However, the colour in this species is rapidly shed through the preservation process. Specimens housed in the DBUA-ECH collection presented features typical of *C. tenuispina*, on the appearance of both straight and crossed pedicellaria. Even the appearance of a second adambulacral in a species or genus otherwise known to be monocanthid was already documented by Verrill (1914) as merely individual variations. The observed brown colour pattern was also found in other areas in the Atlantic (*e.g.,* Pérez-Ruzafa *et al*. 2002; Wirtz & Debelius 2003; Hernández *et al*. 2013). The blue colour morph observed in one of the specimens (Fig. 12D) appears to be also found in Bermuda, NW Atlantic (H.L. Clark 1933).

C. tenuispina can be easily distinguished from the fissiparous *Sclerasterias richardi* by the distribution of crossed pedicellaria, as in the latter species these pedicellaria are found dispersed on the aboral surface and not organized in wreaths around the spines as in the former. Also, the non-fissiparous sea star *Marthasterias glacialis* another common inhabitant of the Azorean shallow waters can be easily distinguished from *C. tenuispina* by having five arms and never more than one madreporite.

Genus *Marthasterias* Jullien, 1878

Marthasterias glacialis (Linnaeus, 1758)

(Fig. 13)

Reports for the Azores:

Asteracanthion glacialis—$Müller & Troschel 1842: 14–15;
Asterias glacialis Lamarck, 1816—Drouët: 211; Barrois 1888: 31;
Asterias glacialis Müller, 1776—$Barrois 1888: 32, 69, 113, 114;
Asterias glacialis Linnaeus, 1758—$Simroth 1888: 231, 232; $Koehler 1909: 116; Koehler 1914b: 269; $Nobre 1924: 88, 1930: 68;
Stolasterias glacialis Linck, 1733—$Perrier 1894: 109;
Stolasterias madeirensis Stimpson, 1862—$Perrier 1896a: 37;
Marthasterias glacialis (Linnaeus, 1758)—$H.L. Clark 1923: 305; Mortensen 1927a: 143–144, fig. 82; $Cadenat 1938: 349; Nobre 1938: 34–36, figs. 8, 9; $Chapman 1955: 400; $Tortonese 1965: 188–192, figs. 89, 91; $Marques 1983: 2; Clark & Downey 1992: 443–445, fig. 67d, pl. 101, fig. C; Moyse & Tyler 1995: 671, fig. 12.4; Pereira 1997: 335; $Morton *et al*. 1998: 62, figs. 3.4Y, 3.7P, 8.1K; Pérez-Ruzafa *et al*. 1999: 49, 2002: 281–282; García-Diez *et al*. 2005: 48; $Micael *et al*. 2006: 5, 2010: 329; Micael & Costa 2010: 321; Pérez-Portela *et al*. 2010: 2015–2028;
Marthasterias glacialis rarispina (Perrier, 1875)—$A.M. Clark 1951: 211–212;
Marthasterias glacialis (Müller, 1776)—$Fisher 1928: 130, pl. 42, fig. 4, pl. 43, fig. 6.

See: Mortensen (1927a); A.M. Clark & Downey (1992); Picton (1993: 36).

Occurrence: Mediterranean Sea and East Atlantic; from Iceland and Finmark (Mortensen 1927a) along the European and West African coasts (Nataf & Cherbonnier 1975) to ?South Africa (A.M. Clark & Downey 1992), including the archipelagos of the Azores (Koehler 1909), Madeira (Augier 1985), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries (Pérez-Ruzafa *et al*. 2003) and Cape Verde (Pérez-Ruzafa *et al*. 1999).

Depth: 0–180 m, rarely below 50 m (A.M. Clark & Downey 1992); AZO: 0–35 m (herein).

Habitat: found on rocky shores, on biogenic detritus, sandy to silty sand substrates, and in *Zostera* and *Posidonia* meadows (Koukouras *et al*. 2007); feeds mainly on molluscs but also on fishes, crustaceans and other echinoderms (Mortensen 1927a).

Larval stage: planktotrophic (Mortensen 1927a); typically gonochoristic, though some cases of hermaphroditism have been reported in the Tyrrhenian Sea (Delavault & Cognetti 1961).

Material examined: DBUA-ECH 103 (Piscina da Lagoa, SMG, AZO, *c.* 37°44'29"N, 25°34'27"W, 25.07.1996, 15 m; 1 spm, R = 83 mm, r = 9 mm); DBUA-ECH 104 (FRM, AZO, *c.* 37°16'14"N, 24°46'52"W, 1990.06.08, 6–8 m; 1 spm, R = 13 mm, r = 3 mm); DBUA-ECH 105 (Rosto do Cão, São Roque, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 1997.02.26, 10 m; 2 spms, R = 84–101 mm, r = 9); DBUA-ECH 106 (FRM, AZO, *c.* 37°16'14"N, 24°46'52"W, 1990.06; 2 spms, R = 100–147 mm, r = 12–17 mm); DBUA-ECH 110 (Poços, São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1996.04.14; 1 spm, R = 60 mm, r = 8 mm); DBUA-ECH 111 (Vila do Porto, SMA, AZO, *c.* 36°56'42"N, 25°08'50"W, 1990.06; 2 spms, R = 79–142 mm, r = 11–80 mm); DBUA-ECH 205 (Baixa de João Lopes, SMA, AZO, *c.* 37°01'13"N, 25°10'05"W, 2014.06.26, 30–35 m; 1 spms, R = 1 mm, r = 0.5 mm).

Description: disc subpentagular with scattered spines forming a more or less distinct pentagon; R/r from two to thirteen in smaller specimens (D = 1–5 mm, respectively) up to 8–11 fold in larger specimens; a larger individual (R = 142 mm, DBUA-ECH 111) was flattened by an inadequate preservation container resulting in a proportion R to r of two fold. Five arms with pentagonal cross-section, long tapering distally. Abactinal skeleton strong, with three longitudinal series of primary plates; the plates in mid-dorsal line of the arm forming a conspicuous regular series, zigzagging distally with one up to two (occasionally three, in larger specimens of R ≥ 78 mm) stout conical spines, encircled by a large wreath of crossed pedicellaria; the dorsolateral series on each side reduced particularly distally, partially spinose with spines (when present) usually smaller than the carinal ones in all specimens except in the smallest ones (R ≤ 13 mm), where they are absent. Superomarginal plates as in the mid-dorsal arm area arranged in a regular series with one to two spines, slightly exceeding in length the carinal ones; also surrounded by wreath of crossed pedicellaria. Inferomarginal with two oblique spines slightly flattened and of similar length to the abactinal ones; the outer one with crossed pedicellaria surrounding only the outer side. A single spineless actinal series. Adambulacral plates monocanthid. Long lanceolate straight pedicellaria scattered on the ventral surface, particularly within the furrow. Valves of crossed pedicellaria with a slightly enlarged tooth on each side of the terminal lip. Colour (in ethanol): all white, with the exception of a small specimen (DBUA-ECH 104), which is light brown with darker brownish spots giving an overall stripped appearance.

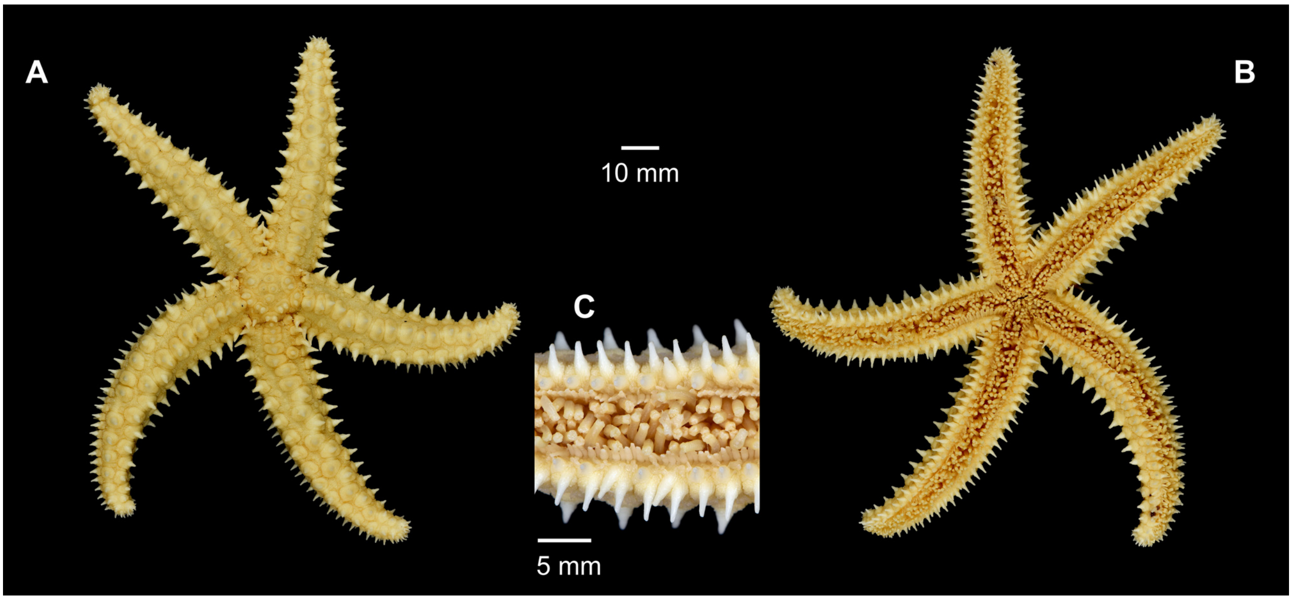

FIGURE 13. *Marthasterias glacialis* (Linnaeus, 1758) (DBUA-ECH 103). Dorsal view (A); ventral view (B); detail of the arm, ventral view (C).

Remarks: *Marthasterias glacialis* is highly polymorphic and has a wide geographical distribution, qualities that have resulted in the description of several synonyms, subspecies and varieties. The validity of these subspecies did not reunite consensus as many believed to be ecophenotypic variations associated with specific environmental conditions (depth, *e.g.,* Mortensen 1933b; Tortonese, 1965; latitude, *e.g*., A.M. Clark 1951). Historically, *M. glacialis* in the Azores was attributed to the form '*rarispina*' by A.M. Clark (1951), a variety originally described as a South African species by Perrier (1875). Its diagnosing characters are essentially focused on the absence of spines on the dorsolateral plate series (*e.g.,* Perrier 1875; H.L. Clark 1923). On the other side of the spectrum is the form '*africana*', another South African variety distinct by its many irregularly arranged abactinal spines (Mortensen 1933b; A.M. Clark 1974). However, Mortensen (1933b) realized the existence of intermediate forms and classified these as 'not very distinct varieties'. Unlike the previous observations by A.M. Clark (1951), the specimens from the Azores housed in the DBUA-ECH collection appear to be identical to the ones from South Africa, figured by Mortensen (1933b: pl. 16, fig. 3) as an example of an intermediate form of the variety '*rarispina*' characterized by having a reduced number of spines in the dorsolateral series. In contrast, the carinal plate series in the DBUA-ECH specimens also presented a somewhat zigzagged arrangement in the distal part of the arms. This feature was associated with the typical form '*rarispina*' by A.M. Clark (1951). However, the smallest specimens (R ≤ 13 mm) in DBUA-ECH collection displayed naked dorsolateral series and the spines on carinal series are not arranged in a zigzagged manner. Regardless, the observed variations found in Azorean animals are not exclusive in the North Atlantic and were also reported in specimens from Madeira, Canaries, Portugal and the Mediterranean Sea (Ludwig 1897; Nobre 1930; A.M. Clark 1951; A.M. Clark & Downey 1992). The colouration pattern has been appointed as another source of variation in *M. glacialis*, which can vary between yellow, green, blue, brown and even pink. In the Azores, large specimens are typically described as blackish with the spinose plates conspicuously white (see for example Wirtz & Debellius 2003). However, small specimens (*e.g.,* DBUA-ECH 103, R = 83 mm) may present a colouration pattern similar to typical *Coscinasterias tenuispina*, light brown to yellowish-white blotched with darker brownish or orange, giving an overall stripped appearance (see remarks under *C. tenuispina*). A more recent study by Wright and co-workers (2016) concluded that *rarispina* and *africana* varieties from South Africa could not be distinguished at a morphological and genetic level. On the other hand comparisons with sequences previously published by Pérez-Portela *et al* (2010) from the European shores and Azores showed that South African populations could represent a distinct species.

Genus *Sclerasterias* Perrier, 1891

Sclerasterias richardi? (Perrier, *in* Milne-Edwards, 1882)

(Fig. 14)

Reports for the Azores:
Sclerasterias richardi (Perrier, *in* Milne-Edwards, 1882)—$Madeira *et al*. 2017b: 11–18.

Type locality: Mediterranean Sea.

See: Perrier (*in* Milne-Edwards 1882: 20–21, as *Asterias richardi*; 1894: 109–112, pl. 9, fig. 4, as *Hydrasterias richardi*); Ludwig (1897: 403–418, pl. 12, figs. 18–22).

Occurrence: known only from the Mediterranean Sea (Tortonese 1965), ?Azores (Madeira *et al*. 2017b) and Cape Verde (Perrier 1894).

Depth: 80–710 m (Falconetti *et al.* 1976); AZO: 135 m (Madeira *et al*. 2017b).

Habitat: soft, detritic to hard substrata (Gautier-Michaz 1958, Tortonese 1965).

Larval stage: planktotrophic; also reproduces asexually through fission (Falconetti *et al.* 1976, 1977).

Material examined: DBUA-ECH 357 (Vila Franca do Campo, SMG, AZO, 37°41’42”N, 25°25’22”W, 2006.07.17, 135 m; 3 spms, R = 5–6 mm, r = 1 mm);

Description: two specimens presenting six arms of unequal sizes (three larger and three smaller) and one animal with three arms of similar dimensions to the larger arms of the six-rayed specimens. Arms broad, pentagonal in cross-section, narrowing gradually into a round arm tip covered by the terminal plate; arms weakly attached to the disc. Reticular plating on the arms arranged in fairly regular longitudinal plate series (carinal, dorsolateral, superomarginal, inferomarginal, adambulacral); arm plates with a round four-lobed shape with exception of the small bridge-like dorsolateral plates. Papulae occupying the interstices between plates, forming two longitudinal rows on each side of the arm. Arm spines forming fairly regular longitudinal series. Carinal plates carrying up to three short and round spines bearing small spinelets at their tips. Dorsolateral plates bearing one small spine. Superomarginal plates armed with two spines similar in size and shape to the carinal and dorsolateral ones. Spine number and size gradually reduced to one small spine near the arm tip in both carinal and superomarginal plates and none in the dorsolateral plates. Inferomarginal plates with one or two flattened, spatulate to clavate enlarged spines, arranged obliquely and slightly enlarged towards the tip. Adambulacral plates diplacanthid bearing two flattened spines arranged obliquely with the internal spines slightly smaller than the external one. Dorsal surface of all specimens partially damaged, preserving at least two madreporites (S-shaped) near the interradial edges; disc also densely covered with small spines, identical in size and shape to those found on the dorsal surface of the arms. Numerous crossed pedicellaria almost as large as the dorsal spines dispersed over the body surface, not forming a wreath around the spines; presence of a slightly enlarged unpaired tooth on the outer face of each valve of the crossed pedicellaria. Straight pedicellaria felipedal, slightly larger than the crossed pedicellaria and restricted to the interradial areas.

Remarks: currently, only two other *Sclerasterias* species are known to the NE Atlantic and Mediterranean Sea: *S. neglecta* (Perrier, 1891) (Bay of Biscay and Mediterranean Sea, 166–887 m) and *S. guernei* Perrier, 1891 (Bay of

Biscay, 160–490 m) (A.M. Clark & Downey 1992). Unlike *S. richardi*, the crossed pedicellaria in these species is distributed in a fashion typical of the genus (*i.e.* in wreaths around the spines; Perrier 1891: 264) and none is known to asexually reproduce by fission. Nonetheless, neither the fissiparous nature nor the distribution of the crossed pedicellaria observed in S. *richardi* appears to be unique in *Sclerasterias*. While adults of Hawaiian *S. euplecta* present all the typical characters of the genus, the juvenile stages were described by Fisher [1906, as *Coscinasterias* (*Distolasterias*) *euplecta*] as fissiparous and presenting a scattered distribution of crossed pedicellaria. These observations have led Fisher (1928) to believe that *S. richardi* was also a juvenile of another *Sclerasterias*, possibly *S. neglecta*. Later, A.M. Clark & Downey (1992) further suggested that *S. richardi* was an invalid species since the description by Perrier (*in* Milne-Edwards 1882, 1894) was based on immature specimens. However, the smallest known specimens of both *S. neglecta* and *S. guernei* (R = 15 mm, r = 3 mm and R = 17 mm, r = ? mm, respectively) were described as having five arms with crossed pedicellaria arranged in circles around the spines (Perrier 1891, 1896a). More recently, Mastrototaro & Mifsud (2008) argued that the unequal number and size of the arms, the presence of multiple madreporites and the documented sexual reproduction by Falconetti and co-workers (1976, 1977) suffice to prove that it was a valid species. Though we agree with Mastrototaro & Mifsud (2008), the position of *S. richardi* (or even of *S. euplecta*) should be re-addressed in future revisions of this genus.

The only other fissiparous sea star known from the coastal waters of the Azores *Coscinasterias tenuispina* can be easily distinguished from *S. richardi* by the arrangement of the crossed pedicellaria in wreaths around the spines and by the monocanthid arrangement of the adambulacral spines. Furthermore, *C. tenuispina* appears to be restricted to the first few meters in the Azores (≤12 m) as opposed to much deeper local record of *S. richardi* (135 m). *Sclerasterias richardi* is one of the latest additions to the Azores echinoderm fauna. Madeira *et al*. (2017b) have identified the specimens herein enumerated among the material collected off the coast of Vila Franca do Campo (São Miguel Island) by the *International Workshop of Malacology and Marine Biology* (2006), one of the rare efforts in the Azores targeting deeper coastal waters (*i.e.* between 50 m and 200 m depth). Nevertheless, the specimens were small and probably immature shedding some doubt on whether they belong to an established population or represent a recent arrival, a question that can only be answered in future studies as further material becomes available.

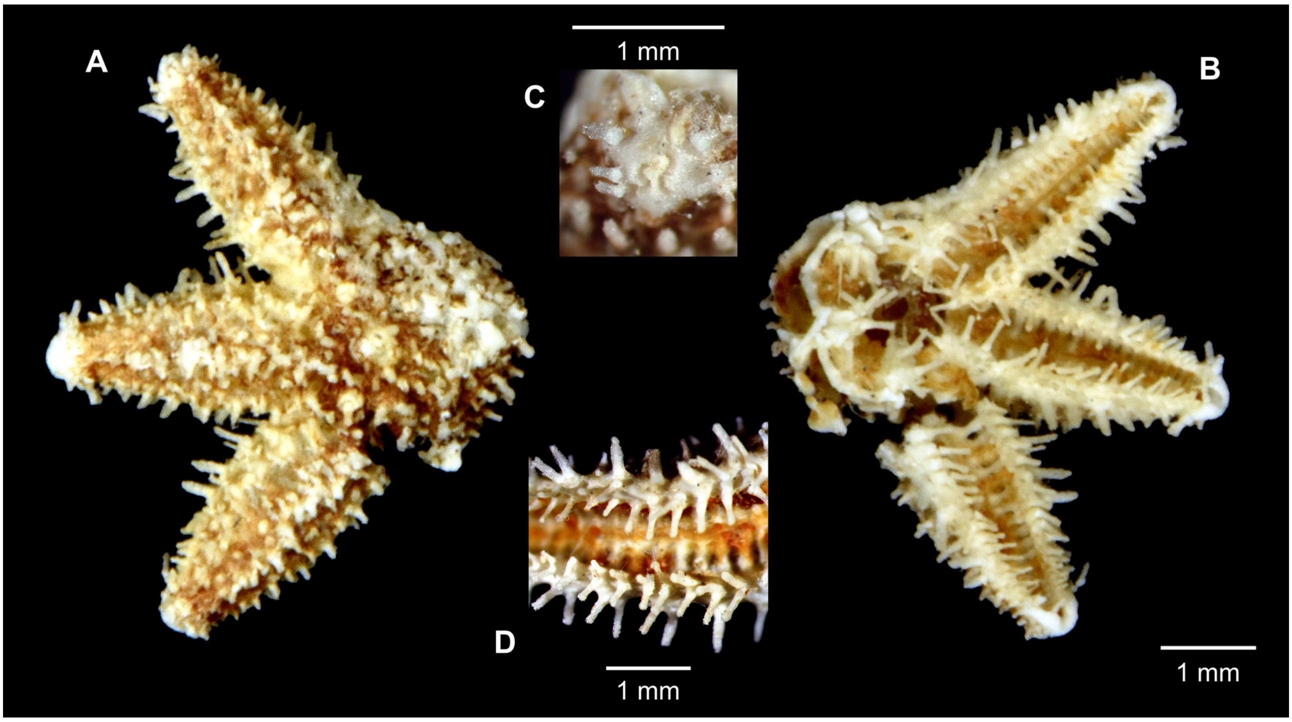

FIGURE 14. *Sclerasterias richardi* (Perrier, *in* Milne-Edwards, 1882) (DBUA-ECH 357). Dorsal view (A); ventral view (B); madreporite (C); detail of the arm, ventral view (D).

Family Pedicellasteridae Perrier, 1884

Genus *Hydrasterias* Sladen, 1889

Hydrasterias sexradiata (Perrier, *in* Milne-Edwards, 1882)

Reports for the Azores:

Pedicellaster sexradiatus, Perrier, *in* Milne-Edwards, 1882—$Koehler 1909: 110–111, pl. 2, fig. 4; Mortensen 1921: 224, 1927a: 130; $Sibuet 1972: 121; Pérès 1992: 254, 255;

Stellosphæra mirabilis Koehler & Vaney, 1906a—?$Koehler 1909: 131–136, pl. 24, fig. 1–10;

non *Hydrasterias ophidion* (Sladen, 1889) —$A.H. Clark 1949: 375 [misidentification];

Hydrasterias sexradiata (Perrier, *in* Milne-Edwards, 1882)—Gage *et al*. 1983: 285–286; A.M. Clark & Downey 1992: 410, figs. 62c–d; García-Diez *et al*. 2005: 48; Dilman 2006: 185, 2008: 147, 2013: 583, 2014: 37–38.

Type locality: off Portugal (between *c.* 40°N–38°N, 12°W).

See: Perrier (*in* Milne-Edwards 1882: 46–47; 1894: 100–102, pl. 9, fig. 2, as *Pedicellaster sexradiatus*); A.M. Clark & Downey (1992).

Occurrence: NE Atlantic, from the Rockall Trough (Gage *et al.* 1983) and the Bay of Biscay (Perrier 1894), southwards to ?Cape Verde (Mortensen 1927a) and on the Mid-Atlantic Ridge from the Reykjanes Ridge (Dilman 2006) to the Azores (Koehler 1909).

Depth: 599–4,260 m (A.M. Clark & Downey 1992); AZO: 599–3,465 m (Koehler 1909).

Habitat: soft substrates, from ooze to sand (Koehler 1909).

Larval stage: planktotrophic (Mortensen 1921).

Remarks: Koehler (1909) identified specimens of '*Stellosphaera mirabilis*' collected by *Princesse Alice*, at stations located within Azorean waters. Mortensen (1921, 1927a) believed that this was actually the larval form of *H. sexradiata*, in an advanced stage of metamorphosis. According to A.M. Clark & Downey (1992), this is yet to be confirmed. The western Atlantic *Hydrasterias ophidion* was reported from the Azores by A.H. Clark (1949), based on his identification of material collected by *Atlantis* (sta 20: 37°50'30"N, 26°00'00"W, 2,562 m). Later, Dilman (2014) placed A.H. Clark's material under *H. sexradiata*, a known native to the Azorean deep waters. Additionally, the inclusion of Cape Verde Archipelago in the geographical distribution of *Hydrasterias sexradiata* in the bibliography (*e.g.,* Mortensen 1927a; A.M. Clark & Downey 1992) is possibly based on a misprint by Koehler (1909), who remarked that the material of this species was collected by *Princesse Alice* between the Azores and Cape Verde, though all listed stations are positioned in the Azores region.

Family Stichasteridae Perrier, 1885b

Genus *Neomorphaster* Sladen, 1889

Neomorphaster margaritaceus (Perrier, *in* Milne-Edwards, 1882)

Reports for the Azores:

Stichaster talismani $Perrier, 1885c: 22–24; Sladen 1889: 431;

Neomorphaster eustichus $Sladen, 1889: 438–439, pl. 66, figs. 3–4, pl. 67, figs. 9–10; $Bell 1892: 87; Koehler 1895c: 444;

Calycaster monecus $Perrier, 1891: 262–264, 1896a: 28–29, pl. 2, figs. 2, 2a, pl. 3, figs. 3, 3a; Grieg 1932: 44;

Gastraster margaritaceus Perrier, *in* Milne-Edwards, 1882—$Perrier 1894: 103–105, pl. 9, fig. 3; Mortensen 1927a: 137–138, fig. 78; Fisher 1930: 207;

Neomorphaster talismani Perrier, 1885c—$Perrier 1894: 134–137, pl. 10, fig. 2, 1896a: 30; $Koehler 1909: 107–108, pl. 6, fig. 5, 1921a: 2; Mortensen 1927a: 134–135, fig. 76; Fisher 1930: 212; *Neomorphaster parfaiti* Koehler, 1895c: 443–444;

Neomorphaster margaritaceus (Perrier, *in* Milne-Edwards, 1882)—A.M. Clark & Downey 1992: 406, figs. 61g–h, pl. 99, figs. A–D; Ringvold 1999: 471; Sneli 1999: 251; García-Diez *et al*. 2005: 48.

Type locality: Bay of Biscay (44°05'00"N, 7°05'46"W).

See: Perrier (*in* Milne-Edwards 1882: 46, as *Pedicellaster margaritaceus*); A.M. Clark & Downey (1992).

Occurrence: Northeast Atlantic, from Faroe waters (Sneli 1999) southwards in the Rockall Trough (Harvey *et* *al*. 1988) to the archipelagos of the Azores and Canaries (Perrier 1894); reported as well to the Faraday Seamount in the Mid-Atlantic Ridge (Dilman 2008).

Depth: 400–2,102(?5,413) m (Koehler 1909); AZO: 938–2,102 m (Perrier 1894, Koehler 1909).

Habitat: soft substrates, from pteropod ooze, mud to sand (Perrier 1894, Koehler 1909); also on gravel and hard substrates (Sneli 1999).

Remarks: Koehler (1909) identified material belonging to *Neomorphaster margaritaceus* (= *Neomorphaster talismani*) collected between the Azores and Canaries by *Princesse Alice* at a depth of 5,413 m (sta 1787: 31°07'N, 24°03'07'W). Koehler commented on the possibility of mislabelling, since the station was far too deep for the occurrence of this species. Later works considered this depth as an exception but nevertheless valid (*e.g.,* Mortensen 1927a, Harvey *et al*. 1988, A.M. Clark & Downey 1992). We are inclined to agree with Koehler (1909) as the second deepest record reported in the bibliography is from 2,102 m (*Princesse Alice*, sta 624: 38°59'00"N, 28°18'05"W) and most of all other records tend to be well above this 2,000 m limit.

Family Zoroasteridae Sladen, 1889

Genus *Zoroaster* Thomson, 1873

Zoroaster fulgens Thomson, 1873

Reports for the Azores:
Zoroaster longicauda $^{\$}$Perrier, 1885c: 19–21; Mortensen 1927a: 131;
Prognaster grimaldii $^{\$}$Perrier, 1891: 259–262, 1896a: 23–25, pl. 2, figs. 1, 1a, 1b;
Prognaster longicauda $^{\$}$Perrier, 1894: 120–125, pl. 10, fig. 1;
Zoroaster fulgens Thomson, 1873—Sibuet 1975: 108; $^{\$}$Dilman 2008: 147.

Type locality: Faroe Channel (lectotype).

See: Downey (1970: 15–17); A.M. Clark & Downey (1992: 403–404, figs. 61c–d, 67a, pl. 96, figs. G–H); Benavides-Serrato *et al*. (2011: 204–205).

Occurrence: Atlantic Ocean, from Newfoundland south to Brazil, eastwards from south of Iceland and the Faroe Channel south to Angola (Sladen 1883, Grieg 1932, Sibuet 1975), including the Azores (Perrier 1894), Canaries and Cape Verde (Koehler 1909).

Depth: (?120) 220–4,810 m (Grieg 1932, Gage *et al*. 1983, A.M. Clark & Downey 1992); AZO: 2,870–3,050 m (Perrier 1891, Dilman 2008).

Habitat: soft substrates, ooze, muddy sand, sand to gravel (Farran 1913, Sneli 1999).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: *Zoroaster fulgens* presents a high degree of variation throughout its geographic and depth range and was described under several synonyms and varieties (see Downey 1970). Historically, the presence of this species in the Azorean waters was recorded under the names *Zoroaster longicauda* (= *Prognaster longicauda*; Perrier 1885c, 1894; *Talisman*) and *Prognaster grimaldii* (Perrier 1891, 1896a; *Hirondelle*). Both species were known only from the material described by Perrier and in the latter case was known only from the Azores. A.M. Clark & Downey (1992) reunited all specimens attributed to the genus previously under the name Z. *fulgens*, including the two Azorean species. Nevertheless, Downey (1970) noted that *Z. fulgens* from the northern part of its range tends to be more spinose and more robust and is generally found below 1,830 m. In contrast, on southern part of its range, this species can be found at depths as shallow as 365 m and tend to have a more compact skeleton, less spinose and slender arms. In turn, Howell *et al*. (2004) identified three depth related morphotypes in Porcupine Seabight (SW of Ireland): a robust form (925–1,750 m), a slender form (1,300–2,200 m) and a long-armed form (3,300–4,020 m). Genetic analysis revealed that these forms are reproductively isolated, and the shallower robust morphotype might represent a distinct species. The known depth range of *Z. fulgens* in the Azores is between the depth intervals recorded by Howell *et al*. (2004) for the two deeper forms. The arm length/disc radius ratio presented by Perrier (1894, 1896a) for *Z. longicauda* (from 2995 m depth) and for *P. grimaldii* (from 2870 m depth) were respectively 16 and 15, both well above the 9.7 given by Howell *et al*. (2004) for the long-armed form. More recently, Dilman (2008) reported material belonging to *Z. fulgens* collected by *G.O. Sars* (*MAR–ECO* cruise) from in northern Azorean waters depths between 2954 and 3050, but gave no descriptions.

Superorder Valvatacea Blake, 1987

Order Notomyotida Ludwig, 1910

Family Benthopectinidae Verrill, 1899

Genus *Cheiraster* Studer, 1883

Subgenus *Cheiraster* (*Cheiraster*) Studer, 1883

Cheiraster (*Cheiraster*) *sepitus* (Verrill, 1885a)

Reports for the Azores:

Pontaster venustus $Sladen, 1889: 52–55, pl. 8, figs. 5, 6, pl. 12, figs. 5, 6; $Perrier 1894: 287–288, 1896a: 47; $Koehler 1909: 14–15, pl. 1, fig. 13;

Pectinaster (*Pontaster*) *venustus* Sladen, 1889—$Koehler 1921a: 2;

Cheiraster (*Cheiraster*) *sepitus* (Verrill, 1885a)—$A.M. Clark 1981: 117–118, figs. 4i–r, 5c; A.M. Clark & Downey 1992: 129–130, figs. 22d–e, 23b, pl. 31, figs. D–H; Benavides-Serrato *et al*. 2011: 142;

Cheiraster sepitus (Verrill, 1885)—Harvey *et al*. 1988: 160–161; García-Diez *et al*. 2005: 47.

Type locality: S of Cape Sable, Nova Scotia, USA.

See: A.M. Clark (1981); A.M. Clark & Downey (1992); Benavides–Serrato *et al*. (2011).

Occurrence: North Atlantic, from Nova Scotia south to the Caribbean (A.M. Clark 1981), east from west of Iceland (A.M. Clark & Downey 1992) and the Rockall Trough (Harvey *et al*. 1988) southwards to the Cape Verde area including the Azores (Koehler 1909).

Depth: 304–3,706 m (Benavides–Serrato *et al*. 2011), mostly 1,000–2,000 m (A.M. Clark 1981); AZO: 1,165–3,706 m (Sladen 1889).

Habitat: soft bottoms, muddy sand to ooze (Koehler 1909).

Remarks: the inaccurate original description of the type material by Verrill (1885a) and subsequent multiplicity of synonymies resulted in an unclear geographical and bathymetric range for *Cheiraster sepitus* (A.M. Clark 1981; A.M. Clark & Downey 1992).

Genus *Pectinaster* Perrier, 1885c

Pectinaster filholi Perrier, 1885c

Reports for the Azores:

Pectinaster filholi Perrier, 1885c—$Perrier 1894: 280–285, pl. 18, figs. 2a–b, pl. 20, figs. 3a–d; Mortensen 1927a: 71; Cherbonnier & Sibuet 1972: 378; A.M. Clark 1981: 118–121; Gage *et al*. 1983: 277; $A.M. Clark & Downey 1992: 139–140, figs. 21b, 22l–m, pl. 34, figs. A–C; Dilman 2006: 184, 2008: 139, 2013: 569, 2014: 31.

Type locality: off Cap Blanc.

See: A.M. Clark (1981); A.M. Clark & Downey (1992).

Occurrence: Atlantic; in the west from south of Nova Scotia to Delaware (Sladen 1889); in the east from the Rockall Trough (Gage *et al*. 1983) southwards to South Africa (Clark 1981) and on the Mid-Atlantic Ridge, from the Reykjanes Ridge (South of Iceland; Dilman 2006) south to the Charlie-Gibbs Fracture Zone (Dilman 2008) and the Azores (Perrier 1894); also reported off the River Plate, South America (Sladen 1889).

Depth: 1,258–4,850 m (AZO: 1,258 m; Sladen 1889, Perrier 1894).

Habitat: soft sediment, mud or *Globigerina* ooze (Sladen 1889, Gage *et al*. 1983).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: Perrier (1885c, 1894) described the deep-sea asteroid *Pectinaster filholi* based on the material collected by *Talisman*, which included the only known specimen from Azorean waters (sta 126, 1883: 38°37'N, 28°20'46"W, 1,258 m), the same specimen re-examined later by A.M. Clark & Downey (1992).

Order Paxillosida Perrier, 1884

Family Astropectinidae Gray, 1840

Genus *Astropecten* Gray, 1840

Astropecten aranciacus? (Linnaeus, 1758)

Reports for the Azores:
Astropecten aranciacus (Linnaeus, 1758)—?$Madsen 1950: 180–181.

Type locality: Mediterranean Sea.

See: Tortonese (1965: 137–140, figs. 60–61).

Occurrence: Eastern Atlantic and Mediterranean Sea; from Portugal south to Angola (Tortonese 1965), including the archipelagos of the ?Azores (Madsen 1950), Madeira, Canaries (Döderlein 1917) and Cape Verde (Entrambasaguas 2008).

Depth: 1–183 m (Madsen 1950).

Habitat: soft sediments (biogenic detritus to sandy silt bottoms); also in *Zostera* and *Posidonia* prairies (Koukouras *et al*. 2007).

Larval stage: planktotrophic (*c.* 60–80 days: Hörstadius 1938).

Remarks: the presence of *Astropecten aranciacus* in Azores is based on a single specimen reported by Madsen (1950) with no further collection data (?Copenhagen Museum). The presence of this species in the Azores would be expected considering the widespread distribution of this species in the north-eastern Atlantic, including most of the archipelagos (Zulliger *et al*. 2009). However, the lack of any other animals from the islands of this well-known shallow-water species casts some doubt on Madsen's report suggesting the possibility of a mislabelled specimen. The presence of *A. aranciacus* in the Azores should, therefore, be considered with caution until new material of this species is retrieved from the archipelago's waters.

Astropecten hermatophilus Sladen, 1883
(Fig. 15)

Reports for the Azores:
Astropecten hermatophilus $Sladen, 1883: 257–259, 1889: 207–208, pl. 33, figs. 5–6, pl. 37, figs. 7–9; $Döderlein 1917: 91–92, 172, pl. 3, figs. 8,9, 9a; Mortensen 1927a: 57; $A.M. Clark & Downey 1992: 36, figs. 11h–j, pl. 8, figs. D, E; Pereira 1997: 335; Micael & Costa 2010: 322; Micael *et al*. 2012: 5;
non *Astropecten pentacanthus* (Philippi, 1837)—$Simroth 1888: 231 [misidentification];
non *Astropecten pentacanthus* (Delle Chiaje, 1827)—Ludwig 1897: 39–47, pl. 2, fig. 5, pl. 6, fig. 8: 231 [based on Simroth 1888];
non *Astropecten irregularis pentacanthus* (Delle Chiaje, 1827)—Koehler 1914b: 273 [based on Simroth 1888]; Madsen 1950: 169–170 [based on Ludwig 1897].

Type locality: Azores (38°38'00"N, 28°28'30"W).

See: Sladen (1883, 1889); A.M. Clark & Downey (1992).

Occurrence: Northeast Atlantic; known from the Azores (Sladen 1883), Canaries (Moreno-Batet & Bacallado 1980) and Gulf of Guinea (A.M. Clark & Downey 1992).

Depth: 10–165(?823) m (AZO; Sladen 1883, herein).

Habitat: buried in soft substrates, mud or sand, feeding on small infaunal fauna, *e.g.,* bivalve *Ervilia castanea* (Montagu, 1803) (Sladen 1889, Moreno-Batet & Bacallado 1980, herein).

Material examined: DBUA-ECH 056 (Horta harbour, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 2009.12.03, 10 m; 2 dry spms, R = 16–24 mm, r = 5–7 mm); DBUA-ECH 057 [Cerco, Caloura (buried in sand), SMG, AZO, *c.* 37°42'26"N, 25°30'37"W, 2010.08.13, 20 m; 1 dry spm; R = 7, r = 3 mm]; DBUA-ECH 059 (SMG, AZO; 2 spms, R = 20–27 mm, r = 6–8 mm); DBUA-ECH 060 (SMG, AZO; 2 spms, R = 19–20 mm, r = 7); DBUA-ECH 061 (Vila Franca do Campo, SMG, AZO, *c.* 37°42'50"N, 25°25'58"W, 3 spms, R = 6–8 mm, r = 3 mm); DBUA-ECH

062 (Água d'Alto, SMG, AZO, *c.* 37°42'55"N, 25°28'27"W, 1993.07.29; 7 spms, R = 7–10 mm, r = 3–4 mm); DBUA-ECH 098 (Horta, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 2010.6.25, 15 m; 1 spm, R = 20 mm, r = 7 mm); DBUA-ECH 099 (SMG, AZO; 1 spm, R = 15 mm, r = 6 mm); DBUA-ECH 101 (SMG, AZO; 2 spm, R = 20–27 mm, r = 7–9 mm); DBUA-ECH 102 (SMG, AZO; 1 spm, R = 19 mm, r = 6 mm); DBUA-ECH 116 (Horta harbour, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 2011.07, 20 m; 1 spm, R = 4 mm, r = 2 mm); DBUA-ECH 167 (SMG, AZO; 3 spms, R = 5–6 mm, r = 2–3 mm).

Description: body pentagonal, flattened dorsoventrally, with five broadly triangular arms. R/r ratio between 2.2–2.3 in the smaller specimens (R < 7 mm) to 3.2–3.4 in the larger (R > 16 mm); paxillar area much broader than the marginal one, densely covered by paxillae, particularly in the area of the epiproctal cone, which is especially prominent in smaller individuals (R < 10 mm). Paxillar spinelets with swollen rounded blunt tips giving an overall granulose aspect to the paxillar area; maximum number of paxillar spinelets present variable, from less than six marginal spinelets with no central spinelet in the smaller specimens (R < 7 mm) to ten to eleven spinelets surrounding up to six central spinelets in the larger specimens (R = 27 mm); central spinelets shorter and more rounded (blunt) than the marginal ones. Madreporite oval. Superomarginal plates small, narrow, tumid, vertical and granulose with a stubby spine or larger tubercle on some or all plates; occasionally a second spine is also present in one or two of the innermost plates on each side of the median interradial line. Number of superomarginal plates (SM) varies proportionally with size, from about 0,5–0,7 SM/R in smaller specimens (R < 6 mm) up to 1,0–1,2 SM/R in larger specimens (R > 19 mm). In smaller specimens (R < 10 mm), each inferomarginal plate has a compressed, lanceolate spine followed by a similar spine, which is about two-thirds shorter. Both spines are aligned slightly oblique to the median line of the plate and become progressively slender towards the tip of the arm. In larger specimens, a third spine is generally present, though its maximum size is less than half the size of the adjacent spine and it tends to disappear distally. On the inferomarginal plates towards the tip of the arm, in larger specimens (R > 15 mm), a third spine is sometimes present next to the largest spine, though very short (a third or less the size of the largest spine) and very slender, having thus the appearance of a supplementary spinelet. Three adambulacral furrow spines truncate or rounded. Subambulacral spines in two rows, broadly truncate, larger than furrow spines; on few of the innermost plates of the larger specimens (>20 mm) one or two supplementary spinelets may be present; no pedicellaria; dorsal paxillar area whitish-yellow to brown with supermaginals and ventral surface white. Shells of the marine bivalve *Ervilia castanae* were found in the stomachs of the many of the specimens.

Remarks: *Astropecten* with over 150 described species worldwide (Zulliger & Lessios 2010) is one of the most difficult shallow-water asteroid genera, encompassing highly polymorphic species with several described subspecies, local varieties and intermediate forms among sympatric species. Thorough the years several authors attempted to revise this genus (*e.g.,* Döderlein 1917; A.M. Clark & Downey 1992; Zulliger & Lessios 2010) though the matter still remains far from resolved. The history of the echinoderm faunal studies in the Azores is a good example of how difficult this genus is. Of a total of five species of *Astropecten* reported at one time to the archipelago, two were dismissed as erroneous since they proved to have been based on misidentifications [*A. irregularis pentacanthus* (Delle Chiaje, 1827)] or on invalid synonymy [*A. bispinosus* (Otto, 1823)]; another two were considered as dubious due to substantiated concerns on the validity of the identifications or on the provenance of the reported specimens [*A. aranciacus* (Linnaeus, 1758) and *A. platyacanthus* (Philippi, 1837)]. Ultimately, the only astropectinid known with certainty from the Azores is *A. hermatophilus*. This species was described by Sladen (1883, 1889) based on a specimen collected by H.M.S. *Challenger* in the Azores (sta 75: 38°38'N, 28°28'30"W, 823 m). In 1888, Simroth included the Mediterranean *A. pentacanthus* among the species collected by him in the Azores. Later, Döderlein (1917) re-identified Simroth material as *A. hermatophilus*. Almost one hundred years later, *A. hermatophilus* was also reported from the Canaries (Moreno-Batet & Bacallado 1980) and the Gulf of Guinea (A.M. Clark & Downey 1992). The latter species is only known from small animals; the type specimen as described by Sladen (1889) is one of the largest specimens known (R = 25 mm) (see also Döderlein 1917, Moreno-Batet & Bacallado 1980, A.M. Clark & Downey 1992). This feature led some authors to question the validity of the species (*e.g*., A.M. Clark & Downey 1992; Zulliger & Lessios 2010). Regardless, on comparing our largest specimen (R = 27 mm) we could clearly recognize the original description and illustrations by Sladen (1889). As our sample included specimens covering a relatively large size spectrum, it was possible to conclude that deviations from the type were size-dependent (*e.g.,* number of paxillar spinelets, number of inferomarginal fringe spines). Additionally, some of the specimens observed herein had shells of the bivalve *Ervilia castanae* in their stomachs and in many instances the shells of this little bivalve were almost as big as the sea star disc.

The depth range of *Astropecten hermatophilus* seems quite remarkable. Sladen (1883, 1889) described this species on the basis of an animal collected by H.M.S. *Challenger*, between Faial and São Jorge islands at a reported depth of 823 m (450 ftms). Interestingly, at the same station he identified as well *Ophidiaster ophidianus* (Lamarck, 1816) and *Hacelia attenuata* Gray, 1840 (= *Ophidiaster attenuatus*), both strictly littoral species. Sladen also reported *Chaetaster longipes* (Bruzelius, 1805) for the same station; though not littoral this species tends to occur at much shallower waters than 820 m. At first instance, it seems that the depth data presented for station 75 should be much shallower than the one presented by Sladen. In contrast, Agassiz (1881) working with the H.M.S. *Challenger* echinoids indicated two sets of depth values of 92–165 m (50–90 ftms) and 823 m (450 ftms) for station 75, though the species identified by the author among the material from station 75 have a wider known bathymetrical range than the species mentioned above (*e.g., Genocidaris maculata* Agassiz, 1869). Thus, the echinoderms altogether found at this station indicate problems relating to the depth data, and Agassiz's (1881) shallower depth values appear more realistic. One has to keep in mind that HMS *Challenger* dredged three times at station 75, which is in an area of high bottom relief and thus delivered material from different depths (namely 50, 90, and 450 fathoms according to the ship log (Thomson & Murray 1885). Apparently, all the material resulting from these three dredges was attributed to station 75, thus causing the confusion mentioned above.

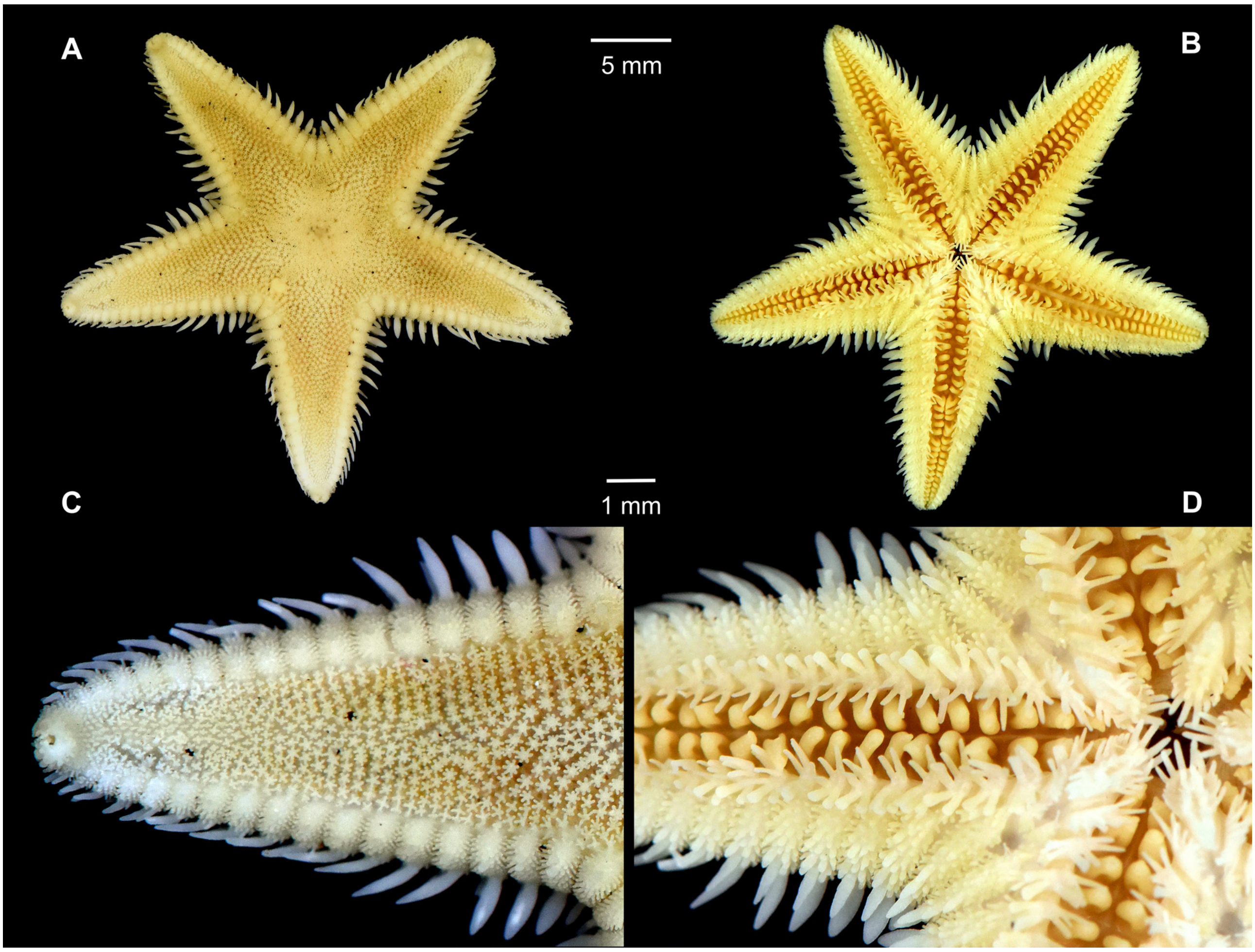

FIGURE 15. *Astropecten hermatophilus* Sladen, 1883 (DBUA-ECH 059). Dorsal view (A); ventral view (B); detail of the arm dorsal view (C); detail of the oral area and arm (D).

Astropecten platyacanthus? (Philippi, 1837)

Reports for the Azores:
Astropecten platyacanthus (Philippi, 1837)—?$^{\$}$Barrois 1888: 71; Koehler 1914b: 274; Pereira 1997: 336;
non *Astropecten bispinosus* (Otto, 1823)—Ludwig 1897: 16–31, pl. 2, fig. 6, pl. 6, fig. 6; Koehler 1921b: 46–47, fig. 33, 34; Mortensen 1927a: 56; Parenzan 1934: 211–216, fig. 7; Nobre 1938: 51–52, figs. 23, 24; Madsen 1950: 181–182; Tortonese

1965: 140–141, fig. 62; Micael & Costa 2010: 322; Micael *et al.* 2012: 5 [all these are based on the erroneous synonymy by Ludwig 1897].

Type locality: Mediterranean Sea.

See: Tortonese (1965: 142–143, figs. 63, 64).

Occurrence: Mediterranean Sea (Tortonese 1965); reported also from the ?Azores (Barrois 1888).

Depth: 2–64 m (Tortonese 1965); ?AZO: 15–20 m (Barrois 1888).

Habitat: soft substrates, on sand and mud (Tortonese 1965).

Remarks: the first and only record of *Astropecten platyacanthus* in the archipelago was reported by Barrois (1888), based on the identification by Ludwig. Historically, *Astropecten platyacanthus* was considered by many authors as a variety of *A. bispinosus* (Otto, 1823). In his review of the Mediterranean sea stars Ludwig (1897) re-assigned Barrois (1888) record under the later species, a decision repeated in later literature. A.M. Clark & Downey (1992) considered both *A. bispinosus* and *A. platyacanthus* endemic to the Mediterranean, and stated that the reports from the Atlantic were based on misidentifications or doubtful locality data. Pereira (1997) concludes that the occurrence of this species in the Azores is possible but unlikely. See above remarks under *A. hermatophilus*.

Genus *Dytaster* Sladen, 1889

Species *Dytaster grandis* (Verrill, 1884)

Dytaster grandis grandis (Verrill, 1884)

Reports for the Azores:

Dytaster biserialis $Sladen, 1889: 77–79, pl. 13, figs. 3, 4; Perrier 1894: 299; Mortensen 1927a: 54;

Dytaster agassizi Perrier, 1894—$Koehler 1909: 22, pl. 4, fig. 7, pl. 6, fig. 1; Mortensen 1927a: 55; Cherbonnier & Sibuet 1972: 377; Sibuet 1975: 101;

Dytaster rigidus Perrier, 1894—$Koehler 1909: 25, pl. 3, fig. 6; Mortensen 1927a: 55;

Dytaster grandis grandis (Verrill, 1884)—A.M. Clark & Downey 1992: 53, figs. 13a–c, pl. 15, figs. A, B; García-Diez *et al.* 2005: 46; $Dilman 2008: 132–134;

Dytaster grandis (Verrill, 1884)—Dilman 2013: 566, 2014: 26.

Type locality: east coast of USA (from Cape Hatteras to Nova Scotia).

See: A.M. Clark & Downey (1992).

Occurrence: North Atlantic, in the west, from the US east coast to the Gulf of Mexico (A.M. Clark & Downey 1992); in the east it is reported from the Porcupine Abyssal Plain (SW of Ireland; Howell *et al*. 2003) and the Bay of Biscay (Cherbonnier & Sibuet 1972) to SW Africa (Sibuet 1975), along the Mid-Atlantic Ridge from the Charlie-Gibbs Fracture Zone to the Azores (Dilman 2008). The subspecies *D. grandis nobilis* Sladen, 1889 is restricted to the Southwest Atlantic (A.M. Clark & Downey 1992).

Depth: 1,000–5,124 m (Dilman 2014); AZO: 2,954–5,005 m (Koehler 1909, Dilman 2008).

Habitat: soft sediments, from mud to ooze; predator (*e.g.,* on other echinoderms) and scavenger, ingesting sediment (Howell *et al*. 2003).

Larval stage: planktotrophic (Tyler *et al*. 1990).

Remarks: when revising *Dytaster* from the Atlantic, A.M. Clark & Downey (1992) reunite the following records from the Azores under the name *Dytaster grandis grandis*: *D. biserialis* described by Sladen (1889) on the basis of material collected by H.M.S. *Challenger* (sta 79: 36°21'N, 23°31'W, 3,706 m), *D. agassizi* and *D. rigidus* both reported by Koehler (1909) based on specimens collected by *Princesse Alice*.

Dytaster insignis (Perrier, 1884)

Reports for the Azores:

Dytaster exilis Sladen, 1889—$Cherbonnier & Sibuet 1972: 376–377.

Type locality: Gulf of Mexico.

See: Downey (1973: 35–36, pl. 9, figs. C–D); A.M. Clark & Downey (1992: 54, pl. 16, figs. G–H).

Occurrence: Atlantic deep waters, reported from the Gulf of Mexico and Caribbean (A.M. Clark & Downey 1992), eastwards to the Rockall Trough (Gage *et al*. 1983) and the Charlie-Gibbs Fracture Zone (Dilman 2013), south to the Azores (Cherbonnier & Sibuet 1972): also off Tristan da Cunha (A.M. Clark & Downey 1992).

Depth: 2,515– 3,670 m (Dilman 2013); AZO: 2,844–3,670 m (Cherbonnier & Sibuet 1972).

Habitat: soft deep-sea ooze; omnivorous scavenger (Gage *et al*. 1983).

Larval stage: planktotrophic (Tyler & Pain 1982).

Remarks: the geographic distribution of the relatively poorly known asteroid *Dytaster insignis* is based on a few isolated reports. Cherbonnier & Sibuet (1972) recorded the species *Dytaster exilis* in the Azores (*Jean Charcot*, *Noratlante* cruise: sta P62C03: 36°47'4"N, 27°11'7"W, 3,670 m; sta P65B10: 36°58'2"N, 26°20'W, 2,871 m), remarking that the specimens were close to the variety *carinata*. A.M. Clark & Downey (1992) listed this variety as a synonym of *D. grandis grandis*, a subspecies already known from the Azores. However, Cherbonnier & Sibuet (1972) concluded that though close to the variety '*carinata*', the total absence of pedicellaria on the dorsal surface of the disc and arms placed the specimens close as well to the *D. exilis* type, a species presently accepted as *D. insignis* (Downey 1973). Using the presence/absence of pedicellaria on dorsal surface as diagnosing character alone and comparing with the descriptions by A.M. Clark & Downey (1992) of both *D. grandis grandis* and *D. insignis*, we are inclined to include the Azorean specimens under the latter species. Furthermore, Dilman (2014) seems to agree with our conclusions, and listed Cherbonnier & Sibuet (1972) Azorean record under this species. Overall, the record from the Azores together with the reports to the Rockall Trough (Gage *et al*. 1983) and to the Charlie-Gibbs Fracture Zone, on the Mid-Atlantic Ridge north of the Azores (Dilman 2013) further substantiate the presence of this species in the East Atlantic.

Dytaster intermedius Perrier, 1891

Reports for the Azores:

Dytaster intermedius $Perrier, 1891: 271, 1896a: 48, pl. 3, figs. 2, 2a, 2b; Mortensen 1927: 55; A.M. Clark & Downey 1992: 54–55; García–Diez *et al*. 2005: 46.

Type locality: Azores (41°40'41"N, 29°04'23"W).

See: Perrier (1891, 1896a); A.M. Clark & Downey (1992: 54–55).

Occurrence: known only from the type material collected in Azores (Perrier 1896a).

Depth: 2,870 m (AZO, Perrier 1896a).

Habitat: soft sediments (muddy sand, Perrier 1896a).

Remarks: A.M. Clark & Downey (1992) believed that this species might represent a juvenile of another *Dytaster* species. According to our knowledge the question is still pending and the type material of *D. intermedius* has not been revised to date.

Dytaster mollis (Perrier, 1885c)

Reports for the Azores:

Crenaster mollis Perrier, 1885c—$Perrier 1894: 310–312, pl. 18, fig. 3;
Dytaster (*Crenaster*) *mollis* Perrier, 1885c—Mortensen 1927a: 55;
Dytaster mollis (Perrier, 1885c)—$A.H. Clark 1949: 372–373; $A.M. Clark & Downey 1992: 55, pl. 16, figs. E–F; Dilman 2014: 26.

Type locality: Azores (38°38'00"N, 25°05'46"W).

See: Perrier (1894); A.M. Clark & Downey (1992).

Occurrence: known only from the Azores.

Depth: 2,560–2,995 m (AZO).

Habitat: soft mud.

Remarks: *Dytaster mollis* is known only from a few specimens, all less than 45 mm in length, collected by

Talisman and *Atlantis* in the Azorean deep waters. A.M. Clark & Downey (1992) believed that this species might represent juveniles of another *Dytaster* species.

Genus *Persephonaster* Wood-Mason & Alcock, 1891

Persephonaster patagiatus (Sladen, 1889)

Reports for the Azores:
non *Psilaster andromeda* (Düben & Karen, 1846)—$^{\$}$Perrier 1896a: 51 [misidentification];
Psilasteropsis patagiatus (Sladen, 1889)—$^{\$}$Koehler 1909: 62–63, pl. 3, fig. 2, pl. 4, fig. 3, pl. 19, fig. 1, 1921a: 2; Farran 1913: 7; Grieg 1932: 19;
Persephonaster patagiatus (Sladen, 1889)—Mortensen 1927a: 65–66, fig. 37; A.M. Clark & Downey 1992: 63–64, figs. 14d, 15f–g, pl. 19, figs. A–C; García-Diez *et al*. 2005: 46; Dilman 2006: 180, 2014: 27;
Psilaster patagiatus Sladen, 1889—Gage *et al*. 1983: 275.

Type locality: off Cape Verde.

See: A.M. Clark & Downey (1992); Benavides-Serrato *et al*. (2011: 127).

Occurrence: North Atlantic, from the Denmark Strait (SW of Iceland; A.M. Clark & Downey 1992), south of the Rockall Trough (Harvey *et al*. 1988) to NW Africa , including the Azores, Madeira and Cape Verde (Koehler 1909); also reported for the Gulf of Mexico and the Caribbean (A.M. Clark & Downey 1992).

Depth: 730–2,970 m (A.M. Clark & Downey 1992); AZO: 1,095–1,919 m (Koehler 1909).

Habitat: soft sediments (Koehler 1909).

Larval stage: lecithotrophic (A.M. Clark & Downey 1992).

Remarks: Perrier (1896a) reported *Psilaster andromeda* based on material collected by *Hirondelle* in the Azores. Later, Koehler (1909) re-examined the material and concluded that Perrier confused *P. andromeda* with *Persephonaster patagiatus* (= *Psilasteropsis patagiatus*), and reassigned the specimens to the latter species (see remarks under *P. andromeda andromeda*).

Persephonaster sphenoplax (Bell, 1892)

Reports for the Azores:
Astropecten sphenoplax Bell, 1892—$^{\$}$Koehler 1909: 42, pl. 17, fig. 8; Mortensen 1927a: 59; Cherbonnier & Sibuet 1972: 374;
Persephonaster humilis (Koehler, 1907a)—$^{\$}$Koehler 1909: 61–62, pl. 19, figs. 2–4; Mortensen 1927a: 64;
Persephonaster sphenoplax (Bell, 1892)—$^{\$}$A.M. Clark & Downey 1992: 65–66, figs. 14e, f. h–j, I, 15i, j, pl. 20, figs. A–C; García-Diez *et al*. 2005: 46.

Type locality: NW of Ireland.

See: A.M. Clark & Downey (1992).

Occurrence: Northeast Atlantic, from the Rockall Trough (A.M. Clark & Downey 1992) to the northern part of the Bay of Biscay (Cherbonnier & Sibuet 1972) and in the Azores (Koehler 1909); possibly also in the SE of Florida (A.M. Clark & Downey 1992).

Depth: (?675)820–1,187 m (AZO: 845–1,187 m; Koehler 1909, A.M. Clark & Downey 1992).

Habitat: soft to hard substrates (Koehler 1909).

Remarks: A.M. Clark & Downey (1992) remarked that Bell's incomplete original descriptions might have led Koehler (1909) to fail to recognise *Persephonaster sphenoplax* in the Azorean material he used to erect *Persephonaster humilis*. The former authors compared material belonging to both species and concluded them to be conspecific, dismissing morphological differences as size-related.

Genus *Plutonaster* Sladen, 1889

Species *Plutonaster agassizi* Verrill, 1880

Plutonaster agassizi notatus Sladen, 1889

Reports for the Azores:

Plutonaster notatus $Sladen, 1889: 97–99, pl. 14, figs. 6–7, pl. 15, figs. 5–6; Perrier 1894: 318–319; $Perrier 1896a: 49; $Koehler 1909: 17–18, pl. 3, fig. 5, pl. 10, figs. 7–12, 1921a: 2; Mortensen 1927a: 63;
Plutonaster abbreviatus $Sladen, 1889: 99–100; Perrier 1894: 313; Mortensen 1927a: 63;
Plutonaster inermis (Perrier, 1885c)—$Perrier 1896a: 49;
Plutonaster granulosus Perrier, 1891—$Perrier 1896a: 49–50, pl. 4, figs. 2, 2a–2d;
Plutonaster rigidus Sladen, 1889—$Koehler 1909: 19–22, pl. 4, fig. 6, pl. 10, figs. 5–6, 1921a: 2; Mortensen 1927a: 63;
Plutonaster agassizi Verrill, 1880—Grieg 1932: 14–15, pl. 4, figs. 2–4;
Plutonaster agassizi notatus Sladen, 1889—$A.M. Clark & Downey 1992: 70–71, pl. 17, figs. C–E; García-Diez *et al.* 2005: 46–47; $Dilman 2008: 134–135.

Type locality: Azores (38°30'N, 31°14'W).

See: A.M. Clark & Downey (1992); Dilman (2008).

Occurrence: Northeast Atlantic, from the Charlie-Gibbs Fracture Zone in the Mid-Atlantic Ridge and off SW Ireland (*c.* 53°N, 20°W) to the Bay of Biscay and the Azores (A.M. Clark & Downey 1992), possibly in the Canaries and Madeira as well (Perrier 1894, Koehler 1909); the subspecies *P. agassizi agassizi* Verrill, 1880 is known from south of Newfoundland to the Caribbean and the Gulf of Mexico, as well as the Cape Verde Archipelago, Ascension Island and South Africa (A.M. Clark & Downey 1992).

Depth: 969–4,252 m (Dilman 2008); AZO: 1,165–2,178 m (Koehler 1909).

Habitat: soft substrates, ooze to muddy sand and rock (Perrier 1894, Koehler 1909).

Remarks: through the historical literature, several *Plutonaster* species were described from the Azores, including two species by Sladen (1889) based on specimens collected by H.M.S. *Challenger* in the Azores: *P. notatus* (sta 73: 38°30'N, 31°14'W, 1,829 m) and *P. abbreviatus* (sta 78: 37°24'N, 25°13'W, 1,829 m). Perrier (1891, 1896a) described *P. granulosus* based on the material collected by *Hirondelle* in the same area. The forms *P. inermis* and *P. rigidus* were also recorded from the Azorean waters respectively by Perrier (1896a) and Koehler (1909, 1921a). A.M. Clark & Downey (1992) concluded that all the above were conspecific and included all Azorean records in the subspecies *P. agassizi notatus*.

Genus *Psilaster* Sladen, *in* Thomson & Murray, 1885

Species *Psilaster andromeda* (Müller & Troschel, 1842)

Psilaster andromeda andromeda? (Müller & Troschel, 1842)

Reports for the Azores:

p.p. *Psilaster andromeda* (Düben & Karen, 1846)—?$Perrier 1894: 195–196; Perrier 1896a: 17, 1896a: 51;
Psilaster andromeda (Müller & Troschel, 1842)—?$Koehler 1909: 60, pl. 2, fig. 3, pl. 16, figs. 8–9; Koehler 1924: 205; Mortensen 1927a: 59–60, fig. 33; Marques 1980: 100; Gage *et al*. 1983: 274–275;
Psilaster andromeda andromeda (Müller & Troschel, 1842)—García-Diez *et al*. 2005: 47.

Type locality: Kattegat (probably off Bohuslan, western Sweden).

See: A.M. Clark & Downey (1992: 77–78, figs. 14a, 15a–c, k, I, pl. 21, figs. D–G); Dilman (2006: 180).

Occurrence: Northeast Atlantic cold waters, from the Arctic south to the SE of Greenland, the Reykjanes Ridge, Iceland-Faeroe Rise and from Scandinavia to the Bay of Biscay (A.M. Clark & Downey 1992, Dilman 2006) and the ?Azores (Koehler 1909); the subspecies *P. andromeda florae* (Verrill, 1889) is known from south of Newfoundland to SE of Cape May, New Jersey (*c.* 38°30'N; A.M. Clark & Downey 1992).

Depth: 70–2,965 m (A.M. Clark & Downey 1992, Dilman 2006); ?AZO: 140–1,440 m (Perrier 1894, Koehler 1909).

Habitat: soft sediments (mud or ooze; A.M. Clark & Downey 1992); predates on molluscs, echinoderms (young spatangoids), foraminifera, etc. (Mortensen 1927a).

Remarks: A.M. Clark & Downey (1992) reviewed the bathymetrical and geographical distributions of *Psilaster andromeda* and concluded that it could not be established with certainty. One of the main contributing factors is that this highly variable species has been frequently confused with other similar species, such as *Persephonaster patagiatus* and *P. sphenoplax*, both overlapping the geographic distribution of *Psilaster andromeda andromeda*. They further suggest that records south of the Bay of Biscay are zoogeographically unlikely, thus implying that the only known Azorean records by Perrier (1894, 1896a) are misidentifications. Historically, Koehler (1909) had already questioned the validity of the determinations made by Perrier on the material from the *Talisman* and *Hirondelle* stating that the later author confused *P. andromeda* with *P. patagiatus*. On re-examination of the material taken by *Hirondelle* Koehler confirmed his suspicions and remarked that all specimens belonged to the latter species. As for the material collected by *Talisman*, Koehler commented that both species were present. However, A.M. Clark & Downey (1992) suspected that Koehler himself confused *P. andromeda* with *P. sphenoplax*. Additionally, on finding a great variability of the diagnostic characters for *P. andromeda* subspecies Dilman (2006) showed some concerns on their subspecific value.

Family Luidiidae Sladen, 1889

Genus *Luidia* Forbes, 1839

Luidia ciliaris (Philippi, 1837)

Reports for the Azores:

Luidia ciliaris (Philippi, 1837)—$Döderlein 1920: 287–288, figs. 8, 17, 34; Madsen 1950: 205–206, fig. 8; A.M. Clark 1982a: 170, fig. 3k; Gage *et al*. 1983: 272; A.M. Clark & Downey 1992: 11–12, figs. 7k, 8h, pl. 2, fig. E; Sneli 1999: 233; ?$Wirtz 2009: 46–47; Micael *et al*. 2012: 5.

Type locality: Sicily, Mediterranean Sea.

See: A.M. Clark (1982a); A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic; from Scandinavia, the Faeroe Channel (Sneli 1999) south to Morocco (Mortensen 1925) and ?Cape Verde (A.M. Clark (1982a), including the Azores, Madeira (Döderlein 1920) and Canaries (Madsen 1950).

Depth: 1–650(?805) m (A.M. Clark 1982a, Gage *et al*. 1983), typically from 25 to 200 m (Madsen 1950); AZO: ?littoral.

Habitat: hard to soft sediments, often found partly buried in gravel (Picton 1993).

Larval stage: planktotrophic (Mortensen 1921).

Remarks: the first record of *Luidia ciliaris* in the Azores can be trace back to Döderlein's (1920) review of the genus, which included a specimen collected in the archipelago from the Simroth collection, though the later author never included any material belonging to this species or genus in his 1888's report. More recently, Wirtz (2009) reported an animal of *Luidia ciliaris* in a large tide-pool at Faial Island (not collected). The latter author claimed that a picture could be found in Wirtz & Debelius (2003), however, the photographed specimen in the 2003 work is from Madeira. The absence of documented specimens in the archipelago in over 80 years places the presence of this species in the Azores in a somewhat precarious position and thus, should be dealt with caution.

Species *Luidia sarsii* Düben & Koren, *in* Düben, 1844

Luidia sarsii sarsii Düben & Koren, *in* Düben, 1844

Reports for the Azores:

Luidia sarsii Düben & Koren, *in* Düben, 1844—$Koehler 1909: 59; $Grieg 1932: 24; $Tortonese 1965: 150–152, fig. 69; A.M. Clark 1982a: 175–180, figs. 1c, 2c, g, 3m–o, v, 6; Sneli 1999: 233–234;

Luidia sarsii sarsii Düben & Koren, 1845—Gage *et al*. 1983: 272; A.M. Clark & Downey 1992: 18–20, figs. 7m, n, v, 8i, pl. 2, fig. B; Pereira 1997: 336; García-Diez *et al*. 2005: 47; Micael & Costa 2010: 322; Micael *et al*. 2012: 5.

Type locality: Norway (lectotype).

See: A.M. Clark (1982a); A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Norway and the Faeroe Bank (Sneli 1999) south to Cape Blanc (Mauritania; A.M. Clark 1982a) including the Azores (Koehler 1909); the subspecies *L. sarsii africana* Sladen, 1889 is restricted to Namibian and South African waters, whereas the subspecies *L. sarsii elegans* Perrier, 1875 is known from the western Atlantic waters (A.M. Clark 1982a).

Depth: 9–1,300 m (Sneli 1999); tends to live in deeper cold waters at its southern geographical range (Picton 1993); AZO: ?100–200 m (Koehler 1909, Grieg 1932).

Habitat: mud, shell-sand, gravel and stones (Sneli 1999); night-active, burying itself in the sand during the day (Picton 1993).

Larval stage: planktotrophic (Domanski 1984).

Remarks: the presence of *Luidia sarsii* in the Azores is based solely on three historical records. Koehler (1909) identified a small damaged specimen (R ≈ 50 mm) among the material retrieved by a bottom trawl at Princesse Alice Seabank (sta 899: 37°57'00"N, 29°14'45"W, 200 m). Interestingly, the second known record is from Grieg (1932) who identified a juvenile (with adhering remnants from the larval stage; R = 4.5 mm) in a pelagic haul at a depth of just 100 m, 3,139 m above the reported bottom depth. This animal may well represent a late stage in what has been designated in the literature as 'giant larvae'. *Luidia sarsii* is characterized by an abnormal large bipinnaria larva capable of maintaining planktotrophic activity in the water column long after the development of the post-larval sea star rudiment (see Domanski 1984). Tortonese (1965) is responsible for the most recent record of this species in the Azores, though he listed material from the archipelago without giving further details on the source of the material. Regardless, the scarcity of documented records could be a result of the apparent bathymetrical distribution of this species in the archipelago, which coincides with the least studied depth range in the area (>50 and <200 m).

Family Porcellanasteridae Sladen, 1883

Genus *Hyphalaster* Sladen, 1883

Hyphalaster inermis Sladen, 1883

Reports for the Azores:

Hyphalaster antonii $^{\$}$Perrier, 1885c: 61–64, 1894: 232–235, pl. 16, fig. 1; Koehler 1909: 29–30;

Hyphalaster parfaiti Perrier, 1885c—Mortensen 1927a: 52; $^{\$}$Lieberkind 1935: 19–25, figs. 6–8, pl. 1, figs. 7–9, pl. 3, figs. 1–2, pl. 4, figs. 11–14; $^{\$}$A.H. Clark 1948: 75;

Hyphalaster inermis Sladen, 1883—$^{\$}$Madsen 1961: 58–71, figs. 6–7, pl. 1, figs. 1–14, pl. 2, figs. 1–4, pl. 3, figs. 1–4, pl. 13, figs. 3–4.

Type locality: off Japan (34°37'N, 140°32'E), Pacific Ocean.

See: Madsen (1961); A.M. Clark & Downey (1992: 98–99, figs. 18g–i, 19a–b, j, pIs. 26, figs. A–C).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian deep water (A.M. Clark & Downey 1992); from the Davis Strait and SW of Greenland (Madsen 1961), south to Caribbean waters (A.M. Clark & Downey 1992), eastwards in the Mid-Atlantic Ridge (Dilman 2013) and from the Rockall Trough to Angola (Sibuet 1975), including the Azores and Cape Verde archipelagos (Perrier 1894, Koehler 1909); recorded also from the Meteor seamounts (Madsen 1961, Howell *et al*. 2003).

Depth: 1,444–5,430 m (Dilman 2013); AZO: 2,995–3,200 m (Perrier 1894, A.H. Clark 1948).

Habitat: soft substrates, *Globigerina* ooze, mud to clay (Koehler 1909, Madsen 1961).

Larval stage: lecithotrophic (Ramirez-Llodra *et al*. 2002).

Remarks: Perrier (1885c, 1894) described *Hyphalaster antonii* based on a single animal collected by *Talisman* in the Azores (sta 131, 1883: 38°28'00"N, 25°05'46"W, 2,995 m). In the report on the porcellanasterids collected by *Danish-Ingolf* expedition, Lieberkind (1935) reviewed the type material of *H. antonii* and established its synonymy with *H. parfaiti*, thus confirming previous suppositions that the Azorean species might represent a juvenile of the later species (*e.g.,* Ludwig 1907). Later, A.H. Clark (1948) reported seven specimens of *Hyphalaster parfaiti* from the archipelago collected by *Atlantis* (sta 15: 35°37'N, 30°51'W, 3,200 m). In a review of the family Porcellanasteridae, Madsen (1961) placed both *Hyphalaster* species reported in the Azores in the synonymy of the cosmopolitan *Hyphalaster inermis*.

Genus *Porcellanaster* Thomson, 1877

Porcellanaster ceruleus Thomson, 1877

Reports for the Azores:

Porcellanaster inermis $Perrier, 1885c: 50–53, 1894: 212–215, pl. 15, fig. 3; Mortensen 1927a: 52;

Porcellanaster ceruleus Thomson, 1877—$Lieberkind 1935: 5–19, figs. 1–5, pl. 2, figs. 1–8, pl. 3, fig. 12, pl. 5, figs. 16–17; Madsen 1961: 126–142, figs. 22–24; Dilman 2006: 179–180, 2008: 137, 2013: 568, 2014: 29.

Type locality: off Delaware, USA (38°34'N, 72°10'W).

See: Lieberkind (1935); Madsen (1961); A.M. Clark & Downey (1992: 100–101, figs. 18a–c, 19d, f, i, pl. 27, figs. A–Q); Dilman (2006; 2008).

Occurrence: deep-water cosmopolitan, except in the Antarctic; from the Davis Strait south to off Cape Cod, eastwards from south of Iceland along the European and African continental slopes to South Africa (Madsen 1961), and in the Azores and the Charlie-Gibbs Fracture Zone, in the Mid-Atlantic Ridge (Perrier 1894, Dilman 2008).

Depth: 1,158–6,035 m, mostly between 1,600–3,000 m (Madsen 1961); AZO: 2,995 m (Perrier 1894).

Habitat: soft substrates, mud, *Globigerina* ooze to clay (Madsen 1961); juveniles prey on foraminiferans and adults are deposit-feeders, burrowing in the sediment (Sumida *et al*. 2001).

Larval stage: lecithotrophic (Sumida *et al*. 2001).

Remarks: Perrier (1885b, c , 1894) described *Porcellanaster inermis*, to house the specimens collected by *Talisman* at waters between Cape Verde and NE Africa (sta 101, 1883: 16°38'00"N, 18°23'46"W, 3200 m) and in the Azores (sta 131, 1883: 38°38'N, 25°05'46"W, 2995 m). On his report on the porcellanasterids from the Danish-Ingolf expedition, Lieberkind (1935) established the synonymy of *P. inermis* with *P. ceruleus*. With the exception of the three specimens collected by *Talisman* no other animals belonging to this species were ever reported from Azorean waters.

Genus *Styracaster* Sladen, 1883

Styracaster armatus Sladen, 1883

Reports for the Azores:

Styracaster spinosus $Perrier, 1885c: 55–59, 1894: 223–226, pl. 17, fig. 2; Sladen 1889: 728; $Koehler 1909: 39–40; $Madsen 1961: 121–123, fig. 37;

Styracaster armatus Sladen, 1883—A.M. Clark & Downey 1992: 102–103, pl. 27, figs. G–H; García-Diez *et al*. 2005: 47; Dilman 2008: 137, 2013: 568–569.

Type locality: off the Caroline Islands (Pacific, 7°45'N, 144°20'E).

See: Madsen (1961); A.M. Clark & Downey (1992).

Occurrence: cosmopolitan, known from the Atlantic, Indian and West Pacific deep waters (A.M. Clark & Downey 1992); in the Atlantic from the Guyana Basin eastwards in the waters between NW Africa and the Cap Verde Archipelago (Perrier 1894) and in the Canary Basin north to the Porcupine Seabight (SW of Ireland; A.M. Clark & Downey 1992); in the Mid-Atlantic Ridge, from the Charlie-Gibbs Fracture Zone (Dilman 2008) south to the Azores (Koehler 1909).

Depth: 2,700–5,422 m (Dilman 2013); AZO: 2,995–4,020 m (Perrier 1894, Koehler 1909).

Habitat: soft substrates, *Globigerina* ooze, mud or muddy sand (Madsen 1961).

Remarks: Perrier (1885b, c, 1894) described *Styracaster spinosus* based on two specimens collected by *Talisman* in the Azores (sta 131, 1883: 38°38'00"N, 25°05'46"W, 2,995 m). Koehler (1909) also reported this species from the Azores based on animals collected by *Princesse Alice* at two stations (sta 527: 38°09'00"N, 23°15'45"W, 4,020 m; sta 745: 38°05'00"N, 23°50'15W", 3,465 m). The material from both cruises was later reviewed by Madsen (1961) in his review of the family Porcellanasteridae as it was the only material known to belong with certainty to this species. Regardless, this species is now considered conspecific with the cosmopolitan *S. armatus* (A.M. Clark & Downey 1992).

Styracaster elongatus Koehler, 1907a

Reports for the Azores:

Styracaster elongatus Koehler, 1907a—$Koehler 1909: 33–38, pl. 19, figs. 5–6, pl. 20, figs. 1, 3–4, pl. 21, figs. 3–5; Madsen 1961: 110–113, fig. 19, pl. 10, figs. 1–2; Sibuet 1975: 101; García-Diez *et al*. 2005: 47.

Type locality: East of the Azores (37°17'N, 20°14'W).

See: Madsen (1961); A.M. Clark & Downey (1992: 103–104, fig. 19k, pl. 27, fig. I).

Occurrence: Indian and Atlantic Oceans (Madsen 1961); from the Gulf of Mexico and Caribbean deep waters (A.M. Clark & Downey 1992), eastwards to the Azores (Koehler 1909), the Porcupine Abyssal Plain (SW Ireland; Howell *et al*. 2002) southwards to the Angola Basin (Sibuet 1975).

Depth: 3,310–6,600 m (A.M. Clark & Downey 1992); AZO: 4,020 m (Koehler 1909).

Habitat: soft sediments, *Globigerina* ooze and sandy mud (Madsen 1961).

Remarks: *Styracaster elongatus* is known from the Azores based on a single specimen reported by Koehler (1909; *Princesse Alice*, sta 527: 38°09'00"N, 23°15'45"W, 4,020 m). The scarcity of local records can be explained by the species' known depth range both in the Azores (>4,000 m) and through its geographical range (>3,000 m).

Family Pseudarchasteridae Sladen, 1889

Genus *Paragonaster* Sladen, *in* Thomson & Murray, 1885

Paragonaster subtilis (Perrier, 1881)

Reports for the Azores:

Pentagonaster elongatus Perrier, 1885c—$Perrier 1885c: 38;
Goniopecten subtilis Perrier, 1881—$Perrier 1885c: 41;
Paragonaster elongatus (Perrier, 1885c)—$Perrier 1894: 362–363 pl. 21, fig. 3, pl. 24, fig. 4; Verrill 1899: 196;
Paragonaster subtilis (Perrier, 1881)—$Perrier 1894: 358–362 pl. 23, fig. 5, pl. 24, fig. 3; $Koehler 1909: 86–87, pl. 4, fig. 2; Mortensen 1927a: 79; $Halpern 1972: 374–378, figs. 5–6; Downey 1973: 57, pl. 22, figs. A, B; Sibuet 1975: 108; Gage *et al*. 1983: 280; A.M. Clark & Downey 1992: 256–257, pl. 62, figs. C, D; García-Diez *et al*. 2005: 47; $Dilman 2008: 140, 2014: 33.

Type locality: Gulf of Mexico (24°33'N, 84°23'W).

See: Halpern (1972); A.M. Clark & Downey (1992).

Occurrence: Atlantic, in the west from off New York, south to the Gulf of Mexico (Halpern 1972), in the east from the Rockall Trough (Gage *et al*. 1983) to the Gulf of Guinea (Sibuet 1975), including the Azores and Cape Verde archipelagos (Koehler 1909).

Depth: 1,058–4,825 m (Halpern 1972); AZO: 2,954–4,261 m (Koehler 1909, Dilman 2008).

Habitat: soft substrates (ooze; Gage *et al*. 1983).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: *Paragonaster subtilis* is a highly variably species and was described in the literature under several names (see A.M. Clark & Downey 1992). For example, Perrier (1885c, 1894) described *Paragonaster elongatus* (= *Pentagonaster elongatus*) based on material collected by *Talisman* at the same station in the Azores (sta 131, 1883: 38°38'00"N, 25°05'46"W, 2,995 m) where the same author recorded also *P. subtilis*. At the time, Perrier remarked that the former might represent just a variety of later species. Halpern (1972) re-examined the type material including that of *P. elongatus* from the Azores and synonymized the two species.

Genus *Pseudarchaster* Sladen, 1889

Species *Pseudarchaster gracilis* (Sladen, 1889)

Pseudarchaster gracilis gracilis (Sladen, 1889)
(Fig. 16)

Reports for the Azores:

Aphroditaster gracilis $Sladen, 1889: 117–120, pl. 17, figs. 1–2, pl. 18, figs. 7–8; Verrill 1899: 195;
Astrogonium gracile Sladen, 1889—Perrier 1894: 342;
Astrogonium necator $Perrier, 1894: 350–355, pl. 23, fig. 1; $Koehler 1909: 74–75;
Pseudarchaster necator (Perrier, 1894)—Verrill 1899: 195; Mortensen 1927a: 86;
Astrogonium aequabile Koehler, 1907a—$Koehler 1909: 66–68, pl. 11, figs. 1–4;
Astrogonium eminens, Koehler, 1907a—$Koehler 1909: 68–71, pl. 16, figs. 3–6;
Astrogonium marginatum $Koehler, 1909: 71–73, pl. 14, figs. 1–4, 1921a: 2;
Pseudarchaster aequabile (Koehler, 1907a)—Mortensen 1927a: 86;
Pseudarchaster eminens (Koehler, 1907a)—Mortensen 1927a: 86;
Pseudarchaster marginatus (Koehler, 1909)—Mortensen 1927a: 86;
Pseudarchaster gracilis (Sladen, 1889)—Mortensen 1927a: 86; $Halpern 1972: 360–366, figs. 1–2; Downey 1973: 59–60, pl. 23, figs. C, D; Walenkamp 1979: 44–47, figs. 16, 19, pl. 10, figs. 1–4; Gage *et al*. 1983: 279–280; *Pseudarchaster gracilis gracilis* (Sladen, 1889)—$A.M. Clark & Downey 1992: 262–263, pl. 62, figs. E–F; García-Diez *et al*. 2005: 47; Benavides-Serrato *et al*. 2011: 170–171.

Type locality: Azores (37°24'N, 25°13'W).

See: Halpern (1972); Walenkamp (1979); A.M. Clark & Downey (1992); Benavides-Serrato *et al*. (2011).

Occurrence: North Atlantic, from Flemish Cap, off Cape Cod (Murillo *et al*. 2015), and from Faeroe waters (Lousy Bank; Sneli 1999), south to the Equator on the both sides of the Atlantic and in the Charlie-Gibbs Fracture Zone (Dilman 2008) and the Azores Archipelago (Koehler 1909) in the Mid-Atlantic Ridge; the subspecies *P. gracilis tessellatus* Sladen, 1889 is restricted to southern Africa (A.M. Clark & Downey 1992).

Depth: 270–2,940 m (Benavides-Serrato *et al*. 2011); AZO: 903–1,940 m).

Habitat: soft substrates, *Globigerina* ooze to fine sand and stones (Koehler 1909, Sneli 1999).

Larval stage: direct or lecithotrophic (Halpern 1972).

Material examined: EMEPC-LUSO L09D18B1 (N of SJG, AZO, 38°42'18"N, 28°01'18"W, 2009.10.02, 903 m; 1 spm, R = 102 mm, r = 31 mm).

Description: stellate and flat body form (R/r = 3.3) with narrow, tapering arms terminating in an acute point; wide, rounded interbrachial arcs. Abactinal plates paxillose, extending to terminal plates. Paxillae proximally hexagonal becoming more square-shaped distally, covered with rounded, flattened central granules and one peripheral row of short, slender spinelets. Madreporite rhombic, small, about one and one-half times the size of the adjacent abactinals, located about three quarters from the centre of the disc and to middle of the interbrachial arc. Anus small, located more or less at the centre of the disc. Superomarginal and inferomarginal plates corresponding; 36 in each side of the arm. Lateral angle of superomarginals compressed so that plates are broad and mainly in the vertical plane; superomarginals closely covered by large, rounded, and flattened granules. Inferomarginals covered by short triangular spinules interspersed by conical spines which are about three times larger. Each actinal plate covered by short spinules and one, rarely two or three larger spines. Actinal spines and spinules similar to those on inferomarginals. One pectinate pedicellariae between every two adjacent actinal plates along row contiguous to adambulacrals, particularly conspicuous in the proximal region; pedicellaria along entire width of plate. Adambulacral plates with angular furrow margin bearing six up to nine somewhat flattened furrow spines with blunt tips. Subambulacral spines irregularly arranged in two rows of intermediate shape and size between the actinal and the furrow spines. Each mouth plates bearing ten furrow spines similar to the adambulacral furrow spines, with a large, thick, unpaired median spine at apex of each mouth plate pair. Rest of each plate covered by spines grading progressively into actinal spinules distally.

Remarks: the highly variable *Pseudarchaster gracilis gracilis* was described for the Azores under five different names (Sladen 1889; Perrier 1894; Koehler 1909, 1921a). Halpern (1972) re-examined the type material from the archipelago and established the synonymy. A.M. Clark & Downey (1992) also analysed the type material of *P. gracilis* described by Sladen (1889; as *Aphroditaster gracilis*) based on specimens collected in Azores by H.M.S. *Challenger* and demoted *P. tessellatus* to a subspecies of *P. gracilis*.

The North Atlantic subspecies *P. gracilis gracilis* can be distinguished from *P. parelii* also occurring in the Azores (see below) by the conical shape and larger size of the actinal and inferomarginal spines. Additionally, *P. parelii* generally has poorly developed pedicellaria and fewer adambulacral and mouth furrow spines (Halpern 1972). This present record substantiates the historical records.

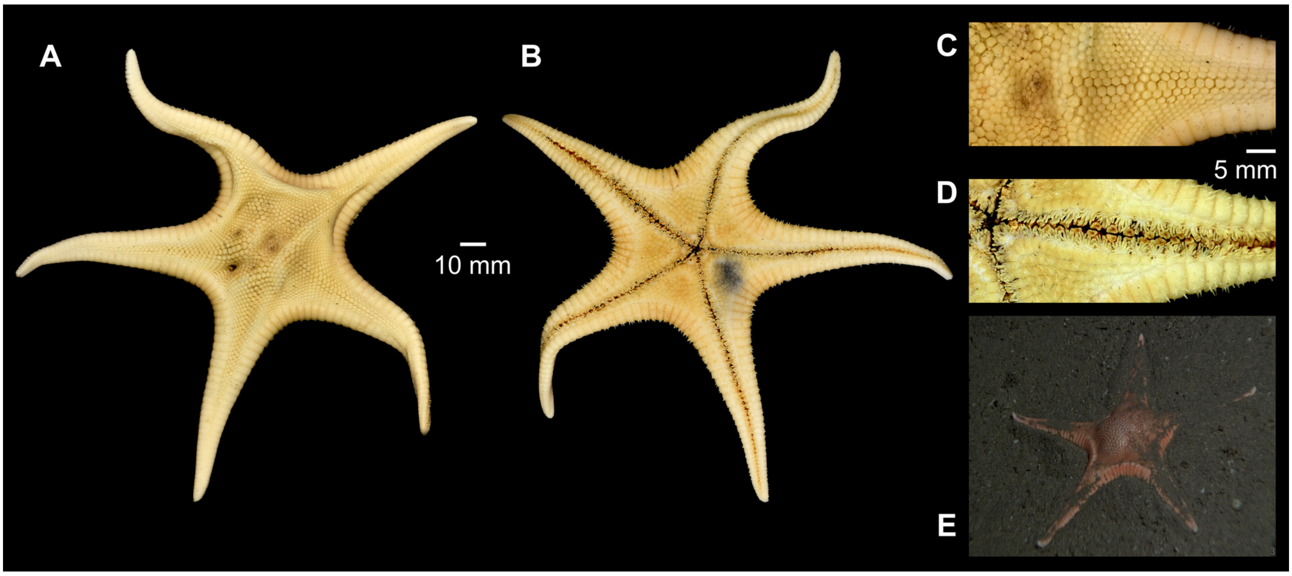

FIGURE 16. *Pseudarchaster gracilis gracilis* (Sladen, 1889) (EMEPC–LUSO L9D18B1). Dorsal view (A); ventral view (B); detail of the disc and arm, dorsal view (C) and ventral view (D); animal *in situ* (38°42'18"N, 28°01'18"W, 2009.10.02, 903 m; E).

Pseudarchaster parelii (Düben & Koren, 1846)

Reports for the Azores:

Astrogonium fallax $Perrier, 1885c: 37, 1894: 347–350, pl. 23, fig. 4, pl. 25, fig. 4; $Koehler 1909: 71, pl. 18, fig. 2; Grieg 1932: 21, pl. 5, fig. 1;
Astrogonium annectens Perrier, 1894—$Perrier 1896a: 45; $Koehler 1909: 65;
Pseudarchaster (*Astrogonium*) *fallax* (Perrier, 1885c)—$Koehler 1921a: 2; Mortensen 1927a: 86;
Pseudarchaster (*Astrogonium*) *annectens* (Perrier, 1894)—Mortensen 1927a: 86;
Pseudarchaster parelii (Düben & Koren, 1846)—$Halpern 1972: 366–370, fig. 5; Gage *et al.* 1983: 279; García-Diez *et al.* 2005: 47.

Type locality: Off Kristiansund, Norway.

See: Halpern (1972); Clark & Downey (1992).

Occurrence: North Atlantic, from the Barents Sea, Newfoundland, and southern Greenland, southwards to Florida; and from Iceland and Norway to Mauritania, including the Azores (Halpern 1972, A.M. Clark & Downey 1992).

Depth: 75–3,540 m (Dilman 2006); AZO: 1,165–1,900 m (Koehler 1909).

Habitat: soft sediments, such as ooze, sand, gravel and stones (Sneli 1999).

Larval stage: lecithotrophic (McEdward & Miner 2001).

Remarks: Halpern (1972) re-examined the material described by Perrier (1885c, 1894) as *Pseudarchaster fallax* (= *Astrogonium fallax*) and *P. annectens* (= *Astrogonium annectens*) from the Azores waters and established their synonymy with *P. parelii*.

Superorder Spinulosacea Blake 1987

Order Spinulosida Perrier, 1884

Family Echinasteridae Verrill, 1867

Genus *Henricia* Gray, 1840

Henricia cylindrella? (Sladen, 1883)

Reports for the Azores:

Cribrella abyssalis Perrier, 1894—?$Koehler 1909: 102;

Henricia abyssalis (Perrier, 1894)—Farran 1913: 26; Mortensen 1927a: 118;

Henricia cylindrella (Sladen, 1883)—?$Madsen 1987: 231–235, figs. 2g, 21–23; ?$A.M. Clark & Downey 1992: 390–391, figs. 60a(?), f–g, pl. 93, fig, B, pl. 94, fig. G; García-Diez *et al*. 2005: 47.

Type locality: NW Scotland (59°29'N, 07°13'W) (lectotype).

See: Grieg (1932: 30, as *Cribrella abyssalis*); Madsen (1987); A.M. Clark & Downey (1992).

Occurrence: Northeast Atlantic, from the northern Rockall Trough south to the Porcupine Seabight, SW Ireland (A.M. Clark & Downey 1992) and the Charlie-Gibbs Fracture Zone (Dilman 2013); probably also extending to the Azores and to waters between Canaries and Morocco (Perrier 1894, Koehler 1909).

Depth: 1,015–2,620 m (Dilman 2013); ?AZO: 1,482–1,805 m (Koehler 1909).

Habitat: soft substrates (?AZO: *Globigerina* ooze; Koehler 1909).

Remarks: in a preliminary report, Perrier (1885c) described a new species *Cribrella abyssicola*, which in his 1894 report was renamed *Cribrella abyssalis* based on material collected by *Talisman* from Morocco. Following the previous author, Koehler (1909) reported the same species from *Princesse Alice* material collected in the Azores, Portugal and NW Africa. In a review of the genus *Henricia* in the NE Atlantic, Madsen (1987) examined a single specimen (R = 43 mm, r = 6 mm) identified as *Cribrella abyssalis*, collected by *Talisman* in the Azores at a depth 1,257 m. Though Perrier (1885c, 1894) did not list any material from the Azores under his newly described species, the material examined by Madsen could represent an unreported specimen (*Talisman*, sta 127: 38°38'00"N, 28°20'46"W, 1,257 m). Madsen proposed that Perrier's species should be synonymized with Sladen's *Henricia cylindrella*. Nevertheless, this author noted that the specimen from the Azores presented slight differences (*i.e.* shorter arms) than the typical *H. cylindrella*. Madsen also listed Koehler's (1909) record of *Cribrella abyssalis* followed tentatively in the synonymy of *Henricia cylindrella*. A.M. Clark & Downey (1992) agreed with Madsen (1987) as they also found *Talisman* specimen from Azores very close to the lectotype of *Henricia cylindrella*. However, these authors were unable to confirm the conspecificity using the Moroccan type material of *H. abyssalis*. New material is needed to better understand the variability and relationship of *H. abyssalis/cylindrella* (see also remarks below under *H. oculata*).

Henricia oculata? (Pennant, 1777)

Reports for the Azores:

Cribrella oculata (Linck) Forbes—?$Perrier 1896a: 39;

Cribrella oculata, (Linck, 1733)—Koehler 1909: 102–103;

non *Henricia sanguinolenta* (Müller, 1776)—Koehler 1921b: 31, fig. 23, 1924: 126–127; Mortensen 1927a: 118–121; Nobre 1938: 39–40, fig. 14;

Henricia oculata (Pennant, 1777)—García-Diez *et al*. 2005: 47; Micael & Costa 2010: 322; Micael *et al*. 2012: 5–6.

Type locality: Anglesey, N. Wales (British Isles).

See: Madsen (1987: 254–257, figs. 3c, 44–45); A.M. Clark & Downey (1992: 393–394, figs. 60q, r, pl. 93, fig. E, pl. 95, figs. F–G).

Occurrence: Northeast Atlantic, known with certainty from the Shetland Islands south to Portugal (Madsen 1987); possibly extending west to Nova Scotia and New England north of Cape Cod (A.M. Clark & Downey 1992) and to the Azores (Perrier 1896a).

Depth: 0–?180 m (A.M. Clark & Downey 1992); ?AZO: 1,266–1,557 m (Perrier 1896a).

Habitat: hard substrates to shell gravel, found as well in sublittoral habitats with considerable hydrodynamics, from kelp forests, tidal streams and on vertical cliffs (Picton 1993).

Larval stage: lecithotrophic (Brun 1978).

Remarks: the highly polymorphic nature of *Henricia* (= *Cribrella*) species makes this genus as whole particularly difficult with a problematic historical synonymy (Madsen 1987; A.M. Clark & Downey 1992; Sneli 1999). For example, the species names *Henricia oculata* (Pennant, 1777) and *H. sanguinolenta* (Müller, 1776) are intermingled and considered synonymous by the time the great oceanographic expeditions reached the Azores

Archipelago. In the report of the asteroids collected by *Hirondelle*, Perrier (1896a) identified material under the name '*Cribrella oculata* (Linck) Forbes' collected at four stations, the first located east of Newfoundland at about 155 m and the remaining three within the Azorean waters between 1,266–1,557 m. Koehler (1909) in his report on the echinoderms collected by *Princesse Alice* also listed the name '*Cribrella oculata*, (Linck)' for specimens from the British Isles and Scandinavia. However, Koehler added also the name '*Cribrella sanguinolenta* (Müller)', remarking that these species were synonymous with *C. oculata* being the oldest. Later, however, the majority of the authors (*e.g.,* Koehler 1921b; Mortensen 1927a; Nobre 1938) adopted the name *H. sanguinolenta*, as Linck's name did not follow the binominal rules (Madsen 1987). It was only in the late 1970's that Pennant's *Henricia oculata* was again accepted as a distinct species (Madsen 1987). As a consequence, the true geographical and bathymetric range of *H. oculata* is still uncertain. The name as presented by Perrier is generally accepted under the synonymy of this species (*e.g.,* Madsen 1987; A.M. Clark & Downey 1992). On the other hand, the Azorean material was retrieved from depths that appear far too deep for *H. oculata* or even for *H. sanguinolenta*, both known from waters no deeper than 200 m. The matter is still pending.

Superorder Valvatacea Blake, 1987

Order Valvatida Perrier, 1884

Family Asterinidae Gray, 1840

Genus *Asterina* Nardo, 1834

Asterina gibbosa (Pennant, 1777)

(Fig. 17)

Reports for the Azores:

Asterina gibbosa Forbes, 1839—$Barrois 1888: 70;
Asteriscus sp.—?Simroth 1888: 231;
Asterina gibbosa (Pennant, 1777)—Koehler 1921b: 32–33, fig. 34, 1924: 131–133; Mortensen 1927a: 98–99, fig. 56; Tortonese 1965: 169–172, figs. 80–82; $A.M. Clark & Downey 1992: 184–185, figs. 30a, 31a, 32a–b, pl. 41, figs. H–J; Moyse & Tyler 1995: 667, fig. 12.3; $Morton *et al*. 1998: 143, fig. 7.4; Pereira 1997: 335; Micael & Costa 2010: 322; Micael *et al.* 2012: 6.

See: A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Scotland to the Azores and Canaries (Tortonese 1965).

Depth: 0–125 m (Mortensen 1927a); AZO: low intertidal to subtidal waters (Morton *et al*. 1998).

Habitat: rocky shores, under stones and crevices during the day (Crump & Emson 1983); also found among algae, sponges and in meadows of *Zostera* and *Posidonia* (Mortensen 1927a, Koukouras *et al.* 2007).

Larval stage: lecithotrophic larva (Haesaerts *et al*. 2006).

Remarks: *Asterina gibbosa* was reported for the first time from the archipelago by Barrois (1888), who remarked that they were quite common under boulders in the littoral of Faial and São Miguel islands (specimens presumably lost). Later, A.M. Clark & Downey (1992) found seven specimens belonging to this species among the zoological collection of the British Museum that reportedly came from the archipelago (no further data). Morton *et al*. (1998) recorded this small sea star from the low intertidal and subtidal of the Azores. Frias Martins one of the co-authors informed us that he frequently found *A. gibbosa* among the boulders in the shallow waters of São Miguel (Fig. 17). More recently, Micael *et al*. (2012) remarked that neither Nobre (1938), Marques (1983) nor themselves found this species in the Azorean shallow waters. Micael and co-authors (2012) suggested that *A. gibbosa* could have disappeared locally from the Azores. Overall, neither the cryptic behaviour nor the small size of *Asterina gibbosa* can explain its almost complete absence in the literature (*e.g.,* Drouët 1861; Chapman 1955; Marques 1983) and in the zoological collections (*e.g.,* DBUA-ECH, DOP, MB–NMHN) covering more than 150 years of zoological studies on the shallow-water fauna of the archipelago. Thus, *Asterina gibbosa* must be considered as a rare species in the Azores, the population density of which appears to vary significantly through time.

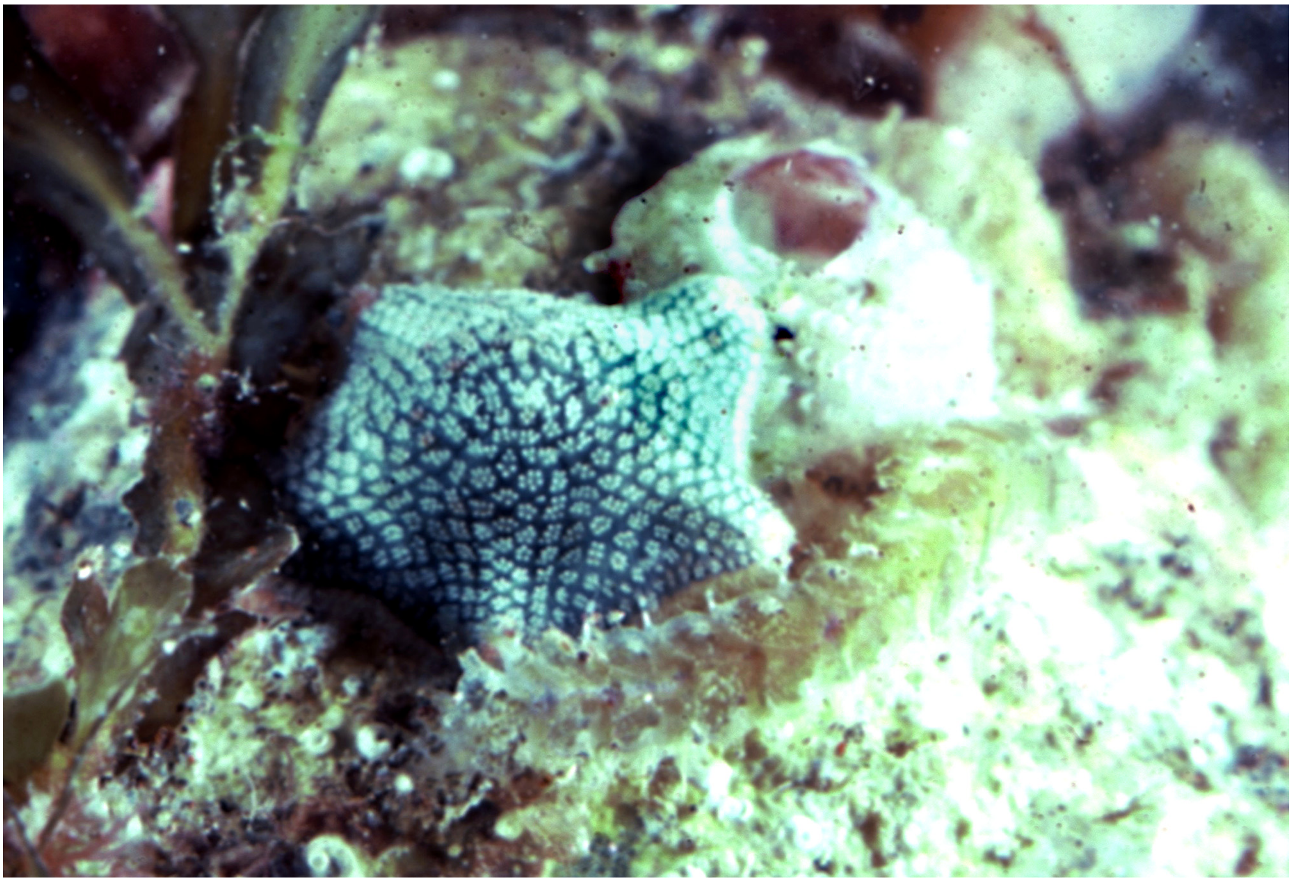

FIGURE 17. *Asterina gibbosa* (Pennant, 1777) *in situ* (São Miguel Island, Azores, *c.* 37°44'53"N, 25°37'56"W, 1985.06, intertidal).

Family Chaetasteridae Sladen, 1889

Genus *Chaetaster* Müller & Troschel, 1840b

Chaetaster longipes (Bruzelius, 1805)

Reports for the Azores:

Chaetaster longipes (Bruzelius, 1805)—$Sladen 1889: 399–400; Koehler 1909: 88–89, 1914b: 274, 1921b: 37–38, fig. 27, 1924: 140–143; Mortensen 1927a: 95; Tortonese 1965: 154–155, fig. 71; Pawson 1978: 9–10; A.M. Clark & Downey 1992: 145, pl. 35, figs. A–B; $Wirtz & Debelius 2003: 274; Garrido *et al*. 2004: 87–88; Wirtz 2006: 77; $Wirtz 2009: 47–48; Micael & Costa 2010: 322; Micael *et al*. 2012: 6.

Type locality: ?Mediterranean Sea.

See: Tortonese (1965); A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and East Atlantic, from Bay of Biscay (Koehler 1909) to Annobón Island in Gulf of Guinea (Nataf &Cherbonnier 1975), including the archipelagos of the Azores (Sladen 1889), Madeira (Wirtz 2006), Canaries (Garrido *et al*. 2004), Cape Verde (Koehler 1909), St Helena (Mortensen 1933c) and Ascension (Pawson 1978).

Depth: 30–1,140 m (Mortensen 1927a); AZO: 30–165(?823) m (Wirtz 2009, Sladen 1889).

Habitat: hard to soft substrates (Garrido *et al*. 2004).

Remarks: Sladen (1889) identified *Chaetaster longipes* among the material dredged by H.M.S. *Challenger* in the Azores (sta 75: 38°38’00”N, 28°28’30”W) at a depth of 823 m. We believe that this material came from much shallower depths than reported, possibly between 91–165 m (see remarks under *Astropecten hermatophilus*).

Family Goniasteridae Forbes, 1841

Genus *Ceramaster* Verrill, 1899

Species *Ceramaster granularis* (Retzius, 1783)

Ceramaster granularis granularis (Retzius, 1783)

Reports for the Azores:
Pentagonaster granularis (Retzius, 1783)—$Perrier 1896a: 45; Koehler 1909: 84–85, pl. 2, fig. 2, pl. 18, figs. 3–4;
Ceramaster granularis (Müller, 1776)—Koehler 1924: 176–177; Mortensen 1927a: 81–82, fig. 44; Sneli 1999: 242;
Ceramaster granularis granularis (Retzius, 1783)—Clark & Downey 1992: 233–234, figs. 39a–b, pl. 55, figs. A–B; García-Diez *et al*. 2005: 47.

Type locality: St. Croix (?Canada).

See: A.M. Clark & Downey (1992).

Occurrence: North Atlantic, from South Greenland Iceland and Newfoundland to Long Island (*c*. 41°N) in the west and to the British Isles in the east (A.M. Clark & Downey 1992), including the Reykjanes Ridge (Dilman 2006) south to the Azores (Perrier 1896a); the subspecies *C. granularis trispinosus* H.L. Clark, 1923 is known only from SW of Vasco da Gama Peak (South Africa; A.M. Clark & Downey 1992).

Depth: 40–2,185 m (Dilman 2006); AZO: 1,384 m (Perrier 1896a).

Habitat: soft to hard substrates, from mud, sand, gravel and stone (Koehler 1909, Sneli 1999).

Larval stage: the large yolky egg of this species could indicate that it may have direct development or a non-feeding larval stage (Mortensen 1927a).

Remarks: *Ceramaster granularis* is known from the Azores from a single record by Perrier (1896a) based on three specimens collected by *Hirondelle* (sta 213: 39°22’48”N, 31°25’16”W, 1,384 m) (see also remarks under *C. grenadensis grenadensis*).

Species *Ceramaster grenadensis* (Perrier, 1881)

Ceramaster grenadensis grenadensis (Perrier, 1881)

Reports for the Azores:
Pentagonaster gosselini $Perrier, 1885c: 35, 1894: 399–401, pl. 26, fig. 4, 1896a: 45; $Koehler 1909: 84, pl. 1, fig. 9;
Pentagonaster balteatus Sladen, 1891—Farran 1913: 9–10;
Ceramaster balteatus (Sladen, 1891)—Mortensen 1927a: 82, fig. 45; $Tortonese 1955: 676–677;
Ceramaster grenadensis (Perrier, 1881)—Downey 1973: 49–50, pl. 17, figs. C–D; Dilman 2014: 32; *Ceramaster grenadensis grenadensis* (Perrier, 1881)—A.M. Clark & Downey 1992: 234–235, figs. 39c–d, pl. 55, figs. C–D; García-Diez *et al*. 2005: 47.

Type locality: Grenada, Caribbean (12°04’N, 61°50”W).

See: A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Atlantic, in the west from Florida to Brazil (Halpern 1970) and in the east from SW Ireland to the Gulf of Guinea (Downey 1973), including the Azores, Canaries and Cape Verde (Perrier 1894, Koehler 1909). The subspecies *Ceramaster grenadensis euryplax* (H.L. Clark, 1923) is restricted to South Africa and *C. grenadensis patagonicus* (Sladen, 1889) is known from the Falkland Islands, Burdwood Bank, Gulf of California and southern Alaska to the Bering Sea (Mortensen 1936). Both *C. grenadensis fisheri* Bernasconi, 1963 and *C. grenadensis productus* Djakonov, 1950 are known only from the Pacific Ocean (A.M. Clark & Downey 1992).

Depth: 200–2,845 m (Mecho *et al*. 2014); AZO: 1,095–1,557 m (Perrier 1896, Koehler 1909).

Habitat: soft substrates, sand, mud to *Globigerina* ooze (Koehler 1909).

Larval stage: lecithotrophic (Mecho *et al*. 2015).

Remarks: *Ceramaster grenadensis* is a highly variable species, a feature reflected by its long list of synonyms, subspecies and varieties. Perrier (1885c, 1894) described *Pentagonaster gosselini* based on material collected by *Talisman*, which included specimens from the Azores. Later, Perrier (1896a) and Koehler (1909) reported the same species among the material collected by *Hirondelle* and *Princesse Alice*, respectively. Farran (1913) synonymized Perrier's species with *Ceramaster balteatus* (= *Pentagonaster balteatus*) described by Sladen (1891) from the southwest of Ireland. Previously, Verrill (1899) had proposed to synonymise *C. balteatus* with *C. granularis* (= *Tosia granularis*), a decision that did not reunited consensus among contemporaneous authors. John & A.M. Clark (1954) accepted Verrill's proposal and placed *P. gosselini* in the synonymy of *Ceramaster granularis* forma *balteatus*. However, Tortonese (1955) argued that *C. balteatus* was morphological distinct from *C. granularis* and only partially sympatric with the latter species, though he could not agree whether the observed differences could be supported at specific or subspecific level. Currently both *C. balteatus* and *P. gosselini* are considered conspecific with *C. grenadensis*.

Genus *Plinthaster* Verrill, 1899

Plinthaster dentatus (Perrier, 1884)

Reports for the Azores:
Pentagonaster grandis $Perrier, 1885c: 35–36;
Pentagonaster perrieri Sladen, 1889: 265; $Perrier 1894: 391–396; $Koehler 1909: 85–86, pl. 2, fig. 7; Mortensen 1927a: 83–84, figs. 46, 47;
Plinthaster (Pentagonaster) perrieri (Sladen, 1889)—$Koehler 1921a: 2;
Plinthaster dentatus (Perrier, 1884)—Halpern 1970: 244–252, figs. 17–19; Downey 1973: 52–53, pl. 19, figs. A–B; Gage *et al*. 1983: 280; A.M. Clark & Downey 1992: 260, pl. 61, figs. D–E; García-Diez *et al*. 2005: 47; Benavides-Serrato *et al*. 2011: 168–169; Dilman 2014: 33.

Type locality: off Grenada, Caribbean (12°03'N, 61°49'W).

See: Halpern (1970); Sumida *et al*. (2001: 26–28, figs. 9a–E); Benavides-Serrato *et al*. (2011).

Occurrence: Atlantic, in the west from North Carolina (Gray *et al*. 1968) southwards to Northern Brazil (Halpern 1970) and in the east from the Rockall Trough (Gage *et al*. 1983) south to the Gulf of Guinea (Koehler 1914b), including the archipelagos of the Azores, Canaries and Cape Verde (Koehler 1909, Grieg 1932).

Depth: 229–2,910 m (A.M. Clark & Downey 1992); AZO: 1,095–1,740 m (Koehler 1909, 1921a).

Habitat: muddy to sandy substrates (Koehler 1909); found also on *Lophelia* coral reefs (Gray *et al*. 1968).

Remarks: the highly variable *Plinthaster dentatus* was described under several different names through the years (see Halpern 1970). For example, Perrier (1885c) described a new species *Pentagonaster grandis* based on specimens collected by *Talisman* in NW Africa and the Azores. Soon after, Sladen (1889) change the name of this species to *Pentagonaster perrieri*, as it could be confused with another goniasterid from the Australian waters known at the time as *Tosia grandis*. Later, Farran (1913) proposed to synonymised *P. perrieri* with the West Atlantic species *P. dentatus*, but the synonymy was only formally accepted in 1970, after the extensive review by Halpern.

Genus *Sphaeriodiscus* Fisher, 1910

Sphaeriodiscus bourgeti (Perrier, 1885c)

Reports for the Azores:
Stephanaster bourgeti $Perrier, 1885c: 31–34, 1894: 403–406, pl. 26, fig. 1;
Sphaeriodiscus bourgeti (Perrier, 1885c)—Mortensen 1927a: 79; Tortonese & Clark 1956: 347, 349, 350.

Type locality: Cape Verde.

See: Perrier (1894); A.M. Clark & Downey (1992: 266, pl. 65, figs. C–E).

Occurrence: Northeast Atlantic, known from the Bay of Biscay (Cherbonnier 1970), Cape Verde, the Azores (Perrier 1894) and Natal (South Africa; H.L. Clark 1926).

Depth: 285–760 m (Perrier 1894, Cherbonnier 1970), AZO: 560 m (Perrier 1894).

Habitat: soft substrates (sand and gravel; Perrier 1894).

Remarks: Perrier (1885c, 1894) described *Stephanaster bourgeti* based on the material collected by *Talisman* in Cape Verde. However, apparently Perrier did not notice that among the listed material there were three individuals from the Azores (sta 123, 1883: 38°23'00"N, 28°49'46"W, 560 m). No other material of *S. bourgeti* is known from the archipelago and, the distribution of this species seems remarkably discontinuous with reported localities quite remote from each other.

Family Odontasteridae Verrill, 1899

Genus *Hoplaster* Perrier, *in* Milne-Edwards, 1882

Hoplaster spinosus Perrier, *in* Milne-Edwards, 1882

Reports for the Azores:

Pentagonaster lepidus $Sladen, 1889: 275–277, pl. 57, figs. 1–4; Perrier 1894: 390; Mortensen 1927a: 77;

Hoplaster spinosus Perrier, *in* Milne-Edwards, 1882—$Perrier 1894: 324–325, pl. 14, fig. 2; Verrill 1899: 197; Gage *et al*. 1983: 278; $A.M. Clark & Downey 1992: 151–152, pl. 36, figs. E, F; Dilman 2014: 31–32;

Hoplaster lepidus (Sladen, 1889)—Verrill 1899: 198.

Type locality: near the Porcupine Seabight (49°47'50"N, 12°41'46"W), SW Ireland.

See: Perrier (*in* Milne-Edwards 1882: 48; 1894); A.M. Clark & Downey (1992).

Occurrence: East Atlantic, from the Rockall Trough (Gage *et al*. 1983) and the Porcupine Seabight (Mortensen 1927a) to off Morocco , including the Azores (A.M. Clark & Downey 1992); reported also south off Cape Town, South Africa (A.M. Clark & Downey 1992).

Depth: 1,795–3,310 m (A.M. Clark & Downey 1992); AZO: 1,829–2,595 m (Sladen 1889, Perrier 1894).

Habitat: soft substrates, sand with pumice stones, ooze or mud (A.M. Clark & Downey 1992).

Remarks: Sladen (1889) described a new species, *Pentagonaster lepidus* based on material collected by H.M.S. *Challenger* in the Azores (sta 78: 37°24'N, 25°13'W, 1,829 m). However, Sladen remarked that this species was an immature form of what could prove to be conspecific to any of the *Pentagonaster* species described by Perrier (1885c) from the same area. Perrier (1894) added material collected by *Talisman* in the Azores (sta 131: 38°38'N, 27°26'W, 2,595 m) to the type material of *Hoplaster spinosus* collected by *Travailleur* in Irish waters. Though, Perrier acknowledge Sladen' species, only after Verrill (1899) *P. lepidus* was synonymized with *H. spinosus*, a decision followed by subsequent authors (*e.g.,* Gage *et al*. 1983; A.M. Clark & Downey 1992).

Family Ophidiasteridae Verrill, 1870

Genus *Hacelia* Gray, 1840

Hacelia attenuata Gray, 1840

(Fig. 18)

Reports for the Azores:

Ophidiaster attenuatus (Gray, 1840)—$Sladen 1889: 403;

Hacelia attenuata (Gray, 1840)—$Koehler 1909: 89, pl. 2, fig. 1, pl. 20, fig. 5; Koehler 1914b: 274, 1924: 165; H.L. Clark 1921a: 87; Koehler 1921b: 40, fig. 29; $Tortonese 1965: 164–166, fig. 78; $Marques 1983: 2, fig. 1; A.M. Clark & Downey 1992: 272–273; $Wirtz & Vader 1996: 17–22; Pereira 1997: 335; $Morton *et al*. 1998: 66, 76, figs. 3.6O, 4.2A; García-Diez *et al*. 2005: 47; Micael & Costa 2010: 322; Micael *et al*. 2012: 6.

See: A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic, in the Gulf of Guinea (A.M. Clark & Downey 1992), the Azores (Marques 1983), Canaries (Bacallado *et al*. 1985) and Cape Verde (Nataf & Cherbonnier 1975).

Depth: 1–190 m (Koukouras *et al*. 2007); AZO: 1–165(?823) m (Sladen 1889, Morton *et al*. 1998); in the Azores this species tends to be particularly abundant at depths deeper than 40 m (Marques 1983).

Habitat: hard substrates to biogenic detritus, gravel, sand and shells to sandy silt (Koehler 1909, Koukouras *et al*. 2007); also associated with deep-water coral communities of *Dendrophyllia ramea* (Linnaeus, 1758) (Bacallado *et al*. 1985).

Material examined: DBUA-ECH 074 (Baixa do Ouro, Caloura, SMG, AZO, *c*. 37°43'32"N, 25°32'47"W, 1996.12.05, 15 m; 3 spms, R = 75–99 mm, r = 13–17 mm).

Description: disc of moderate size, five arms, long, rounded abactinally and flattened actinally, tapering gently to rather acute tip. Body covered with densely packed granules. Abactinal plates small, flat, arranged in regular longitudinal rows. Each of the ten pore areas containing up to 32 papular pores; Lowermost row nearest adambulacrals with double pore areas but each containing less than half the number of pores. Both marginal series more distinct distally; last few plates in each series enlarged, tumid and bare (as are the last few carinal plates). Three rows of actinal plates proximally, the outermost one not extending to end of arm. Adambulacral plates with two blunt, flattened, parallel furrow spines, proximal one larger; one large, blunt, slightly flattened subambulacral spine. No pedicellaria. Colour (in ethanol) white.

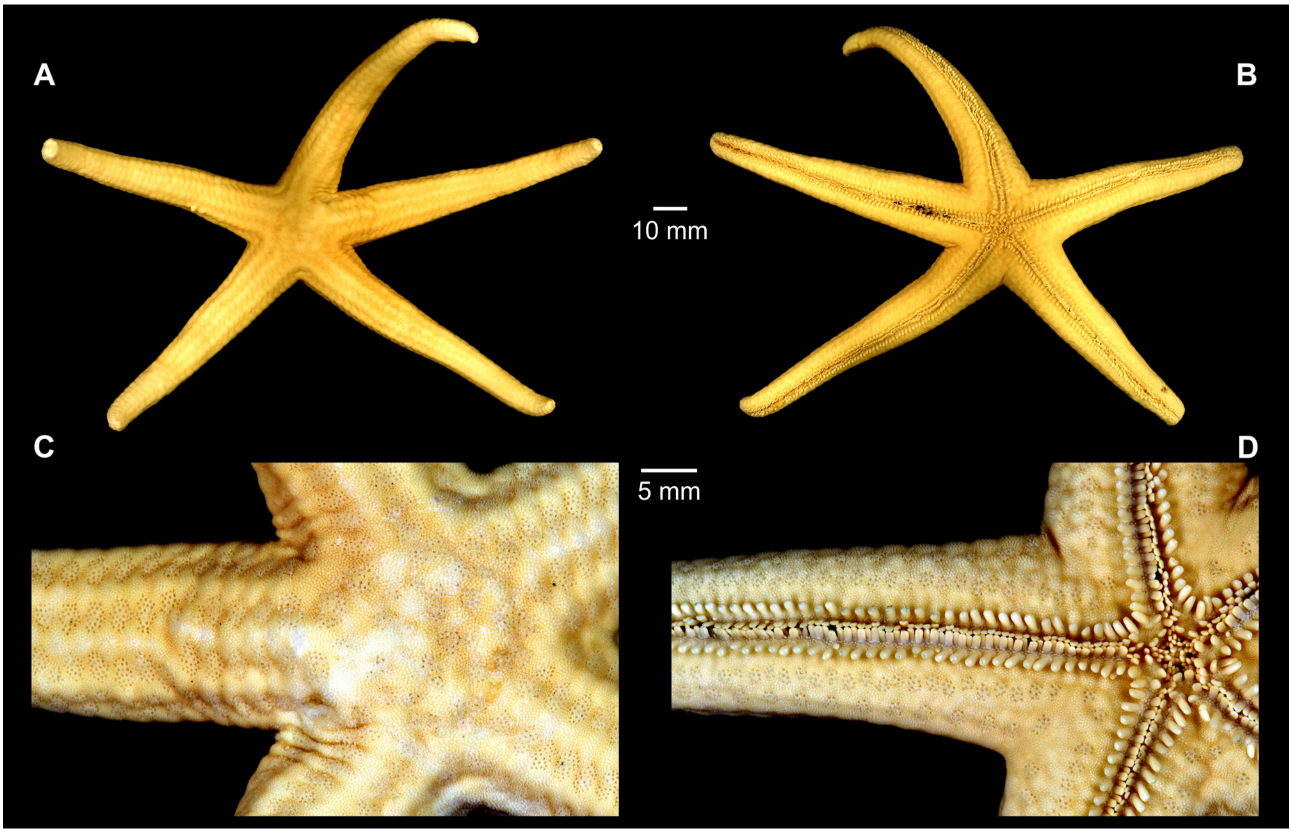

FIGURE 18. *Hacelia attenuata* Gray, 1840 (DBUA-ECH 074). Dorsal view (A); ventral view (B); detail of the arm and disc, dorsal view (C), ventral view (D).

Remarks: *Hacelia attenuata* can be easily distinguished from the only other ophidiasterid known from the shallow waters of the Azores (≤50 m), *Ophidiaster ophidianus* (Lamarck, 1816) by the overall shape of the body whereas in the first species the arms tend to be flattened ventrally and in the second species tubular. Also in *H. attenuata* the number of longitudinal rows of papular areas tends to be higher than in *O. ophidianus*, ten and eight respectively. Regardless, these two sea stars tend to be bathymetrically separate as *O. ophidianus* occurs typically in the first few meters and *H. attenuata* becomes abundant in waters below 40 m. Also, *H. attenuata* can be easily distinguished from *H. superba* the only other species of genus *Hacelia* known to occur in the Atlantic, as the latter has typically less pores in each of the papular areas (8–22), thicker broad-based arms and an ridged abactinal surface due to its the tumid plates and sunken popular areas (A.M. Clark & Downey 1992). See below remarks under *O. ophidianus*.

Sladen (1889) reported *Hacelia attenuata* (= *Ophidiaster attenuatus*) among the material collected by H.M.S. *Challenger* in the Azores, presumably at a depth of 823 m (sta 75: 38°38'00"N, 28°28'30"W), which is notably deep for a shallow-water species. Moreover, this species was identified together with other species that are generally found at depths lower than 150 m, suggesting a misprint in the dredge depth. It is very likely that the maximum reported depth lay somewhere between 92–165 m (see remarks under *Astropecten hermatophilus*).

Genus *Ophidiaster* Agassiz, 1836

Ophidiaster ophidianus (Lamarck, 1816)
(Fig. 19)

Reports for the Azores:
Asterias loevigata Lamarck—?$Drouët 1861: 93, 211;
Ophidiaster ophidianus Agassiz, 1836—$Barrois 1888: 71;
Ophidiaster sp.—?$Simroth 1888: 231;
Ophidiaster ophidianus (Lamarck, 1816)—$Sladen 1889: 403; $Perrier 1894: 330, 1896a: 44; $Koehler 1909: 92; Koehler 1914b: 274, 1924: 163–164; H.L. Clark 1921a: 79; Nobre 1924: 89; $Nobre 1930: 68–69, 1938: 46, fig. 20; $Cadenat 1938: 351, 373; Madsen 1950: 219; $Tortonese 1965: 160–164, figs. 75–77; $Pawson 1978: 10, fig. 3; $Marques 1983: 2; A.M. Clark & Downey 1992: 281–282, figs. 44e, f, pl. 69, fig. F; $Wirtz & Vader 1996: 17–22; Pereira 1997: 335; $Morton *et al*. 1998: 63, figs. 2.5Y, 3.4Z, 3.5T, 5.2L, 8.1N; Pérez-Ruzafa *et al*. 1999: 47–48, 2002 :280; $Cardigos *et al*. 2005: 165; García-Diez *et al*. 2005: 47; $Micael *et al*. 2006: 5, 2011: 205–216, figs. 2–7, 2013: 1087–1095, 2014: 1–10, figs. 2–3; Micael & Costa 2010: 322; Micael *et al*. 2012: 6.

Type locality: Western Mediterranean Sea.

See: Tortonese (1965); A.M. Clark & Downey (1992).

Occurrence: Mediterranean Sea and Northeast Atlantic; from the North African coasts (Madsen 1950) south to Rolas islet in São Tomé (Koehler 1914b), including the archipelagos of the Azores (Marques 1983), Madeira (Augier 1985), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries (Pérez-Ruzafa *et al*. 2003), Cape Verde (Pérez-Ruzafa *et al*. 1999) and Saint Helena (Mortensen 1933c).

Depth: 0–105 m (A.M. Clark & Downey 1992); AZO: 0–165(?823) m (Sladen 1889, Morton *et al*. 1998).

Habitat: rocky and coralligenous habitats (Tortonese 1965), occasionally found on soft sediments (Koukouras *et al*. 2007); in Azores common among rocks at low-tide and also in rock pools (Morton *et al*. 1998).

Larval stage: lecithotrophic (Micael *et al*. 2014).

Material: DBUA-ECH 075 (Baixa do Cerco, Caloura, SMG, AZO, *c*. 37°42’20”N, 25°30’30”W, 2010.08.13, 20 m; 1 spm, R = 67 mm, r = 7 mm); DBUA-ECH 076 (FRM, AZO, *c*. 37°16’14”N, 24°46’52”W, 1990.06; 1 spm, r = 10 mm); DBUA-ECH 080 (Poços, São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.20, 30 m; 2 spms, R = 79–93 mm, r = 10–12 mm); DBUA-ECH 081 (Poços, São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.17, 12 m; 3 spms, R = 110–122 mm, r = 10–13 mm); DBUA-ECH 082 (Banco João de Castro, AZO, *c*. 38°13’18”N, 26°36’12”W, 1996.07.27, 30 m; 1 spms, R = 120 m, r = 15 mm); DBUA-ECH 112 (Vila do Porto, SMA, AZO, *c*. 36°56’42”N, 25°08’50”W, 1990.06; 1 spm, R = 122 mm, r = 13 mm); DBUA-ECH 409 (Poças de Santa Cruz, GRA, AZO, *c*. 39°05’16”N, 28°00’25”W, 2010.08.5, 1–2 m; 2 spm, R = 126–138 mm, r = 10–15 mm); DBUA-ECH 410 (Santa Cruz, GRA, AZO, *c*. 39°05’16”N, 28°00’25”W, 2010.08.6, intertidal; 1 spm, R = 130 mm, r = 20 mm).

Description: disc small with five relatively long, cylindrical arms slightly constricted at the insertion with the disc and a blunt distal extremity; many specimens with missing distal part of the arms or arms with different degrees of regrowth. Body densely covered by granulation, with larger flattened granules intermingled by finer granules. Papular areas in eight regular longitudinal rows. Maximum number of papular pores per area from 8–10 in the smallest specimen (DBUA-ECH 075, R = 67 mm) increasing progressively with the size of the animals to more than 20. Abactinal plates cruciform. Adambulacral plates bearing two blunt, rounded furrow spines, distal one smaller than proximal one. One large, thick, blunt subambulacral spine; no pedicellaria. Colour (in vivo) orange to bright red with or without darker blotches. Colour (in ethanol): whitish with some traces of the original orange colouration.

Remarks: On redescribing *Ophidiaster guildingii* Gray, 1840, H.L. Clark (1921a) concluded that this Western Atlantic species can be distinguished from the Eastern Atlantic *O. ophidianus* primarily by the relative shape of the spines in the adambulacral armature, but also by its colour pattern, slender rays, coarser granulation and larger and fewer papulae. Mortensen (1933c) commented that the colour pattern could not be used as a diagnostic character, since animals of *O. ophidianus* from Santa Helena and the Canaries can also present a molted pattern, a character considered to be characteristic of *O. guildingii*. Madsen (1950) believed that both forms were the same species, and suggested to demote *O. guildingii* to a subspecies of *O. ophidianus*. Tortonese (1965) commented on the high variability in colour patterns presented by Mediterranean specimens, from bright orange, red, pink to violet, with or without spots of variable number and size. Nataf & Cherbonnier (1975) noted that the number of papillae is highly variable too, depending on the size of the animals. Our own observations on Azorean specimens are in accordance with the data presented by these authors. Nataf & Cherbonnier (1975) also observed that the granulation is also variable, a trait as well observed by us. Pawson (1978) recommended that the limits of variation, particularly of the colour patterns should be further studied. Most of the individuals housed in the DBUA-ECH collection showed no presence of conspicuous blotches, however little or nothing of the original colour survived in the preservation medium. In Wirtz & Debellius (2006: 276) a photograph taken in Faial Island (Azores) of two specimens side by side can be found: one uniform bright red and the other bright red with small dark blotches. Sympatric occurrence of these two-colour morphs was observed in the field by us (Figs. 19E, F). In a phylogeographic study by Micael *et al*. (2014) on *O. ophidianus* populations from the Azores, Madeira and Mediterranean, no evidence of significant differences were found, suggesting a recent range expansion.

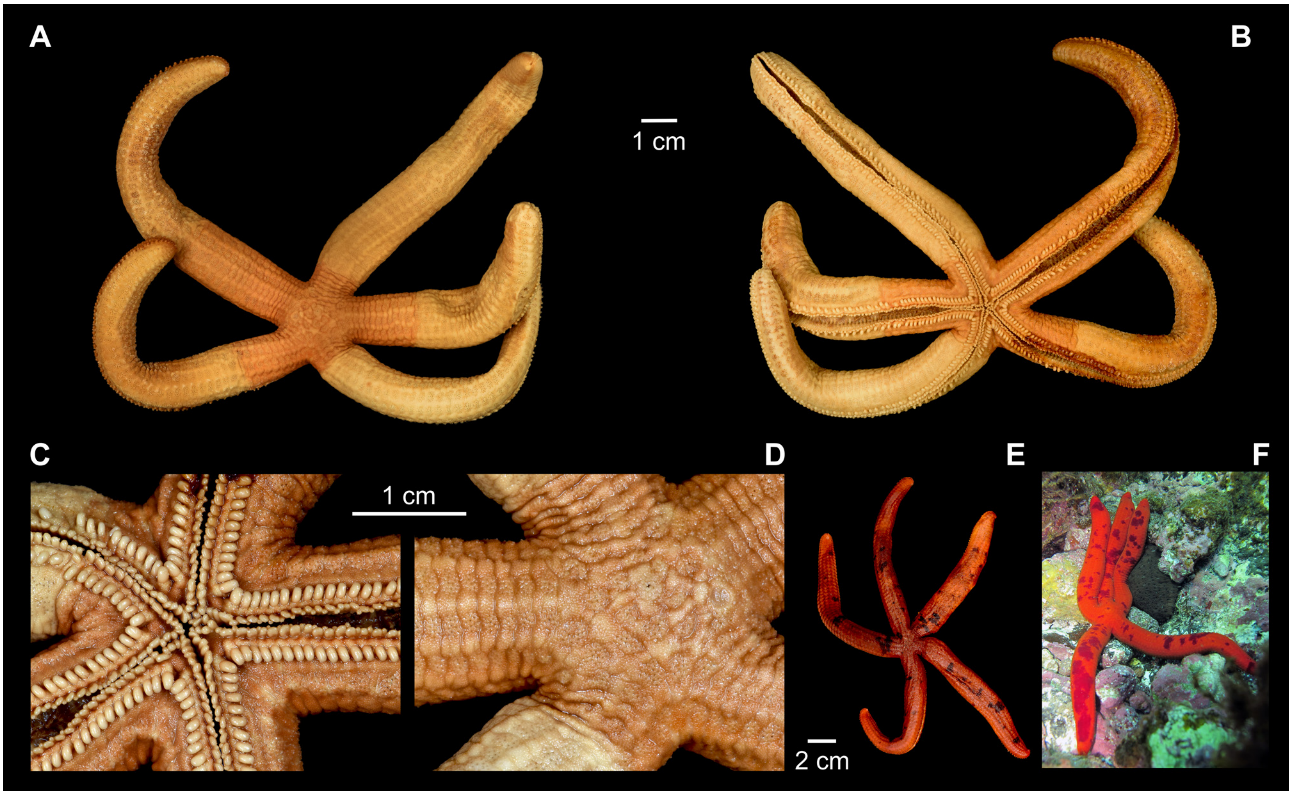

FIGURE 19. *Ophidiaster ophidianus* (Lamarck, 1816) (DBUA-ECH 081: A–D; DBUA-ECH 409: E). Dorsal view (A); ventral view (B); detail of the arm and disc, dorsal view (C), ventral view (D); molted colour pattern (E); animal *in situ* (Pico Island, Azores, ca. 38°23'22"N, 28°15'04"W, 2010.08.20, 1 m: F).

The deep-water *O. reyssi* (see below) the only other known *Ophidiaster* species in the Azores can be easily distinguished from *O. ophidianus* by the presence of pedicellaria and by the overall shape of the body with arms tapering from a broad base. Additionally, *O. reyssi* can also be distinguished from all other *Ophidiaster* species by the isolated small bead-like subambulacral spines and a very fine body granulation (A.M. Clark & Downey 1992).

Drouët (1861) published the first possible report of this species in the archipelago under the name *Asterias loevigata*. Simroth (1888) found a specimen identified as *Ophidiaster ophidianus* at Ponta Delgada Museum, which he believed to be equivalent to Drouët's *Asterias loevigata*. Barrois (1888) contested Drouët identification and place it under the name *O. ophidianus*, one of the most common sea stars of the present-day Azorean shallow water (Morton *et al*. 1998; Micael *et al*. 2010). The closest name to the original identification is *A. laevigata* (Linnaeus, 1758), now accepted as *Linckia laevigata* (Linnaeus, 1758), a sea star of similar shape but restricted to the Indo-Pacific, which makes it an unlikely candidate. However, the *subspecies Asterias laevigata varietas* Lamarck, 1816 is considered a synonym of *Hacelia attenuata* a species present in the Azores (A.M. Clark & Downey 1992; see above). The only description provided by Drouët (1861) and by Simroth (1888) is the bright red and orange red colour of the specimens, respectively. Unfortunately, in the Azores both species *O. ophidianus* and *H. attenuata* can have bright red and orange colours. In the historical collection of the Museum Carlos Machado (Ponta Delgada, São Miguel Island) we have found some animals belonging to *O. ophidianus*. However, we could not ascertain if those specimens were the same as the ones referred by Simroth. Thus, without the original material it is impossible to further discuss the original identification, and considering the conspicuous presence of *O. ophidianus* in the Azorean shallow waters, we are inclined to accept Barrois (1888) rectification, a view also accepted by Pereira (1997). In any case, Nobre (1924, 1930) place Simroth's record under *O. ophidianus*, but we could not ascertain if Nobre saw Simroth's original material. Sladen (1883, 1889) reported this strictly shallow-water species to the Azores from a depth of 823 m (H.M.S. *Challenger*, sta 75: 38°38'00"N, 28°28'30"W), though showing some concerns due to the size of the specimen since in his opinion it was almost too small for an accurate determination, an opinion later joined by H.L. Clark (1921a). Nevertheless, the station depth was in all probability much shallower than the one reported (see remarks under *Astropecten hermatophilus*), about 91–165 m, which falls in the maximum depth limit for *O. ophidianus*. Additionally, among the material housed at DBUA-ECH we have found a specimen collected in the area of Don João de Castro Seamount (between Terceira and São Miguel islands), one of the rare examples in Azores of a shallow-water hydrothermal-active volcanic seamount. This species was also recorded by Cardigos *et al*. (2005) in the same area.

Ophidiaster reyssi **Sibuet, 1977**

Reports for the Azores:
Ophidiaster reyssi $^{\$}$Sibuet, 1977: 1085–1090, figs. 1A–C; $^{\$}$A.M. Clark & Downey 1992: 282, pl. 69, figs. G, H.

Type locality: Azores (39°33'00"N, 31°17'30"W).

See: Sibuet (1977); A.M. Clark & Downey (1992).

Occurrence: known only from the Azores (Sibuet 1977) and the Mediterranean Sea (A.M. Clark & Downey 1992).

Depth: 128–350 m (A.M. Clark & Downey 1992); AZO: 350 m (Sibuet 1977).

Habitat: hard substrate (Sibuet 1977).

Remarks: *Ophidiaster reyssi* was described by Sibuet (1977) based on an individual collected in Azores by the oceanographic mission *Biacores* (by the research vessel *Jean Charcot*). A.M. Clark & Downey (1992) reported a second specimen from the Mediterranean Sea (near Sicily), expanding the geographical distribution of *Ophidiaster reyssi*, which was otherwise known only from the holotype.

Subphylum Echinozoa Haeckel, 1896

Class Echinoidea Leske, 1778

Subclass Cidaroidea Smith, 1984

Order Cidaroida Claus, 1880

Superfamily Cidaridea Gray, 1825

Family Cidaridae Gray, 1825

Subfamily Cidarinae Mortensen, 1928

Genus *Cidaris* Leske, 1778

Cidaris cidaris (Linnaeus, 1758)

(Fig. 20)

Reports for the Azores:

Dorocidaris papillata (Leske, 1778)—$Koehler 1895a: 224, 1898: 8, 1909: 214–215, 1921a: 3; Nobre 1938: 104–105, figs. 45, 55;

Cidaris cidaris (Linnaeus, 1758)—Mortensen 1927a: 272–273, figs. 149, 150–152, 1928: 289–298, pl. 30, figs. 3–4, pl. 31, figs. 1–10, pl. 67, fig. 5, pl. 72, figs. 20–22; $Cadenat 1938: 363; Harvey 1956: 63; Marques 1980: 104; $Pérès 1992: 253; García-Diez *et al.* 2005: 50; Mironov 2006: 98–99; Schultz 2006: 32, fig. 53–55;

See: Mortensen (1928); Mironov (2006); Schultz (2006).

Occurrence: East Atlantic and the Mediterranean Sea, from south of Iceland and Norway south to equatorial West Africa including the Azores, Madeira, Canaries and Cape Verde and Santa Helena (Koehler 1909, Mortensen 1903, 1928, 1933c, Mironov 2006); also in Gorringe, Josephine and the Meteor seamounts (Mironov 2006).

Depth: 20–2,010 (?4,275) m (Mironov 2006, Koukouras *et al*. 2007); AZO: 165–1,385 m (Koehler 1909, herein).

Habitat: mud, fine sand, gravel to hard substrates (Koehler 1898, 1909); an opportunistic scavenger; feeds also on deep-sea reef building corals such as *Lophelia pertusa* (Linnaeus 1758) and *Madrepora oculata* (Linnaeus 1758) (Stevenson & Rocha 2012).

Larval stage: planktotrophic (Emlet 1995).

Material examined: DOP–2976 (Banco Cavala, AZO, 38°16'12"N, 30°39'00"W, 2008.07.08, 723 m; 1 spm, D = 20 mm); DOP–2977 (Banco Cavala, AZO, 38°16'12"N, 30°39'00"W, 2008.07.08, 723 m; 1 spm, D = 12 mm); DOP–4335 (Banco Princesa Alice, off SW PIX, AZO, 38°00'10.80"N, 29°19'04.80"W, 2010.09.03, 165–219 m; 1 spm, D = 10 mm); DOP–7933 (Banco Princesa Alice, off SW PIX, AZO, 37°58'51.60"N, 29°31'22.80"W, 2011.28.05, 384 m; 1 spm, D = 5 mm); EMEPC-LUSO L09D18B2 (N of SJG, AZO, 38°42'14"N, 28°01'25"W, 2009.10.02, 869 m; 1 spm, D = 52 mm).

Description: test circular, flattened to almost spherical (test height between 55–70%D). Ambulacra distinctly sinuate, about 20% of the interambulacra in width. Marginal series of tubercles regular. The largest specimen (EMEPC-LUSO L09D18B2; D = 52 mm) presented a regular double series of inner tubercles with a distinct naked median line, becoming a single series just near the apical disc. Pore zones sunken; pores of equal size, each pair separated by a narrow wall. Primary tubercles perforated, not crenulate; areoles are rather large and deep, not confluent; subambital areoles distinctly transverse-oval; mamelon rather large, with the boss rather low. Scrobicular tubercles not very conspicuous. Interradial and adradial zones distinct and naked, both conspicuously sunken. Apical disc covered with small tubercles of uniform size in larger individuals (D ≥ 20 mm), leaving a fairly conspicuous bare edge between the plates. Apical disc large, dicyclic; genital pores closed in the smaller specimens (D ≤ 11 mm); Periproct quite flat, covered by moderate number of plates. Peristome smaller than the apical disc, circular to sub-pentagonal. Primary spines rather long, about 2–2.5 times the diameter of the test, cylindrical, thick at the base, tapering very gently, and covered with a fine, spongy coat of anastomosing hairs; oral primaries spines relatively short and flattened with finely serrate edges; scrobicular spines flattened, tapering to a rounded point; marginal ambulacral spines slender, pointed, slightly flattened in the basal part and about half the length of the scrobicular spines. Both large and small globiferous pedicellariae usually present in fair numbers; globiferous pedicellaria with a distinct terminal teeth; large tridentate pedicellaria present on both oral and apical sides. Colour (in ethanol): generally of a uniform light brown to white; spines white or cream; occasionally some of the primary spines are pinkish to dark brown red colour (*e.g.,* DOP 2976); some of the larger spines of the largest individuals (EMEPC-LUSO L09D18B2) are encrusted with serpulids and cirripeds.

Remarks: among the five cidaroids reported from the Azores, *Cidaris cidaris* is the only species known to occur with certainty in the extant waters of the archipelago. Though highly variable this species is easily distinguished from the remaining species by the presence of a coat of hairs covering the primary spines and by the presence of enlarged terminal teeth in the globiferous pedicellaria.

Historically, abundant material from the Azores identified as *C. cidaris* (as *Dorocidaris papillata*) is listed in the cruises reports of *Princesse Alice* and *Hirondelle* (Koehler 1898, 1909, 1921a), from depths of 500 and 1,200 m. Cadenat (1938) in his report of the expedition of the *Président Théodore-Tissier* also recorded this species in the archipelago from a similar depth. This species appears to be quite common in the Azores at this depth range as the footage by ROV *LUSO* (EMEPC, 2009 expedition) seems to exemplify. They show cidaroids most likely belonging to *C. cidaris* in practically any kind of environment from sediment to vertical walls (Figs. 20D–F).

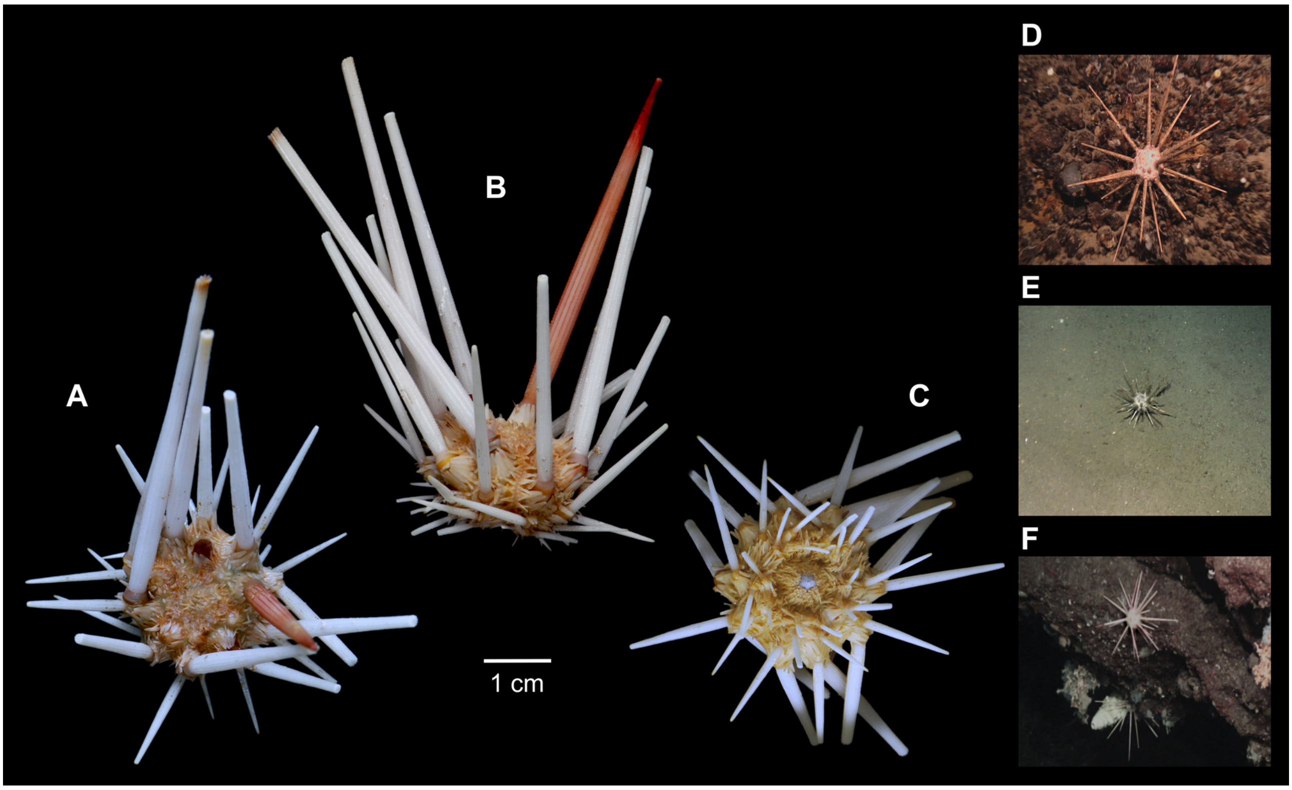

FIGURE 20. *Cidaris cidaris* (Linnaeus, 1758) (DOP 2976: A–C; EMEPC–LUSO L09D18B2: D). Aboral view (A); oral view (B); lateral view (C); animal *in situ* (38°42'14"N, 28°01'25"W, 2009.10.02, 869 m: D); cidaroids possible belonging to *C. cidaris in situ* in the Azores deep-waters (EMEPC–LUSO, 38°31'45"N, 27°56'16"W, 2009.10.04, 869 m, E; 38°14'07"N, 26°33'27"W, 2009.10.09, 815 m: F).

Genus *Eucidaris* Pomel, 1883

Eucidaris tribuloides? (Lamarck, 1816)

Reports for the Azores:
Cidaris tribuloides Lamarck, 1816—$Koehler 1895a: 224, 1898: 8–10; Pereira 1997: 333; García-Diez *et al*. 2005: 50; Micael & Costa 2010: 322;
Eucidaris tribuloides (Lamarck, 1816)—Mortensen 1928: 400–408, pl. 41, figs. 9–16, pl. 48, fig. 1, pl. 73, fig. 1, pl. 86, fig. 16; Harvey 1956: 63; Pérez-Ruzafa *et al*. 1999: 50–51; Micael *et al*. 2012: 3.

See: H.L. Clark (1925: 21–22); Mortensen (1928); Lares & McClintock (1991); Schultz (2006: 38–39, figs. 65–67); Lessios *et al*. (1999); Madeira *et al*. (2011: 245–248).

Occurrence: restricted to the tropical areas of the Atlantic; in the west from South Carolina and Bermuda to Brazil (Mortensen 1928); in the west, present in the Gulf of Guinea (Koehler 1914b), Cape Verde (Koehler 1909), the ?Azores (Koehler 1898), Ascension (Mortensen 1936) and St Helena (Mortensen 1933c).

Depth: 0–450 m (Mortensen 1928); ?AZO: 130 m (Koehler 1898).

Habitat: mainly a littoral form, occurring under stones and crevices and among corals (Mortensen 1928, Pawson 1978).

Larval stage: planktotrophic (Emlet 1995).

Fossil record: *Eucidaris tribuloides* is a common presence in the Pliocene fossiliferous outcrops in Santa Maria Island, Azores (Madeira *et al*. 2011, Ávila *et al*. 2015b).

Remarks: Koehler (1895a, 1898) identified a small individual of *E. tribuloides* among the material collected by *Hirondelle* in the Azores (sta 226: 38°31’19”N, 28°34’31”W, 130 m). The specimen may represent a vagrant that managed to arrive in the Azores, *i.e.* it does not represent a real self-sustained population (for discussion see Madeira *et al.* 2011). Thus, until new material is collected in this area, the presence of this species in the archipelago should be treated with caution.

Subfamily Stereocidarinae Lambert, 1900

Genus *Stereocidaris* Pomel, 1883

Stereocidaris ingolfiana? Mortensen, 1903

Reports for the Azores:
Stereocidaris ingolfiana Mortensen, 1903—?$^{\$}$Pérès 1992: 254, 258.

Type locality: Denmark Strait.

See: Mortensen (1903: 38–41, pl. 6, figs. 1–5, pl. 8, figs. 4, 10–11, 16, 19–21, 23, 26, 28, 30, 36, pl. 11, figs. 12, 16–17, 23, 28, 30, 32–33; 1928: 267–268, pl. 27, figs. 1–3, pl. 70, fig. 6).

Occurrence: North Atlantic, from the Denmark Strait south to the Caribbean in the west and to Cape Verde in the east (Mortensen 1928).

Depth: 300–1,745 m (Mortensen 1928); ?AZO: 2,050–3,300 m (Pérès 1992).

Habitat: soft sediments (Koehler 1909).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: Pérès (1992) claimed to have observed *Stereocidaris ingolfiana* during a dive made by the bathyscaphe *Archimède* north of São Miguel Island (2,050 m depth) and east of Santa Maria Island (3,150–3,300 m depth). No specimen was collected and the identification seems to have rested solely on the long size of the spines of the observed animals. Pérès observations could represent an intermediary record between the east and West Atlantic populations, though *S. ingolfiana* known depth range is slightly shallower than the depth reported by this author. In the other hand, *Cidaris cidaris* is the only cidaroid confirmed species to occur in the archipelago with abundant documented material (see above). At macroscopic level these two species are almost identical, and in many instances the diagnose rests on the observation of pedicellaria (see Mortensen 1927a, 1928). Thus, until material belonging to *S. ingolfiana* is documented in the archipelago, Pérès observation must be placed as a dubious record (see also remarks under *Histocidaris purpurata*).

Superfamily Histocidaroidea Lambert, 1900

Family Histocidaridae Lambert, 1900

Genus *Histocidaris* Mortensen, 1903

Histocidaris purpurata? (Thomson, 1872b)

Reports for the Azores:
Porocidaris purpurata Thomson, 1872b—?$^{\$}$Pérès 1992: 252.

Type locality: about 100 miles to the north of the Hebrides.

See: Mortensen (1928: 104–107, pl. 1, fig. 6, pl. 3, figs. 3–5, as *Poriocidaris purpurata*); Gage *et al.* (1985: 179 as *Poriocidaris purpurata*).

Occurrence: North Atlantic; in the East from southern Iceland south to the Canaries and Western Sahara (Koehler 1909, Mortensen 1927b, 1928); in the west known only from the Caribbean (Phelan 1970); reported elsewhere in South African waters (Filander *et al.* 2019).

Depth: 300–1,800 m (Gage *et al.* 1985); AZO: ?800 m (Pérès 1992).

Habitat: soft sediments, from sandy mud to muddy bottoms (Koehler 1909, Mortensen 1928); gut contents revealed bottom material and fragments of crustaceans (Mortensen 1928).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: on a dive made by the bathyscaphe *Archimède* in the Azores, Pérès (1992) reported to have observed animals of *Histocidaris purpurata* with their typical long spines with alternating bands of purple and violet. This cidaroid species has a wide distribution in the Atlantic, thus its report in the Azores could be easily considered as an intermediate location between its distribution in the Caribbean and the European or NW Africa records. However, no specimen was collected in the Azores that on a close examination in the laboratory could substantiate Pérès observations. Another cidaroid species known to occur in area *Cidaris cidaris* is characterised by high morphological variability, including the colour of its spines (primary or secondary) which can vary from the typical white or pinkish to brownish-purplish spines (Fig. 20; see also Mortensen 1928). Historically, the Azores was extensively dredged at depths similar to the observations by Pérès (*e.g.,* Koehler 1898, 1909). As a result, abundant material of *Cidaris cidaris* became available, but remarkable none of the oceanographic cruises managed to secure a single specimen of *H. purpurata*. Thus, until animals collected in the area prove to belong to this species, the record of this species in the archipelago should be treated with caution.

Subclass Euechinoidea Bronn, 1860

Infraclass Acroechinoidea Smith, 1981

Order Diadematoida Duncan, 1889

Family Diadematidae Gray, 1855a

Genus *Diadema* Gray, 1825

Diadema africanum? Rodríguez *et al.*, 2013

Reports for the Azores:
Diadema africanum Rodriguez *et al*. 2013—$^{\$}$Minderlein & Wirtz 2014: 2, fig. 2.

Type locality: Tenerife, Canary Islands.

See: Rodrigues *et al*. (2013).

Occurrence: East Atlantic, from Senegal to Gulf of Guinea (Koehler 1914b, Rodrigues *et al*. 2013) and also in the Azores (Minderlein & Wirtz 2014), Madeira (Alves *et al*. 2001), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries (Hernández *et al*. 2013), Cape Verde (Pérez-Ruzafa *et al*. 2002) and São Tomé (Koehler 1914b).

Depth: strictly a littoral form (Alves *et al*. 2001; Hernández *et al*. 2013); AZO: 8 m (Minderlein & Wirtz 2014).

Habitat: hard substrates (Alves *et al*. 2001; Hernández *et al*. 2013).

Larval stage: probably planktotrophic (inferred from the genus; see Emlet 1995).

Remarks: the inclusion of the Azores in the geographical distribution of *Diadema antillarum* by Mortensen (1940a) at the time appears to be a product of a misprint since no specimen belonging to this species was reported from the archipelago (see below remarks under *Centrostephanus longispinus*). Recently, however, Minderlein & Wirtz (2014) have identified *Diadema africanum* in Santa Maria Island, making the Azores the northernmost limit for this species. Nevertheless, considering its known gregarious behaviour and conspicuous presence on shallow rocky shores throughout this species distribution (Alves *et al.* 2001; Schultz 2006; Hernández *et al*. 2008), it is hard to believe that *D. africanum* could represent a case of an overlooked shallow–water element of the Azores in over 150 years of echinoderm studies in the area. In the future, it will be interesting to understand if the specimen found in the southernmost island of the Azores represent a solitary vagrant or a recent established population, as a result of a recent range expansion of this tropical East Atlantic form to the northern waters of the Azores. Minderlein & Wirtz (2014) remarked that since its collection in 2010 no other sightings have been reported, indicating that the presence of this species in the archipelago could be a direct result of the global warming, as occasional propagules find the increasingly warmer waters in the Azores suitable for establishment. Its rare occurrence could be the result of lag times between the initial invasion event(s) to population outbreaks, which are a common phenomenon in the invasion process of many marine species. For example, after its initial discovery more than a decade ago, the alien invasive *Diadema setosum* still is exceptionally rare in the Mediterranean (Bronstein *et al*. 2017).

Genus *Centrostephanus* Peters, 1855

Centrostephanus longispinus (Philippi, 1845)
(Fig. 21)

Reports for the Azores:

Centrostephanus longispinus (Peters, 1855)—$^{\$}$Barrois 1888: 74; Koehler 1909: 220, pl. 31, fig. 20, 1921b: 113, fig. 74;

Centrostephanus longispinus (Philippi, 1845)—Koehler 1914b: 277; Mortensen 1927a: 277, 1940a: 300–307, figs. 95c, 154–156, pl. 34, figs. 1–11, pl. 35, figs. 11–12, pl. 75, figs. 5–24; $^{\$}$Chapman 1955: 399; Harvey 1956: 63; Tortonese 1965: 311–312, figs. 143–145; $^{\$}$Marques 1983: 4, fig. 5; Pawson & Miller 1983: 4, fig. 1; $^{\$}$Wirtz & Martins 1993: 59; $^{\$}$Morton *et al*. 1998: 76, fig. 4.2H; Pereira 1997: 333; $^{\$}$Wirtz & Debelius 2003: 257; $^{\$}$Micael *et al*. 2006: 5; $^{\$}$Mironov 2006: 104–106; Schultz 2006: 91–93, figs. 164–168; Haddad & Barreiros 2008: 9; Micael & Costa 2010: 323, 2012: 4.

Type locality: Sicily, Mediterranean Sea.

See: Mortensen (1940a; 1951a: 296–297); Pawson & Miller (1983); Mironov (2006); Schultz (2006).

Occurrence: Mediterranean Sea and Atlantic, in the East Atlantic from Morocco south to Angola (Cherbonnier 1959, Tortonese 1965), including the Azores (Marques 1983), Madeira (Augier 1985), Canary (Bacallado *et al*. 1985) and Cape Verde archipelagos (Mortensen 1927b) and Ampere, Gorringe, Josephine, Seine, Great Meteor, Dacia and Conception seamounts (Mironov 2006); in the western Atlantic, reported from the Gulf of Mexico and the Caribbean to Brazil, including the Brazilian island of Trindade (Pawson & Miller 1983; belonging to the Trindade and Martin Vaz Archipelago, not to be confused with the Caribbean island Trinidad).

Depth: 12–360 m (Mironov 2006); AZO: 6–468 m (herein).

Habitat: detritic and rocky substrates (Pawson & Miller 1983); feeds on bottom detritic material and algae (Mortensen 1940a).

Larval stage: probably planktotrophic (inferred from the genus; see Emlet 1995).

Material examined: DBUA-ECH 001 (Piscina da Lagoa, SMG, AZO, *c.* 37°44’29”N, 25°34’27”W, 1996.07.25, 15 m; 2 spms, D = 59 mm); DOP 5467 (Condor Seamount, AZO, 38°32’13”N, 28°59’06”W, 2010.08.06, 468 m; 1 spm, D = 10 mm); EMEPC-LUSO L09D9B03S01 (Gorringe Bank, NE Atlantic, 36°42’49”N, 11°09’54”W, 2009.09.13, 130 m; 1 spm, D = 25 mm); MB-NMHN 382–20758 (Caloura, SMG, AZO, *c.* 37°42’46”N, 25°29’44”W, 1977, 8 m; 1 spm, D = 53 mm); MB-NMHN 388–20764 [Varadouro (submarine cave), FAY, AZO, *c.* 38°33’49”N, 28°46’28”W, 1979.08.02, 6 m; 1 spm, D = 30 mm]; MB-NMHN 422–20798 (Ponta da Galera, SMG, AZO, *c.* 37°42’20”N, 25°30’33”W, 1979, 18 m; 1 spm, D = 57 mm); MB-NMHN 435–20811 (Ponta Delgada harbour, SMG, AZO, *c.* 37°44’13”N, 25°39’26”W, 1982; 1 spm, D = 6 mm).

Description: test circular, flattened above and below, height about 50%D, though in most of larger specimens the test tends to be somewhat inflated adapically, reaching as much as 72%D. Ambulacra tuberculation typically composed of a single primary tubercle about the same size as the primary tubercles in the corresponding interambulacra (absent in the area above the ambitus), and one conspicuous smaller secondary tubercle located in the perradial median zone; pore pairs in a straight line adapically, changing to arcs of three closer to the ambitus and crowded at the peristomial edge; ambulacral area about 65 to 75% of the interambulacral area at the ambitus. In interambulacra, large primary tubercle occupying most of the plate; the small interradial space occupied by small secondary tubercles; the adradial area occupied by a larger secondary tubercle reaching a considerable size at the ambitus of larger specimens. Apical disc about 33 to 40%D; in larger specimens the ocular plates are insert; in the smallest specimen (MB-NMHN 435–20811, D = 6 mm) some of the plates are still exsert and no periproctal scales exist. In the second smallest specimen (DOP–5467, D = 10 mm) some plates are already present in the periproctal membrane and ocular plates I, IV, and V are insert; ocular plates naked or with one spine in the smallest specimens to up to two spines in the largest specimens; genital plates (madreporite inflated) bear up to three spines, with the exception of the smallest specimens in which the plates are naked or bear a single spine; the periproct is covered with small naked scales in the two smaller specimens; all other specimens have scales with spines, especially in the area surrounding the anal opening; gonopores not open in the two smallest individuals (≤10 mm D). Peristome larger in the smaller individuals, about 50%D diminishing proportionally in larger specimens to about 37%D; buccal membrane with plates particularly numerous in the ambulacral areas; paired buccal plates bear pedicellariae. Most of the spines were broken in all specimens, particularly in the ambital area; primary spines hollow, verticilate, and very fragile; spines on the oral side terminate in a crown shaped tip; on the apical side, the uppermost spines small club-shaped (claviform spines) with bright purple to pink tips (with the exception of the smallest specimen in which such spines are not yet present). Larger specimens black to dark brown or light brown in the case of the dry specimens from Museu Bocage; specimens of intermediate sizes (DOP–5467, EMEPC-LUSO L09D9B03) with the same pattern as the larger specimens, with the exception of the presence of a white line in the median area of both ambulacra and interambulacra; the smallest specimen (MB-NMHN 435–20811) almost white coloured, with the primary tubercles and the apical plating of a darker pinkish colour; spine colouration highly variable; the largest individuals (DBUA-ECH 001) with conspicuous dark coloured spines, though some of the spines presented a weak lighter red banding; spines of the largest dry specimens (MB-NMHN 422–20798 and MB-NMHN 382–20758) of a light brown colour at the basis, progressively changing to a more purplish tone or interchanging distally between the two colours, forming a banded pattern in many spines; all specimens of intermediate to smaller sizes with conspicuous yellow and purple to pinkish banded spines.

Remarks: until recently, the occasional reports of *Diadema antillarum* from the Azores were most likely a result of confusions with *Centrostephanus longispinus*. As was one time noted by Wirtz & Martins (1993: 59), ‘at least those along the coasts of Faial seen by us are a black colour morph of *Centrostephanus longispinus* and not *Diadema antillarum*’. Nevertheless, and aside from morphological similarity between the two species, another possible source for such misidentifications is the unusual depth at which *C. longispinus* can occur in the Azores, as low as 5 m in sheltered areas such as ports or underwater cave-like habitats (Chapman 1955; Wirtz & Martins 1993; Morton *et al*. 1998; Micael *et al*. 2006, *personal observation*).

The unusual black colour shown by some of the Azorean individuals in opposition to the typical lighter colours, as described for the type specimens from the Mediterranean Sea [Philippi 1845, as *Cidaris* (*Diadema*) *longispina*] is another reason for confusion. H.L. Clark (1921b) described a closely resembling species, *C. rubricingulus*, from the Caribbean, which according to Mortensen (1940a) could only be distinguished from *C. longispinus* by the interambulacral tuberculation, spine structure and pedicellaria morphology. The later author considered the colour pattern in *C. longispinus* far too variable to be considered as a diagnostic character. However, H.L. Clark’s and Mortensen’s descriptions were based on very few specimens available at the time. Later, Pawson & Miller (1983) based on new material agreed with Fell (1975) to treat the East Atlantic species as a subspecies of *C. longispinus* since they could not support any of the diagnostic characters pointed out by Mortensen (1940a). In addition, they concluded that the colour of the spines is a diagnostic character that can distinguish the western solid dark colour spines from the lighter banded colour spines of the eastern subspecies. Nevertheless, Pawson & Miller (1983) alerted that the absence of banding could only be expected in individuals larger than 25 mm in total diameter.

In the Azores, *C. longispinus* can adopt a large spectrum of colours from purplish with whitish-banded spines to solid black colour pattern, with no conspicuous banding of spines (see Marques 1983; Wirtz & Debelius 2003). Unfortunately, due to the very fragile nature of the spines in this species, the specimens herein examined were lacking most of the spines. Nevertheless, it was possible to confirm the presence of banding pattern in the spines of all but one specimen (DBUA-ECH 001, D = 59 mm). However, understanding that in larger specimens banding is not a constant trait of all spines in one individual and that frequently banding is present in the distal part of the spine only, it was impossible to determine whether this specimen could have any banded pattern present if all its spines had survived intact. The colour in the eastern form of *C. longispinus* is known to change under exposure to different light conditions, and the activity of black chromatophores is well studied in this species (*e.g.,* Dambach 1969; Weber & Dambach 1974; Gras & Weber 1977). Additionally, Pawson & Miller (1983) mentioned that bleaching spines (*i.e*. removal of black pigment) from western Atlantic *C. longispinus* specimens uncover the presence of a banding pattern, in otherwise solid dark individuals. The material herein examined reveals yet another source of colour variation, the method of preservation. Marques (1983) described the specimens collected at the Azores during a 1979’s expedition as solid black with no banding pattern. On figure 5 presented by Marques one can clearly recognize specimen MB-NMHN 422–20798, the same specimen that now can be characterized by spines possessing a clear banding pattern (Fig. 21F). Thus, methods of preservation such as dehydration seems to mimic the effects of bleaching, possible due to the shrinkage or destruction of the black pigment chromatophores and tissue degradation, turning once black specimen into a ‘banded’ animal. Mironov (2006) studied the variation of reported diagnostic characters reported by Mortensen (1940a) and Pawson & Miller (1983) in specimens of *C. longispinus* throughout its geographical range. Although he did find some indication for a geographical gradient from east to west in the primary spines colouration of adult specimens, he regarded it as far too inconsistent to retain the subspecies. Our results agree with Mironov and we thus refrain from assigning the Azorean specimens to either subspecies. In contrast to Mironov (2006) who noted that the minimum total diameter at which the genital pores were developed was of 9 mm, the specimen of 10 mm D examined by us had no gonopores yet.

C. longispinus can be easily distinguished from other sea-urchin species inhabiting the Azorean coastal waters by its very long spines and the presence of conspicuous bright purple to pink claviform spines around the apical disc (Fig. 21D).

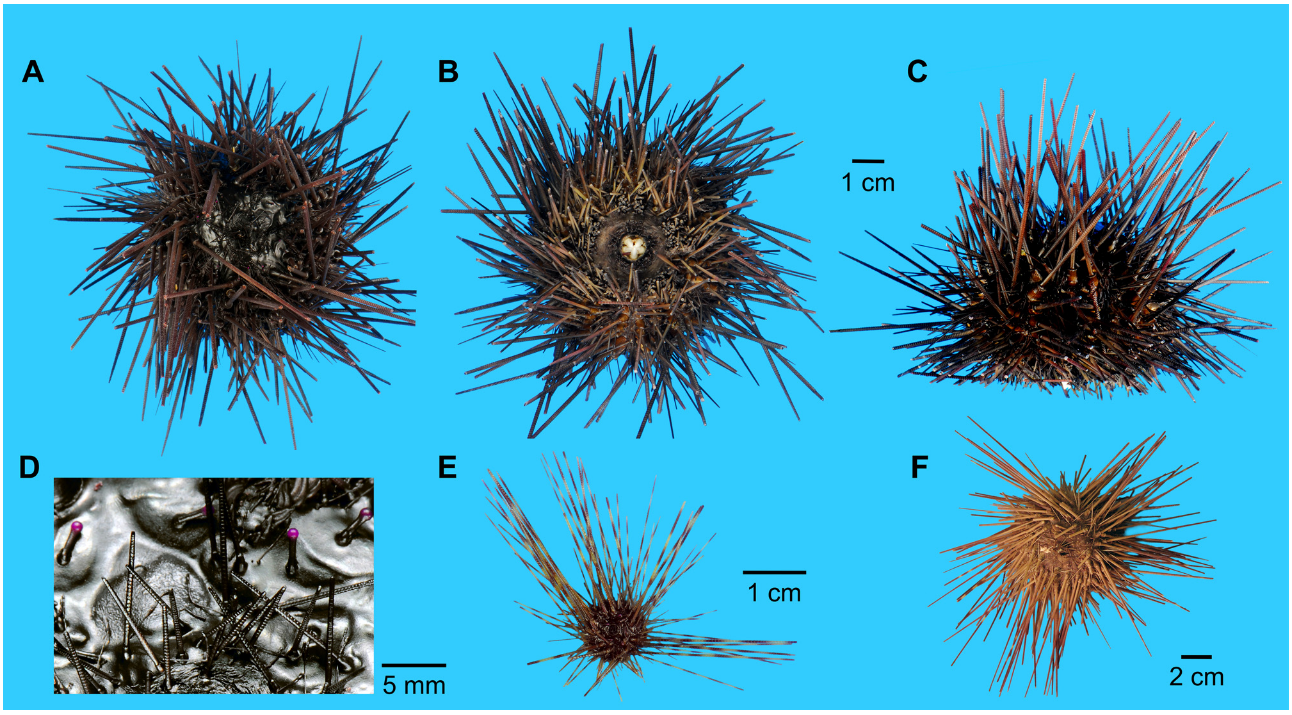

FIGURE 21. *Centrostephanus longispinus* (Philippi, 1845) (DBUA-ECH 001: A–D; DOP 5467: E; MB-NMHN 422–20798: F). Aboral view (A); oral view (B); lateral view (C); detail of the apical area showing claviform spines (D); aboral view of a juvenile (E); aboral view of a dry specimen (F).

Order Pedinoida Mortensen, 1939

Family Pedinidae Pomel, 1883

Genus *Caenopedina* Agassiz, 1869

Caenopedina cubensis Agassiz, 1869

Reports for the Azores:

Hemipedina cubensis (Agassiz, 1869)—$^{\$}$Koehler 1909: 221–226, pl. 1, fig. 1, pl. 30, figs. 8–17, pl. 31, fig. 21;

Caenopedina cubensis Agassiz 1869—Mortensen 1927a: 277, 1940a: 96–99, pl. 2, figs. 19–20, pl. 66, figs. 1–9; Serafy & Fell 1985: 20, fig. 11; García-Diez *et al*. 2005: 50.

Type locality: off Havana, Cuba.

See: Koehler (1909); Mortensen (1940a).

Occurrence: North Atlantic, in the West, in USA coast from northern Nova Scotia to the Caribbean and the Gulf of Mexico (Downey 1968, Serafy & Fell 1985); in the East recorded from the Azores and Canaries (Koehler 1909).

Depth: 250–1,187 m (Koehler 1909, Serafy & Fell 1985); AZO: 1,187 m (Koehler 1909).

Habitat: soft substrates (Koehler 1909); feeds on bottom detritus (Serafy & Fell 1985).

Larval stage: planktotrophic (Emlet 1995).

Remarks: *Caenopedina cubensis* is known from the Azores by two specimens reported by Koehler (1909) on the material collected by *Princesse Alice* (sta 1311: 37°37'00"N, 25°20'45"W, 1,187 m).

Infraclass Carinacea Kroh & Smith, 2010

Superorder Calycina Gregory, 1900

Order Salenioida Delage & Hérouard, 1903

Family Saleniidae Agassiz, 1838

Genus *Salenocidaris* Agassiz, 1869

Salenocidaris hastigera (Agassiz, 1879)

Reports for the Azores:

Salenia hastigera Agassiz, 1879—$Koehler 1895a: 224, 1898: 9, 1921a: 3; Nobre 1938: 109–110;
p.p. *Salenia hastigera* Agassiz, 1879—$Koehler 1895b: 228, 1909: 219–220;
non *Salenia profundi* (Duncan, 1877)—Mortensen 1927a: 289;
non *Salenocidaris profundi* (Duncan, 1877)—Mortensen 1935: 354–357, pl. 85, figs. 1, 2, 29, 30, 35, 36, pl. 86, figs. 1, 2;
Salenocidaris hastigera (Agassiz 1879)—$Sibuet 1972: 122–123; $Mironov 2014: 122;
non *Salenocidaris profundi profundi* (Duncan, 1877)—García-Diez *et al*. 2005: 50 [based on Mortensen 1927a].

Type locality: Pacific (Banda Sea).

See: Agassiz (1879: 198–199, as *Salenia hastigera*).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian Oceans; in the Atlantic confirmed from the Azores and Atlantis Seamount (Mironov 2014).

Depth: 370–2,605 m (Mironov 2014); AZO: 793–2,440 m (Koehler 1909).

Remarks: historically, *S. hastigera* was confused with two closely resembling species, *S. varispina* Agassiz, 1869 and *S. profundi* (Duncan, 1877). Following Agassiz's (1879, 1881) descriptions, Koehler (1895a, 1895b, 1898, 1909, 1921a) recorded this species from the Azores. Later, Mortensen (1927a, b, 1935, 1940b) considered all the records of this species in the Atlantic as misidentifications of *S. profundi*, retaining the name *S. hastigera* to the form from the Indo-Malayan region. Sibuet (1972) ignored Mortensen's decision and place the identification of a small specimen collected by the bathyscaphe *Archimède* in the Azores (1,730 m depth) under the later species. More recently, Mironov (2006, 2014) confirmed the presence of this species in the Azorean waters, at a maximum depth of 2,440 m. The true geographical distribution and depth range in the Atlantic of *S. hastigera* is still pending on a future review (Mironov 2006, 2014). Regardless, if all reports for the archipelago are returned back to the original determination of *S. hastigera* by Koehler (1895a, 1895b, 1898, 1909) it leaves no record of *S. profundi* in the archipelago. Additionally, Mortensen (1935) assumed that among the material of *S. hastigera* reported by Koehler there were specimens belonging to *S. varispina*, and the re-examination of a specimen from *Princesse Alice* collected within the Azorean waters (sta 578: 38°26'N, 26°30'45"W, 1,732 m) confirmed his suspicions (see below).

Salenocidaris varispina Agassiz, 1869
(Fig. 22)

Reports for the Azores:

Salenia varispina (Agassiz, 1869)—$Agassiz 1881: 55–56, pl. 4, figs. 1–2;
p.p. *Salenia hastigera* Agassiz, 1879—$Koehler 1895b: 228, 1909: 219–220;
Salenocidaris varispina Agassiz, 1869—Mortensen 1927a: 289; $Mortensen 1935: 350–354, fig. 193a, pl. 66, fig. 9, pl. 84, fig. 4, pl. 85, figs. 3–4, 8, 16–17, 37; $Mironov 2006: 106; Mironov 2014: 122–123.

Type locality: Off Double Head Shot Key, Cuba.

See: Agassiz (1869: 254–256); Mortensen (1935); Mironov (2006).

Occurrence: cosmopolitan, known from the Atlantic and Pacific Oceans (Mironov 2006); in the west Atlantic from south of Cape Cod to Brazil (Agassiz 1881, Serafy & Fell 1985), and in the east Atlantic from Bay of Biscay to off Ascension Island (Agassiz 1881, Mortensen 1935), including the archipelago of the Azores, and the Atlantis, Tropic and Antialtair seamounts (Mironov 2006).

Depth: (?290) 610–2,600 m (Mironov 2006); AZO: (?718)1,165–1,830 m (Agassiz 1881, Koehler 1909).

Habitat: typically found on fine-grained sediments (Agassiz 1881); feeds on bottom material, including foraminifera (Mortensen 1935).

Larval stage: planktonic (Mortensen 1935).

Material examined: EMEPC-LUSO L09D22S1 (D. João de Castro Bank, AZO, *c.* 38°14'02"N, 26°33'37"W, 2009.10.09, 718–825 m; 1 bt, D = 2 mm); EMEPC-LUSO L09D25ARB21 (between São Jorge and Pico Island, *c.* 38°36'19"N, 28°06'47"W, 2009.10.21, 1,179 m; 1 spm, D = 3 mm).

Description: test small, low and hemispherical with a flattened oral side. Apical disc dicyclic, relatively large (about 80%D), occupying much of the aboral side. Plates of the apical disc densely ornamented with rough papillae arranged somewhat concentrically. Periproct off centre and angular, larger than the suranal plate. No genital pores open. Ambulacral plating simple except for plates adjacent to the peristome, which are bigeminate. Pores small; pore areas slightly widened at the peristome. One primary tubercle per ambulacral plate, slightly smaller than the corresponding one in the interambulacra. A pair of sphaeridia at the peristomial edge of each ambulacrum. Interambulacral plates each with a single, large, crenulated and non-perforated primary tubercle. Primary spines long, slender and verticillated, more than twice the size of the test (broken off at the tips); milled ring prominent; thorns developed primarily on upper (aboral spines) or lateral sides (oral spines). Secondary spines spatulated and rather broad. Periproctal spines short, thick and club-shaped to almost globular. Tridentate pedicellariae could not be found. Triphyllous and ophicephalus pedicellariae common, including the distal area of the apical disc. Colour (in ethanol): periproct deep purple; apical disc, peristome and secondary spines purple; tube feet cream white; primary spines uniform white with a purple base.

Remarks: as with other *Salenocidaris* recorded from the archipelago, *S. varispina* was frequently misidentified, confused with the close resembling species, *S. profundi* and *S. hastigera*. For example, Mortensen (1935) re-examined a small specimen from *Princesse Alice* collected in Azorean waters (sta 578: 38°26’00”N, 26°30’45”W, 1,732 m) previously identified by Koehler (1909) as *S. hastigera*, and reassigned it to *S. varispina*. Nevertheless, more recently, Mironov (2006) found four specimens of *S. varispina* collected north of São Miguel Island by the *Jean Charcot* (*Biacores* cruise, sta 179: 38°05’30”N, 25°46’30”W, 1,590–1,665 m), further substantiating the presence of this species in the archipelago.

The main diagnostic character of *S. varispina* is the relative short and wider valves of its tridentate pedicellariae (Mironov 2006). Other characters are also used to distinguish this species from *S. profundi* or *S. hastigera* are: broader interambulacral areas, broader secondary spines, thick and short periproctal spines and shorter and less thorny spines with the thorns only well developed in the adapical side (Mortensen 1935; Mironov 2006). In spite of the colour variability presented by *S. varispina* the presence of a dark purple periproct is also considered characteristic of this species (Mortensen 1935; Mironov 2006). The specimens herein examined were small (D < 3 mm) and not fully developed. Also, both lack important diagnostic characters as no tridentate pedicellaria were present. However, we feel confident that they belong to *S. varispina*. The complete specimen (EMEPC-LUSO L09D25ARB21) presented many of the typical features of *S. varispina*, particularly the deep-purple periproct. The ornament of the primary spines varied slightly from typical *S. varispina*. This deviation could be dismissed as age dependent based on previous observations by Mortensen (1935). The identification of the naked test (EMEPC-LUSO L09D22S1) was less safe as most of diagnostic characters in this genus rely on external appendages, none of which were present. However, comparing the test of both specimens they are nearly identical with comparable arrangement and ornamentation of the apical disc and the plating and tuberculation of the ambulacral and interambulacral areas. The known depth ranges of *S. hastigera* (370–2,605 m) and *S. varispina* are similar (650–2,600 m), though the former is also known from shallower depths outside the Atlantic (Mironov 2014). Reports in the Azores appear to follow the same general pattern, though *S. varispina* (1,165–1,830 m) is known locally from a narrower depth range than *S. hastigera* (793–2,440 m). The naked test herein reported (EMEPC-LUSO L09D22S1) was collected at shallower depth (718–825 m) than previous records of this species from the archipelago. Regardless, Mironov (2014) concluded that in the Northeast Atlantic *S. varispina* typically occurs in depths shallower than 2,000 m, whereas *S. hastigera* usually occurs deeper (>1,900 m).

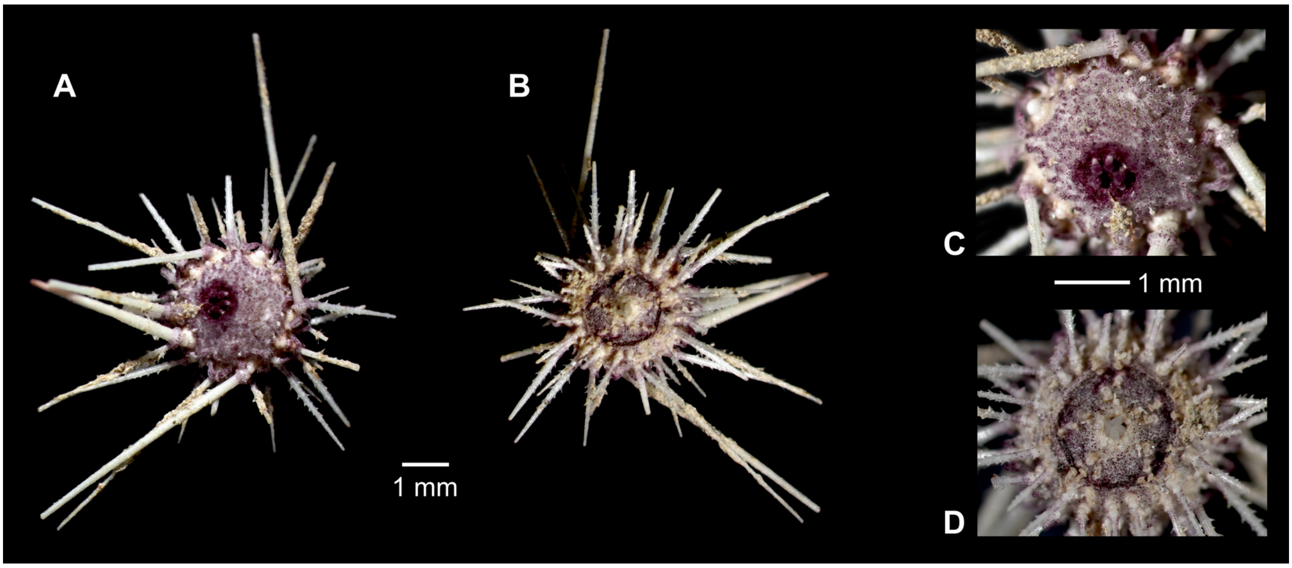

FIGURE 22. *Salenocidaris varispina* Agassiz, 1869 (EMEPC–LUSO L09D25ARB21: A–D). Aboral view (A); oral view (B); detail of the aboral surface (C) and oral surface (D).

Superorder Echinacea Claus, 1876

Order Arbacioida Gregory, 1900

Family Arbaciidae Gray, 1855a

Genus *Arbacia* Gray, 1835

Arbacia lixula (Linnaeus, 1758)
(Fig. 23)

Reports for the Azores:

Echinus aequituberculatus—$Drouët 1861: 93;
Echinocidaris aequituberculatus Desmoulins—$Drouët 1861: 210–211; Barrois 1888: 31;
Arbacia aequituberculata Gray, 1835—$Agassiz 1863: 20;
Arbacia pustulosa Gray, 1835—Agassiz 1872: 232–234, pl. 1g, fig. 5, pl. 2a, figs. 15–33, pl. 5, figs. 19–21, pl. 28, fig. 6, pl. 38, figs. 10a–c; $Barrois 1888: 74–75; $John 1889: 285;
Arbacia pustulosa (Leske, 1778)—$Simroth 1888: 231; $Koehler 1895a: 224, 1898: 9;
Arbacia lixula (Linnaeus, 1758)—Jackson 1912: 158; Mortensen 1927a: 290, 1935: 566–572, pl. 70, fig. 13, pl. 87, figs. 11, 12; Harvey 1956: 51, 63; $Marques 1983: 4–5; $Marques 1984: 103–108, fig. 1; Pereira 1997: 333–334; $Morton *et al.* 1998: 92–93, figs. 3–3H1, 3–4X, 5–1R, 5–2T1, 8–1M; Pérez-Ruzafa *et al.* 2002: 284–285; $Wirtz & Debelius 2003: 259; Cardigos *et al.* 2005: 165; García-Diez *et al.* 2005: 50; Schultz 2006: 118–119, figs. 211–215; $Haddad & Barreiros 2008: 9, fig. 3c; Micael & Costa 2010: 322; $Micael *et al.* 2010: 329; $Kroh *et al.* 2011: 99–105, figs. 2–4; Madeira *et al.* 2011: 248–249, figs. 4, 5A, 6A; Micael *et al.* 2012: 3; $Wangensteen *et al.* 2012: 1–16;
Arbacia aequituberculata (Blainville, 1825)—Koehler 1921b: 113–114, fig. 75; $Nobre 1924: 89; $Nobre 1930: 30, 69; $Cadenat 1938: 366, 373; $Chapman 1955: 399;
non *Arbaciella elegans* Mortensen, 1910—$Marques 1983: 5 [juvenile of *A. lixula*]; Pereira 1997: 334 [based on Marques 1983]; Haddad & Barreiros 2008: 9; Micael & Costa 2010: 322 [based on Marques 1983]; Micael *et al.* 2012: 3 [based on Marques 1983].

See: Mortensen (1935); Schultz (2006); Wangensteen *et al.* (2012).

Occurrence: East Atlantic and Mediterranean Sea; present along the Atlantic warmer waters of Africa to the Gulf of Guinea and Angola (Mortensen 1927a, Cadenat 1938, Cherbonnier 1959), including the Azores, Madeira, Selvagens, Canaries and Cape Verde (Pérez-Ruzafa *et al.* 2002, Wangensteen *et al.* 2012); it is present as well in Brazil (Wangensteen *et al.* 2012).

Depth: 0–55 m, common on the first few meters in the Azores (<15–18 m), but can occur at depths as great as 55 m (herein).

Habitat: hard substrata, particularly dominant on exposed rocky shores of the Azores (Morton *et al*. 1998); nocturnal omnivorous grazer (Schultz 2006).

Larval stage: planktotrophic (*c.* 26 days; George 1990).

Fossil record: spines and test fragments were reported from Pleistocene sediments of Santa Maria Island (Madeira *et al*. 2011).

Material examined: DBUA-ECH 013 (Rosto do Cão, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 1997.02.07, 13 m; 1 broken bt); DBUA-ECH 014 [Capelas (Morro), SMG, AZO, *c.* 37°50'37"N, 25°41'18"W, 1996.05.26, 9 m; 1 spm, D = 36 mm]; DBUA-ECH 015 (São Roque, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 2006.07.11, intertidal; 1 bt, D = 38 mm); DBUA-ECH 016 (Vila Franca do Campo, SMG, AZO, *c.* 37°42'50"N, 25°25'58"W, 2006.07.20, intertidal; 1 bt, D = 38 mm); DBUA-ECH 107 (FRM, AZO, *c.* 37°16'14"N, 24°46'52"W, 1990.06; 3 spms, D = 36–46 mm); DBUA-ECH 235 (Horta harbour, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 2009.12.4, 5 m; 1 bt, D = 3 mm); DOP 3014 (Channel PIX–FAY, AZO, 38°34'16"N, 28°32'31"W, 2008.06.16, 55 m; 1 spm, D = 10 mm); DOP 3024 (Channel PIX–FAY, AZO, 38°34'16"N 28°32'31"W, 2008.06.16, 50 m; 1 spm, D = 4 mm); MB-NMHN 367–20743 (Ponta Delgada harbour, SMG, AZO, *c.* 37°44'12"N, 25°39'26"W, 1982, collected and identified by Vasco Marques as *Arbaciella elegans*; 11 spms, D = 5–8 mm); MB-NMHN 372–20748 (Castelo Branco, FAY, AZO, *c.* 38°31'05"N, 28°43'23"W, collected and identified by Vasco Marques as *Arbaciella elegans*; 3 spms, D = 5–13 mm); MB-NMHN 385–20761 (SMG, AZO, 1982; 7 spms, D = 24–45 mm); MB-NMHN 385–2076 (SMG, AZO, 1988; 7 spms, D = 24–45 mm); MB-NMHN 401–20777 (SMG, AZO, 1982; 3 spms, D = 38–40 mm); MB-NMHN 403–20779 (Castelo Branco, FAY, AZO, *c.* 38°31'05"N, 28°43'23"W, 1979; 4 spms, D = 30–50 mm); MB-NMHN 412–20788 (SMG, AZO, 1988; 7 spms, D = 35–50 mm); MB-NMHN 415–20791 (SMG, AZO, 1982; 7 spms, D = 27–52 mm); MB-NMHN 416–20792 (SMG, AZO, 1982; 5 spms, D = 43–52 mm); MB-NMHN 548–20924 (Baixinha, GRA, AZO, *c.* 39°05'13"N, 27°59'09"W, 1982.08.10, 15 m; 5 spms, D = 50–58 mm).

Description: test circular, hemispherical, flattened on the oral side with a height about of 40–50%D. Epistroma well developed, particularly evident on the aboral side. Apical disc about 50%D in smaller specimens changing gradually to about 21%D in larger animals, naked and in most dicyclic, though the Oc V tends to be wedged in between the genital plates. Madreporite enlarged. Periproct oval shaped, with four naked anal plates; Gonopores open at sizes greater than 6 mm, though in some individuals as large as 10 mm are still not developed (*e.g.,* DOP 3014). Ambulacra narrow, about 30–40% of the inter-ambulacra at the ambitus, but widening to twice the size of the interambulacra at the peristomal edge; plates trigeminate, bearing a single primary tubercle each. These are arranged in alternating fashion near the apical disc but changing to a double vertical series just above the ambitus. Primary tubercles in the interambulacra reduced to one per plate in the area surrounding the apical disc, becoming numerous towards the ambitus, reaching up to four to five per plate in the larger specimens, the most interradial of which is usually smaller; in smaller specimens (<13 mm D), the spines only develop at the ambitus, about the third or fourth plate from the apical disc, giving a rather naked appearance of apical side. Peristome relatively large, about half of the D, ambulacral margins protruding and interambulacra terminating in well-defined buccal notches, giving the peristome an overall sinuous pentagonal appearance. Primary spines about 60–70%D; the primary spines in the small individuals (<5 mm D) are dorsoventrally flattened, sword like shaped, changing to the typical tip-pointed spines seen in larger specimens through ontogeny. Colour: solid black to dark brown; in smaller specimens (<5 mm), the spines are rather translucid with a black hue. Colour (naked test): interambulacra and ambulacra pink or reddish, particularly so in pore zones; apical disc can be darker, with a greyish hue.

Remarks: according to the text, Drouët (1861) only found *Arbacia lixula* (=*Echinocidaris aequituberculatus*) in Terceira Island and concluded that it was a rare species in the Azores. Conversely, Barrois (1888, as *Arbacia pustulosa*) commented that this species was quite common in rocky shores of the Azores, where it occurs in association with *Paracentrotus lividus* (as *Strongylocentrotus lividus)*. Marques (1983, 1984) reported densities of *Arbacia lixula* up to 15 individuals/m^2 on São Miguel and Graciosa rocky shores, between 2 and 15 m depth. Marques' observations agree with our observations though no quantitative studies have been made recently. Marques also noted that *P. lividus* and *A. lixula* seldom co-occur in the Azores. Though both species are frequently observed in same low intertidal waters of the archipelago (<2 m), we agree with Marques in the sense that *Arbacia lixula* tends to be more numerous in relatively more exposed shores, such as vertical walls in ports, whereas *P. lividus* seems to prefer areas of low slope and with less direct exposure to the wave action, living inside bore-holes (personal observation).

Cardigos *et al*. (2005) recorded this species in the area of Don João de Castro Seamount (between Terceira and São Miguel islands), one of the rare examples in Azores of a shallow-water hydrothermal-active volcanic seamount (the top of the seamount lies 13 m deep).

Additionally, small specimens of this species have been misidentified as *Arbaciella elegans* Mortensen 1910, including the ones re-examined here from Museu Bocage (MB-NMHN 367–20743 and MB-NMHN 372–20748), collected and identified by Marques (1983). A recent revision showed that records of *Arbaciella* in North Atlantic and Mediterranean waters were misidentifications of juveniles of *Arbacia lixula*, reducing the distribution of this species to the original tropical West African coasts, south of Cap Blanc (for discussion see Kroh *et al*. 2011).

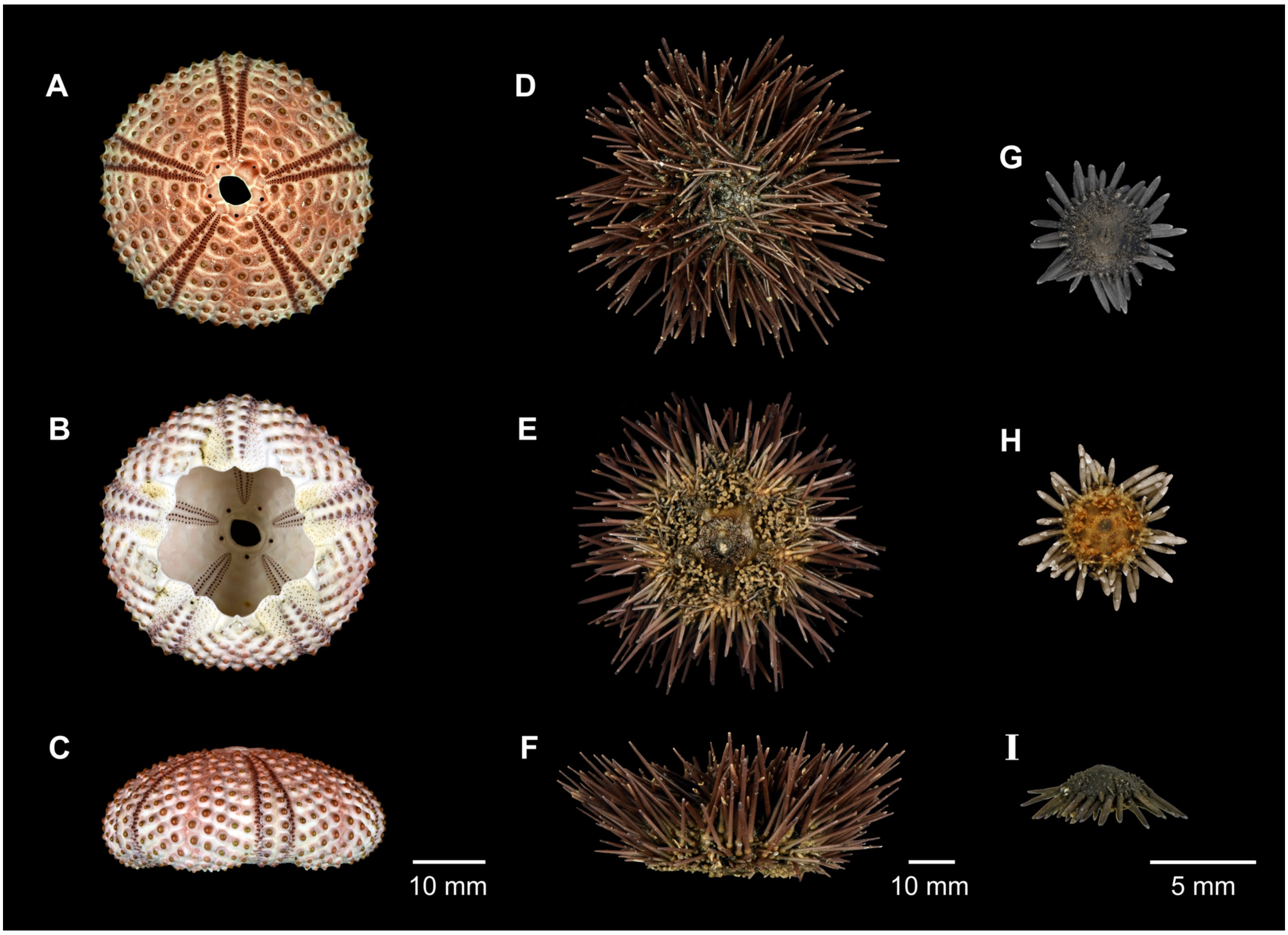

FIGURE 23. *Arbacia lixula* (Linnaeus, 1758) (DBUA-ECH 015: A–C; DBUA-ECH 020: D–F; DOP 3024: G–I). Aboral view (A, D, G); oral view (B, E, H); lateral view (C, F, I).

Order Camarodonta Jackson, 1912

Infraorder Echinidea Kroh & Smith, 2010

Family Echinidae Gray, 1825

Genus *Echinus* Linnaeus, 1758

Echinus melo Lamarck, 1816

(Fig. 24)

Reports for the Azores:

Echinus melo Lamarck, 1816—$Koehler 1909: 232; Koehler 1921b: 118–119, fig. 79; Nobre 1938: 115–116, fig. 52; Mortensen 1943a: 53–57, pl. 9, figs. 2, pl. 13, figs. 2, pl. 17, fig. 1; Harvey 1956: 64; Tortonese 1965: 332–333, fig. 157B; Marques

1980: 105; Pereira 1997: 334; García-Diez *et al*. 2005: 50; Mironov 2006: 110; Schultz 2006: 190, figs. 252–253; Micael & Costa 2010: 323; Micael *et al*. 2012: 4;
p.p. *Echinus acutus*—$^{\$}$Wisshak *et al*. 2010: 2382, fig. 2L.

See: Mortensen (1943a); Mironov (2006); Schultz (2006); Minin (2012).

Occurrence: Mediterranean Sea and northeast Atlantic, from the British Islands (Mortensen 1927a) to the northwest African coasts (Mortensen 1925), including the Azores (Koehler 1909), Canary and Cape Verde archipelagos (Agassiz 1872) and the Josephine, Ampere and Meteor seamounts (Mironov 2006).

Depth: 25–1,100 m (Mortensen 1943a); AZO: 200–475 m (Koehler 1909, herein).

Habitat: muddy bottoms to hard substrates (Koehler 1909, 1921b).

Material examined: EMEPC L09D17B1 (E of TER, AZO, 38°39'52"N, 26°51'22"W, 2009.09.30, 475 m; 1 spm, D = 185 mm).

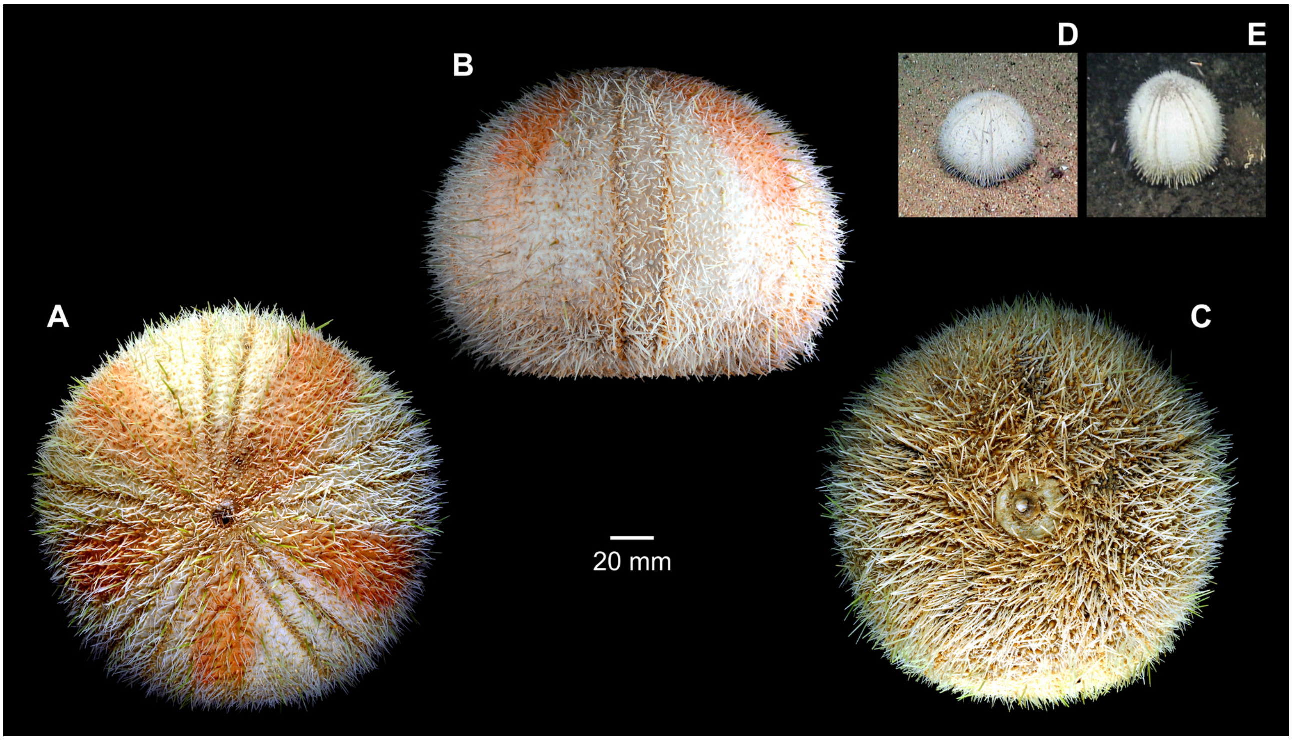

FIGURE 24. *Echinus melo* Lamarck, 1816 (EMEPC–LUSO L09D17B1: A–D). Aboral view (A); lateral view (B); oral view (C); animal *in situ* (D); echinoid most possibly belonging to *E. melo in situ* in Azorean deep waters (EMEPC–LUSO, 38°47'50"N, 27°28'57W", 455 m: E).

Description: test globular, slightly pentagonal with a height about of 75%D; Apical disc dicyclic, about 12%D. Periproctal plates with none to two spines. Madreporite enlarged. Gonopores open. Ambulacra about half the width of the interambulacra; in general, every ambulacral plate and every second interambulacral plate aborally bearing a primary tubercle; ambulacral plating trigeminate with pore-pairs in arcs of three at a distance from the edge of ambulacra. Peristome slightly larger than the apical disc (17%D). Primary spines short (10%D) and slender; on the oral side primary spines somewhat flattened with blunt tip; each peristomal plate with a small spine. Valves of globiferous pedicellaria with one short lateral tooth on each side below the end tooth; basal part with round angles and as long as the blade. Large form of tridentate pedicellariae (up to 3 mm) with straight, narrow valves (edges with numerous small serrations). Small form with slender, slightly curved valves. Valves of ophicephalous pedicellariae constricted in the middle and with round edges armed with minute teeth. Colour: test cream white; pore areas brown; primary spines white to green with white tips; secondary spines white; madreporite ochre. For some unknown reason the preserved specimen became tinged by a light pink hue.

Remarks: *Echinus melo* can be easily identified from other echinid species (except *Gracilechinus acutus*) known to occur in the Azores by its spherical large test reaching a maximum diameter of 170 mm (Mironov 2006) to 185 mm. Another easy recognizable character is the large distance between the pore zone and the adradial suture. *Echinus melo* was previously documented for the Azores by a single small specimen reported by Koehler (1909) based on the material collected in the Princesse Alice Bank (*Princesse Alice*, sta 899: 37°57’00”N, 29°14’45”W, 200 m). The new record further substantiates the presence of this species in the Azorean deep waters. Also, during EMEPC cruise (2009) in the Azores, an animal believed to belong to this species was captured on video east of Terceira Island at similar depths (38°47'50"N, 27°28'57"W, 455 m, Fig. 24E). See also remarks below under *Gracilechinus acutus*.

Genus *Gracilechinus* Fell & Pawson, 1966

Gracilechinus acutus? (Lamarck, 1816)

Reports for the Azores:

Echinus acutus Lamarck, 1816—?Koehler 1898: 7, 23; Nobre 1938: 114–115, figs. 48, 51; García-Diez *et al*. 2005: 50; p.p.?$^{\$}$Wisshak *et al*. 2010: 2382, fig. 2L; Micael & Costa 2010: 323;
Gracilechinus acutus (Lamarck, 1816)—Micael *et al*. 2012: 4.

See: Mortensen (1943a: 43–52, pl. 3, fig. 3, pl. 5, figs. 1–5, pl. 6, figs. 1–5, pl. 7, figs. 7–9, pl. 8, figs. 1–10, pl. 10, figs. 1–2, pl. 54, fig. 26, as *Echinus acutus*).

Occurrence: Mediterranean Sea and Northeast Atlantic, in the north from the Denmark Strait, Iceland, the Barents Sea, and Scandinavia [*G. acutus norvegicus* (Düben & Koren 1846); Mortensen 1943a], southwards along the European (Koehler 1898, Nobre 1938) and North African coasts (Döderlein 1906, Cadenat 1938) to Sierra Leone (Madsen 1957).

Depth: 20–1,280 m (Mortensen 1943a); ?AZO: 380–500 m (herein).

Habitat: from detritic bottoms, where feeds on all kind of bottom living organisms, with preference for crustaceans and foraminifera (Mortensen 1943a).

Larval stage: planktotrophic (Emlet 1995).

Remarks: Koehler (1898) examined young specimens collected by *Hirondelle* in Azorean waters between 1,372 and 1,850 m, which he identified as possible *G. acutus* or *G. alexandri* though due to their small sizes (less than 1 cm) he could not identify them without doubt. Later, Koehler (1909) reviewed the material from *Hirondelle* and established that the specimens did not belong to *G. acutus*. The author also added it was not possible to identify the material because of their small size and lack of pedicellaria. Recently, Wisshak *et al.* (2010: 2383, fig. 2L) presents a photograph of an echinoid taken at 380 m in the southern Faial Channel, which they identified as *G. acutus* (= *Echinus acutus*). They also observed that this large echinoid was abundant at a depth of 500 m. However, the photograph portraits a large white animal basketball-shaped with relatively short spines. The spherical white test and the short spines points towards *E. melo* (Fig. 24) and not to *G. acutus*, which is generally characterized in the Atlantic by a subconical brightly coloured test (Koehler 1921b). However, images provided by Max Wisshak of additional specimens observed at 460 m, suggest that they indeed observed both *G. acutus*, as well as *E. melo*. Unfortunately, no material was collected by Wisshak and co-workers precluding to verify the identification based on images taken by the submersible *Lula*. Both species are very variable in colour, shape and spine length (see Mortensen 1943a) and thus are difficult to distinguish even in the lab. It is, therefore, usually impossible to confirm their identity based on photographs alone (especially in specimens exhibiting slightly intermediate characteristics). Consequently, unless collected and verified by direct examination, the presence of *G. acutus* in the Azorean EEZ, though likely, remains unconfirmed.

Gracilechinus affinis (Mortensen, 1903)

Reports for the Azores:

Echinus affinis Mortensen, 1903—$^{\$}$Koehler 1909: 229–230, pl. 31, figs. 1–2, 19; Mortensen 1927a: 305–306, fig. 174, 1943a: 83–86, pl. 11, figs. 1–7, pl. 55, figs. 15, 17, 19; Gage *et al.* 1985: 183–184; Serafy & Fell 1985: 21, fig. 26;
Gracilechinus affinis Mortensen, 1903—Mironov 2014: 123.

Type locality: south of Iceland.

See: Mortensen (1903: 150–152, pl. 5, figs. 4, 8, pl. 15, figs. 3, 10, pl. 16, figs. 6, 20, pl. 18, figs. 4, 16, 28, pl. 19, fig. 27, pl. 20, figs. 17, 21; 1943a).

Occurrence: North Atlantic, from the east coast of the USA, the Denmark Strait and Iceland (Mortensen 1903) south to Rockall Trough (Döderlein 1906), Galicia (N Spain; Koehler 1921a) and the Azores (Koehler 1909).

Depth: 770–2,700 (?5,300) m (Mironov 2014); AZO: 1,482–2,252 m (Koehler 1909).

Habitat: soft bottoms, muddy sand to ooze (Koehler 1909, Gage *et al*. 1985); possibly an opportunistic scavenger (Gage *et al*. 1985).

Larval stage: planktotrophic (Young & Tyler 1993).

Remarks: *Gracilechinus affinis* is known from the Azores only from Koehler (1909) who reported this species (as *Echinus affinis*) among the material collected by *Princesse Alice* at several stations. This species was the fourth species of the genus *Gracilechinus* reported from the archipelago at one time. The presence in the Azores of *G. acutus* and *G. elegans* were dismissed as unconfirmed and erroneous respectively since the first was based on poorly preserved juveniles (see remarks under *G. alexandri*) and the other is likely to be based on misprint by Mortensen (1927a), reducing the presence of this genus in the Azores to just two species.

Gracilechinus alexandri (Danielssen & Koren, 1883)

Reports for the Azores:

Echinus alexandri Danielssen & Koren, 1883—$^{\$}$Koehler 1895b: 229, 1909: 230; Mortensen 1927a: 304–305, figs. 167.1, 172–173, 1943a: 65–68, figs. 20a, 21a–b, pl. 11, figs. 8–11; Grieg 1932: 42; Gage *et al*. 1985: 184; Serafy & Fell 1985: 4, 20, 21–22, fig. 29; ?$^{\$}$Pérès 1992: 255; García-Diez *et al*. 2005: 50 $^{\$}$Desbruyères *et al*. 2006: 479, figs. 1–4;
Gracilechinus alexandri (Danielssen et Koren, 1883)—Mironov 2014: 123–124.

Type locality: off Lofoten (69°18’N, 14°32’E), Norway.

See: Danielssen & Koren (1883: 294–296, pl. 3–4, figs. 7–16; as *Echinus alexandri*); Mortensen (1903: 146–150, pl. 5, figs. 2, 3, 5,7, pl. 15, figs. 13, 17, pl. 16, fig. 8, pl. 17, figs. 9, 11, 19, 23, 25, pl. 19, figs. 16, 31, 34, 38, pl. 20, figs. 1, 2, 27, pl. 21, figs. 18–20, 27; 1943a); Desbruyères *et al*. (2006).

Occurrence: North Atlantic, in the west, along the east side of North America (Serafy & Fell 1985) and in the east from Icelandic, Scandinavian and British deep waters (Mortensen 1903, 1927a), southwards to the Bay of Biscay and the Azores (Koehler 1909); possibly also in Tristan da Cunha (Mortensen 1943a).

Depth: 230–3,150 m (Desbruyères *et al*. 2006); AZO: 1,165–1,940(?2,560) m (Koehler 1909, Pérès 1992).

Habitat: soft substrates, ooze to sand (Koehler 1909, Gage *et al*. 1985); diet consisting of bottom mud with foraminiferans (Serafy & Fell 1985); feeds also on deep-sea reef building corals such as *Lophelia pertusa* and *Madrepora oculata* (Stevenson & Rocha 2012); can be found in the vicinity of deep-water hydrothermal vents (Desbruyères *et al*. 2006).

Larval stage: planktotrophic (Emlet 1995).

Remarks: Koehler (1898) examined young specimens collected by *Hirondelle* in Azorean waters between 1,372 and 1,850 m, which he identified as possible *Gracilechinus acutus* (= *Echinus acutus*) or *Gracilechinus alexandri* (= *Echinus alexandri*) but due to the small size of the animals (less than 1 cm) he could not ascertain without doubt. The confirmation of *G. alexandri* presence in the archipelago was made later by Koehler (1895b, 1909) who identified material belonging to this species collected by *Princesse Alice* at several stations located inside the Azorean waters. During a dive made by the bathyscaphe *Archimède* north of the São Miguel, Pérès (1992) claimed to observe an animal of this species at a depth of 2,560 m, though no specimen was collected. More recently, a small population of *G. alexandri* was found at one time in the vicinity of the Azorean Mid-Atlantic hydrothermal vent field Lucky Strike, from which a specimen has been figured in the Handbook of Deep-Sea Hydrothermal Vent Fauna by Desbruyères *et al*. (2006).

Family Parechinidae Mortensen, 1903

Genus *Paracentrotus* Mortensen, 1903

Paracentrotus lividus (Lamarck, 1816)

(Fig. 25)

Reports for the Azores:

Echinus lividus Lamarck, 1816—$Drouët 1861: 210; Barrois 1888: 31;
Toxopneustes lividus (Lamarck, 1816)—$Agassiz 1863: 23; $Simroth 1888: 231;
Strongylocentrotus lividus (Lamarck, 1816)—$Agassiz 1872: 446–447, pl. 5b, fig. 3, pl. 24, fig. 25; $Barrois 1888: 75; John 1889: 285; $Koehler 1895a: 225, 1898: 24; Jackson 1912: 162;
Paracentrotus lividus (Lamarck, 1816)—Koehler 1914b: 278; Mortensen 1927a: 306–309, figs. 175–177; $Cadenat 1838: 367; Nobre 1938: 118–119, figs. 48–49, 66; $Mortensen 1943a: 157–168, figs. 69–72, pl. 17, figs. 2–3, pl. 22, figs. 1–9, pl. 57, figs. 1–3, 11, 12, 20; $Chapman 1955: 399; Harvey 1956: 51, 65; $Tortonese 1965: 337–341, figs. 160–162; $Marques 1983: 5–6, 1984: 105; Moyse & Tyler 1995: 678–680, fig. 12.8; Pereira 1997: 334; Pérez-Ruzafa *et al.* 1999: 52–53, 2002: 285–286; $Cardigos *et al.* 2005: 165; García-Diez *et al.* 2005: 50; Schultz 2006: 194–195, figs. 361–363; Haddad & Barreiros 2008: 9, fig. 3a; Ávila *et al.* 2009: 27, 2010: 56; Micael & Costa 2010: 323; $Micael *et al.* 2010: 329;$Wisshak *et al.* 2010: 2382; Madeira *et al.* 2011: 249–250, figs. 5C, 6C, 7C; Micael *et al.* 2012: 3, 5.
non *Psammechinus microtuberculatus* (Blainville, 1825)—$Marques 1983: 5 [misidentification].

See: Mortensen (1943a); Schultz (2006).

Occurrence: Mediterranean Sea and northeast Atlantic, from Ireland (Mortensen 1927a), along the coast of Europe (Nobre 1938) to Mauritania (Chapman 1955), including the archipelagos of the Azores (Marques 1989), Madeira (Alves *et al*. 2001), Selvagens (Pérez-Ruzafa *et al.* 2002), Canaries (Pérez-Ruzafa *et al.* 2003) and Cape Verde (Pérez-Ruzafa *et al.* 1999).

Depth: 0–80 m (Tortonese 1965), rarely below 30 m (Picton 1993); AZO: 0–40(?207) m (Koehler 1898, herein).

Habitat: preferentially rocky shores where it can bore holes in the rock (Schultz 2006); diet mainly of algae (Mortensen 1943a).

Larval stage: planktotrophic (Emlet 1995).

Fossil fauna: remains of this species, spines and test fragments were found in Pleistocene sediments of Santa Maria Island (Madeira *et al*. 2011). At the Pleistocene outcrop at Prainha, bore-holes were found on a basaltic rock about 5 m above present sea level, which were attributed to *P. lividus* boring activities (Ávila *et al*. 2009, 2010).

Commercial value: edible (Picton 1993).

Material examined: DBUA-ECH 123 (São Roque, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 2012.11.16, intertidal; 1 spm, D = 5 mm); DBUA-ECH 138 (Poças de Santa Cruz, GRA, AZO, *c.* 39°05'16"N, 28°00'25"W, 2010.08.02, intertidal; 1 spm, D = 13 mm); DBUA-ECH 164 (Baia do Rosto do Cão, São Roque, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 1990.07; 14 spms, D = 9–14 mm); DBUA-ECH 166 (off Vila Franca do Campo, SMG, AZO, 37°41'17"N, 25°25'06"W, 2006.07.15, 129–207 m; 1 bt, D = 7 mm); DBUA-ECH 190 (Vila Franca do Campo, SMG, AZO, *c.* 37°41'39"N, 25°27'27"W, 2006.07.21, 95–121 m; 1 bt, D = 3 mm); DBUA-ECH 280 (Ponta Delgada harbour, SMG, AZO, *c.* 37°44'12"N, 25°39'26"W, 1996.12.04; 1 spm, D = 34 mm); DBUA-ECH 287 (Rosto do Cão, São Roque, SMG, AZO, *c.* 37°44'37"N, 25°38'19"W, 1990.05.14, 1 m; 1 spm, D = 45 mm); DBUA-ECH 323 (Islet of Mosteiros, SMG, AZO, *c.* 37°53'25"N, 25°50'06"W, 2011.07.07, 26 m; 2 spms, D = 8–12 mm); DBUA-ECH 337 (Piscinas de Santa Cruz, FLS, AZO, *c.* 39°27'18"N, 31°07'30"W, 2007.07.22, intertidal; 7 spms, D = 15–49 mm); DBUA-ECH 338 (SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1997.7, intertidal; 1 spm, D = 9 mm); DBUA-ECH 412 (Santa Cruz, GRA, AZO, *c.* 39°05'16.00"N, 28°00'25"W, 2010.08.06, intertidal; 2 spms, D = 51–58 mm); MB-NMHN 39–357 (Castelo Branco, FAY, AZO, *c.* 38°31'05"N, 28°43'23"W, 25 m, collected and identified by Vasco Marques as *Paracentrotus* cf. *gaimardi*; 1 bt, D = 9 mm); MB-NMHN 39–354 (Horta, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 1979, collected and identified by Vasco Marques as *Psammechinus microtuberculatus*; 1 bt, D = 7 mm); MB-NMHN 39–355 (Castelo Branco, FAY, AZO, *c.* 38°31'05"N, 28°43'23"W, 1979, collected and identified by Vasco Marques as *Psammechinus microtuberculatus*; 1 bt and 1 dry spm, D = 6 mm).

Description: test circular, relatively low with a height of about 40%D in smaller specimens increasing to almost 60% in larger specimens. Apical disc dicyclic. Periproctal plates naked; Small individuals with three naked periproctal plates, one large and two other ones half the size of the large one. Genital pores closed in the smallest individual (D = 5 mm; DBUA-ECH 123). Ambulacral plates polygeminate, with four to five pore pares per plate at the ambitus in smaller specimens and five pore pairs throughout in larger specimens; one large primary tubercle per ambulacral plate, with secondary tubercles forming a zigzag series along the midline of the area; primary tubercles in the ambulacral plates of the same size as the ones in the interambulacra. Interambulacra with two regular series of primary tubercles flanked one or two sub-equal secondary tubercles. Peristome somewhat sunken, from 45–

60%D in smaller specimens (<9 mm D) to 34–36%D in larger specimens (>33 mm D). Peristomal membrane with small-scattered plates. Primary spines long and robust, about 20–30%D in smaller specimens increasing to more 50–60%D in larger specimens. Globiferous pedicellaria with one large terminal tooth and one lateral tooth on each side. Colour variable, from dark green/purple to lighter green/purple or with primary spines dark coloured at the base and becoming lighter towards the tips.

Remarks: the genus *Paracentrotus* comprises just two extant shallow-water species, *P. lividus* (Europe and NW Africa waters) and *P. gaimardi* (South Atlantic tropical waters: Gulf of Guinea, Angola and Brazil) (Schultz 2006). Mortensen (1943a) compared and discussed several diagnostic characters considered in the previous literature and concluded that none could be considered as reliable due to the high morphological variation demonstrated by both species. Nevertheless, Mortensen considered that the best character was the ornamentation on the apical disc, although he commented that it was also subject to variation as animals from both species could present a rather weak striation. Another character discussed by Mortensen was the number of pore pairs being almost constantly five in *P. lividus* and usually four in *P. gaimardi*. Again, both species show a degree of overlapping variation with some specimens of *P. gaimardi* having plates bearing five pore pairs and specimens of *P. lividus* presenting four to six pore pairs. The collection of Museu Bocage houses an unreported specimen from the Azores, collected and identified by Marques Vieira as *Paracentrotus* cf. *gaimardi*. The specimen presents only four pore pairs at the ambitus, a character that Marques Vieira may have used to identify the Azorean animal as western *P.* cf. *gaimardi*. However, taking in to account the size of the Azorean specimen (≈9 mm), the lack of ornamentation of the apical disc, and the NE Atlantic origin, we strongly believe that the specimen represents a young *P. lividus*, a common inhabitant of the Azorean rocky shores.

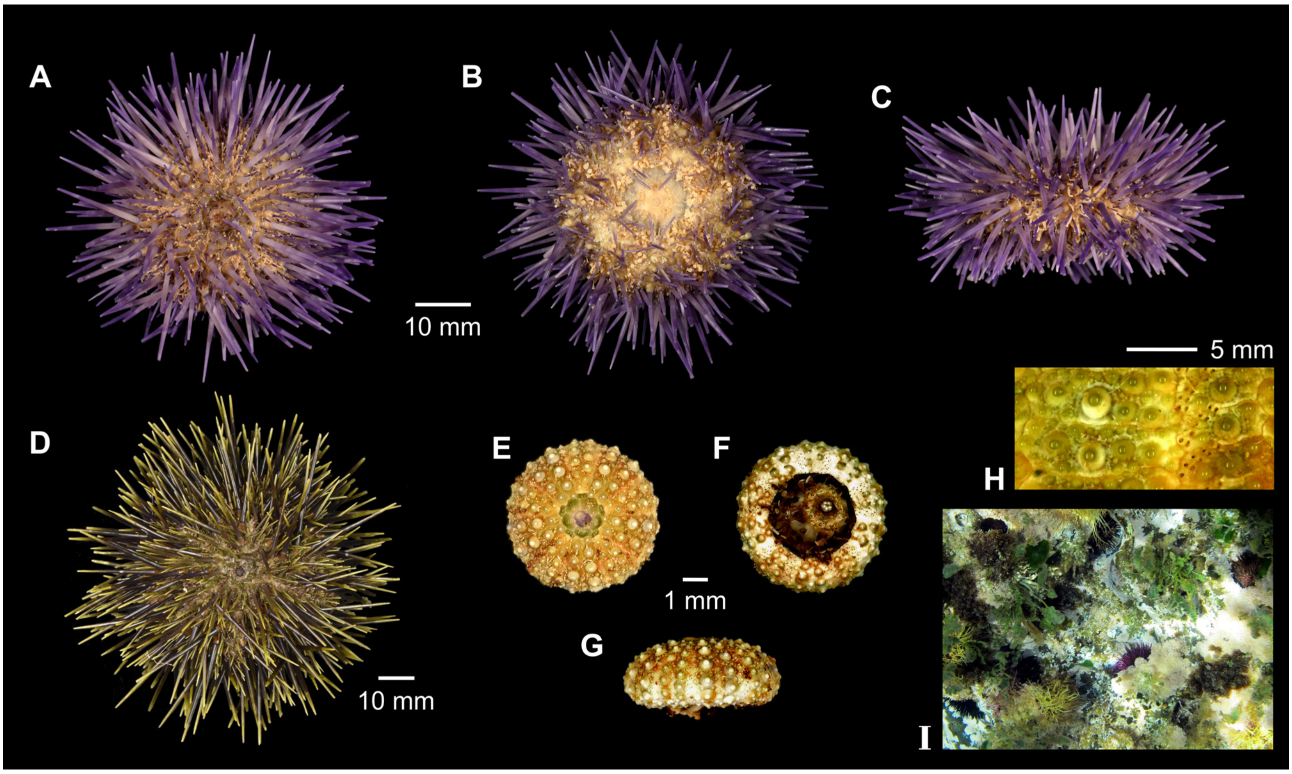

FIGURE 25. *Paracentrotus lividus* (Lamarck, 1816) (DBUA-ECH 280: A–C; DBUA-ECH 337: D; DBUA-ECH 412: H; MB-NMHN 39–354: E–F). Aboral view (A, D, E); oral view (B, F); lateral view (C, G); ambulacral and interambulacral plates (H); *in situ* (Santa Maria Island, Azores, 2010.07.02, intertidal: I).

Marques Vieira's echinoderm collection at the Museu Bocage also houses three small animals (D = 6 mm, see Fig. 25E–G) identified as *Psammechinus microtuberculatus*, a species believed to be endemic to the Mediterranean Sea (see below remarks under *P. miliaris*). Marques (1983) remarked that this species was the least frequent echinoid species in the Azores shallow waters. Thus, it is quite likely that the material housed at the Museum is the sole material used by Marques on which his report of *P. microtuberculatus* from the Azores was based. However, all three specimens possess ambulacral plates with four pore pairs per plate, a feature not found in

Psammechinus. Furthermore, the valves of globiferous pedicellaria from the only complete specimen were typical of the genus *Paracentrotus*, presenting a single pair of lateral teeth beneath the terminal tooth, not several as would be expected in *Psammechinus* specimens. Apparently, Marques (1983) had misidentified juveniles of *P. lividus* as *P. microtuberculatus*.

Paracentrotus lividus is a typical inhabitant of the first few meters of the Azorean rocky shores, with a maximum reported depth in the Azores of *c.* 40 meters. Specimens dredged from 95–200 m all are slightly abraded naked tests possibly transported after the animals' death to these depths. Additionally, Cardigos *et al.* (2005) recorded this species in the area of Don João de Castro Seamount (between Terceira and São Miguel islands), one of the rare examples in Azores of a shallow-water hydrothermal-active volcanic seamount (the top of the seamount lies 13 m deep). See also remarks under *Arbacia lixula*.

Genus *Psammechinus* Agassiz & Desor, 1846

Psammechinus miliaris? (Müller, *in* Knorr, 1771)

Reports for the Azores:

non *Echinus microtuberculatus* Blainville, 1825—?$^{\$}$Barrois 1888: 109 [misidentification];

Psammechinus miliaris (Gmelin, 1791)—Mortensen 1927a: 294–295; Nobre 1938: 110–111, figs. 48–49;

non *Psammechinus microtuberculatus* (Blainville, 1825)—Nobre 1938: 111–112 [based on Barrois 1888]; Tortonese 1965: 333–335, fig. 159 [based on Nobre 1938]; ?$^{\$}$Castro & Viegas 1983: 24 [misidentification]; Pereira 1997 [based on Barrois 1888]: 334; Haddad & Barreiros 2008: 9; Micael & Costa 2010: 323 [based on Nobre 1938]; Micael *et al*. 2012: 4 [based on Barrois 1888];

Psammechinus miliaris (Müller, *in* Knorr, 1771)—?$^{\$}$Mortensen 1943a: 127–139, figs. 56a–b, 57, 58a–b, 59a, 60b, 63b, pl. 10, figs. 3–5, pl. 18, figs. 1–7, 20–21, pl. 58, figs. 19, 23– 25; Moyse & Tyler 1995: 680, 12.8; Schultz 2006: 198–198, figs. 370–372; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

See: Mortensen (1943a); Schultz (2006).

Occurrence: Northeast Atlantic, from Iceland and Scandinavia (Mortensen 1903) to Cape Blanc (Mortensen 1925, Nobre 1938), including the ?Azores (Barrois 1888), ?Madeira (Jesus & Abreu 1998), ?Canaries and ?Cape Verde (Tortonese 1965).

Depth: 0–100 m (Mortensen 1927a); ?AZO: 10–20 m (Barrois 1888).

Habitat: virtually any kind of bottom (on bouldery sheltered shores, among sea-grass or algae, under stones, on rocks; Picton 1993); omnivorous, depending on the bottom on which it lives (Mortensen 1943a).

Larval stage: planktotrophic (Emlet 1995).

Commercial value: edible (Lawrence, J.M. 2007).

Remarks: *Psammechinus microtuberculatus* (Blainville, 1825) was frequently reported from the Azores, unfortunately without descriptions. Koehler (1921b) showed some concerns about the records for the Atlantic, since he believed that the geographical range of this species did not go further than the Iberian Peninsula. Mortensen (1927b, 1943a) stated that the species *Psammechinus microtuberculatus* was endemic to the Mediterranean Sea and all reports of this species in the NE Atlantic were a result of misidentifications with close related species *Psammechinus miliaris* or *Paracentrotus lividus*. Additionally, on reviewing the material collected by Simroth (unreported) Mortensen (1943a) concluded that the animals were far too small (D = 2.5 mm) to allow a reliable identification. Mortensen also added that the material report by Barrois (1888) from the Azores as *P. microtuberculatus* was presumably lost. We have no knowledge on the whereabouts of Castro & Viegas (1983) material or even if any specimens were actually deposited in a collection. The specimens identified by Marques (1983) as *Psammechinus microtuberculatus* (housed in the zoological collections of Museu of Bocage–MNHM) proved to be juveniles of *Paracentrotus lividus*, a common inhabitant of the Azores coastal waters (see remarks under *Paracentrotus lividus*). After critically examining the echinoid extant material in the DBUA-ECH collection we could not find a single specimen belonging to either *P. microtuberculatus* or *P. miliaris*. In sum, the only known *Psammechinus* material from the Azores is either lost or too small to allow a reliable identification. Both *P. miliaris* and *P. microtuberculatus* species have a planktotrophic larval development with a high dispersal potential (Emlet 1995). Thus, it is not entirely unlikely that new recruits from the NE Atlantic or even Mediterranean continental coasts could have reached the insular coasts. Furthermore, it is not unprecedented to have Mediterranean species present in the Azores (*e.g.,* the sea star *Sclerasterias richardi*). Nevertheless, we follow Mortensen (1943a) in assigning the historical reports of *P. microtuberculatus* from the Azores to *P. miliaris*. In the absence of well documented adult specimens, the presence of *P. miliaris* in the Azores, however, needs to remain doubtful until confirmed by new records.

Superfamily Odontophora Kroh & Smith, 2010

Family Toxopneustidae Troschel, 1872

Genus *Sphaerechinus* Desor, 1856

Sphaerechinus granularis (Lamarck, 1816)

(Fig. 26)

Reports for the Azores:

Echinus brevispinosus Risso, 1826—$^{\$}$Drouët 1861: 210; Barrois 1888: 31;

Sphaerechinus granularis (Lamarck, 1816) —$^{\$}$Agassiz 1863: 23, 1872: 159–160, 452–453, pl. 5a, fig. 7, pl. 6, figs. 16–17; p.p.$^{\$}$Agassiz 1881: 106–107; $^{\$}$Barrois 1888: 109–110; $^{\$}$Simroth 1888: 231, 233; John 1889: 285; $^{\$}$Koehler 1895a: 225, 1898: 23; Jackson 1912: 162; $^{\$}$Nobre 1924: 89, 1930: 69; $^{\$}$H.L. Clark 1925: 140–141; Mortensen 1927a: 309–312, figs. 178–180; $^{\$}$Cadenat 1938: 367–368; Nobre 1938: 119–120, figs. 48, 49, 66; Mortensen 1943b: 515–526, figs. 242c, 309–314, pl. 39, figs. 1–4, pl. 40, figs. 1–5, pl. 41, figs. 1–7, pl. 56, figs. 1, 8, 10, pl. 25, fig. 13; $^{\$}$Chapman 1955: 399; Harvey 1956: 51, 66; $^{\$}$Tortonese 1965: 323–327, figs. 151–154; $^{\$}$Marques 1983: 5; Pereira 1997: 334; $^{\$}$Maciel & Gonçalves 1998: 182; $^{\$}$Morton *et al*. 1998: 150–151, figs. 3–3L1, 8–1L; Pérez-Ruzafa *et al*. 2002: 285; $^{\$}$Wirtz & Debelius 2003: 258; $^{\$}$Cardigos *et al*. 2005: 159; García-Diez *et al*. 2005: 50; Mironov 2006: 112; Schultz 2006: 266–267, figs. 509–513; Haddad & Barreiros 2008: 9, fig. 3d; Micael & Costa 2010: 323; $^{\$}$Micael *et al*. 2010: 329; Madeira *et al*. 2011: 250, figs. 5B, 6B; Micael *et al*. 2012: 4.

See: Mortensen (1943b); Schultz (2006).

Occurrence: Mediterranean Sea and northeast Atlantic; from Channel Islands to the Gulf of Guinea (Mortensen 1943b), including the Azores (Marques 1983), Madeira (Alves *et al*. 2001), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries (Mortensen 1927b), Cape Verde (Agassiz 1881) and Gorringe and Dacia seamounts (Mironov 2006).

Depth: 0–120 m (Chapman 1955, Koukouras *et al*. 2007); AZO: 0–60 m (Chapman 1955, Marques 1983).

Habitat: generally found on hard substrates (AZO), but also on *Posidonia* and *Zostera* meadows, silty sand or maërl bottoms (Mortensen 1943b, Koukouras *et al*. 2007).

Larval stage: planktotrophic (Emlet 1995).

Fossil fauna: remains of this species, spines and test fragments were found in Pleistocene sediments at Santa Maria Island (Madeira *et al*. 2011).

Commercial value: edible (Tortonese 1965).

Material examined: DBUA-ECH 025 (São Roque Islet, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2006.11.07, 3 m; 1 bt, D = 54 mm); DBUA-ECH 026 (São Roque Islet, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2006.11.07, 3–5 m; 1 bt, D = 85 mm); DBUA-ECH 027 (São Roque Islet, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2006.11.07, 3–5 m; 1 bt, D = 82 mm); DBUA-ECH 028 (São Roque Islet, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2006.11.07, 3–5 m; 1 bt, D = 63 mm); DBUA-ECH 030 (Banco D. João de Castro, AZO, *c.* 38°13’18”N, 26°36’12”W, 2006; 1 spm, D = 70 mm); DBUA-ECH 031 (Banco D. João de Castro, AZO, *c.* 38°13’18”N, 26°36’12”W, 1996.07.02, 30 m; 5 spms, D = 81–87 mm); DBUA-ECH 032 (Cerco, Caloura, SMG, AZO, *c.* 37°42’26”N, 25°30’37”W, 20 m; bt, D = 21 mm); DBUA-ECH 054 (Santa Cruz, GRA, AZO, *c.* 39°05’16”N, 28°00’25”W, 2010.08.02, intertidal; 1 spm, D = 11 mm); DBUA-ECH 140 (Poças de Santa Cruz, GRA, AZO, *c.* 39°05’16”N, 28°00’25”W, 2010.08.07, intertidal; 4 spms, D = 37–54 mm); DBUA-ECH 158 (FRM, AZO, *c.* 37°16’14”N, 24°46’52”W, 1990.06, 45 m; 2 spms, D = 6–11 mm); MB-NMHN 410–20786 (Baixinha, GRA, AZO, *c.* 39°05’13”N, 27°59’09”W, 1979; 2 spms, D = 92–100 mm); MB-NMHN 285–18681 [Pópulo (Praia Grande), SMG, AZO, *c.* 37°45’00”N, 25°37’24”W, 1980; 1 spm, D = 55 mm]; MB-NMHN 368–20744 (Horta harbour, FAY, AZO, *c.* 38°31’51”N, 28°37’23”W, 1979; 2 spms, D = 12–18 mm).

Description: test circular, flattened orally, height reaching about 55–65%D, the peristome area is at most only slightly depressed. Apical disc hemicyclic, with Oc. I and V insert, though in the smaller specimens the latter can be exsert (D < 11 mm). Periproct nearly ellipsoid, enclosing numerous periproctal plates of various sizes, many of which bear a slender spine; in smaller individuals periproct bearing one larger anal plate. Gonopores closed in the smallest specimens (D ≈ 6 mm; DBUA-ECH 158). Ambulacra with irregular arcs of four or five pore pairs per plate in smaller specimens (D ≤ 30 mm) up to six pore pairs per plate in larger animals; in smaller specimens the number of pore pairs drop to five (D ≤ 30 mm) or four (D ≤ 11 mm). Number of ambulacral primary tubercles at the ambitus from one in small specimens (D ≤ 11 mm) up to two or three in larger animals; free space of both adradial and perradial zones filled with small secondary tubercles and miliary granulation. The number of primary tubercles in the interambulacra at the ambitus from two in small specimens (D ≤ 18 mm) up to six in large specimens (D ≥ 80 mm); adradial and interradial spaces filled by smaller secondary tubercles of various sizes. Peristome from 50–57%D in small specimens (D ≤ 11 mm) decreasing in relative size in larger specimens to about 22–25%D; buccal membrane with small embedded plates and devoid of spines. Gill slits well developed particularly in larger specimens, giving an overall almost pentagonal shape to the peristome. Presence of large globiferous pedicellaria (≈3 mm in larger specimens). Primary spines relative short and stout, with blunt tips. Colour: naked test purple or light brown; spines white, brown or bright violet with or without whitish tips; smaller specimens (D ≤ 11 mm) with green, orange or brown tests and primary spines white, bright pink, orange, reddish-brown or brown with or without whitish tips.

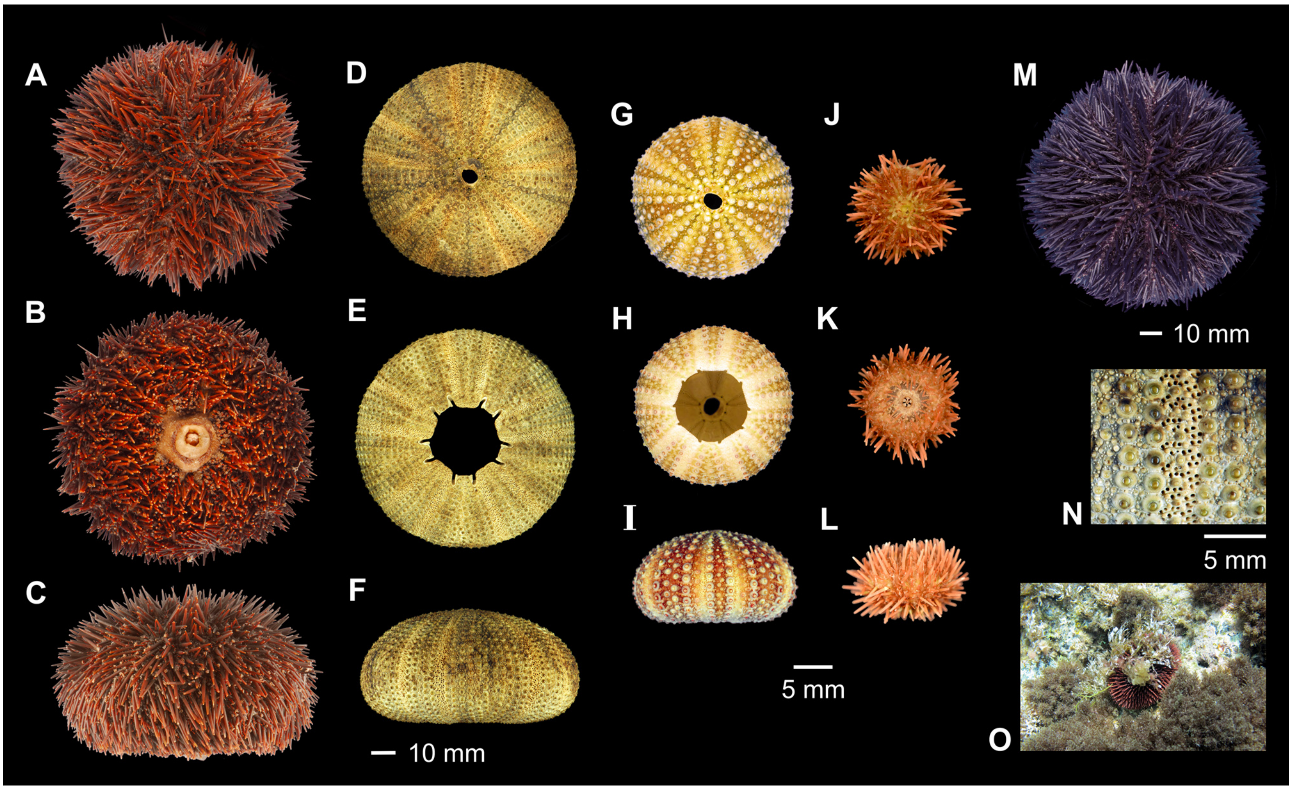

FIGURE 26. *Sphaerechinus granularis* (Lamarck, 1816) (DBUA-ECH 031: A–C, M; DBUA-ECH 027: D–F; DBUA-ECH 032: G–I; DBUA-ECH 158: J–L; DBUA-ECH 028: N). Aboral view (A, D, G, J, M); oral view (B, E, H, K); lateral view (C, F, I, L); detail of the pore areas (N); *in situ* (Santa Maria Island, Azores, 2010.07.02, intertidal: O).

Remarks: Mortensen (1943b) reviewed the intraspecific variation in *S. granularis*, which included some of the Azorean specimens' particularities, *i.e.* the higher number of pore pairs in the ambulacral plates. He rejected the hypothesis of specimens with six pore pairs per plate as belonging to a different species or a variety. Our results suggest that specimens with different number of pore pairs coexist in the same area. Furthermore, a higher number of pore pairs on the ambulacra is not exclusive for the Azores population. Agassiz (1872) reported specimens with six pore pairs from a batch from the Mediterranean Sea or Canaries (which location he did not specified), dismissing it as an ontological variation. Our observations, in contrast, agree with Mortensen (1943b) who showed that such differences are not dependent on the size of the animal. In spite of the intraspecific variation being overall constant throughout the species geographic range, we could not help notice the colour morph presented as 'typical' by several authors for the Mediterranean Sea is the purple/violet colour (*e.g.,* Koehler 1921b; Mortensen 1927a;

Tortonese 1965; Schultz 2006). In contrast, in the Azores, the brown colour morph appears very common if not the most common. Nonetheless, the presence of both colour morphs in the same area, or even clutching together to the same rock is not uncommon in the Azorean subtidal (*personal observation*).

The red colour morph of *Genocidaris maculata*, a species also native to the archipelago, have historically been confused with juveniles of *S. granularis* (Figs. 26J-L; Koehler 1921b; Mortensen 1943b). For example, Agassiz (1881) recorded *S. granularis* from the Azores (H.M.S. *Challenger*, sta 75: 38°37'N, 28°30'W). On re-examination of this material, later authors (*e.g*., H.L. Clark 1925; Mortensen 1943b) realized that Agassiz failed to notice the presence of a reddish colour morph of *Genocidaris maculata* among the batch (see remarks under *Genocidaris maculata*).

Infraorder Temnopleuridea Kroh & Smith, 2010

Family Trigonocidaridae Mortensen, 1903

Genus *Trigonocidaris* Agassiz, 1869

Trigonocidaris albida Agassiz, 1869

Reports for the Azores:

Trigonocidaris albida Agassiz, 1869—$^{\$}$Koehler 1895a: 224, 1895b: 228, 1898: 22–23, 1909: 227; Mortensen 1927a: 292, 1943b: 318–321 pl. 18, figs. 10–13; García-Diez *et al*. 2005: 50; Mironov 2006: 111; Benavides-Serrato *et al*. 2012: 71–72.

Type locality: Caribbean.

See: Mortensen (1943b); Benavides-Serrato *et al*. (2012).

Occurrence: cosmopolitan, in the North Atlantic, Pacific and Indian Oceans (Mironov 2006); from the Gulf of Mexico and the Caribbean (Benavides-Serrato *et al*. 2012) eastwards to the Iberian Peninsula (Koehler 1896) and Morocco (Mironov 2006), including the archipelagos of the Azores and Canaries, and the Seine, Josephine and Meteor seamounts (Koehler 1909, Mironov 2006).

Depth: 70–720 m (Mortensen 1943b); AZO: 349–550 m (Koehler 1909).

Habitat: mud, sand, gravel to hard substrates (Koehler 1898, 1909), and in association with azooxanthellate corals (Benavides-Serrato *et al*. 2012); feeds on foraminifera (Mortensen 1943b).

Larval stage: planktotrophic (Emlet 1995).

Remarks: in the Azores, *Trigonocidaris albida* is known only from Koehler's reports (1898, 1909) based on material collected at several stations by the *Hirondelle* and *Princesse Alice*. The rarity of records in the archipelago might be explained by the minute size that characterizes this sea urchin, easily overlooked or lost (depending on the sampling method employed) during the rare occasions in which waters from its typical depth ranges (>70 m) were surveyed in the archipelago waters (see also below remarks under *Genocidaris maculata*).

Genus *Genocidaris* Agassiz, 1869

Genocidaris maculata Agassiz, 1869

(Fig. 27)

Reports for the Azores:

Temnechinus maculatus Agassiz, 1869.—Agassiz 1872: 165, 215, 286–289, pl. 8, fig. 1–18; $^{\$}$Koehler 1898: 21–22, pl. 8, figs. 3, 9;

p.p. *Sphærechinus granularis*—$^{\$}$Agassiz 1881: 106–107;

Genocidaris maculata Agassiz, 1869—Mortensen 1903: 85, 1927a: 292, 1943b: 358–362, figs. 219, 220, pl. 18, figs. 37– 47; $^{\$}$Koehler 1909: 226–227, pl. 31, fig. 3; Koehler 1921b: 115–116, fig. 76; $^{\$}$H.L. Clark 1925: 76–77; Tortonese 1965: 321–322, fig. 150; Serafy & Fell 1985: 21; Pereira 1997: 334; García-Diez *et al*. 2005: 50; Mironov 2006: 211–212; Micael & Costa 2010: 323; Micael *et al*. 2012: 4;

Gonocidaris maculata Agassiz, 1869—Koehler 1914b: 278, 283;

Genocidaris maculata splendes Mortenten (1927b)—Mortensen 1943b: 362–363, fig. 221a.

Type locality: Caribbean waters.

See: Agassiz (1869: 262–263); Mortensen (1943b); Mironov (2006); Benavides-Serrato *et al*. (2012: 70).

Occurrence: Mediterranean Sea and Atlantic (Tortonesen 1965); in the West from Cape Cod, through the Caribbean to North Brazil waters (Serafy & Fell 1985); in the East from the North African coasts to the Gulf of Guinea (Cadenat 1938), including the Azores (Koehler 1990), Madeira (Jesus & Abreu 1998), Canary archipelagos (Mortensen 1943b), and Gorringe, Josephine and Seine seamounts (Mironov 2006).

Depth: 12–500 m (Tortonese 1965); AZO: (?0)20–200(?823) m (Agassiz 1881, herein).

Habitat: sandy to coralligenous substrates (Koehler 1909, 1921b); feeds on bottom material, ingesting small benthic animals (*e.g.,* foraminiferans, molluscs and bryozoans; Serafy & Fell 1985).

Larval stage: planktotrophic (Emlet 1995).

Material examined: DBUA-ECH 144 (off Vinha da Areia, Vila Franca do Campo, SMG, AZO, 37°42'11"N, 25°25'04"W, 2006.09.05, 66 m; 2 bts, D = 4–7 mm); DBUA-ECH 146 (off Ribeira das Tainhas, SMG, AZO, 37°41'57"N, 25°25'08"W, 2006.07.24, 144–198 m; 2 bt, D = 4–5 mm); DBUA-ECH 147 (off Vinha da Areia, Vila Franca do Campo, SMG, AZO, 37°42'09"N, 25°25'04"W, 2006.09.05, 81 m; 1 bt, D = 4 mm); DBUA-ECH 149 (off Ribeira das Tainhas, SMG, Azores, 37°42'01"N, 25°25'01"W, 2006.07.24, 117–145 m; 1 bt, D = 6 mm); DBUA-ECH 151 (São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1997.07.14, 30 m; 1 spm, D = 7 mm); DBUA-ECH 153 (São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1997.07.14, 30 m; 1 spm, D = 7 mm); DBUA-ECH 154 (Água d'Alto, SMG, AZO, *c.* 37°42'55"N, 25°28'27"W, 1991.07.30; 1 spm, D = 7 mm); DBUA-ECH 155 (Poços de São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1996.07.08, intertidal; 1 spm, D = 7 mm); DBUA-ECH 159 (Vila Franca do Campo, SMG, AZO, 37°41'39"N, 25°27'11"W, 2006.07.21, 95–121 m; 3 bts, D = 5–6 mm); DBUA-ECH 160 (São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1997.07.14, 1991.07.11; 1 specimen, D = 7 mm); DBUA-ECH 186 (Vila Franca do Campo, SMG, AZO, 37°41'34"N, 25°27'15"W, 2006.07.19, 126–171 m; 1 bts, D = 5 mm); DBUA-ECH 204 (Baixa do João Lopes, SMA, AZO, *c.* 37°01'13"N, 25°10'05"W, 2014.06.26, 30–35 m; 1 spm, D = 6 mm); DBUA-ECH 221 (São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10W", 1997.07.14, 1997.07.11, 20 m; 1 spm, D = 5 mm); DBUA-ECH 327 (Sabrina Bank, SMG, 37°52'55"N, 25°54'25"W, 2011.07.08, 200 m; 1 spm, D = 8 mm); L09D9B20S01 (Gorringe Bank, 36°42'49"N, 11°09'54"W, 2009.09.13, 130 m; 2 bt, D = 6 mm); DOP 3015 (Channel PIX–FAY, AZO, 38°34'15.60"N, 28°32'31.20"W, 2008–06–16, 50 m; 1 spm, D = 8 mm).

Description: test hemispherical, relatively high, height varying from about 48–50%D in smaller specimens (D < 4 mm) to 65–70%D in larger specimens (D > 6 mm). Apical disc dicyclic with oculars well separated from periproct. Periproctal membrane with one large naked round plate (with conspicuous radial striation) and few very small additional plates. Genital plates with three to five spines and oval (elongated) pores. Peristome mostly naked except for the small buccal plates with few pedicellariae. Ambulacra with one primary tubercle per plate, occasionally slightly smaller than the corresponding one in the interambulacral plates, forming a more or less regular vertical series; bases of primary tubercles indented, particularly in the ambulacral areas. Ambulacral plates trigeminate with the pores forming a regular straight vertical series; pore-zones slightly sunken. Interambulacra presenting a single primary tubercle per plate forming a regular vertical series. Spines smooth relatively small (16–24%D). Globiferous pedicellaria with double poison glands and a single, tooth on one side beneath the terminal tooth. Colour: naked test green, brown or light brown with white spots just above the ambitus; spines hyaline, with red or pink bands; exceptionally white with traces of pink bands on some of the spines (DBUA-ECH 327).

Remarks: Mortensen (1927b) described a new extant *Genocidaris* species, *G. splendens* based on material collected by *Talisman* in the Canaries. This species differed from the typical *G. maculata* by its bright red colour, low test, the presence of a depression in the ambulacral (and interambulacral) midline aborally and a relative smaller suranal plate. In a later review, Mortensen (1943b) downgraded his species to a variety of *G. maculata* as all discussed diagnostic characters proved to be unreliable with both species presenting intermediate characters. Mortensen (1943b) concluded that *G. splendens* was at best just a colour variability of *G. maculata*. In spite of the great morphological variation revealed by the material herein examined we found no clear evidence that any of the specimens belong to the variety '*splendens*'. None had a particularly small suranal plate, a low test, or mid-line depressions. Regarding the colour pattern our material comprehended all possible transitions from the 'typical' olive through various shades of red. Our observations agree with Mironov (2006) who also questioned the validity of the variety '*splendens*', based on animals from the Ormonde and Gorringe seamounts (NE Atlantic).

In the DBUA-ECH collection we have found a small white echinoid collected from the Sabrina Bank, SW of

São Miguel Island (DBUA-ECH 327, Fig. 27J–L). At first it was assumed to be the small echinoid *Trigonocidaris albida*, a species that also lives in the Azores at similar depths (see above). This species generally presents a white test with the distal edge of the apical disc light orange or greenish-yellow and white spines that aborally present a light red band just above the base. However, on closer examination we have found it to be a typical *G. maculata* with exception of its very unusual colour. Aside from the colour pattern, the specimen does not present many of the typical morphological characteristics of the genus *Trigonocidaris* or the species *T. albida,* such as a low test height (≤50%D), buccal membrane covered by large imbricate plates or a periproct with four large angular plates (see Mortensen 1943b). On the contrary, the specimen presented a relatively high hemispherical test (≈60%D), a naked buccal membrane with exception of the buccal plates and a peristome with a very large round and green suranal plate. Also, the test of DBUA-ECH 327 was not conspicuously ornamented as is typical observed in *T. albida*. The globiferous pedicellaria can be differentiated easily based on the poison glands, which are single in *T. albida* and double in *G. maculata* and in our white specimen (see Mortensen 1903, pl. 8, fig. 7). Though both species present globiferous pedicellaria with a single unpaired tooth beneath the terminal tooth, the ones of our white specimen look like typical *G. maculata* pedicellariae: a widened basal part with sharp corners, a very narrow blade (see Mortensen 1903, pl. 7, fig. 30).

Historically, *G. maculata* was mistakenly reported in the Azores by Agassiz (1872, as *Tenmechinus maculatus*) based on material collected in the Josephine Seamount. Later, Agassiz (1881) identified the species *Sphaerechinus granularis* among the material collected by the H.M.S. *Challenger* in the Azores (sta 75: 38°37'N, 28°30'W), which later were re-identified by H.L. Clark (1925) as red coloured *G. maculata* (see also remarks under *S. granularis*).

G. maculata is a small echinoid typical of low subtidal waters up to 500 m. However, among the material examined we have found one specimen (DBUA-ECH 155, Fig. 27 A–C) labelled as being collected in the intertidal waters of São Miguel Island. The possibility of mislabelling could not be overruled. However, the area where the specimen was collected is characterized by a sheltered and rather large tide-pool. Small animals of this species could survive among the crevices, algae or under the boulders in the relative protected waters of this tide-pool, in a similar fashion of the much larger echinoid *Centrostephanus longispinus*, also a typical deeper inhabitant of littoral waters but seen in waters as low as 5 m depth in some places in the Azores (see remarks under *C. longispinus*). Conversely, Agassiz (1881) reported two different depths for the H.M.S. *Challenger*, station 75 where *G. maculata* was identified (92–165 m and 823 m), suggesting perhaps a mislabelling. Studying the known depth ranges of other echinoderms species also collected at this station we believe that shallower depth values are likely to be the correct ones (see remarks under *Astropecten hermatophilus*).

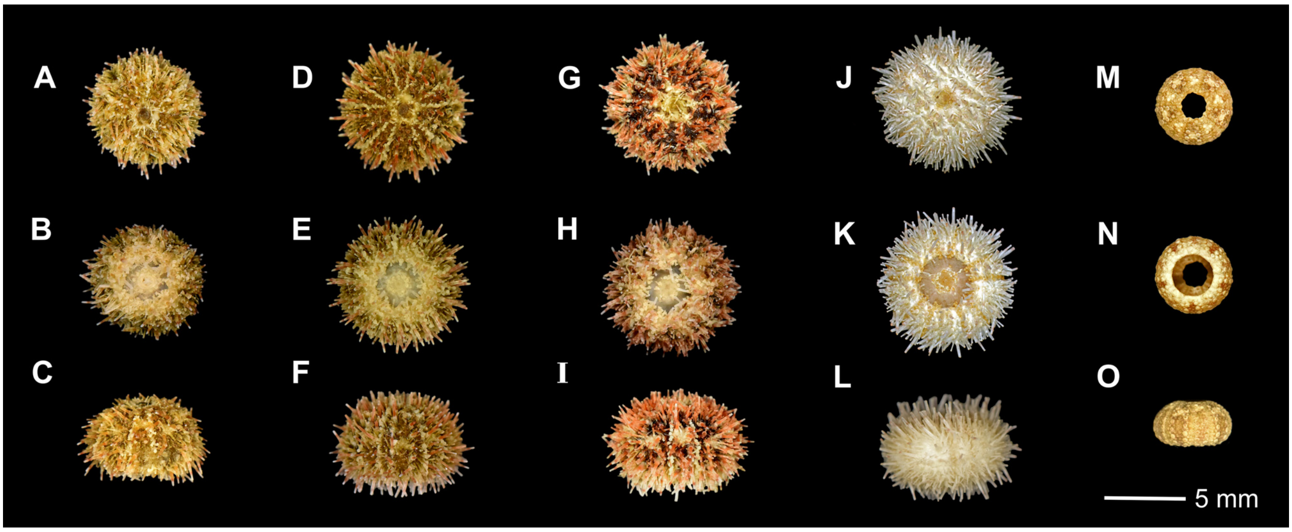

FIGURE 27. *Genocidaris maculata* Agassiz, 1869 (DBUA-ECH 155: A–C; DBUA-ECH 151: D–F; DOP 3015: G–I; DBUA-ECH 327: J–L; DBUA-ECH 258: M–O). Aboral view (A, D, G, J, M); oral view (B, E, H, K, N); lateral view (C, F, I, L, O).

Order Echinothurioida Claus, 1880

Family Echinothuriidae Thomson, 1872b

Genus *Araeosoma* Mortensen, 1903

Araeosoma fenestratum (Thomson, 1872b)

Reports for the Azores:
Araeosoma fenestratum (Thomson, 1872b)—Marques 1980: 104; $Mironov 2006: 103.

Type locality: off the coast of Portugal.

See: Thomson (1872b: 741–744, pl. 63, figs. 9–10, pl. 66, figs. 1–5, pl. 67, figs. 1–9, as *Calveria fenestrate*); Mortensen (1935: 233–237, pl. 29–30, pl. 78, fig. 11); Benavides-Serrato *et al*. (2012: 51–52).

Occurrence: North Atlantic, from the Denmark Strait (Mortensen 1903) to the Caribbean and the Gulf of Mexico (Benavides-Serrato *et al*. 2012), eastwards from off Scotland and the Rockall Trough (Gage *et al*. 1985; Harvey *et al*. 1988) to Portugal (Thomson 1872b), including the Azores and the Meteor Seamounts (Mironov 2006).

Depth: 148–1,270 m (Mironov 2006); AZO: ?900 m (herein).

Habitat: soft sediments, on fine sand to mud (Gage *et al*. 1985); gut contents include bottom sediments together with a variety of sponges and plant fragments (Serafy & Fell 1985); feeds also on deep-sea reef building corals such as *Lophelia pertusa* and *Madrepora oculata* (Stevenson & Rocha 2012).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: it is likely that when Marques (1980) mentioned the presence of *Araeosoma fenestratum* in the Azores he was referring to unreported specimens collected by *Biacores* expedition in the archipelago. These specimens were mentioned by Mironov (2006) who noted that in the collection of MNHN Paris there are numerous *Araeosoma* taken in the Azorean waters by *Jean Charcot* (*Biacores* cruise, unreported) Cruise and mostly labelled by Vasco Marques as belonging to *A. fenestratum*. Additionally, the later author identified several specimens belonging to *A. fenestratum* in Meteor waters bordering the Azores. In 2009, during the expedition EMEPC-LUSO an echinothurid likely to belong to this species was captured on video on the seabed of the Azorean deep waters, north of São Jorge Island (38°42'18"N, 28°01'18"W, 900 m; Fig. 28A–B) and south of Pico Island (36°36'25"N, 28°06'43"W, 2009.10.21, 1,102 m; Fig. 28C).

Genus *Calveriosoma* Mortensen, 1934

Calveriosoma hystrix (Thomson, 1872b)

Reports for the Azores:
Asthenosomum hystrix (Agassiz 1881)—$Koehler 1895a: 224, 1895b: 228;
Asthenosomum hystrix (Thomson, 1872b)—$Koehler 1898: 9–10;
Areosoma hystrix (Thomson, 1872b)—$Koehler 1909: 216–217; Mortensen 1927a: 282–283, figs. 156.1, 158.2, 159; Nobre 1938: 107–108, fig. 47;
Calveriosoma hystrix (Thomson, 1872b)—Mortensen 1935: 222–227, figs. 126–128, pl. 23, figs. 1–5, pl. 24, fig. 1, pl. 68, fig. 12; $Pérès 1992: 252, 254; García–Diez *et al*. 2005: 50.

Type locality: between Faeroe Island and Scotland (59°26'N, 8°23'W).

See: Mortensen (1903: 70–72, as *Calveria hystrix*; 1935).

Occurrence: Northeast Atlantic, from off SW Iceland (Mortensen 1903) southwards to Northeast African waters (Koehler 1909, Mortensen 1927b), including the Azores (Koehler 1909), and the Canaries (Mortensen 1927b), and Meteor seamounts (Koehler 1898).

Depth: 360–1,800 m (Mortensen 1935); AZO: 800–1,528 m (Koehler 1898, 1909).

Habitat: on sand, mud to soft ooze (Koehler 1898, Gage *et al*. 1985).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: historically, *Calveriosoma hystrix* was frequently confused and in many instances regarded as conspecific with *Araeosoma fenestratum* (Mortensen 1903, 1935), another echinoid native to the archipelago deep waters (see above). As a result, older records particular prior to the review by Mortensen (1903) should be regarded with caution considering that they could be referring to either of the two species.

Subfamily Hygrosomatinae Smith & Wright, 1990

Genus *Hygrosoma* Mortensen, 1903

Hygrosoma petersii (Agassiz, 1880)

Reports for the Azores:

non *Phormosomum luculentum* (Agassiz, 1879)—\$Koehler 1895a: 224, 1895b: 228. [misidentified];

non *Phormosoma uranus* Thomson, 1877—\$Koehler 1898: 7, 10–15, pl. 1, fig. 1, pl. 3, figs. 5, 6, pl. 9, figs. 49, 50 [misidentified see comments under *P. uranus*];

Hygrosoma petersii (Agassiz, 1880)—\$Mortensen 1903: 176, fig. 11, pl. 11, figs. 4, 27, pl. 12, fig. 42, pl. 13, figs. 8, 13; \$Koehler 1909: 217–218; Mortensen 1927a: 284–285, figs. 156.2, 158. 1, 161; \$Mortensen 1927b: 27; Grieg 1932: 41; Mortensen 1935: 202–208, figs. 118–119, pl. 13, pl. 14, figs. 1–3, pl. 15, figs. 1–2, pls. 16 –17, pl. 18, fig. 2, pl. 19, fig. 2, pl. 78, figs. 1, 3–5, 24, 25; Gage *et al*. 1985: 180–181; Serafy & Fell 1985: 20, fig. 17; García-Diez *et al*. 2005: 50; Mironov 2006: 103.

Type locality: Caribbean.

See: Grieg (1932); Mortensen (1935).

Occurrence: Atlantic, from the east coast of the USA to the Caribbean (Pawson 1982), eastwards from the British Isles to South Africa (Mortensen 1935), including the Azores (Koehler 1909), Canaries (Grieg 1932) and the Atlantis Seamount (Meteor; Mironov 2006); possibly in Bermuda's deep waters as well (Mironov 2006).

Depth: 200–3,800 m (Mironov 2014); AZO: 1,165–2,870(?3,237) m (Koehler 1909, herein).

Habitat: opportunistic scavenger, on soft ooze (Gage *et al*. 1985).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: in a preliminary report, Koehler (1895a, 1895b, 1896c, 1898) identified specimens from the Azores and Bay of Biscay (*Hirondelle*, *Princesse Alice* and *Caudan* cruises) as *Hygrosoma luculentum* (= '*Phormosomum luculentum*') and *Tromikosoma uranus* (= *Phormosoma uranus*). Mortensen (1903) questioned Koehler's previous identifications based on the examination of a specimen belonging to *H. petersii* collected in the Azores by *Talisman* (sta 126: 38°37'00"N, 28°20'46"W, 1,258 m). Subsequently, Koehler (1909) agreed with Mortensen and re-identified the material as *H. petersii*. During the expedition EMEPC-LUSO (2009, 2008), animals likely to belong to this species were captured on video on the seabed of the Azorean deep waters, between São Jorge and Pico islands (38°34'12"N, 28°03'17"W, 1,250 m, Fig. 28D, E) and near the Hirondelle Seamount (between São Miguel and Terceira, 37°56'12"N, 26°10'31"W, 3,237 m, Fig. 28F).

Subfamily Sperosomatinae Smith & Wright, 1990

Genus *Sperosoma* Koehler, 1897b

Sperosoma grimaldii Koehler, 1897b

Reports for the Azores:

Sperosoma grimaldii \$Koehler, 1897b: 302–307, 1898: 16–21, pl. 2, fig. 2, pl. 3, figs. 3, 4, pl. 4, fig. 8, pl. 9, fig. 48, 1909: 218–217; \$Mortensen 1903: 75–78, pl. 4, figs. 3–5, pl. 11, fig. 9. pl. 12, fig. 16, pl. 13, figs. 12, 23, pl. 14, figs. 2, 4, 4a, 6, 11, 31, 33, 1927b: 27; Mortensen 1927a: 287–288, figs. 156.3, 163, 1935: 184–187, figs. 107–108, pl. 8, figs. 1–2; Grieg 1932: 40–41; Marques 1980: 105; Gage *et al*. 1985: 181; García-Diez *et al*. 2005: 50; Mironov 2006: 103–104; \$Mironov 2008: 4, tab. 1; Mironov 2014: 121.

Type locality: Azores.

See: Koehler (1897b); Mortensen (1903).

Occurrence: Northeast Atlantic, from south of Iceland and Faroe south to the Gulf of Guinea (Mortensen 1927a, b, Chesher 1966), including the Azores, Canaries and Cape Verde archipelagos (Koehler 1909), and the Great Meteor seamount (Mironov 2006).

Depth: 235–2,910 m (Mortensen 1927b, Mironov 2006); AZO: 1,213–2,107 m (Koehler 1898, Mironov 2008).

Habitat: sand, mud to ooze (Koehler 1909, Gage *et al*. 1985).

Larval stage: lecithotrophic. (Emlet 1995).

Remarks: Koehler (1897b, 1898) described a new species of echinothuroid, *Sperosoma grimaldii* based on material collected in Azorean deep waters by *Hirondelle* and *Princesse Alice*. Until recently, the presence of this species in the archipelago has been restricted to the type material and to the historical reports by this author. Mironov (2008) published a table mentioning this echinoid collected by *G.O. Sars* (*MAR–ECO* expedition), which included stations located in the northern-most waters of the Azores.

Genus *Tromikosoma* Mortensen, 1903

Tromikosoma koehleri Mortensen, 1903

Reports for the Azores:

Tromikosoma cf. *koehleri* Mortensen, 1903—$Mironov 2008: 4, tab. 1;
Tromikosoma koehleri Mortensen, 1903—Mironov 2014: 122.

Type locality: Davis Strait.

See: Mortensen (1935: 167–168, fig. 100, pl. 5).

Occurrence: North Atlantic, from the Davis Strait (Mortensen 1903) south to the Charlie-Gibbs Fracture Zone and north of the Azores (Mironov 2008).

Depth: 2,517–3,527 m (AZO: 2,954–2,968 m; Mironov 2008).

Habitat: probably a bottom-feeder living on soft sediments.

Remarks: *Tromikosoma koehleri* was only known from its type locality. More recently, Mironov (2008) reported this species among the material collected by *G.O. Sars* (*MAR–ECO* expedition) in the Charles-Gibbs Fracture Zone. The same author listed material likely to belong to this rare species collected at stations located in the northern waters of the Azores (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55''N, 30°20''W, 2,954–2,968 m). Later, however, Mironov (2014) placed the *MAR-ECO*' station from the Azores in the geographical distribution of this species. Mironov also added that this species is very closely related to *T. uranus* also known from the Atlantic (see below). Both species are known from very little material, and may prove to be identical.

Tromikosoma uranus? (Thomson, 1877)

Reports for the Azores:

Phormosoma uranus Thomson, 1877—?$Agassiz 1881: 103–104, pl. 18c, fig. 12;
non *Phormosoma uranus* Thomson, 1877—Koehler 1898: 7, 10–15, pl. 1, fig. 1, pl. 3, figs. 5–6, pl. 9, figs. 49, 50. [misidentified *H. petersii*];
Echinosoma uranus Thomson, 1877—?$H.L. Clark 1925: 57.

Type locality: Gorringe Ridge, off Portugal (36°23'N, 11°18'W).

See: Mortensen (1935: 168–170, pl. 6, figs. 2– 3, pl. 75, figs. 19–21).

Occurrence: Northeast Atlantic, from off Portugal (Thomson 1877) to off the Western Sahara coast (Mortensen 1927b) and the ?Azores (H.L. Clark 1925).

Depth: 938–2,745 m (Mortensen 1935); ?AZO: 1,830 m (H.L. Clark 1925).

Habitat: most probably a bottom-feeder on soft sediments.

Remarks: *Tromikosoma uranus* was recorded from the Azores based on specimens collected by the H.M.S. *Challenger* (Agassiz 1881), *Hirondelle* and *Talisman* (Koehler 1898). Except for H.M.S. *Challenger* material, all other were re-examined and re-assigned to *H. petersii* (Mortensen 1903; Koehler 1909; Mortensen 1935). The specimen from H.M.S. *Challenger* was a young specimen (7 mm) in a poor state of preservation, which rendered the identification impossible (see Mortensen 1903). The occurrence of this species in the area should be considered with caution, until new material is retrieved from the Azores (see remarks under *T. koehleri*).

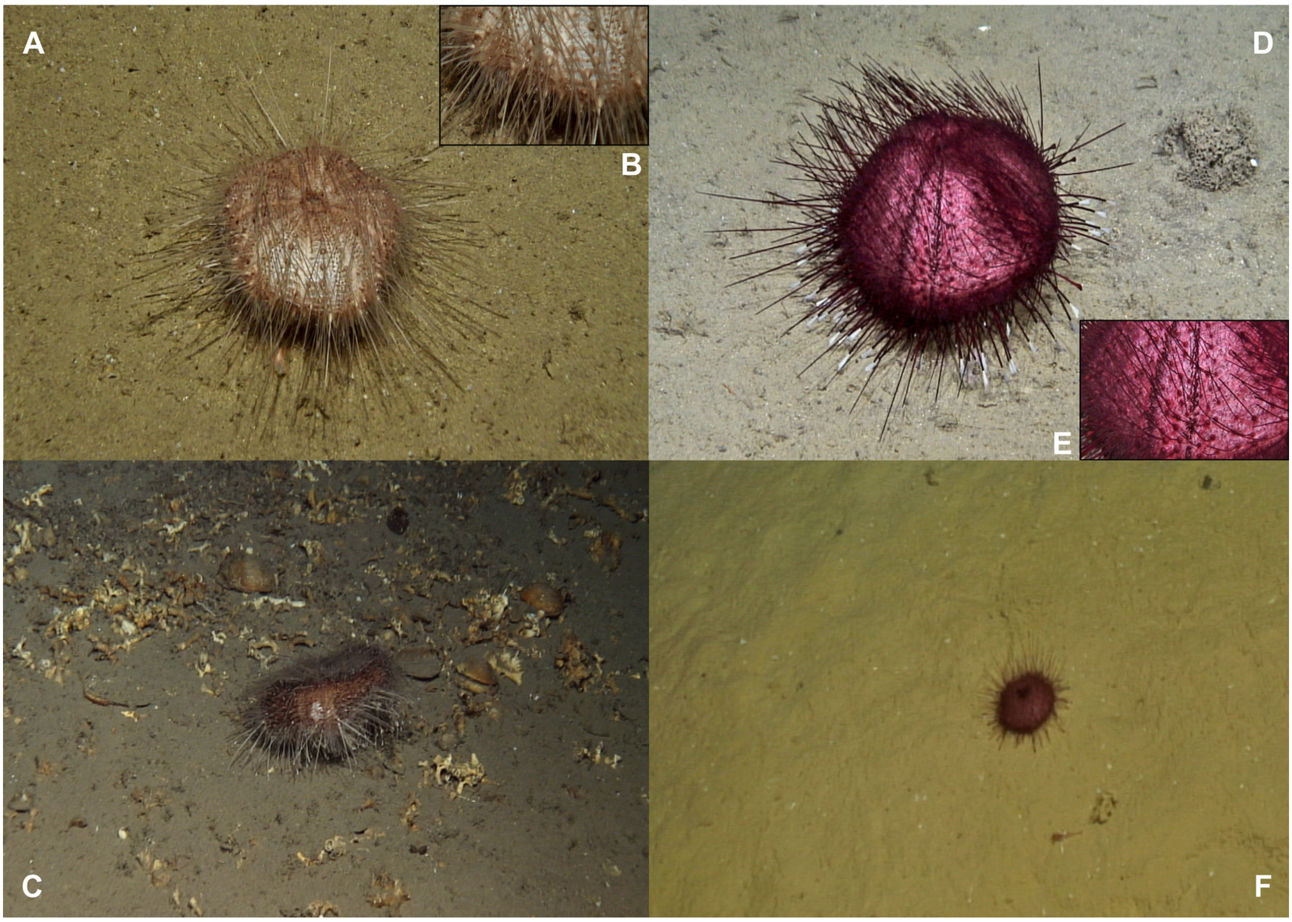

FIGURE 28. Echinothuriids in the Azorean deep-waters, most probably belonging to *Araeosoma fenestratum* (Thomson 1872) (EMEPC–LUSO, 38°42'18"N, 28°01'18"W, 2009.10.02, 900 m: A, B; 36°36'25"N, 28°06'43"W, 2009.10.21, 1,102 m: C) and *Hygrosoma petersii* (Agassiz, 1880) (EMEPC–LUSO, 38°34'12"N, 28°03'17"W, 2008.11.10, 1,250 m: D, E; 37°56'12"N, 26°10'31"W, 2009.10.08, 3,237 m: F).

Family Phormosomatidae Mortensen, 1934

Genus *Phormosoma* Thomson, 1872b

Species *Phormosoma placenta* Thomson, 1872b

Phormosoma placenta placenta Thomson, 1872b

Reports for the Azores:
Phormosoma placenta Thomson, 1872b—$^{\$}$Mortensen 1927b: 25; Mortensen 1935: 125–135, figs. 80–82, pl. 1, figs. 1–5, pl. 2, figs. 1–19, pl. 74, figs. 1–6, 19; Marques 1980: 105; Benavides-Serrato *et al*. 2012: 53.

Type locality: about 100 miles to the north of the Butt of the Lewis, in Scottish waters (59°43'N, 7°40'W).

See: Thomson (1872b: 732–737, pl. 62, figs. 1–5, pl. 63, figs. 1–9, 9a); Mortensen (1935).

Occurrence: North Atlantic, in the Davis Strait (Mortensen 1903) south to the Northeast coast of USA (Koehler 1921a, H.L. Clark 1925) eastwards south of Iceland (Mortensen 1903) to Gulf of Guinea (Koehler 1909, Grieg 1932, Chesher 1966), including the Azores, Canary and Cape Verde archipelagos (Koehler 1909, Mortensen 1927b). The subspecies *P. placenta sigsbey* Agassiz, 1880 and *P. placenta africana* Mortensen, 1934 are reported from the Caribbean and South African waters, respectively (Mortensen 1935, Serafy & Fell 1985).

Depth: 215–2,500 m (Mortensen 1935); AZO: 1,257 m (Mortensen 1927b).

Habitat: gregarious bottom-feeder (Serafy & Fell 1985) on soft sediments (muddy sand to soft ooze; Gage *et al*. 1985).

Larval stage: lecithotrophic (Emlet 1995).

Remarks: the record of *Phormosoma placenta* in the Azores is based on Mortensen (1927b) who identified this species among the material collected by *Talisman* (sta 127, 1883: 38°38’00”N, 28°20’46”W, 1,257 m).

Infraclass Irregularia Latreille, 1825

Superorder Atelostomata Zittel, 1879

Order Spatangoida Agassiz, 1840

Suborder Brissidina Stockley *et al*., 2005

Family Brissidae Gray, 1855b

Genus *Brissopsis* Agassiz, 1840

Species *Brissopsis lyrifera* (Forbes, 1841)

Brissopsis lyrifera lyrifera (Forbes, 1841)

Reports for the Azores:

Brissopsis lyrifera (Forbes, 1841)—[$]Koehler 1895a: 225, 1898: 7, 24, 73; Grieg 1932: 43; Nobre 1938: 132–133, fig. 57; Pereira 1997: 335; Micael & Costa 2010: 323; Micael *et al*. 2012: 4; García-Diez *et al*. 2005: 51.

Type locality: Scotland, British Isles.

See: Forbes (1841: 187–189); Mortensen (1951b: 380–390, pl. 30, figs. 1–4, 7–13, pl. 32, figs. 15, 20, 22, pl. 57, fig. 15); Chesher (1968: 90–96, figs. 8, 18–19; pl. 21, figs. a–b, as *Brissopsis lyrifera capensis*).

Occurrence: Mediterranean Sea and east Atlantic, from Iceland and Scandinavia (Mortensen 1907) to NW Africa (Mortensen 1927a, b, Grieg 1932), including the Azores (Koehler 1898); the subspecies *B. lyrifera capensis* Mortensen 1907 was reported from South Africa, the Gulf of Guinea and the Caribbean (Chesher 1966, 1968).

Depth: 5–2,250 m (Mortensen 1951b, Mecho *et al*. 2014); AZO: 130 m (Koehler 1898).

Habitat: buried in sand, mud to detritic substrates (Mortensen 1927a, Cherbonnier 1969).

Larval stage: planktotrophic (Harvey *et al.* 1988).

Remarks: the only known material of *Brissopsis lyrifera* from the Azores is restricted to a single small specimen identified by Koehler (1895a, 1898) among the material collected by *Hirondelle* (sta 226: 38°31’19”N, 28°34’31”W) in the channel between Pico and Faial islands, at a depth of 130 m.

Genus *Brissus* Gray, 1825

Brissus unicolor (Leske, 1778)

(Fig. 29)

Reports for the Azores:

Brissus unicolor Klein—[$]Barrois 1888: 111; Koehler 1921b: 133–134, fig. 92;

Brissus unicolor (Leske, 1778)—Mortensen 1951b: 509–514, pl. 38, fig. 10; Tortonese 1965: 375–378, figs. 170, 184–185; [$]Wirtz & Martins 1993: 58–59; Pereira 1997: 335; [$]Morton *et al*. 1998: 146, fig. 7.4M1; Pérez-Ruzafa *et al*. 2002: 286–287; [$]Wirtz & Debelius 2003: 261; Schultz 2006: 385, figs. 727–728; Micael & Costa 2010: 323; Micael *et al*. 2012: 4;

Brissus brissus (Leske, 1778)—H.L. Clark 1917: 218–219, 1925: 218; Mortensen 1927a: 326; Harvey 1956: 67.

See: Mortensen (1951b); Schultz (2006).

Occurrence: Mediterranean Sea and Atlantic; in the West Atlantic recorded from Florida and the Caribbean (Mortensen 1951b) including Bermuda (H.L. Clark 1942); in the east present in the Azores (Barrois 1888), Madeira

(H.L. Clark 1925), Selvagens (Pérez-Ruzafa *et al*. 2002), Canaries and Cape Verde (Agassiz 1872); reported as well from ?Saint Helena and Ascension islands (Pawson 1978).

Depth: 0–?240 m (Mortensen 1951b); AZO: ?7–45 m (herein).

Habitat: buried on soft substrates or under stones (Schultz 2006).

Material examined: DBUA-ECH 008 (Carapacho, GRA, AZO, *c.* 39°00'44"N, 27°57'28"W, 2010.09.05, 17 m; 1 bt, TL = 85 mm)**;** DBUA-ECH 009 (Calheta do Nesquim, PIX, AZO, *c.* 38°24'08"N, 28°04'42"W, 7–10 m; 1 bt, TL = 86 mm)**;** DBUA-ECH 010 (Lajes, PIX, AZO, *c.* 38°23'22"N, 28°15'04"W, 2010.09.25, 5–6 m; 1 bt, TL = 111 mm)**;** DBUA-ECH 012 (FRM, AZO, *c.* 37°16'14"N, 24°46'52"W, 1990.06, 45 m; 1 spm, TL = 9 mm).

Description: test outline elongated to oval (weight about 70–80%TL); no anterior notch; aboral side convex with the posterior interambulacrum raised as a keel; in lateral view posterior end low, rounded in the smallest individual (DBUA-ECH 012; TL = 9 mm) to obliquely truncate in the larger specimens; oral side flattened, slightly convex; sides of test somewhat tumid. Frontal ambulacrum flush, narrow with vertically elongated, minute unipores; paired ambulacra distinctly petaloid, sunken; anterior petals forming an almost straight line, perpendicular to the major axis of the test; posterior petals longer than the anterior ones, diverging at 45°. Pore-series equally developed. Apical disc anterior, ethmolytic, with four genital pores, the posterior pair significantly larger than the anterior one. Genital pores not formed in the smallest specimen (DBUA-ECH 012; TL = 9 mm). Madreporite extended posteriorly beyond the posterior oculars. Periproct on the posterior end of the test, elliptical in shape with pointed ends. Peristome near the anterior edge of the test, semilunar, about 16–20%TL. Labrum short and wide; sternum large and broad, densely covered by tubercles in more or less fan-shaped arrangement. Antero-Iateral ambulacra strongly developed adorally, forming conspicuous phyllodes; postero-Iateral ambulacra narrow and naked on the oral side. Subanal fasciole bilobed, distinct and complete, enclosing five pores pairs on each side in all, except for the smallest specimen (TL = 9 mm), in which the fasciole as not yet fully formed and only four subanal tubefeet are present on each side. Peripetalous fasciole well developed, more or less bilaterally symmetrical along the anterior-posterior axis, bending inwards between the petals. In the anterior interambulacra it forms two more or less sharp angles on each side. Tuberculation dense and uniform, only in the anterior interambulacra the tubercles are somewhat larger. Spines short and fine; Plastron spines spatulate. Colour: test greyish white to creamy white. All examined dead tests showed a circular borehole, assumed to be evidence of drilling predation (possibly by gastropods).

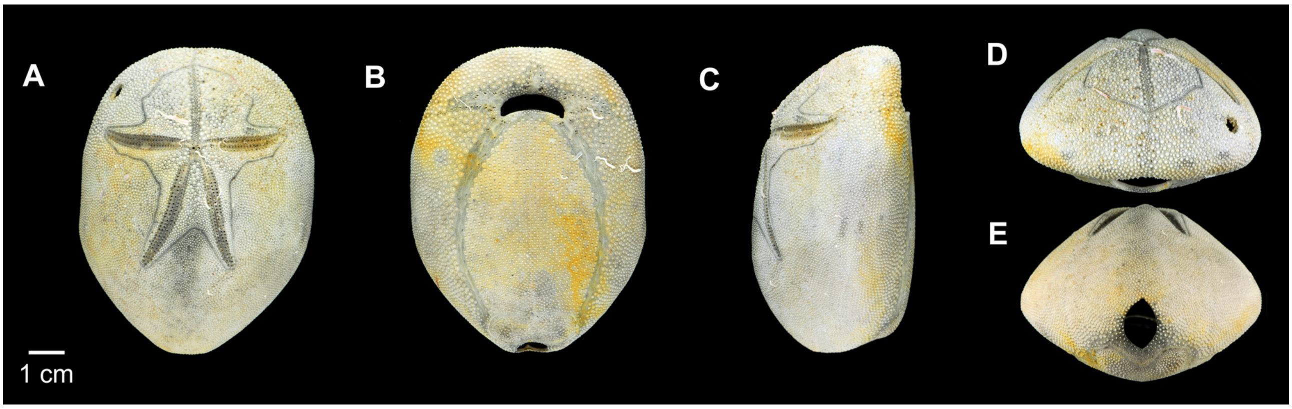

FIGURE 29. *Brissus unicolor* (Leske, 1778) (DBUA-ECH 045). Aboral view (A); oral view (B); lateral view (C); anterior view (D); posterior view (E).

Remarks: the specimens housed in the DBUA-ECH collection show all the features of a typical *Brissus unicolor*, with one single exception. The posterior end in this species is described as vertically truncated, an important diagnostic feature distinct from other *Brissus* species such as *B. latecarinatus* (Leske*,* 1778) (*e.g.*, Mortensen 1951b; Schultz 2006). However, in our adult animals the shape of the posterior end is closer to what is described for the later species. Another atypical feature presented by DBUA-ECH' specimens is the number of pores (five) enclosed within the subanal fasciole, which is typically four in *B. unicolor*, only occasionally five (Mortensen 1951b). The adult specimens observed herein, however, all have five per ambulacrum.

Brissus unicolor was reported from the archipelago by Barrois (1888) who at the time commented that this species was one of the rarest echinoderms in the archipelago. In the DBUA-ECH collection this species is represented only by five specimens, and all but one are dead tests, showing signs of having been exposed on the bottom surface for some time (erosion and encrustation by serpulids). However, the small number in the collection does not simply suggest a rare status locally. This species is a large echinoid that lives typically buried in the sand, though occasionally individuals can be found under rocks (personal observation), outside the scope of direct observation or sampling by divers. Barrois also commented that the only locality where this species appears to be common was inside the crater of Vila Franca Islet (São Miguel Island). With the exception of the young specimen (DBUA-ECH 012) for which we have no collection details, all the remaining specimens derived from areas with similar habitat characteristics to the one described by Barrois, *i.e.* sandy to muddy sandy bottoms in relatively protected areas (see also Morton *et al*. 1998).

Family Palaeotropidae Lambert, 1896

Genus *Palaeotropus* Lovén, 1874

Palaeotropus josephinae Lovén, 1871

Reports for the Azores:

Palæotropus josephinae $Lovén, 1874: 17–18, pl. 12, fig. 105, pl. 13, figs. 108–113, pl. 32, fig. 200; Agassiz 1881: 218; H.L. Clark 1917: 152–153; Mortensen 1927a: 322, 1950: 294–298, figs. 205, 206a, 207b, pl. 25, figs. 14, 19, 21–22, 30–33; García-Diez *et al*. 2005: 51; Mironov 2006: 115–117, figs. 6–7;

Palaeotropus Hirondellei $Koehler, 1895a: 226–227, 1895b: 230–231, 1898: 29–30, pl. 5, figs. 12–14, pl. 6, figs. 26–27, pl. 9, fig. 47, 1909: 244–245, pl. 30, figs. 18–23, pl. 31, figs. 4–5, 1921a: 3.

Type locality: Azores (Vila Franca, São Miguel).

See: Lovén (1874); Mortensen (1950); Mironov (2006).

Occurrence: East Atlantic, known from the Bay of Biscay, the Azores Archipelago (Koehler 1909), Hyeres and tropic NE Atlantic seamounts (Mironov 2006); also reported from a seamount located north of St. Helena (11°37'S, 5°12'W; Mironov 2006).

Depth: 300–1,600 m (AZO: 500–1,600 m; Koehler 1909, Mironov 2006).

Habitat: soft to hard bottoms (mud, sand, gravel and rock; Koehler 1898, 1909).

Larval stage: planktotrophic (Mortensen 1950).

Remarks: Lovén (1871, 1874) described the deep-water species *Palaeotropus josephinae* based on material collected by *Josephine* expedition near Vila Franca do Campo, in the south of São Miguel Island. Throughout the historical bibliography this species is a constant presence in deep water tows in the Azorean deep waters. For example, Koehler (1895a, 1898) described a new species *Palaeotropus hirondellei* based on material collected in the Azores by *Hirondelle* (sta 102: 38°23'45"N, 28°31'16"W, 927 m). H.L. Clark (1917) argued that Koehler overlooked *Palaeotropus josephinae* described by Lovén from the same area, that both species portrayed animals of different sizes, and synonymized the two species, an opinion shared by later authors (*e.g.,* Mortensen 1950; Mironov 2006).

Superfamily Spatangoidea Gray, 1825

Family Loveniidae Lambert, 1905

Genus *Araeolampas* Serafy, 1974

Araeolampas atlantica Serafy, 1974

Reports for the Azores:

non *Homolampas fragilis* (Agassiz, 1869)—$A.H. Clark 1949: 376 [misidentified];

Araeolampas atlantica $Serafy, 1974: 44–46, figs. 1a–c, 2a–b; Mironov 2014: 127.

Type locality: off Virginia (37°50'N, 73°04'W).

See: Serafy (1974); Mironov (2008).

Occurrence: North Atlantic, in the west from off Virginia to north of Haiti, in the east from north of the Azores to off Gabon (Serafy 1974, Mironov 2008).

Depth: 1,920–3,595 m (AZO: 2,585 m; Serafy 1974).

Habitat: probable endobenthic in soft substrata.

Remarks: the presence of *Araeolampas atlantica* in the archipelago is based on the material collected by *Atlantis* cruise west of São Miguel Island, firstly identified by A.H. Clark (1949) as *Homolampas fragilis* (Agassiz, 1869) and then reassigned to *Araeolampas atlantica* by Serafy (1974) upon re-examination.

Subfamily Echinocardiinae Cooke, 1942

Genus *Echinocardium* Gray, 1825

Echinocardium cordatum (Pennant, 1777)

(Fig. 30A)

Reports for the Azores:

Echinocardium flavescens (Müller, 1776)—?$Barrois 1888: 110 [early juveniles, identification doubtful];

Echinocardium cordatum (Pennant, 1777)—$Marques 1983: 6; $Pereira 1997: 334; Wirtz & Debelius 2003: 261; Micael & Costa 2010: 323; Madeira *et al*. 2011: 257; Micael *et al*. 2012: 4.

See: Mortensen (1927a: 331–334, figs. 194.1–2); Higgins (1974, 1975); De Ridder *et* al. (1987); Schultz (2006: 411, fig. 772).

Occurrence: antitropical, present in the W Pacific, E Atlantic and Mediterranean Sea (Egea *et al.* 2016); in the east from Scandinavia and the British Isles to Morocco (H.L. Clark 1925, Mortensen 1925), including the Azores (Marques 1983), Madeira (Jesus & Abreu 1998) and Canaries (Hernández *et al*. 2013); also present in South Africa (Mortensen 1951b).

Depth: 0–230 m (Mortensen 1927a); AZO: 15–20 m (herein).

Habitat: buried in mud, sand to gravel (Mortensen 1927a, Higgins 1974).

Larval stage: planktotrophic (31–35 days; Schipper *et al*. 2008);

Fossil record: fossil remains belonging to the genus *Echinocardium* were documented in the Pliocene fossiliferous outcrops of Santa Maria (Madeira *et al*. 2011).

Material examined: DBUA-ECH 083 (Baia do Rosto do Cão, São Roque, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 1990.07.5, 15–20 m; 1 broken spm; TL = 38 mm);

Description: test very fragile (oral side missing) with a subrounded (greatest weight ≈ TL). Anterior end truncated in lateral view; frontal ambulacrum sunken. Larger tubercles mostly absent, except for the edge of the anterior ambulacrum. Apical disc posterior with four genital pores. Internal fasciole shield-shaped, longer than wide (width = 42% length), almost half of the test length; 35–36 pores on each side of ambulacrum III within the fasciole, arranged in the following manner: small pores aligned proximally in a single series relatively; in the mid-section larger pores somewhat transversely elongated and more crowded forming an irregular biserial arrangement (area of largest weigh of the fasciole); at the anterior end circular pores more widely spaced, forming again a single series. Specialized penicillate tube feet present. Rows of the pair petals somewhat convergent and depressed; petal IV and V with 9(IVa)–14(IVb) and 12(Vb)–11(Va) pore pairs, respectively. Periproct round and truncated. Anal fasciole expanding along the sides of the periproct onto the aboral side. Spines relatively uniform through the aboral region with the exception of elongated spines of the frontal ambulacrum forming an apical tuft. No pedicellaria were found, except for a few small tridentate (≈200 µm) with leafshaped valves with irregularly serrate edge. Colour: naked test cream, spines light brown and brown tube feet.

Remarks: Marques (1983) was the first to report *Echinocardium cordatum* from the archipelago. We have not found the specimen(s) in the Vasco Marques collection at the Bocage Museum. Nevertheless, later Wirtz & Debelius (2003) published a photograph portraying an *E. cordatum in situ* in Faial Island. Unfortunately, none of the authors have specified at which depth this species seems to occur in the archipelago (see below remarks under *E. flavescens*).

The specimen housed in DBUA-ECH collection was rather damaged, lacking the entire oral area. Regardless, this specimen presents the typical double arrangement of the pores of ambulacrum III of *E. cordatum*. In contrast, the specimen lacks many features expected in a typical *E. cordatum*, having a weakly sunken ambulacrum III aborally. On the other hand, *E. cordatum* is characterised by a high degree of morphological variation and the observed departure from the norm is well inside the documented variability of this species (see Higgins 1974, 1975). Unfortunately, only one type of pedicellariae was found. The small tridentate pedicellariae are similar to what Mortensen (1907) described for *E. cordatum*. However, this type of pedicellariae is not diagnostic, and similar morphologies can be found in other species known from the NE Atlantic such *E. flavescens* (Mortensen 1907).

***Echinocardium* sp.**

(Figs. 30B–H)

Material examined: DBUA-ECH 084 (SMG, AZO; 1 damaged spm, TL = 24 mm); DBUA-ECH 086 (off Vinha da Areia, SMG, AZO, 37°42'11"N, 25°25'04"W, 2006.09.05, 66 m; 3 spms, TL = 11–14 mm); DBUA-ECH 091 (Vila Franca do Campo, SMG, AZO, 37°42'33"N, 25°24'35"W, 2006.07.25, 36 m; 2 spms, TL = 7–9 mm); DBUA-ECH 093 (Vila Franca do Campo, SMG, AZO, 37°42'37"N, 25°24'34"W, 2006.07.25, 23 m; 1 spm, TL = 9 mm); DBUA-ECH 094 (Azores, 20 m; 2 broken spms, TL = 18 mm); DBUA-ECH 097 (off Ribeira das Tainhas, Vila Franca do Campo, SMG, AZO, 37°42'04"N, 25°25'02"W, 2006.07.24, 48–117 m; 1 spm, TL = 7 mm); DBUA-ECH 278 (off Vinha da Areia, Vila Franca do Campo, SMG, AZO, 37°42'12"N, 25°25'15"W, 2006.09.05, 63 m; 1 spm, TL = 13 mm); DBUA-ECH 419 (off Vinha da Areia, Vila Franca do Campo, SMG, AZO, 37°42'00"N, 25°25'15"W, 2006.09.05, 81 m; 1 spm, TL = 14 mm); DBUA-ECH 420 (off Vila Franca do Campo, SMG, AZO, 37°42'12"N, 25°25'08"W, 2006.10.03, 58 m; 1 spm, TL = 14 mm).

Description: test very fragile, round to oval, moderately high (61–67%TL); anterior contour high and truncated in lateral view. Frontal ambulacrum somewhat sunken, being more obvious in larger specimens. Larger tubercles mostly absent, except for a few at the edge of ambulacrum III. Apical disc posterior of centre; genital pores not visible in specimens of 14 mm or smaller. Paired petals slightly depressed with pore-series somewhat convergent; petals IV and V with 5–9(IVa), 8–14(IVb) and 7–11(Vb), 7–11(Va) pore pairs, respectively. Oral side flattened with relative large peristome (21–23%TL) slightly anterior; labrum rounded, slightly projecting, reaching the second adjoining ambulacra plate; plastron keeled toward a sharp posterior point; presence of phyllodal tube feet. Periproct round and truncate; Internal fasciole shield-shaped, wider in the smaller specimens (width ≥ 70% length; TL ≤ 9 mm) becoming narrower in larger specimens (width = 50% length; TL = 24 mm; DBUA-ECH 084); the overall size of the internal fasciole larger in the larger specimens (48%TL; DBUA-ECH 084) than in the smaller individuals (33%TL, TL ≤ 9 mm); pores of frontal ambulacrum within the fasciole in regular single series with specialized penicillate tube feet; pore size increasing towards the anterior end (size difference more apparent in smaller individuals). Number of pores on each side of the anterior ambulacrum within the fasciole increases from the smallest size class (TL = 7 mm) to the largest specimen (TL = 24 mm, DBUA-ECH 084), from 9 to 22, respectively. Subanal fasciole diamond shaped, acute at its lower end and with up to two pore pairs per ambulacrum in the larger individuals. Anal fasciole expanding along the sides of the periproct onto the aboral side, adjoining but separate from subanal fasciole. Spines relatively uniform through the aboral region with the exception of the conspicuous presence of elongated spines forming an apical tuft in the frontal ambulacrum adapically. No pedicellaria were found. Colour (in ethanol): white test and spine and brown tube-feet.

Remarks: in the Atlantic the genus *Echinocardium* is represented by 12 extant species (Mironov 2006), five of which are known to occur in the NE Atlantic: *E. cordatum*, *E. flavescens*, *E. pennatifidum*, *E. mediterraneum* and *E. meteorense* (Mortensen 1951b; Mironov 2006). Jesus & Fonseca (1999) reported two additional species previously thought to be endemic to the Mediterranean Sea from the south of Portugal: *E. fenauxi* and *E. mortenseni*. *Echinocardium* species typically live in shallow waters, though most could be characterized almost as eurybathic by having a bathymetric range that extends to waters below the 200 m (Tortonese 1965). *E. meteorense* is an exception as it occurs at waters between 300–450 m (Mironov 2006).

In general, the genus *Echinocardium* is characterised by rather difficult systematics with many morphological diagnostic characters overlapping interspecifically and showing great intraspecific variability (individual or ontological variation; David & Laurin 1996). The first record of *Echinocardium* in the Azores was made by Barrois (1888) based on very small specimens dredged in São Miguel Island. Later Koehler (1909) re-examined Barrois' material and commented that it contained only very small and fragile specimens, lacking many diagnostic structures such as the pedicellaria. Curiously, both authors' remarks could be used to characterise the material presently housed in the DBUA-ECH collection. Most of these specimens were collected during the *Third International Workshop of Malacology and Marine Biology* (2006). *Echinocardium* was a frequent presence in the tows but few individuals survived the sediment weight while handling the dredge. The material stored at the DBUA-ECH collection is composed by heavily damaged tests, not exceeding 23 mm in size. Nevertheless, these specimens can be easily distinguished from *E. mediterraneum* and *E. pennatifidum* as both species lack specialized tube feet in the anterior ambulacrum. This feature is reflected by the shape and arrangement of the pores inside the internal fasciole, which in both species is characterised by widely spaced small sized pores (Mortensen 1907). Our specimens from the Azores can also be distinguished from *E. flavescens* by the presence of a depressed frontal ambulacrum and almost complete absence of larger tubercles on the aboral side. Moreover, the number of pore pairs in the pair petals appears to be significantly higher in our individuals than what was published in the bibliography for *E. flavescens* of similar size classes (*e.g.,* Mortensen 1907). A closely resembling species of *E. flavescens*, *E. mortenseni*, is also distinct from our material by having a relatively longer test contour, slightly lower test height, with no obvious frontal depression, a relative shorter inner fasciole (≤33%TL) and shorter anterior petals (≤10 pores) at comparable size classes (Mortensen 1907; Koehler 1909, as *E. intermedium*). The deep-water *E. meteorense* can be ruled out by being characterized by relative small and inconspicuous internal fasciole (<25–27%TL) and by a parallel arrangement in the pore columns of the paired petal (Mironov 2006). Also *E. meteorense* known depth range is significantly deeper than the reported depth for DBUA-ECH specimens. In contrast, the diagnostic features mentioned above place the examined material close to *E. cordatum*. However, none of the examined specimens presented the pores in the frontal ambulacrum in an irregular double series arrangement, a feature unique in *E. cordatum* (Mortensen 1951b). On the other end, *E. fenauxi* has the pores in the frontal ambulacrum disposed in a similar fashion as our specimens, *i.e.* in a single series. At first instance the examined specimens appear to belong to this species. However, *E. fenauxi* is also characterised by having a large depressed test and a periproct wider than long, which is not consistent with the observations on the specimens from the Azores.

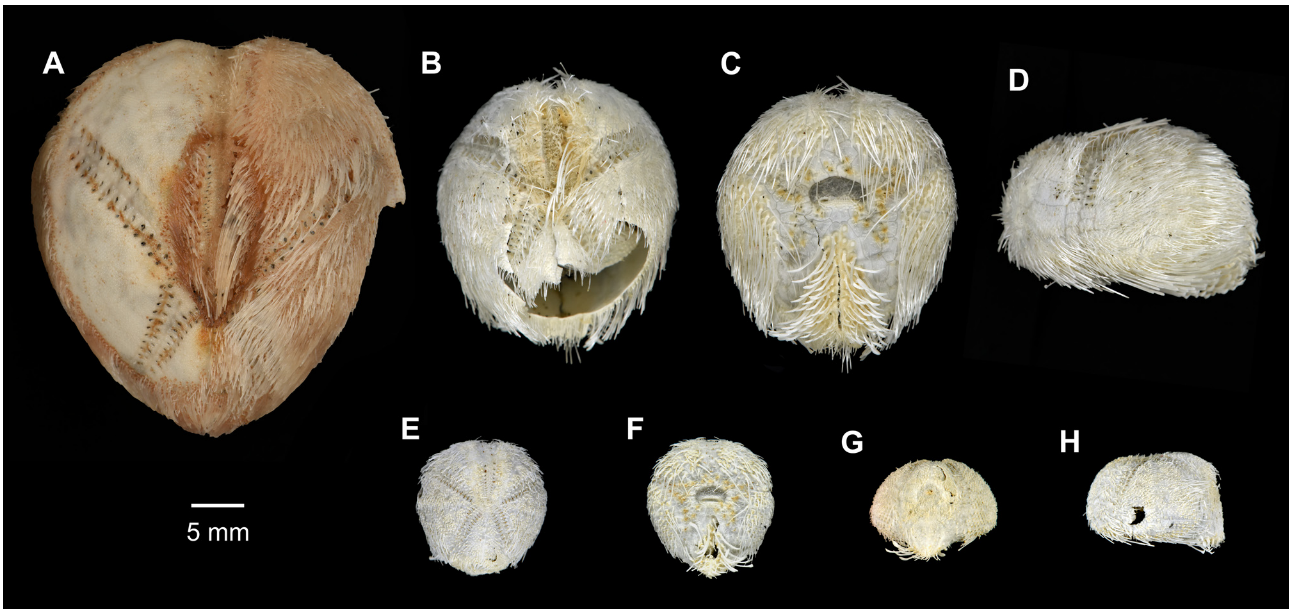

FIGURE 30. *Echinocardium cordatum* (Pennant, 1777) (DBUA-ECH 083: A) and *Echinocardium* sp. (DBUA-ECH 084: B–D; DBUA-ECH 278: E–H). Apical view (A, B, E); oral view (C, F); posterior view (G); lateral view (D, H).

The validity of *E. fenauxi* has been contested (Egea *et al*. 2016), since its original description by Péquignat (1963). In a preliminary genetic study, *E. cordatum* and *E. fenauxi* were ordered on the molecular trees according to their geographic origin, failing to separate the morphospecies (Laurin *et al*. 1994). Féral *et al*. (1998) also failed to genetically differentiate *E. fenauxi* from *E. cordatum*. Furthermore, the diagnostic characteristics listed above for *E. fenauxi* appear to fall well in the known variability the polymorphic *E. cordatum* as was demonstrated the studies by Higgins (1974, 1975). In contrast, available genetic data on *E. cordatum* indicates that it is a cryptic species complex (Egea *et al*. 2016).

Mortensen (1936) tentatively identified a damaged specimen of about 20 mm from Cape Verde (7–11 m of depth) as *E. connectens*. This species is still known only by the fragmentary type material from Saint Helena

(Mortensen 1933c). Nevertheless, Mortensen's description and figures of the specimen from Cape Verde are in every aspect consistent with the material examined here, particularly when comparing specimens of similar size (DBUA-ECH 94, TL = 18–19 mm). Unfortunately, no further material of *Echinocardium* from Cape Verde has been recorded to date. In the future it would be interesting to compare specimens from these archipelagos as new and better-preserved material becomes available.

Echinocardium flavescens **(Müller, 1776)**

Reports for the Azores:
Echinocardium flavescens (Müller, 1776)—?$Barrois 1888: 110; Koehler 1914b: 279, 1921b: 136–137, fig. 95; Mortensen 1927a: 334–335, figs. 194.3, 195.4, 196.2, 197.1, 1951b: 158–160; Nobre 1938: 128–129, fig. 55; $Tortonese 1965: 366–367, fig. 180; Pereira 1997: 334; Micael & Costa 2010: 323; Madeira *et al*. 2011: 257; Micael *et al*. 2012: 4.

See: Tortonese (1965); Schultz (2006: 413, fig. 413).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Iceland and Scandinavia south to Portugal (Mortensen 1927a, 1927, Nobre 1938), Madeira (Jesus & Abreu 1998) and the Azores (Tortonese 1965).

Depth: 5–360 metres (Tortonese 1965); ?AZO: 15–30 m (Barrois 1888).

Habitat: buried in gravel, sand, muddy, detritic and coralligenous bottoms (Koehler 1921b).

Larval stage: planktotrophic (McEdward & Miner 2001).

Remarks: *Echinocardium flavescens* was first reported by Barrois (1888), who noted that all his specimens though quite abundant in all the dredges between 15 and 30 meters, appeared unusually small to what he had seen in French coasts. On re-examination of Barrois' material, Koehler (1909) disagreed with the previous author's identification, observing that all specimens appear to be young *E. cordatum* and not *E. flavescens* (see above). However, the author also added that the animals were far too small for an accurate determination and lacked important diagnostic characters such as the pedicellaria. Nonetheless, Tortonese (1965) later examined animals coming from Faial Island and confirmed the presence of this species in the archipelago.

Additionally, Barrois failed to collect *Echinocyamus pusillus* (= *Echinocyamus angulosus*) from the Azores. This author used the absence of this species from his dredges together with the minute sized that supposedly characterize the insular *E. flavescens* to explain that in his opinion Drouët (1861) mistook *E. flavescens* for *Echinocyamus pusillus*. During the *International Workshop of Malacology and Marine Biology* (2006) abundant material of both *Echinocardium* and *Echinocyamus* was retrieved from several dredges in the south coast of São Miguel Island. On that account, we are inclined to disagree with Barrois since both *Echinocardium* and *Echinocyamus* appear to be quite common in the Azores. Notwithstanding, *E. pusillus* tends to occur in coarser sediments than *Echinocardium* species (Nichols 1959; Higgins 1974), and this apparent biotope partitioning could explain why Barrois reported one species and failed to do so for the other (see as well remarks under *E. pusillus*).

Suborder Paleopneustina Markov & Solovjev, 2001

Family Paleopneustidae Agassiz, 1904

Genus *Peripatagus* Koehler, 1895b

Peripatagus cinctus **Koehler, 1895b**

Reports for the Azores:
Peripatagus cinctus $Koehler, 1895b: 231–233, 1909: 248–251, pl. 31, figs. 6–18; Mortensen 1927a: 322, 1950: 306; García-Diez *et al*. 2005: 51; Mironov 2006: 119.

Type locality: Azores (38°47'40"N, 28°17'05"W).

See: Koehler (1895b, 1909); Mironov (2006).

Occurrence: cosmopolitan, scattered records from both East Atlantic and Pacific water; in the Atlantic reported from the Azores (Koehler 1909) and the seamounts of Atlantis (Meteor), Tropic (off NW Africa), Zubov and Valdivia (Walvis Ridge, off the coast of Namibia); also reported from a seamount located north of St. Helena (11°37'S, 5°12'W; Mironov 2006).

Depth: 290–1,494 m (Koehler 1909, Mironov 2006); AZO: 880–1,494 m (Koehler 1909).

Habitat: sand and rock (Koehler 1909).

Remarks: the geographical distribution of this *Peripatagus cinctus* in the Atlantic is presently restricted to oceanic systems. Firstly described for the Azores by Koehler (1895b; *Princesse Alice*, sta 616: 38°47'40"N, 28°17'05"W, 1,022 m) this species was then later reported from several oceanic seamounts.

Family Schizasteridae Lambert, 1905

Genus *Aceste* Thomson, 1877

Aceste bellidifera Thomson, 1877

Reports for the Azores:

Aceste bellidifera Thomson, 1877—$Koehler 1909: 246–247; Mortensen 1927a: 321; García-Diez *et al*. 2005: 51; Mironov 2006: 115, 2014: 127.

Type locality: off Gomera Island, Canaries.

See: Thomson (1877: 349–351, figs. 95–96); Mortensen (1950: 332–333, figs. 224, 225).

Occurrence: Atlantic, in the west recorded from the USA (*c.* 37°N) and the Caribbean to southern America, and Tristan da Cunha (Agassiz 1881, Serafy & Fell 1985, Mironov 2014); in the east recorded from the Iberian Basin (Mironov 2014), Morocco (Mortensen 1927b), Josephine Seamount (Mironov 2006), the Azores (Koehler 1909) and Canaries (Thomson 1877).

Depth: 550–5,400 m (Serafy & Fell 1985, Mironov 2014); AZO: 1,360 m (Koehler 1909).

Habitat: buried on soft substrates, mud to sandy mud and shells (Agassiz 1881, Pawson & Pawson 2013).

Remarks: the record of *Aceste bellidifera* in the Azores is based on a single small specimen (≈14 mm TL) identified by Koehler (1909) among the material collected by *Princesse Alice* (sta 703: 39°21'20"N, 31°05'45"W, 1,360 m).

Superorder Neognathostomata Smith, 1981

Order Clypeasteroida Agassiz, 1872

Suborder Scutellina Haeckel, 1896

Infraorder Laganiformes Desor, 1847

Family Echinocyamidae Lambert & Thiéry, 1914

Genus *Echinocyamus* van Phelsum, 1774

Echinocyamus grandiporus Mortensen, 1907

(Fig. 31)

Reports for the Azores:

p.p. *Echinocyamus pusillus* Gray—$Koehler 1898: 24;

Echinocyamus grandiporus $Mortensen, 1907: 33–36, fig. 2a, pl. 12, figs. 1, 3, 5, 8, 10–16, 21, 25, 28; $Koehler 1909: 234, pl. 4, fig. 8; Mortensen 1927a: 315, 1948: 183; $Mironov & Sagaidachny 1984: 183–184, fig. 2(1); García-Diez *et al*. 2005: 51; Mironov 2006: 113–114; Madeira *et al.* 2011: 255; Benavides-Serrato *et al*. 2012: 99.

See: Mortensen (1907); Mironov (2006).

Occurrence: North Atlantic; from Florida to Brazil (Tommasi 1966, Benavides-Serrato *et al*. 2012), eastwards to off Mauritania (Mortensen 1927b), the Azores (Koehler 1909) and Canaries archipelagos; also reported from the Antialtair, Josephine, Gorringe and Meteor seamounts (Mironov 2006).

Depth: 110–2,310 m (Mortensen 1927b, Mironov & Sagaidachny 1984); AZO: 320–1,385 m (Koehler 1909, Mironov & Sagaidachny 1984).

Habitat: typically from soft substrates (sand to gravel; Koehler 1909).

Material examined: EMEPC-LUSO L09D17B68R (E of TER, AZO, 38°40'07"N, 26°51'27"W, 2009.09.30, 460 m; 1 bt, TL = 7 mm); EMEPC-LUSO L09D22S1 (D. João de Castro Bank, AZO, *c*. 38°14'02"N, 26°33'37"W, 2009.10.09, 718–825 m; 4 bts, D = 4–5 mm); EMEPC-LUSO L09D22S2 (D. João de Castro Bank, AZO, *c*. 38°13'52"N, 26°33'58"W, 2009.10.09, 476–718 m; 2 bts, TL = 4–5 mm); EMEPC-LUSO L09D22S3 (D. João de Castro Bank, AZO, *c*. 38°13'52"N, 26°33'58"W, 2009.10.09, 476–718 m; 1 bt, TL = 4 mm); EMEPC-LUSO L09D25B14 (Channel SJG–PIX, AZO, 38°36'19.09"N, 28°06'46.64"W, 2009.10.21, 1,180 m; 1 bt, TL = 9 mm); EMEPC-LUSO L09D25B43 (Channel SJG–PIX, AZO, 38°36'19.09"N, 28°06'46.64"W, 2009.10.21, 1,180 m; 1 spm, TL = 4 mm); EMEPC-LUSO L09D26RB17a (Channel SJG–PIX, AZO, 38°37'32"N, 28°08'23"W, 2006.10.23; 2 bts, TL = 3–4 mm).

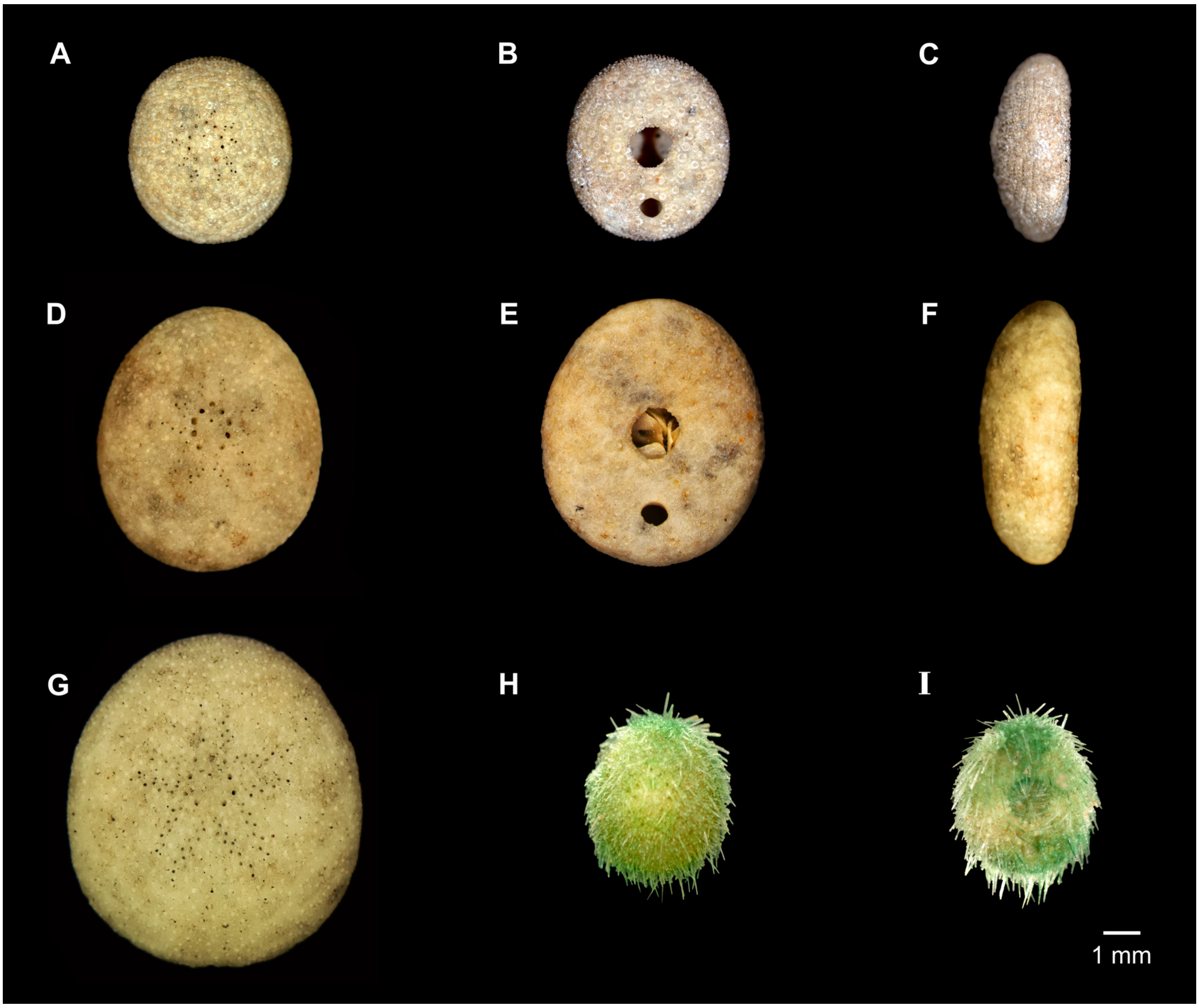

FIGURE 31. *Echinocyamus grandiporus* Mortensen, 1907 (EMEPC–LUSO L09D22S2: A–C; EMEPC–LUSO L09D17B68R: D–F; EMEPC–LUSO L09D25B14: G; EMEPC–LUSO L09D25ARB43: H–I). Apical view (A, D, G, H); oral view (B, E, I); lateral view (C, F).

Description: test oval (width = 85–90%TL) and relatively low (height = 36–45%TL). Five ocular pores forming a circle with four genital pores; ocular pores as large as the genital pores, though distinctly narrowing inwards;

madreporic plate a little elevated with a central pore skew to the anterior part. Petals short, not reaching the edge of the test; pore-series parallel, with two or three (TL ≤ 4 mm) in small up to six pore pairs (TL = 9 mm, EMEPC–L09D25B14) in large specimens per row of the posterior ambulacra. Oral area flat. Peristome round to subpentagonal about 20–24%TL. Periproct small (9–11%TL), fully oral and round to transverse oval. Primary spines slender up to 15%TL. Colour: white naked test, also spines (tinge with green after preservation in ethanol).

Remarks: Koehler (1898) examined the rich clyperasteroid material collected by *Hirondelle* in the Azores, which he reported as all belonging to *Echinocyamus pusillus*. On erecting a new deep-water species of *Echinocyamus*, Mortensen (1907) re-examined material from *Hirondelle* and *Princesse Alice* and referred part of the specimens to *E. grandiporus*. Later, Koehler (1909) agreeing with the previous author reported further Azorean material from *Princesse Alice* under Mortensen's new species. In a review of this genus, Mironov & Sagaidachny (1984) also examined material *E. grandiporus* from the Azores. The material examined here further re-enforces the presence of this deep-water species in the Azores. Generally, this species differs from other *Echinocyamus* species known in the archipelago by its large ocular pores that together with the gonopores form a conspicuous circle. *E. grandiporus* is further distinct from *E. pusillus* by the less developed petals (Mortensen 1907). Mironov (2006) remarked that the close related species *E. scaber macrostomus* occasionally also features large ocular pores. Nonetheless, this later species can also be separated by having relative larger peristome and periproct and by the rudimentary petals (Mortensen 1948). See also remarks under *E. pusillus*.

***Echinocyamus pusillus* (Müller, 1776)**

(Fig. 32)

Reports for the Azores:

Echinocyamus angulosus Leske, 1778—$Drouët 1861: 211;

Echinocyamus pusillus Gray 1825—Agassiz 1872: 111–112, pl. 11, fig. 3, pl. 13, figs. 1–8, 1881: 226; p.p.$Koehler 1898: 24;

Echinocyamus pusillus (Müller, 1776)—$Simroth 1888: 231; Bell 1892: 160–161, pl. 16, figs. 8–9; $Mortensen 1907: 31–33, fig. 2, pl. 12, figs. 4, 6, 9, 18–20, 22, 23, 26, 27, 29–31; $Koehler 1909: 235–236, pl. 4, fig. 10; Koehler 1914b: 278; $Nobre 1924: 89, 1930: 6, 1938: 122–123, fig. 29; Mortensen 1927a: 316–317, figs. 182–183; Grieg 1932: 42; Mortensen 1948: 178–183; $Tortonese 1965: 346–348, fig. 164; $Marques 1983: 6; $Mironov & Sagaidachny 1984: 126–183; Pereira 1997: 334; $Morton *et al.* 1998: 143, fig. 7.4L1; García-Diez *et al.* 2005: 51; Mironov 2006: 114; Schultz 2006: 317–318, figs. 597–598; $Wirtz 2009: 48, fig. 1f; Micael & Costa 2010: 323; Madeira *et al.* 2011: 255, fig. 11; Micael *et al.* 2012: 3; *Echinocyamus minutus* (Pallas, 1774)—Harvey 1956: 66.

See: Mortensen (1907, 1948).

Occurrence: Mediterranean Sea and northeast Atlantic, from Iceland and Scandinavia, along the European coasts to Sierra Leone (Mortensen 1907, 1951a, Koehler 1909, H.L. Clark 1925), including the archipelagos of the Azores, Madeira (Koehler 1909), Canaries (Bacallado *et al.* 1985) and Cape Verde (Cadenat 1938), and the Ampère, Gorringe and Meteor seamounts (Mironov 2006).

Depth: AZO: 0–207(?1,250) m (Koehler 1909, herein).

Habitat: lives buried in soft substrates, in sand, detritic and gravelly bottoms where it feeds on detritus and foraminifera (Koehler 1898, Picton 1993).

Larval stage: planktotrophic (Mortensen 1927a).

Fossil record: also reported from the Pliocene and Pleistocene outcrops of Santa Maria Island (Madeira *et al.* 2011, 2017a).

Material examined: DBUA-ECH 011 (Água d'Alto, SMG, AZO, 37°42'55.48"N, 25°28'27.39"W, 2006.08, intertidal; 1 bt, TL = 7 mm); DBUA-ECH 036 (Água d'Alto, SMG, AZO, *c.* 37°42'55"N, 25°28'27"W, 2009.04.25, intertidal; 47 bts, TL = 4–8 mm); DBUA-ECH 037 (off Marina of Vila Franca do Campo, SMG, AZO, 37°41'42"N, 25°25'22"W, 2006.07.17, 135 m; 1 spm, 15 bts, TL = 3–5 mm); DBUA-ECH 038 (Vila Franca do Campo, SMG, AZO, 37°41'34"N, 25°27'34"W, 2006.07.19, 167–189 m; 16 bts, TL = 3–5 mm); DBUA-ECH 039 (Vila Franca do Campo, SMG, AZO, 37°41'39"N, 25°27'11"W, 2006.07.21, 95–121 m; 70 bts, TL = 3–6 mm); DBUA-ECH 040 (Vila Franca do Campo, SMG, AZO, 37°41'52"N, 25°27'13"W, 2006.07.24, 45–47 m; 11 bts, TL = 4–6 mm); DBUA-ECH 041 (off Praia da Vinha da Areia, SMG, AZO, 37°42'45"N, 25°25'24"W, 2006.07.21, 14 m; 14 bts, TL = 4–6 mm); DBUA-ECH 042 (off Ribeira das Tainhas, SMG, AZO, 37°42'01"N, 25°25'14"W, 2006.07.24, 98–108 m; 13 bts, TL = 3–5 mm); DBUA-ECH 043 (off Ribeira das Tainhas, SMG, AZO, 37°42'01"N, 25°25’01”W, 2006.07.24, 117–145 m; 8 bts, TL = 3–5 mm); DBUA-ECH 044 (off Ribeira das Tainhas, SMG, AZO, 37°41’57”N, 25°25’08”W, 2006.07.24, 144–198 m; 24 bts, TL = 4–7 mm); DBUA-ECH 045 (off Ribeira das Tainhas, SMG, AZO, 37°42’17”N, 25°25’09”W, 2006.07.24, 34–63 m; 14 bts, TL = 3–5 mm); DBUA-ECH 046 (off Cais do Tagarete, Vila Franca do Campo, SMG, AZO, 37°42’07”N, 25°25’14”W, 2006.07.25, 52 m; 1 spm, 32 bts, TL = 2–5 mm); DBUA-ECH 047 (off Cais do Tagarete, Vila Franca do Campo, SMG, AZO, 37°41’53”N, 25°25’15”W, 2006.07.25, 180 m; 11 bts, TL = 3–6 mm); DBUA-ECH 048 (Vila Franca do Campo SMG, AZO, 37°41’17”N, 25°25’10”W, 2006.07.25, 129–207 m; 4 bts, TL = 3–4 mm); DBUA-ECH 049 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42’43”N, 25°21’33”W, 2006.07.26, 38 m; 2 bts, TL = 4 mm); DBUA-ECH 050 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°41’57”N, 25°22’08”W, 2006.07.26, 156–360 m; 2 bts, TL = 4 mm); DBUA-ECH 051 (off Praia de Água d’Alto, SMG, AZO, 37°42’24”N, 25°28’59”W, 2006.07.26, 66 m; 62 bts, TL = 2–7 mm); DBUA-ECH 052 (off Vinha da Areia, Vila Franca do Campo, SMG, AZO, 37°42’37”N, 25°25’18”W, 2006.07.26, 56 m; 58 bts, TL = 2–7 mm); DBUA-ECH 124 (São Roque, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 2012.11.16, intertidal; 1 spm, TL = 2 mm); DBUA-ECH 129 (Rosto do Cão, São Roque, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 1990.07.4, 9,5 m; 3 spms, TL = 5 mm); DBUA-ECH 183 (Baixa do Porto, Lajes, FLS, AZO, *c.* 39°22’50”N, 31°10’00”W, 1990.10.27; 1 bts, TL = 3 mm); DBUA-ECH 293 (Baia de Belém, São Roque, SMG, AZO, *c.* 37°44’37”N, 25°38’19”W, 1990.07.4, 8,6 m; 1 spm; TL = 5 mm); DBUA-ECH 311 (off Ribeira das Tainhas, SMG, AZO, 37°42’33”N, 25°25’53”W, 23 m; 2 spms, TL = 3 mm); DBUA-ECH 324 (Sabrina Bank, SMG, AZO, 37°52’23”N, 25°54’00”W, 2011.07.07, 140 m; 1 spm, 7 bts, TL = 3–4 mm); DBUA-ECH 367 (Vila Franca, SMG, AZO, 37°42’39”N-25°27’26”W, 2006.07.21, 18–20 m; 2 spms, TL = 5 mm); DBUA-ECH 370 (Vila Franca, SMG, AZO, 37°42’42”N-25°24’38”W, 2006.07.25, 17 m; 1 spm, TL = 4 mm); DBUA-ECH 373 (Islet of Via do Porto, SMA, AZO, *c.* 36°56’23”N, 25°10’16W”, 7 m; 2 spms, TL = 3–4 mm); DBUA-ECH 383 (Horta, FAY, AZO, *c.* 38°31’51”N, 28°37’23”W, 2010.03.02; 1 spm, TL = 4 mm); DBUA-ECH 435 (Vila Franca do Campo, SMG, AZO, 37°41’41”N–37°41’17”N, 25°25’26”W–25°25’10”W, 2006.07.25, 129–207 m; 1 spm, TL = 3 mm); EMEPC-LUSO L9D9B20(S1) (Gorringe Bank, NE Atlantic, 36°42’49”N, 11°09’54”W, 2009.09.13, 130 m; 20 bts, TL = 2–5 mm).

Description: test small, flattened, variable in form; outline generally elongated oval, though among the smallest specimens frequently ellipsoid (width ≈66–74%TL; TL < 3 mm) becoming more circular or subpentagonal in larger individuals (width ≈100%TL; TL ≥ 7 mm). Apical disc central to slightly posterior, with large genital pores and five small ocular pores. The lower half of the apical side locally depressed in larger individuals (TL = 7–8 mm). Oral area mostly flat; depression between the peristome and periproct particularly evident in the larger specimens (TL > 5 mm). Peristome circular to subpentangular, relatively concave; diameter of the peristome about 30–33%TL in smaller individuals (TL < 3 mm) decreasing to 13–19%TL in larger specimens (TL ≥ 7 mm). Periproct ellipsoid to round, small (6–12%TL) lies halfway between the peristome and the posterior margin. Petals well developed, but not reaching the edge of the test; pore-series almost parallel, open distally, reaching ten pore pairs per column in the posterior ambulacra in the largest specimens (TL = 7–8 mm). Spines short, relatively uniform. Colour (in ethanol): test and spines white or cream, occasionally green.

Remarks: in general, the genus *Echinocyamus* shows a great deal of intraspecific morphological variation, often depending on the age and size of the animal. Mironov & Sagaidachny (1984) attempted to clarify the limits between intra and interspecific variability in several *Echinocyamus* species, constructing a diagnostic set made of several morphometric and meristic characters. The Azorean specimens herein examined showed as expected, high intraspecific variation, explained for the most part by differences in size of the specimens and thus dismissed as allometric variation (see remarks under *E. grandiporus*).

The first report of this species in the archipelago comes from Drouët (1861) who noted they are quite common on the coasts of São Miguel. Barrois (1888) believed that Drouët confused *E. pusillus* with *Echinocardium flavescens*. The material reported by Drouët (1861) could not be located, thus making impossible to verify Barrois’ statement. However, we are inclined to believe Drouët’s original identification. In São Miguel, dead tests of *E. pusillus* are relatively easy to find in the intertidal, particularly on sandy beaches, among the debris left by the low tide (Nobre 1930, *personal observation*). They are also a common presence among the material dredged in the Azores at depths up to 200 m. Also, the maximum recorded depth of this species was reported by Koehler (1909) based on dead tests collected by *Princesse Alice* in Azorean waters between 650 and 914 m (sta 2214: 39°26’10”N, 31°21’30”W) and 1,250 m (sta 1349: 38°35’30”N, 28°05’45”W). The recorded depths may not represent a real bathymetric limit but rather be biased by transportation, as Koehler remarked. The light but robust *Echinocyamus* tests make it possible to keep their overall integrity even long after the animal is dead. Unfortunately, many of the documented reports for this species do not provide any description of the specimens, thus making impossible to understand the real depth range of this species. Storage in the DBUA-ECH collection we have found living specimens to a maximum reported depth of 140 m. Even though it is more than likely that *E. pusillus* lives at higher depths, we have accepted this value as the maximum depth in the archipelago for this species at present. Additionally, Mironov (2006) referred to station 166 (*Princesse Alice*) where Koehler (1909) had reported *E. pusillus* as being located in the Mid-Atlantic Ridge to the north of the Azores. This station is not in Azores waters but in the western shores of France (47°26'30"N, 3°12'05"W). Apparently Mironov had confused the symbol representing the degree of latitude with a zero.

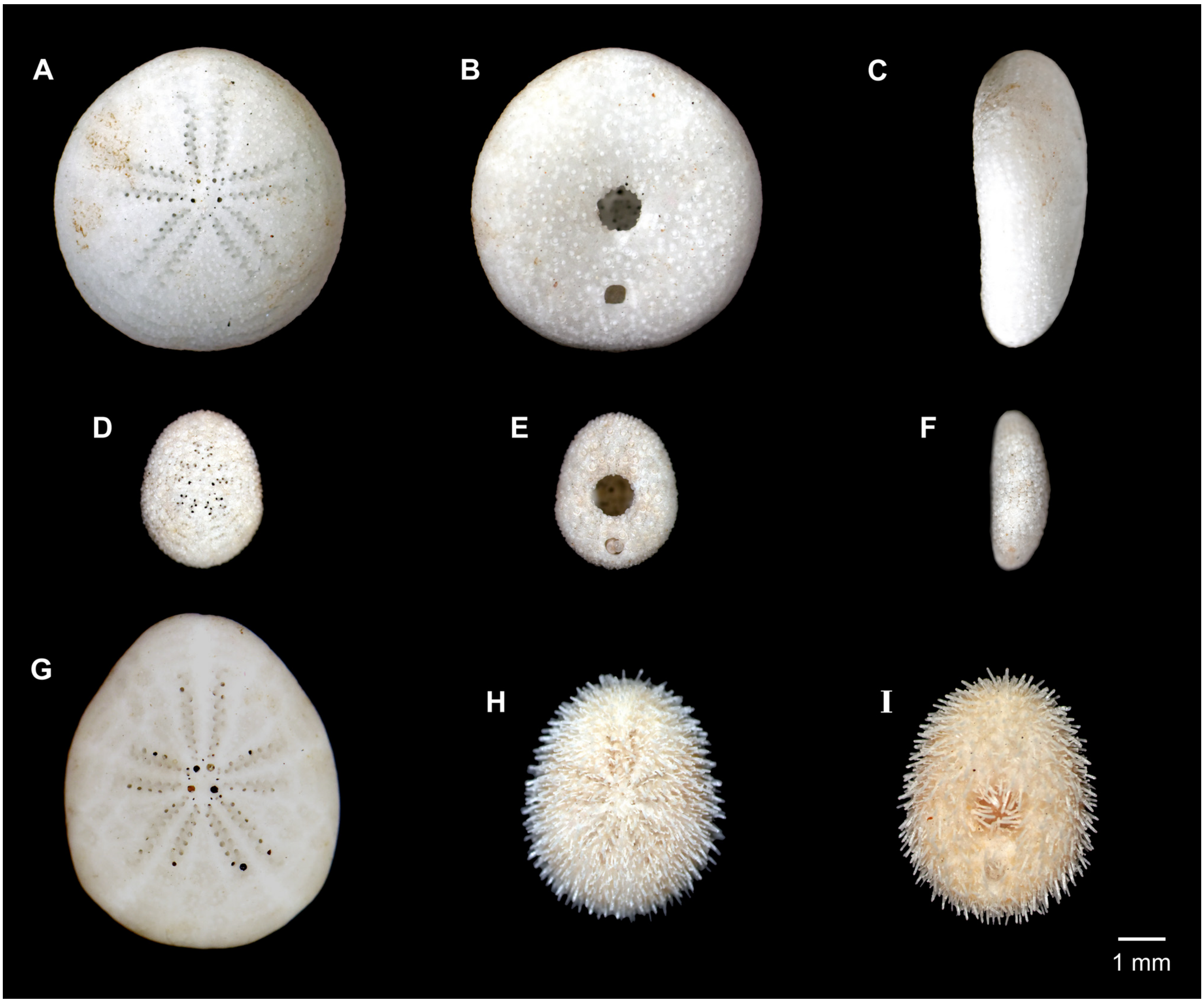

FIGURE 32. *Echinocyamus pusillus* (Müller, 1776) (DBUA-ECH 036-3: A–C; DBUA-ECH 036-5: G; L09D17S5: D–F; DBUA-ECH 129: H–I); Apical view (A, D, G, H); oral view (B, E, I); lateral view (C, F).

Species *Echinocyamus scaber* de Meijere, 1903

Echinocyamus scaber macrostomus Mortensen, 1907

Reports for the Azores

Echinocyamus macrostomus $^{\$}$Mortensen, 1907: 36–37, pl. 12, figs. 2, 7, 17, 24; $^{\$}$Koehler 1909: 235, pl. 4, figs. 9–10; Mortensen 1927a: 315, 1948: 183–184; García-Diez *et al*. 2005: 51; Madeira *et al.* 2011: 255;

Echinocyamus scaber macrostomus Mortensen, 1907—$^{\$}$Mironov & Sagaidachny 1984: 186–187, fig. 2.2; Mironov 2006: 113–114; Mironov 2014: 124.

See: Mortensen (1907; 1927b: 30–31); Mironov & Sagaidachny (1984).

Occurrence: North Atlantic, in the west from the Blake Plateau to Cuba (Mironov 2014), in the east from

Portugal to Cape Verde (Mortensen 1907, 1927b) including the archipelagos of the Azores and Madeira (Mortensen 1907) and the Josephine, Tropic and Meteor seamounts (Mironov 2006). The subspecies *E. scaber scaber* de Meijere, 1903 is reported from the Indo-Pacific (Mironov & Sagaidachny 1984).

Depth: 1,010–2,820 m, though bare tests have been reported as deep as 3,140 m (Mironov & Sagaidachny 1984); AZO: 1,560–2,178 m (Mortensen 1907, Koehler 1909).

Habitat: mud to sand (Koehler 1909).

Remarks: Mortensen (1907) described two species of *Echinocyamus*, *E. macrostomus* and *E. grandiporus* using material, which included animals collected in Azorean deep waters. Mortensen (1907) considered his two new deep-water species closely related though *E. macrostomus* tended to live in deeper waters. In contrast, Mironov & Sagaidachny (1984) considered *E. macrostomus* closely related with *E. scaber* and downgraded Mortensen species to a variety of the later. Additionally, Mironov (2006) observed that some of the specimens from Meteor and Anti-altair seamounts presented intermediate characteristics between this subspecies and *E. grandiporus*, suggesting that they could represent hybrids.

Class Holothuroidea de Blainville, 1834

Order Apodida Brandt, 1835

Family Chiridotidae Östergren, 1898

Genus *Chiridota* Eschscholtz, 1829

Chiridota abyssicola Marenzeller, 1892

Reports for the Azores:

Chiridota abyssicola $^{\$}$Marenzeller, 1892: 65, 1893: 19, pl. 1, fig. 5, pl. 2, fig. 7; Perrier 1902: 276; Mortensen 1927a: 437; García-Diez *et al*. 2005: 52;

p.p. *Chiridota lævis* (Fabricius)—H.L. Clark 1907: 28–29.

Type locality: North of the Azores (41°40'41"N, 26°44'09"W).

See: Marenzeller (1893); H.L. Clark (1907: 119–120, as *Chiridota lævis*).

Occurrence: known only from the Azores (Marenzeller 1893).

Depth: AZO: 2,870 m (Marenzeller 1893).

Habitat: soft substrates (clayish sand; Marenzeller 1893).

Remarks: Marenzeller (1892, 1893) described *Chiridota abyssicola* based on a single specimen collected by *Hirondelle* within the archipelago waters (sta 248: 41°40'41"N, 26°44'9"W, 2,870 m). This species is known only from the type specimen. In a review of apodous holothurians, H.L. Clark (1907) united under the name *C. laevis* several species described from both the Atlantic and Pacific, turning a species previously known only to the Antarctic shallow waters to one of the most widely distributed species of the genus *Chiridota*, both in terms of geographic and bathymetric range. Notwithstanding, the same author believed that among the shallow and deep-water forms there was more than one species. However, the variability of the diagnostic characters was such (often depending on the age and size of the animal) that H.L. Clark was unable to clearly define each of the species. The decision of making *C. abyssicola* conspecific with *C. laevis* did not reunite consensus as the latter was viewed as a cold shallow-water species (*e.g.,* Mortensen 1927a; Deichmann 1930; Heding 1935). Regardless, whether *C. abyssicola* should be merged with the highly variable *C. laevis* will depend on future work. For now, we have chosen to retain the historical species, restricted to the Azorean deep waters.

Family Synaptidae Burmeister, 1837

Genus *Leptosynapta* Verrill, 1867

Leptosynapta inhaerens (Müller, 1776)

Reports for the Azores:
Leptosynapta inhaerens (Müller, 1776)—$^{\$}$Wirtz 2009: 48, fig. 1e.

Type locality: Norway.

See: Tortonese (1965: 104–105, fig. 45); Picton (1993: 82–83).

Occurrence: Mediterranean Sea and Northeast Atlantic; from Scandinavian arctic waters south along European coasts (Tortonese 1965) to the Azores (Wirtz 2009) and Canaries (Pérez-Ruzafa *et al*. 1992a).

Depth: 0–173 m, mostly between the first few meters and 50 m deep (Pérez-Ruzafa *et al*. 1992a); also found in tide-pools (AZO; Wirtz 2009).

Habitat: soft sediments buried in muddy sand or gravel, and amongst *Zostera* and *Caulerpa* and in sandy tide pools (Picton 1993, Pérez-Ruzafa *et al*. 1992a).

Larval stage: Planktotrophic, hermaphroditic (Mortensen 1927a, McEdward & Miner 2001).

Remarks: recently, Wirtz (2009) discovered small specimens belonging to *Leptosynapta inhaerens* in tide-pools in Faial Island, turning the archipelago to the westernmost limit for this species.

Order Dendrochirotida Grube, 1840

Family Cucumariidae Ludwig, 1894

Genus *Abyssocucumis* Heding, 1942

Abyssocucumis abyssorum (Théel, 1886a)

Reports for the Azores:
Cucumaria abyssorum Théel, 1886a—$^{\$}$Marenzeller 1892: 64, 1893: 14; Ludwig 1894: 122–127, pl. 9, figs. 28, 29, pl. 13, figs. 1–5; Perrier 1902: 275; Mortensen 1927a: 396; Deichmann 1930: 139; Grieg 1932: 11, fig. 9; $^{\$}$Cherbonnier 1941: 93–103, figs. 1, 3;
Abyssocucumis abyssorum (Théel, 1886)—García-Diez *et al*. 2005: 51.

Type locality: off Crozet Island (46°16'S, 48°27'E).

See: Théel (1886a: 66–67 pl. 4, fig. 6, pl. 16, fig. 6); Heding (1942: 33–35, figs. 34–36); Massin & Hendrickx (2011: 418).

Occurrence: cosmopolitan, known from all oceans except in the Arctic (Hansen 1975); in the Atlantic from the Davis Strait (Heding 1942) eastwards from south of Iceland (Deichmann 1930) and the Rockall Trough (Gage *et al*. 1985) to the Azores (Marenzeller 1892).

Depth: 869–4,810 m (Gage *et al*. 1985); AZO: 2,870 m (Marenzeller 1892).

Habitat: soft substrates (muddy sand to ooze; Théel 1886a, Marenzeller 1892).

Remarks: the presence of this species in Azores is based on a single dredge by *Hirondelle* (sta 248: 41°40'41"N, 26°44'9"W) (Marenzeller 1892, 1893). Though this abyssal holothurian was never re-collected again in the archipelago, more recently *A. abyssorum* was repeatedly retrieved from the Mid-Atlantic Ridge just north of the Azorean waters (Gebruk 2008; Rogacheva *et al*. 2013).

Genus *Pawsonia* Rowe, 1970

Pawsonia saxicola? (Brady & Robertson, 1871)

Reports for the Azores:
Cucumaria montagui (Fleming, 1828)—$^{\$}$Marenzeller 1892: 65, 1893: 15–17; Perrier 1902: 275; Koehler 1921b: 150–152, fig. 101;
Cucumaria saxicola Brady & Robertson, 1871—Mortensen 1927a: 401–402, fig. 240; Tortonese 1965: 75–76;
Pawsonia saxicola (Brady & Robertson, 1871)—Pérez-Ruzafa *et al*. 1992a: 167; Pereira 1997: 333; García-Diez *et al*. 2005: 51; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

Type locality: Ireland.

See: Brady & Robertson (1871: 690–691, pl. 71, figs. 1–4, as *Cucumaria saxicola*); McKenzie (1991: 156–157, figs. 8e–i).

Occurrence: Mediterranean Sea and northeast Atlantic, from the British Islands (McKenzie 1991) to the Canaries (Hernández *et al*. 2013) and ?Azores.

Depth: 0–50 m (McKenzie 1991); ?AZO: 130 m (Marenzeller 1892).

Habitat: in rock crevices, under stones or among algae (Picton 1993).

Larval stage: lecithotrophic (Newth 1916).

Remarks: during the late 19 and early 20th centuries, a serious debate took place to decide if *Cucumaria montagui* was a valid species or a junior synonym of *Pawsonia saxicola* or *Aslia lefevrei* (*e.g.,* Marenzeller 1893; Norman 1905; Orton 1914). *Cucumaria montagui* was reported from the Azores by Marenzeller (1892, 1893) based on the material collected by *Hirondelle* on a station located in the channel between Pico and Faial islands, at a depth of 130 m. Marenzeller proved later to be incorrect on the use of the name 'montagui' for this cucumarid, and the report from the Azores was accepted under the synonymy of *P. saxicola* in later works. In his review, McKenzie (1991) considered that the depth of the Azorean record was far too deep for this shallow-water species and suggested that it could be a result of a misidentification. However, it is hard to believe that Marenzeller, who was very familiar with the forms we now know as *P. saxicola* could have misidentified the species. Among the fauna collected by *Hirondelle* at this station, we find a collection of animals belonging to the shallow-water realm such as *Thyone inermis* (see below), a species with a depth range very similar to *P. saxicola*. This suggests that the depth at which these holothurians were collected could have been much shallower than the reported 130 m. Regardless, this species was never recollected in the archipelago and thus the inclusion of *P. saxicola* in the Azorean fauna should be considered with caution.

Family Phyllophoridae Östergren, 1907

Genus *Thyone* Jaeger, 1833

Thyone inermis? Heller, 1868

Reports for the Azores:

Thyone inermis Heller, 1868—?[$]Marenzeller 1892: 66, 1893: 17; ?[$]Hérouard 1902: 45; Perrier 1902: 276; Mortensen 1927a: 408, fig. 246; Nobre 1938: 142; Deichmann 1954: 397; Miller & Pawson 1984: 40–41, figs. 32, 33; Pereira 1997: 333; Bohn 2004: 518; García-Diez *et al*. 2005: 51;

Havelockia inermis (Heller)—Tortonese 1965: 90–91, fig. 37B; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

Type locality: Adriatic Sea, Mediterranean Sea.

See: Koehler (1921b: 167, fig. 167); McKenzie (1991: 141–146); Bohn (2004); Pawson *et al*. (2010: 28).

Occurrence: Northeast Atlantic and Mediterranean Sea, reported from the English Channel south to Portugal (Bohn 2004, Jesus & Fonseca 1999) and the ?Azores (Marenzeller 1892).

Depth: mostly above 30 m (McKenzie 1991); ?AZO: ?130–?1,385 m (Marenzeller 1892, Hérouard 1902).

Habitat: lives buried in muddy to sandy habitats (Tortonese 1965).

Remarks: the shallow-water cucumarid *Thyone inermis* was recorded in the archipelago by Marenzeller (1892, 1893) and Hérouard (1902) at unusual depths, both well below the maximum depth accepted for this species. The first author identified this species among the material collected by *Hirondelle* (sta 226) between Pico and Faial islands, at a depth of 130 m. However, it is possible that material was collected at shallower depths than what was reported (see remarks under *Pawsonia saxicola*). In the second report, Hérouard recorded *T. inermis* at two stations sampled by *Princesse Alice* in the Azorean waters (sta 553: 37°42'40"N, 25°05'15"W; sta 575: 38°27'00"N, 26°30'15"W) between 1,165–1,385 m. The depth values alone seem to suggest that the material was neither *T. inermis* nor a species of *Thyone*, a shallow-water genus (Pawson & Miller 1981).

The taxonomy of the *Thyone* as in other dendrochirote holothurians is rather intricate (with a resulting problematic synonymy) particularly in the case of the European species, which are still awaiting an extensive revision (McKenzie 1991). Most of the characters used to separate species show a great degree of overlap, frequently forcing the identifications to be based on a sum of characteristics rather than on a single character. Moreover, dendrochirote holothurians are also characterized by species showing a large degree of morphological plasticity resulting from ontogenetic, environmental and genetic variability, coupled with the occasional drastic effects of fixation (*e.g.,* partial to total dissolution of ossicles) (Pawson & Miller 1981; McKenzie 1991) making the identification rather difficult and in some cases impossible. The inclusion of this species in the Azorean extant fauna should be considered under caution, until new material belonging to *T. inermis* is taken in the area that could corroborate the historical records.

Order Elasipodida Théel, 1882

Family Elpidiidae Théel, 1882

Genus *Amperima* Pawson, 1965

Amperima furcata (Hérouard, 1899)

Reports for the Azores:

Kolga furcata $^{\$}$Hérouard, 1899: 171, fig. 2, 1902: 40–41, pl. 3, fig. 7, pl. 6, figs. 4–10, pl. 8, fig. 17;
Periamma (*Kolga*) *furcatum* (Hérouard, 1899)—Perrier 1902: 276; Deichmann 1930: 134;
Periamma furcata (Hérouard, 1899)—Hérouard 1923: 91; Mortensen 1927a: 368;
Amperima furcata (Hérouard, 1899)—$^{\$}$Hansen 1975: 159, fig. 75; García-Diez *et al*. 2005: 51; $^{\$}$Gebruk 2008: 50, 51; Rogacheva *et al*. 2013: 600–601, figs. 7A, E, 17K, 18M, N, 19C.

Type locality: Mid-Atlantic Ridge, Azores (39°11’00”N, 30°44’40”W).

See: Hérouard (1902); Rogacheva *et al*. (2013: 600–601, figs. 7A E, 17K, 18M, N, 19C).

Occurrence: Atlantic and Pacific deep waters (Rogacheva *et al*. 2013); in the Mid-Atlantic Ridge, from the Charles-Gibbs Fracture Zone south to the Azores (Gebruk 2008) and east to the Bay of Biscay (Hérouard 1923).

Depth: 1,846–4,700 m (Rogacheva *et al*. 2013); AZO: 1,846–2,968 m (Hérouard 1902, Gebruk 2008).

Habitat: frequent swimmer (benthopelagic; Rogacheva *et al*. 2013); on muddy sand (Hérouard 1902).

Remarks: *Amperima furcata* was initially described by Hérouard (1899, 1902, as *Kolga furcata*) based on specimens collected by *Princesse Alice* in the Azores. The type material was later reviewed by Hansen (1975) who transferred this species to the genus *Amperima* Pawson, 1965. More recently, Gebruk *et al*. (2008) identified new material collected by *G.O. Sars* (*MAR–ECO* Cruise) in northern-most Azorean waters (sta 40/367: 42°55’N, 30°20’W, 2,954–2,968 m), thus confirming the historical record.

Rogacheva *et al*. (2012) observed this deposit feeder swimming above the sea floor for the first time. According to these authors, though spending most of its time feeding on sedimentary plains this species is a frequent swimmer, a possible adaptation to the patchy nature of its habitat. The ability to swim together with its known abyssal depth range may explain the rarity of records in the archipelago throughout its range.

Genus *Ellipinion* Hérouard, 1923

Ellipinion delagei (Hérouard, 1896)

Reports for the Azores:

Scotoplanes delagei $^{\$}$Hérouard, 1896: 167–168, fig. 3, 1902: 39–40, pl. 6, figs. 1–3, pl. 8, figs. 8–9; Perrier 1902: 276;
Ellipinion (*Scotoplanes*) *delagei* (Hérouard, 1896)—$^{\$}$Hérouard 1923: 90–91;
Ellipinion Delagei (Hérouard, 1896)—Mortensen 1927a: 368, figs. 218.4–5; Deichmann 1930: 133; $^{\$}$Hansen 1975: 163; Harvey *et al*. 1988: 185–186; García-Diez *et al*. 2005: 51.

Type locality: Azores (37°42’40”N, 25°05’15”W).

See: Hérouard (1902); Rogacheva *et al*. (2013: 601, figs. 7F–N, 19K).

Distribution North Atlantic, from the Mid-Atlantic Ridge (Charlie-Gibbs Fracture Zone; Rogacheva *et al*. 2012) to the Azores (Hérouard 1902), east to the Rockall Trough (Harvey *et al*. 1988), south to Cape Verde (Hérouard 1923) and west to the Bahamas (Pawson 1982).

Depth: 1,165–2,750 m (Rogacheva *et al*. 2013); AZO: 1,165–1,494 m (Hérouard 1902).

Habitat: frequent swimmer (benthopelagic; Rogacheva *et al*. 2012); on soft substrates (Hérouard 1902).

Remarks: *Ellipinion delagei* was first described by Hérouard (1896, 1902; as *Scotoplanes delagei*) based on material collected by *Princesse Alice* in the Azores. Later, Hérouard (1923) identified further material belonging to *E. delagei* collected by *Hirondelle* in Azorean waters (sta 3293: 38°47'N, 30°16'W, 1,331 m). Hansen (1975) re-analysed the type material in a review of the deep-water holothurians. Aside from the specimens collected by the historical cruises, no further individuals are known from the Azores Archipelago. Rogacheva *et al*. (2012), the first to observe this deposit feeder swimming above the sea floor, classified this species as a frequent swimmer, spending most of its time feeding on the sea floor (see above remarks under *Amperima furcata*).

Genus *Peniagone* Théel, 1882

Peniagone azorica Marenzeller, 1892

Reports for the Azores:

Peniagone azorica $Marenzeller, 1892: 64, 1893: 12–13, pl. 1, fig. 4, pl. 2, fig. 5; $Hérouard 1902: 42–43, pl. 6, figs. 21–26; Perrier 1902: 275; Hérouard 1923: 87–88; Mortensen 1927a: 369; Deichmann 1930: 137; Grieg 1932: 8, fig. 4; $Hansen 1956: 44, 1975: 138–142, fig. 63, pl. 10, figs. 1–3; ?$Pérès 1992: 254; García-Diez *et al*. 2005: 51.

Type locality: Azores (41°40'41"N, 26°44'09"W).

See: Marenzeller (1893); Rogacheva *et al*. (2013: 603–605, figs. 9, 12H, 12I, 17J, 19D).

Occurrence: North Atlantic, from Iceland (Hansen 1975) south to the Bay of Biscay (Hérouard 1923) and along the Mid-Atlantic Ridge (Rogacheva *et al*. 2013) to the Azores (Marenzeller 1892).

Depth: 1,385–4,020 m (Rogacheva *et al*. 2013); AZO: 1,385–4,020 m (Hérouard 1902, Hansen 1975).

Habitat: frequent swimmer (benthopelagic; Rogacheva *et al*. 2012); on soft sediments, sand, mud, clay to ooze (Marenzeller, 1892, Hérouard 1902).

Larval stage: lecithotrophic (Tyler *et al*. 1985b).

Remarks: *Peniagone azorica* was first described by Marenzeller (1892, 1893) based on material collected in Azores by *Hirondelle*. Hérouard (1902) also identified this species based on material collected in the Azores by *Princesse Alice* (sta 527: 38°09'N, 23°15'45"W, 4,020 m). In a review of the deep-water holothurioids, Hansen (1956, 1975) re-examined the material collected by *Princesse Alice* and discover further unreported specimens collected by the same cruise in the Azores. In spite of the Azores being the type locality, no other material belonging to *P. azorica* is known from the Azorean deep waters. Rogacheva *et al*. (2012) classified *P. azorica* as a frequent swimmer, thought spending most of its time feeding on the sea floor.

Peniagone diaphana (Théel, 1882)

Reports for the Azores:

Scotoanassa translucida $Hérouard, 1899: 171–172, fig. 3, 1902: 43–45, pl. 3, figs. 4–6, pl. 6, figs. 17–20; Perrier 1902: 276; Mortensen 1927a: 368, figs. 217.2, 218.2–3.

Type locality: Great Australian Bight, Pacific (42°42'S, 134°10'E).

See: Théel (1882: 55–56, pl. 9, figs. 3–5, pl. 35, fig. 18, pl. 44, fig. 9, as *Scotoanassa diaphana*); Hansen (1975: 153–155, fig. 71, pl. 10, figs. 7–8); Gebruk *et al*. (1997: 155–156, figs. 1, A–D).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Antarctic Oceans (Hansen 1975); recorded from several isolated localities throughout the Atlantic, including the Charlie-Gibbs Fracture Zone (Mid-Atlantic Ridge; Gebruk 2008), Rockall Trough, Porcupine Abyssal Plain (Gage *et al*. 1985), Bay of Biscay (Hérouard 1923), Gulf of Guinea (Hansen 1975), Angola Basin (Bohn 2006) and the Azores (Hérouard 1902).

Depth: 1,520–5,600 m (Hansen 1975); AZO: 5,005 m (Hérouard 1902).

Habitat: benthopelagic (preferential swimmer; Gebruk *et al*. 1997); on soft sediments (mud; Hansen 1975).

Larval stage: lecithotrophic (Tyler *et al.* (1985a).

Remarks: Hérouard (1899, 1902) described *Scotoanassa translucida*, based on specimens collected by *Princesse Alice* between the Azores and the European continent, at a station located in the easternmost waters of the archipelago (sta 749: 39°54'00"N, 21°06'45"W, 5,005 m). Later, Hansen (1975) established the synonymy of Hérouard's species with the Pacific *P. diaphana* (Théel, 1882). This species is a benthopelagic animal that spends a considerable amount of time in the water column (Miller & Pawson 1990). Gebruk *et al*. (1997) described juveniles taken about 10 to 200 m above the seabed, at a depth from 4,031 to 4,565 m. The great difficulty of sampling benthopelagic holothurians at great depths could be the reason for its somewhat sparse distribution in the Atlantic, particularly in the Azores, where only a single tow from about 5,000 m depth delivered specimens of *P. diaphana*.

Peniagone longipapillata Gebruk, 2008

Reports for the Azores:
Peniagone longipapillata $Gebruk, 2008: 56–58, figs. 1B, 9–10; Gebruk *et al*. 2014: 162.

Type locality: Mid-Atlantic Ridge, north of the Azores waters (43°01'N, 28°33'W).
See: Gebruk (2008); Rogacheva *et al*. (2013: 606–608, figs. 12K–M, 17O, 18F, G, P).

Occurrence: Northeast Atlantic, on the Mid-Atlantic Ridge from the Charlie-Gibbs Fracture Zone to the north of the Azores (Gebruk 2008) and eastwards to the Whittard Canyon and Porcupine Seabight (Rogacheva *et al*. 2013).

Depth: 2,272–3,500 m (Rogacheva *et al*. 2012, 2013); AZO: 2,954–3,050 m (Gebruk 2008).

Habitat: frequent swimmer (benthopelagic; Rogacheva *et al*. 2013).

Remarks: Gebruk (2008) recently reported specimens belonging to *Peniagone longipapillata* among the material taken in northern Azorean waters (*G.O. Sars*, *MAR–ECO*, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m; sta 46/372: 42°46'N, 29°16'W; 3,005–3,050 m). This holothurian was observed swimming for the first time by Rogacheva *et al*. (2012) and classified by these authors as a frequent swimmer, though spending most of its time feeding on the sea floor.

Peniagone marecoi Gebruk, 2008

Reports for the Azores:
Peniagone marecoi $Gebruk, 2008: 54–56, figs. 7–8; Gebruk *et al*. 2014: 162.

Type locality: Mid-Atlantic Ridge, Azores (42°46'N, 29°16'W).

See: Gebruk (2008).

Occurrence: known only from the Mid-Atlantic Ridge, from the Charlie-Gibbs Fracture Zone to the north of the Azores (Gebruk 2008).

Depth: 1,702–3,505 m (AZO: 2,063–3,050 m; Gebruk 2008).

Habitat: a probable benthopelagic species.

Remarks: Gebruk (2008) described *Peniagone marecoi*, based on material collected in the Mid-Atlantic Ridge, in the northern waters of the Azores EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 46/372: 42°46'N, 29°16W', 3,005–3,050 m).

Genus *Penilpidia* Gebruk, 1988

Penilpidia midatlantica Gebruk, 2008

Reports for the Azores:
Penilpidia midatlantica $Gebruk, 2008: 52–54, figs. 4–6; Rogacheva *et al*. 2013: 610–611.

Type locality: Mid-Atlantic Ridge, Azores (42°48'N, 29°38'W).

See: Gebruk (2008).

Occurrence: known only from the Mid-Atlantic Ridge, from SE of the Charlie-Gibbs Fracture Zone (Rogacheva *et al*. 2013) south to the Azores (Gebruk 2008).

Depth: 2,063–2,750 m (Gebruk 2008, Rogacheva *et al*. 2013); AZO: 2,063–2,107 m (Gebruk 2008).

Habitat: a probable benthopelagic species (Rogacheva *et al*. 2012).

Remarks: Gebruk (2008) described *Penilpidia midatlantica* based on material collected in the Mid-Atlantic Ridge, in the northern waters of the Azores EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 42/368: 42°48'N, 29°38'W, 2,063–2,107 m). Additionally, on reviewing the genus *Penilpidia* with a redescription of its type species *P. ludwigi* (Marenzeller, 1893), Gebruk *et al*. (2013) recently concluded that due to differences in ossicles composition and morphology, *P. midatlantica* should be assigned to a new genus.

Family Laetmogonidae Ekman, 1926

Genus *Benthogone* Koehler, 1895c

Benthogone rosea Koehler, 1896c

Reports for the Azores:

Benthogone rosea Koehler, 1896—$^{\$}$Hérouard 1923: 38–39; Mortensen 1927a: 363–364, figs. 215–216; Grieg 1932: 5–6; Nobre 1938: 162–163; García-Diez *et al*. 2005: 51.

Type locality: Bay of Biscay.

See: Koehler (1896c: 114–117, figs. 2, 3, 36, 37); Hansen (1975: 48–49, fig. 15).

Occurrence: cosmopolitan; in the Atlantic from Ireland (Mortensen 1927a) south to Cape Verde, including the Azores, Madeira and Canaries (Hérouard 1923, Grieg 1932); recorded elsewhere off Kenya and north of New Zealand (Hansen 1975).

Depth: 450–2,480 m (Cherbonnier 1970, Hansen 1975), common at about 2,000 m (Gage *et al*. 1985); AZO: 1,900 m (Hérouard 1923).

Habitat: epibenthic deposit-feeder on muddy sand to *Globigerina* ooze substrates (Hérouard 1923, Bisoll *et al*. 1984).

Larval stage: direct development (Tyler *et al*. 1985c).

Remarks: Hérouard (1923) identified the only known specimen from the Azores, collected by *Princesse Alice* (sta 1334: 39°30'N, 29°02'15"W, 1,900 m).

Genus *Laetmogone* Théel, 1879

Laetmogone violacea Théel, 1879

Reports for the Azores:

non *Laetmogone wyvillethomsoni* Théel, 1879—?$^{\$}$Hérouard 1902: 31–32, pl. 4, figs. 10–16;

Laetmogone violacea Théel, 1879—$^{\$}$Perrier 1902: 390–398, pl. 19, figs. 1–7; Mortensen 1927a: 361–363, figs. 213, 214; Deichmann 1930: 120–121; Grieg 1932: 5; $^{\$}$Hansen 1975: 58–61, figs. 21–22, pl. 8, fig. 8, pl. 9, figs. 9–10; Pérez-Ruzafa *et al*. 1992a: 171; García-Diez *et al*. 2005: 52.

Type locality: South Pacific Ocean.

See: Perrier (1902); Hansen (1975).

Occurrence: cosmopolitan, present in the Atlantic, Pacific and Indian Oceans; from Greenland and Iceland (Heding 1942) south to Cape Verde (Hérouard 1923), including the archipelagos of the Azores (Perrier 1902).

Depth: 225–1,804 m (Hansen 1975); AZO: 1,442–?1,550 m (Hérouard 1902, Perrier 1902).

Habitat: epibenthic deposit-feeder on soft sediments, muddy sand to mud (Hérouard 1923, Hanse 1975).

Larval stage: lecithotrophic (Tyler *et al*. (1985c).

Remarks: Perrier (1902) identified *L. violacea* among the material collected by *Talisman* in the NE Atlantic, including specimens from the Azores (sta 121, 1883: 37°35'N, 29°25'46"W, 1,442 m). During the same year, Hérouard (1902) described another species of the same genus from Azorean waters, the Antarctic *Laetmogone wyvillethomsoni* (*Princesse Alice*, sta 683: 38°20'N, 28°04'45"W, 1,550 m). Historically, *L. violacea* has been confused with *L. wyvillethomsoni*. Hansen (1975) considered that *L. wyvillethomsoni* was restricted to the Southern Ocean and Antarctica waters and all historical reports from the Atlantic (*e.g.,* Koehler 1896c; Grieg 1932) would prove to be misidentifications with closely similar species such as *L. violacea*. However, when Hansen re-examined the material assigned to *L. wyvillethomsoni* dredged by *Princesse Alice* in the Azores, the author believed that it belonged to a new species. Unfortunately, the poor preservation and the small number of specimens that constituted *Princesse Alice*'s material did not allow Hansen to further provide a clear identification. No other specimens sharing the characteristics of *Princesse Alice* material were reported again and the matter is still unresolved. Nevertheless, some authors like García-Diez *et al*. (2005) have placed the record of *L. wyvillethomsoni* by Hérouard in the synonymy of *L. violacea*.

Family Psychropotidae Théel, 1882

Genus *Benthodytes* Théel, 1882

Benthodytes gosarsi Gebruk, 2008

Reports for the Azores:

Benthodytes gosarsi $^{\$}$Gebruk, 2008: 49–52, figs. 1A, 2–3; Rogacheva *et al*. 2013: 598–599, fig. 17E; Gebruk *et al*. 2014: 160.

Type locality: Mid Atlantic Ridge, Azores (42°55'N, 30°20'W).

See: Gebruk (2008); Rogacheva *et al*. (2012: 217, figs. J–L; 2013: 598–599, fig. 17E).

Occurrence: North Atlantic, Mid-Atlantic Ridge from Iceland south to the Azores (Gebruk 2008, Rogacheva *et al*. 2013).

Depth: 2,238–3,680 m (Rogacheva *et al*. 2013); AZO: 2,954–2,968 m (Gebruk 2008).

Habitat: occasional swimmer (benthopelagic), on soft substrates (Gebruk 2008, Rogacheva *et al*. 2012).

Remarks: Gebruk (2008) described *Benthodytes gosarsi*, based on specimens collected by *G.O. Sars* (*MAR–ECO* expedition) in the northern-most waters of the Azorean EEZ. More recently, Rogacheva *et al*. (2012) observed *in vivo* animals belonging to this species swimming above the sea-floor in the area of the Charles-Gibbs Fracture Zone, north of the Azores. These authors inferred that *B. gosarsi* is deposit-feeder that rarely swims and does so usually as a response to local disturbances or to travel to a different location on the sea floor.

Benthodytes janthina Marenzeller, 1892

Reports for the Azores:

Benthodytes janthina $^{\$}$Marenzeller, 1892: 66, 1893: 10–11, pl. 1, fig. 3, pl. 2, fig. 4; Perrier 1902: 275; Mortensen 1927a: 373; García-Diez *et al*. 2005: 52.

Type locality: North of the Azores (41°40'41"N, 26°44'09"W).

See: Marenzeller (1893).

Occurrence: known only from the type specimen collected in the northern waters of the Azores.

Depth: 2,870 m (AZO; Marenzeller 1893).

Habitat: soft bottoms (clayish sand; Marenzeller 1893).

Remarks: Marenzeller (1892, 1893) described *Benthodytes janthina*, based on a single specimen collected by *Hirondelle*, roughly 160 miles north of Terceira Island. The specimen lacked complete information on important diagnostic characters, such as the ossicles that were broken and partially dissolved. Nevertheless, *B. janthina* was later recorded from several localities in the NE Atlantic, from Greenland (Heding 1942) to Cape Verde (Hérouard 1923). Hérouard (1902) attempted to complete Marenzeller's initial description based on individuals collected by *Princesse Alice*, which included material dredge within Azorean waters (sta 673: 37°51'00"N, 26°53'45"W, 2,252 m). Hansen (1975) reviewed these reports and concluded that they resulted from confusion with other *Benthodytes* species, such as *B. typica*. As a result, *B. janthina* was again reduced to the type specimen. Furthermore, Hansen (1975) commented that due to the poor preservation state of the holotype it was not possible to review the species' status and its affinities. On studying deep-sea material from the Porcupine Abyssal Plain (SW Ireland), Billett (1988) believed that both *B. janthina* and *B. lingua* Perrier, 1896b were junior synonyms of the Indo-Pacific *B. sordida* Théel, 1882, dismissing many of the diagnostic characters as individual variation or a result of the preservation process (*e.g.,* shrinkage and retraction, loss of colour, absence of ossicles). Recently, Rogacheva *et al*. (2009) considered *B. sordida* to be conspecific with Indo-Pacific *B. abyssicola* Théel, 1882, and dismissed the Atlantic records as misidentifications. The matter whether Azorean *B. janthina* is conspecific with other Atlantic *Benthodytes* species (*B. lingua*?) or indeed *B. abyssicola*, is still pending on future revisions of the genus.

***Benthodytes lingua* Perrier, 1896b**

Reports for the Azores:

Pannychia glutinosa $Hérouard, 1902: 32, pl. 4, fig. 17; Perrier 1902: 286, 373; Mortensen 1927a: 360; García-Diez *et al*. 2005: 52;

Benthodytes lingua Perrier, 1896b—Deichmann 1930: 124–125; Hansen 1975: 80–82, fig. 29, pl. 9, figs. 3–5, pl. 12, figs. 2–3; Pérez-Ruzafa *et al*. 1992a: 172, fig. 1H; $Gebruk 2008: 51.

Type locality: off Morocco (30°08'00"N, 11°40'46"W).

See: Perrier (1896b: 302; 1902: 456–461, pl. 12, figs. 1–2, pl. 21, figs. 1–9); Hansen (1975); Rogacheva *et al*. (2013: 599, fig. 18B).

Occurrence: Atlantic; in the west from off the coast of New England to the Gulf of Mexico (Deichmann 1954), eastwards from Greenland (Heding 1942) and along the Mid-Atlantic Ridge in the Charlie-Gibbs Fracture Zone (Rogacheva *et al*. 2013), and from the Rockall Trough (Gage *et al*. 1985) to South Africa (Hansen 1975), including the Azores (Hérouard 1902) and Canaries (Perrier 1902).

Depth: 860–4,700 m (Rogacheva *et al*. 2013); AZO: 2,102–3,050 m (Hérouard 1902, Gebruk 2008).

Habitat: benthopelagic; soft sediments, fine sand, clay, mud to ooze (Hérouard 1902, Perrier 1902, Rogacheva *et al*. 2013).

Remarks: Hérouard (1902) described a new species, *Pannychia glutinosa*, based on a specimen of about 60 mm, collected by *Princesse Alice* in the Azores (sta 624: 38°59'00"N, 28°18'05"W, 2,102 m). Later, Deichmann (1930) assumed that Hérouard' specimen was a juvenile of *B. lingua* and synonymised the two species, an opinion shared by later authors. Recently, Gebruk *et al*. (2008) identified animals belonging to *B. lingua* in waters north of the islands (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m; sta 46/372: 42°46'N, 29°16'W, 3,005–3,050 m) substantiating the presence of this species in the archipelago.

***Benthodytes sanguinolenta* Théel, 1882**

Reports for the Azores:

Benthodytes sanguinolenta Théel, 1882—$Gebruk 2008: 51.

Type locality: off the coast of Chile, Pacific.

See: Hansen (1975: 94–96, pl. 3, figs. 1–4, pl. 4, figs. 1–4, pl. 5, figs. 1–4, pl. 6, figs. 1–4, pl. 9, figs. 6–7, pl. 12, figs. 4–5).

Occurrence: cosmopolitan, Atlantic and Indo-Pacific (Hansen 1975); reported in the Puerto Rico Trench, off the Bahamas (Miller & Pawson 1990) and in the Charlie-Gibbs Fracture Zone to north of the Azores (Gebruk 2008).

Depth: 768–7,250 m, mostly below 2,000 m (Hansen 1975); AZO: 2,954–2,968 m (Gebruk 2008).

Habitat: facultative swimmer (Miller & Pawson 1990), on sandy clay to *Globigerina* ooze (Hansen 1975).

Remarks: Gebruk (2008) recently identified *Benthodytes sanguinolenta* among the material collected at the northern border of the Azorean EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m). During the EMEPC (2009), ROV *Luso* has captured footage of a *Benthodytes* holothurian, likely to belong to *B. sanguinolenta* near the Hirondelle Seamount (sta L09D21: 37°56’11”N 26°10’32”W, 3,236 m; Fig. 33).

FIGURE 33. An elasipodid in the Azorean deep-waters, most probably belonging *Benthodytes sanguinolenta* Théel, 1882 (EMEPC–LUSO 37°56'11"N, 26°10'32"W, 2009.10.08, 3,236 m).

Benthodytes typica Théel, 1882

Reports for the Azores:

Benthodytes typica Théel, 1882—?$Marenzeller 1892: 66, 1893: 12; Perrier 1902: 274, 456; Mortensen 1927a: 273, fig. 221; Deichmann 1930: 123–124; Grieg 1932: 10, fig. 8, pl. 3, figs. 6–7; Nobre 1938: 170; $Sibuet 1972: 123; $Hansen 1975: 89–93, fig. 36, pl. 1, figs. 1–4, pl. 2, figs. 1–4; Pérez-Ruzafa *et al*. 1992a: 172–173; García-Diez *et al*. 2005: 52; $Gebruk 2008: 51;

Benthodytes glutinosa Perrier, 1896b—Perrier 1900: 119; Mortensen 1927a: 374; Grieg 1932: 10–11, pl. 3, figs. 1–2; non *Benthodytes janthina* Marenzeller, 1892—$Hérouard 1902: 30 [misidentification].

Type locality: Gulf of Cadiz (35°47’N, 8°23’W).

See: Théel (1882: 103–104, pl. 27, fig. 7, pl. 35, fig. 4, pl. 38, fig. 5, pl. 44, fig. 8); Hansen (1975).

Occurrence: cosmopolitan, present in the Pacific, Indian and Atlantic Oceans (Hansen 1974); from Nantucket to the Gulf of Mexico and the Caribbean (Deichmann 1954), in the east from the Porcupine Abyssal Plain (Grieg 1932) south to the Azores (Perrier 1902), Canaries and ?Cape Verde (Hérouard 1923).

Depth: 1,873–4,700 m, though reported at depths as shallow as 315 m (Hansen 1975); AZO: 2,063–3,300 m (Gebruk 2008)).

Habitat: benthopelagic (juveniles only, Hansen 1975); deposit feeder on muddy sediments (Bisoll *et al*. 1984).

Larval stage: produces large eggs (up to 3 mm; Hansen 1975), possibly indicative of a direct development.

Remarks: *Benthodytes typica* is a highly variable species (Hansen 1975) rarely recovered in good conditions, mostly just 'broad muscle bands and some shreds of skin' (Deichmann 1954). Marenzeller (1893) reported this species to the Azores for the first time, based on two specimens collected by *Hirondelle* (sta 248: 41°40'41"N, 26°44'9"W, 2,870 m). However, the author left his identification as uncertain due to the incomplete and deteriorated state of the animals. Perrier (1900) mentioned the Azores as the type locality for *B. glutinosa* (= *B. typica*), though the material came from two *Talisman* stations located in the Mid-Atlantic Ridge area, about 400 to 600 miles south of the Azores (see Perrier 1902). Hérouard (1902, 1923) reported *B. janthina* among the material dredged by *Princesse Alice*, which included individuals collected within Azorean waters (sta 673: 37°51'00"N, 26°53'45"W, 2,252 m). Hansen (1975) re-examined *Princesse Alice* material and concluded that the specimens were quite different from *B. janthina* type material but strikingly similar to *B. typica*. Sibuet (1972) identified four animals collected by the bathyscaphe *Archimède* at stations west and east of Santa Maria Island, between 2,500–3,300 m depths. More recently, Gebruk *et al*. (2008) identified specimens belonging to *B. typica* at several stations located in waters north of the islands substantiating the presence of this species in the archipelago.

***Benthodytes valdiviae* Hansen, 1975**

Reports for the Azores:

Benthodythes aff. *valdiviae* Hansen, 1975—$Gebruk 2008: 50;
Benthodytes valdiviae Hansen, 1975—Gebruk *et al.* 2014: 159–160.

Type locality: off Western Sahara (24°35'N, 17°05'W).

See: Hansen (1975: 82–84, figs. 30–31).

Occurrence: Atlantic, known from off the coast of the Western Sahara, off south-western Cape (South Africa ; Thandar 1999) and north of the Azores (Gebruk 2008).

Depth: 2,480–3,050 m (Hansen 1975, Gebruk 2008); AZO: 3,005–3,050 m (Gebruk 2008).

Remarks: the poorly known holothurian *Benthodytes valdiviae* was identified by Gebruk (2008) among the material collected in the northernmost waters of the Azorean EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 46/372: 42°46'N, 29°16'W, 3,005–3,050 m).

Genus *Psychropotes* Théel, 1882

***Psychropotes depressa* (Théel, 1882)**

Reports for the Azores:

Euphronides talismani $Perrier, 1902: 441–444, pl. 20, fig. 15; $Hérouard 1902: 30–31, pl. 2, figs. 19–22; Mortensen 1927a: 375; Deichmann 1930: 129;
Psychropotes depressa (Théel, 1882)—$Hansen 1975: 106–111, figs. 43–44, pl. 7, figs. 1–3, pl. 12, fig. 8, pl. 14, figs. 1–2; García-Diez *et al*. 2005: 52; $Gebruk 2008: 50, 51.

Type locality: Gulf of Cadiz (35°47'N, 8°23'W).

See: Hansen (1975); Rogacheva *et al*. (2013: 599, figs. 17F–G).

Occurrence: cosmopolitan, in the Pacific and Atlantic; from off the coast of the United States (*c.* 40°N) south to the Gulf of Mexico and the Caribbean (Deichmann 1930, Hansen 1975), eastwards off Iceland (Hansen 1975) and the Charlie-Gibbs Fracture Zone south along the Mid-Atlantic Ridge to the Azores (Gebruk 2008) and from the Rockall Trough (Gage *et al*. 1985) south to the Gulf of Guinea (Hansen 1975), including the Canaries (Perrier 1902).

Depth: 957–4,060 m (Hansen 1975); AZO: 2,063–3,050 m (Gebruk 2008).

Habitat: benthopelagic (Rogacheva *et al*. 2012); soft sediments (Perrier 1902).

Larval stage: direct (Tyler & Billett 1987).

Remarks: Perrier (1896b, 1902) described *Euphronides talismani*, based on a poorly preserved individual collected by *Talisman* in Azorean waters (sta 129, 1883: 38°00'00"N, 27°02'46"W, 2,220–2,155 m). Hansen (1975) re-examined the holotype and established the synonymy with *P. depressa*. Recently, Gebruk (2008) identified specimens at several stations on the north border of the Azorean waters, further substantiating the presence of this cosmopolitan species in the archipelago. Additionally, both juveniles and adults of *P. depressa* are known to occasionally swim when disturbed or to change locations on the sea floor (Gebruk *et al*. 1997; Rogacheva *et al*. 2012).

Psychropotes longicauda **Théel, 1882**

Reports for the Azores:

Psychropotes grimaldii $Hérouard, 1896: 164, fig. 2, 1902: 25–27, pl. 3, figs. 1–2; Perrier 1902: 276; Mortensen 1927a: 376; Deichmann 1930: 130; García-Diez *et al*. 2005: 52;
Psychropates fucata Perrier, 1900: 119;
Psychropotes longicauda Théel, 1882—$Hansen 1975: 115–126, figs. 49–54, 118, pl. 7, figs. 4–6, pl. 12, fig. 7; $Gebruk 2008: 50, 51.

Type locality: Pacific (53°55'S, 108°35'E).

See: Hansen (1975).

Occurrence: cosmopolitan, present in the Atlantic, Pacific, Indian and Southern Oceans (Hansen 1975); from the Rockall Trough (Gage *et al*. 1985) and SE of the Charlie-Gibbs Fracture Zone (Gebruk 2008) south to southern Africa and Antarctic waters (Hansen 1975), including the Azores (Hérouard 1902).

Depth: 2,210–5,173 m (Hansen 1975); AZO: 2,954–4,020 m (Hérouard 1902, Gebruk 2008).

Habitat: benthopelagic (juveniles only; Miller & Pawson 1990); on muddy sediments (Perrier 1902).

Larval stage: direct (Tyler & Billett 1987).

Remarks: *Psychropotes longicauda* is a highly variable species, a fact reflected by its high number of synonyms (Hansen 1975). Historically, two of the junior synonyms were associated with Azorean waters: *P. grimaldii* by Hérouard (1896) and *P. fucata* by Perrier (1896b). The first species was known only from the type material collected by *Princesse Alice*, east of São Miguel waters (sta 527: 38°09'N, 23°15'45"W, 4,020 m). Initially, Perrier (1900) listed the Azores as the type area for the second species, but in reality the material of *P. fucata* was dredged by *Talisman* between the archipelago and the European continental shores (sta 135, 43°15'N, 21°40'W) (Perrier 1902). Regardless, on the re-examination of *P. grimaldii* and *P. fucata* Hansen (1975) remarked that the diagnostic characters found by both Hérouard and Perrier were mere individual differences and thus proposed their synonymy with *P. longicauda*. Recently, Gebruk (2008) identified *P. longicauda* from the northern border of the Azorean EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m), further substantiating the presence of this species in the archipelago.

Psychropotes semperiana **Théel, 1882**

Reports for the Azores:

Psychropotes kerhervei $Hérouard, 1902: 27–30, pl. 4, figs. 1–9; Perrier 1902: 287; Nobre 1938: 172;
Euphronides kerhervei (Hérouard, 1902)—Mortensen 1927a: 375;
Psychropotes semperiana Théel, 1882—$Hansen 1975: 102–105, figs. 41–42; Pérez-Ruzafa *et al*. 1992a: 173.

Type locality: ?South Atlantic.

See: Théel (1882: 100–101, pl. 34, figs. 10–11); Hansen (1975); Bohn (2006: 4, 10–12, figs. 2B–E, 5).

Occurrence: cosmopolitan, in Atlantic and Indian Oceans (Hansen 1975); in the Caribbean south to the Mid-Atlantic Ridge, east of Tristan da Cunha (35°41'S, 20°55'W; Théel 1882) and eastwards from the Porcupine Abyssal Plain (Gebruk *et al*. 1997) south to the Angola Basin (22°27'36"S, 03°27'54"E; Bohn 2006), including the Azores and Canaries archipelagos (Hérouard 1902, 1923).

Depth: 2,695–5,610 m (Hansen 1975, Bohn 2006); AZO: 5,005 m; Hérouard 1902).

Habitat: benthopelagic (juveniles; Gebruk *et al*. 1997); soft sediments, from sandy mud to *Globigerina* ooze (Perrier 1902, Hansen 1975).

Larval stage: direct (Tyler & Billett 1987).

Remarks: Hérouard (1902) described *Psychropotes kerhervei* based on two individuals collected by *Princesse Alice* in the easternmost waters of the archipelago (sta 749: 39°54'N, 21°06'45"W, 5,005 m). Later Hérouard (1923) identified specimens belonging to this species among the material collected by *Princesse Alice* at two further stations, one located near Tenerife (Canaries, sta 1757) and the other between the Azores and Portugal (sta 1306). Hansen (1975) re-examined animals belonging to *Psychropotes kerhervei*, including the material identified by Hérouard (1902, 1923), and established the synonymy with *P. semperiana*.

Order Holothuriida Miller *et al.*, 2017

Family Holothuriidae Burmeister, 1837

Genus *Holothuria* Linnaeus, 1767

Subgenus *Holothuria* (*Halodeima*) Pearson, 1914

Holothuria (*Halodeima*) *mexicana*? Ludwig, 1875

Reports for the Azores:

Holothuria mexicana Ludwig, 1875—?[$]Hérouard 1902: 7–8, pl. 1, fig. 16; Deichmann 1957: 9–11, figs. 21–38; Pereira 1997: 333; García-Diez *et al*. 2005: 51; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

Type locality: Gulf of Mexico.

See: Deichmann (1930: 74–76, pl. 5, figs. 15–20; 1957); Cutress (1996: 55, 63, figs. 4E–J, 7–9); Benavides-Serrato *et al*. (2012: 186–187).

Occurrence: Western Atlantic, in the Gulf of Mexico and the Caribbean (Purcell *et al*. 2012); possibly extending its distribution to the Azores (Hérouard 1902).

Depth: 0–20 m (Laguarda-Figueras *et al*. 2001); ?AZO: 98 m (Hérouard 1902).

Habitat: sand, coralligenous to rocky substrates, coral reefs, seagrass beds, sandy or rubble bottoms and mangrove habitats (Purcell *et al*. 2012).

Larval stage: planktotrophic (McEdward & Miner 2001).

Commercial value: edible (Purcell *et al*. 2012).

Remarks: Hérouard (1902) believed that the two specimens collected by *Princesse Alice* in the Azores (sta 882: 38°3'40"N, 28°34'45"W, 98 m) belonged to the tropical shallow-water species *H. mexicana*. Deichmann (1954), however, considered that the presence of *H. mexicana* in the East Atlantic was either due to mislabelling or to a recent introduction, but 'without being really established'. We are more incline to believe that it was a result of a misidentification. Hérouard (1902) described the Azorean individuals as small and poorly preserved, with the calcareous ring partially dissolved, a particularity that could explain the absence of ossicles in the specimens, *i.e.* most probably dissolved by the used preservation medium. In the absence of diagnostic characters, the identification by Hérouard rested entirely on the colour pattern. He remarked on the small brown spots covering the dorsal side, which can be found in a number of holothurians species present in the NE Atlantic, including the Azores. In contrast, adults of *H. mexicana* typically have a black or dark brown upper side and light coloured under side, occasionally totally black or with brown spots ventrally and pale dorsally (Deichmann 1930, 1954, 1957). Cutress (1996) described a colour pattern in small juveniles belonging to this species similar to what was observed by Hérouard. However, Cutress also noted that by the time juveniles reach 20 mm, the brown flecks already started to coalesce forming irregular dark patches. Hérouard did not mention the precise size of the second specimen, but the illustration given (pl. 1, fig. 1) was of a specimen of about 70 mm TL when alive (30 mm TL after preservation). Thus, the colour pattern as presented in this specimen does not support Hérouard identification as an animal at this size should have had a more solid colour pattern closer to what is observed in a typical *H. mexicana* adult. Furthermore, *H. mexicana* is a strictly shallow-water species, with a maximum reported depth of 20 m, which places the Azorean specimens outside its maximum depth range. Though, the small size of the *Princesse Alice* specimens and the destruction of main diagnostic characters make the identification of the specimens virtually impossible, the colour pattern and depth may offer some clues. For example, comparing the description and illustration presented by Hérouard with the one presented by Marenzeller (1893) for *H. lentiginosa* the two seem strikingly similar. The later was described based on a single specimen dredged by *Hirondelle* near Pico and Faial islands.

Subgenus *Holothuria* (*Holothuria*) Linnaeus, 1767

Holothuria (*Holothuria*) *mammata* Grube, 1840

(Fig. 34)

Reports for the Azores:

non *Holothuria tubulosa* Gmelin, 1791—$Nobre 1924: 89, 1930: 23, 70 [misidentification]; Nobre 1938: 143–144, figs. 58.1, 69.1 [based on Nobre 1924, 1930]; $Marques 1983: 4, fig. 8 [misidentification]; Pereira 1997: 333 [based on previous misidentifications]; $Morton *et al*. 1998: 98, 169, figs. 5.2T, 8.8R [misidentification]; $Wirtz 2009: 46 [misidentification]; Micael & Costa 2010: 323 [based on previous misidentifications]; $Micael *et al*. 2010: 329 [misidentification]; Micael *et al*. 2012: 4 [based on previous misidentifications];

non *Holothuria dakarensis* Panning, 1939—$Rowe 1969: 153, 154 [misidentification]; Pérez-Ruzafa *et al.* 1992b: 154–155, 1999: 57, 2002: 287–288 [based on Rowe 1969];

Holothuria mammata Grube, 1840—?$Pawson & Shirley 1977: 915, 919; $Borrero-Pérez *et al*. 2009: 51–69, figs. 1–7, 2010: 900, 2011: 1–12, figs. 1–4.

Type locality: Mediterranean Sea.

See: Tortonese (1965: 57, fig. 18); Borrero-Pérez *et al*. (2009).

Occurrence: Northeast Atlantic and the Mediterranean Sea, from south of Portugal to the Azores, Madeira, Selvagens and Canaries (Borrero-Pérez *et al*. 2009).

Depth: 0–77 m (Perrier 1902, herein); a common presence in the low intertidal and infralitoral of the Azorean shores.

Habitat: sand, mud, gravel to hard substrata, on sea-grass prairies and in large tide-pools (Hérouard 1923, Pérez-Ruzafa *et al.* 1992b, 2002).

Larval stage: planktotrophic (Domínguez-Godino *et al*. 2018).

Commercial value: edible (Borrero-Pérez *et al*. 2009).

Material examined: DBUA-ECH 394 (Poços, São Vicente, SMG, AZO, *c.* 37°50'06"N, 25°40'10"W, 1996.07.17, 13 m; 1 spm, TL = *c.* 200 mm); DBUA-ECH 397 (Lajes, PIX, AZO, 38°23'22"N, 28°15'04"W, 2010.09.24, 1–2 m; 10 spms, TL = 109–230 mm); DBUA-ECH 406 (Santa Cruz, FLS, AZO, 39°27'17.79"N, 31°07'30.48"W, 2011.04.23, intertidal; 14 spms, TL = 80–330 mm).

Description: body cylindrical, flattened ventrally. Tegument smooth, not thick. Mouth subventral and anus terminal. Dorsal surface with large mammillate papillae organized in six irregular longitudinal rows. Presence of a collar of small oral papillae. Ventral surface with tube-feet organized more or less in three longitudinal series (middle one somewhat subdivided in two). Most animals eviscerated. Cuvierian tubules inconspicuous. Table discs spinose, arched and somewhat reduced; tables with tetrabasal spires, of moderate height, crowded by acicular spines. Buttons, thick with a rugose appearance, covered by numerous small pointed knobs and with three or more pairs of small holes. Colour: uniform dark brown.

Remarks: in general, *H. mammata* can be easily distinguished from other shallow-water *Holothuria* species known to occur in the Azores by their inability to eject Cuvierian tubules (see remarks under *H. sanctori*). Among the sea cucumbers inhabiting the Azorean shallow waters, *H. mammata* differs also by its well developed spinose ossicles. Though closely resembling Mediterranean *H. tubulosa*, this species is distinct by the presence of a Cuvierian organ, relatively larger dorsal papillae and relatively larger tables (Rowe 1969).

Holothuria mammata is one of the most common elements of the Azorean shallow-water biota, particularly in relatively protected bays both natural (*e.g.,* natural lagoon in Lajes, Pico Island; Ávila *et al*. 2011) and manmade (*e.g.,* port of Ponta Delgada, São Miguel Island; *personal observation*). However, it was only in 2009 that this species was identified with certainty in the archipelago by Borrero-Pérez and co-workers. Historically, *H. mammata* was frequently confused with a closely similar species from the Mediterranean Sea, *H. tubulosa* (Gmelin 1791). Both species present a high degree of morphological variability, and in some cases the individuals may present intermediate diagnostic characters. Borrero-Pérez *et al*. (2009) showed that Atlantic records of *H. tubulosa* were a result of misidentifications with *H. mammata*, given that the former is restricted to the Mediterranean Sea. Thus, historical reports of *H. tubulosa* from the Azores should be considered as *H. mammata*. Another similar species, *H. dakarensis* Panning, 1939, was at one time included in the Azores echinoderm fauna by Rowe (1969). Pawson & Shirley (1977) believed that Rowe based his statement on specimens from Faial Island, deposited in the collection of the British Natural History Museum. On re-examination of this material, the authors concluded the animals belonged either to *H. mammata* or *H. tubulosa*. As the latter is restricted to the Mediterranean Sea these specimens are more likely to belong to *H. mammata*. Furthermore, Borrero-Pérez *et al*. (2009) also showed that in the Eastern Atlantic *H. dakarensis* is restricted to southern latitudes along the African coasts, from Senegal and Cape Verde to Angola.

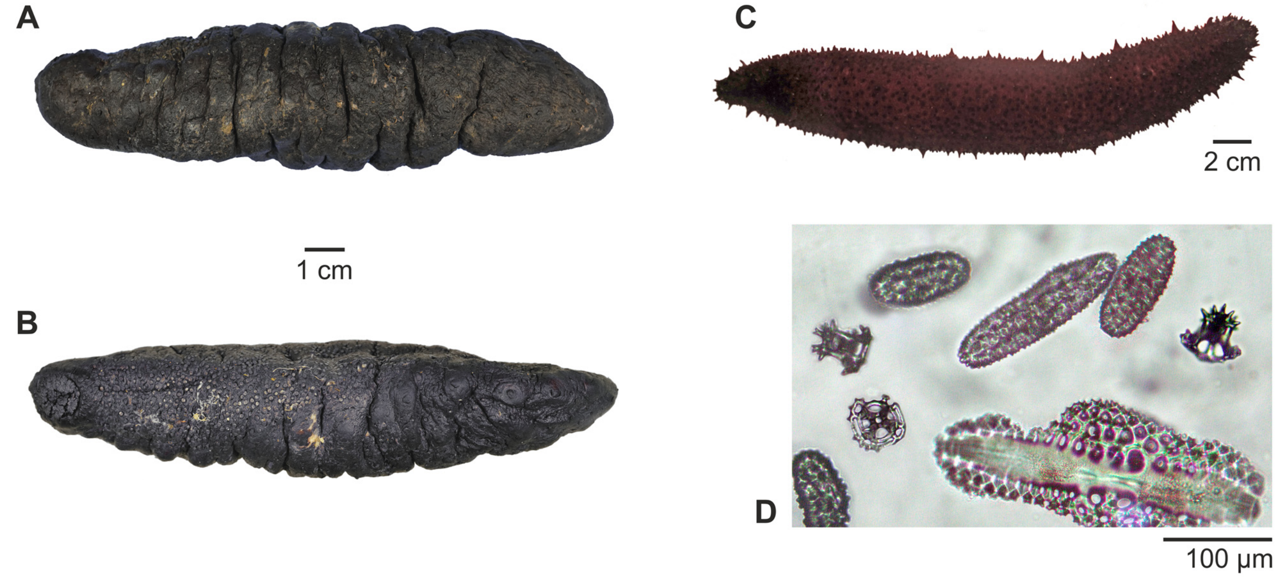

FIGURE 34. *Holothuria* (*Holothuria*) *mammata* Grube, 1840 (DBUA-ECH 397: A, B, D; DBUA-ECH 406: C). Dorsal view (A); ventral view (B); specimen, when alive (C).

Subgenus *Holothuria* (*Panningothuria*) Rowe, 1969

Holothuria (*Panningothuria*) *forskali* Delle Chiaje, 1823
(Fig. 35)

Reports for the Azores:
Holothuria forskali Delle Chiaje, 1823—[$]Marques 1983: 4, fig. 6; Pereira 1997: 333; [$]Morton *et al.* 1998: 98, 169, figs. 5.2T, 8.8R; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

See: Koehler (1921b: 179–180, fig. 135); O'Loughlin *et al*. (2007).

Occurrence: Mediterranean Sea and northeast Atlantic, from Scandinavia south to the coast of Morocco (Hérouard 1929, Tortonese 1965, Rowe 1969), including the Azores (Marques 1983), Madeira (Bianchi *et al*. 1998) and Canaries (Pérez-Ruzafa *et al*. 1992b).

Depth: 0–850 m (Koehler 1921b, Mecho *et al*. 2014); AZO: 0–12 m (herein).

Habitat: soft to hard substrata and among algae and seagrass beds (Pérez-Ruzafa *et al*. 1992b, Morton *et al*. 1998).

Larval stage: probably planktotrophic (inferred from the genus, see McEdward & Miner 2001).

Material examined: DBUA-ECH 392 (in front of the Marina, Ponta Delgada, SMG, AZO, *c.* 39°00'44"N, 27°57'28"W, 1997.04.18, 12 m; 1 spm, TL = 82 mm); DBUA-ECH 393 (Cerco, Caloura, SMG, AZO, 37°42'26"N, 25°30'37"W, 1996.07.13, intertidal; 1 specimen, TL = 92 mm); DBUA-ECH 398 [Capelas (Morro), SMG, AZO, *c.* 37°50'37"N, 25°41'18"W, 1996.05.26, 9 m; 1 spm, TL = 165 mm]; DBUA-ECH 434 (Horta harbour, FAY, AZO, *c.* 38°31'51"N, 28°37'23"W, 2011.03.11, 6 m; 1 spm, TL = 65 mm).

Description: body almost cylindrical, flattened ventrally. Body wall relatively thick. Epidermis smooth and very delicate. Mouth subventral surrounded by a crown of 20 peltate tentacles (cauliflower-like). Well-developed conical papillae irregularly arranged dorsally and laterally; presence of a collar of small oral papillae. Ventral surface with numerous tube feet in four rows. Well developed Cuvierian tubules. Calcareous deposits scarce, mostly composed of much reduced tables (<50 μm) with four holes; buttons absent; tube-feet and papillae also with elongate, irregularly branched rods; the tentacles with curved rods. Colour (*in ethanol*): solid deep brown to black bivium (papillae the same colour as the body) and trivium slightly lighter. Colour (*in vivo*; DBUA-ECH 434): body deep brown with or without white papillae tips.

Remarks: *Holothuria forskali* can be distinguished *in situ* based on gross morphology characters, such as the very dark brown to black body colour with white papillae (although not always visible) and the presence of well developed Cuvierian tubules (Koehler 1921b). In the Azores, neither the dark colour nor the presence of Cuvierian tubules are exclusive to this sea cucumber. *Holothuria sanctori*, which is known as well to eject Cuvierian tubules if disturbed, shows an extraordinary degree of variability in its colour pattern: from dark brown or black body to a blackish ventral surface with an almost bright yellow dorsum on which the yellow rings can become so numerous that it is hard to perceive the dark background (Fig. 36). Intermediate colour forms in *H. sanctori* can present less conspicuous yellow (almost white) rings that could be confused with the white papillae described for *H. forskali*.

In the characterization of the marine coastal biota of the Azores, Morton *et al*. (1998) illustrated just two species of sea cucumbers, *H. mammata* (under the name *Holothuria tubulosa*) and *H. forskali*. They noted that the later species was a conspicuous presence in certain areas, such as tide-pools and marine lagoons. They also added that this species has the particularity of readily ejecting Cuvierian tubules when disturbed. We believe that Morton *et al*. (1998) may have overlooked the presence of *H. sanctori* in the studied areas. In the Azores, *H. sanctori* can be quite abundant in areas of relatively low hydrodynamism, reaching at times spectacular densities like these observed by Pérez-Ruzafa *et al*. (1992b) for the Canaries.

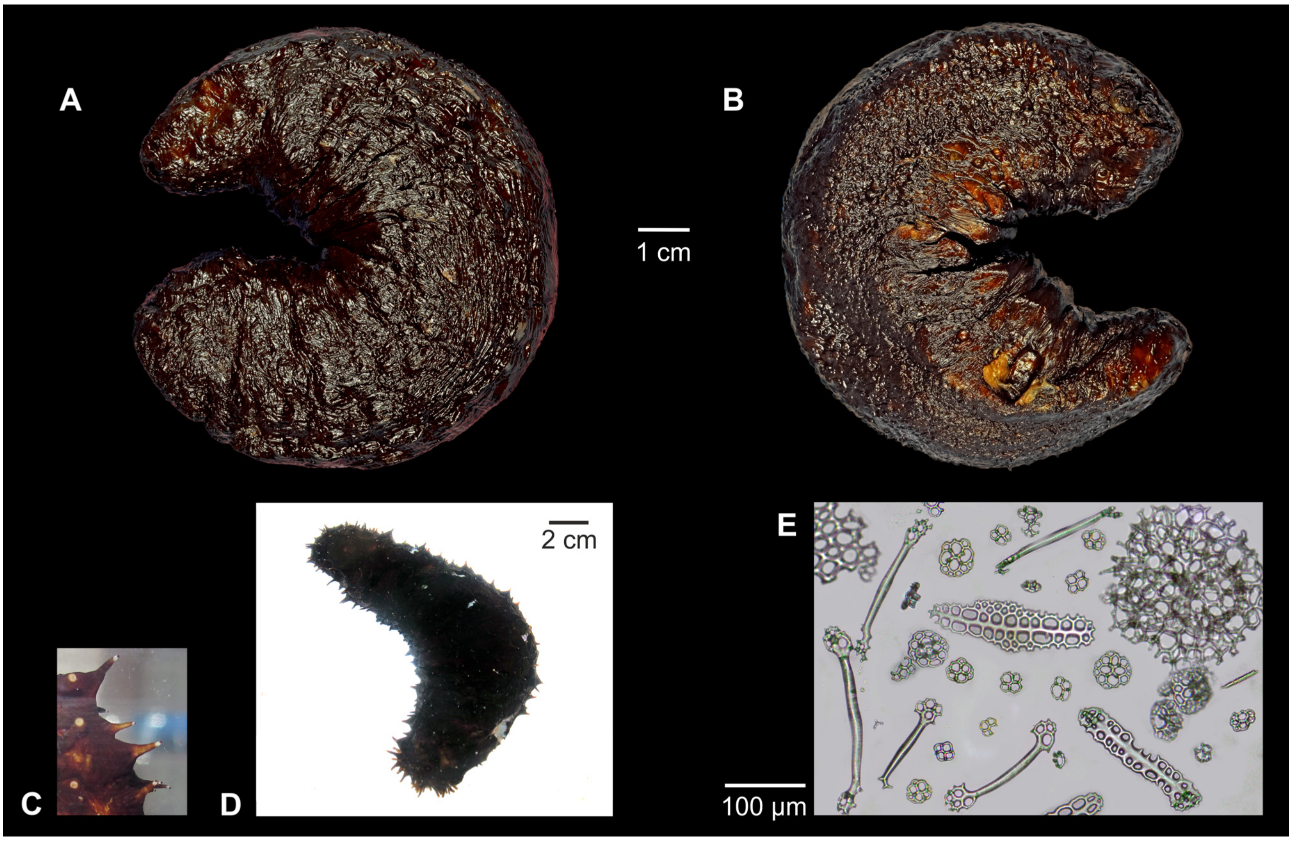

FIGURE 35. *Holothuria* (*Panningothuria*) *forskali* Delle Chiaje, 1823 (DBUA-ECH 398: A, B, E; DBUA-ECH 434: C, D). Dorsal view (A); ventral view (B); detail of the papillae (C); specimen, when alive (D); ossicles (E).

Subgenus *Holothuria* (*Platyperona*) Rowe, 1969

Holothuria (*Platyperona*) *sanctori* Delle Chiaje, 1823

(Fig. 36)

Reports for the Azores:

Holothuria farcimen $^{\$}$Selenka, 1867: 330, pl. 18, fig. 65; Théel 1886a: 220; $^{\$}$Perrier 1899: 299, 1902: 477–481, pl. 15, figs. 15–27;

Holothuria Sanctori Delle Chiaje 1823—$^{\$}$Barrois 1888: 112; $^{\$}$Koehler 1921b: 171–174, figs. 127–128; $^{\$}$Chapman 1955: 398; Tortonese 1965: 61–62, figs. 21A, 22; Pawson 1978: 27, figs. 11j, l; $^{\$}$Marques 1983: 4, fig. 7; Pérez-Ruzafa *et al*. 1992b: 150–151; Pereira 1997: 333; Pérez-Ruzafa *et al*. 1999: 55–56, 2002: 287; Micael & Costa 2010: 323; $^{\$}$Micael *et al*. 2010: 329; Micael *et al*. 2012: 4.

Type locality: Naples, Mediterranean Sea.

See: Koehler (1921b); Borrero-Pérez *et al*. (2009, 2010).

Occurrence: Mediterranean Sea and northeast Atlantic, from the Bay of Biscay (Koehler (1921b) to Saint Helena (Mortensen 1933c) and Ascension islands (Mortensen 1933c), including the Azores (Marques 1983), Madeira (Théel 1886a), Selvagens (Ruzafa *et al*. 2002), Canaries (Ruzafa *et al*. 1992b) and Cape Verde (Ruzafa *et al*. 1999).

Depth: 0–30 m (Pawson 1978, Tortonese 1965); in the Azores it is a common species in the first few meters.

Habitat: hard to soft substrates, under rocks and crevices, in sea-grass prairies and tide pools (Pawson 1978, Ruzafa *et al*. 2002).

Larval stage: probably planktotrophic (inferred from the genus, see McEdward & Miner 2001).

Commercial value: edible (Sicuro & Levine 2011).

Material examined: DBUA-ECH 189 (Poços, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.16, 14–20 m; 1 spm, TL = 120 mm); DBUA-ECH 320 (in front of the Marina, Ponta Delgada, SMG, AZO, *c*. 39°00’44”N, 27°57’28”W, 1997.04.18, 12 m; 1 spm, TL = 86 mm); DBUA-ECH 396 (Lajes, PIX, AZO, *c*. 38°23’22”N, 28°15’04”W, 2010.09.24, 1–2 m; 15 spms, TL = 77–148 mm); DBUA-ECH 400 (Poços, São Vicente, SMG, AZO, *c*. 37°50’06”N, 25°40’10”W, 1996.07.17, 13 m; 1 spm, TL = 125 mm) DBUA-ECH 401 (Banco João de Castro, AZO, *c*. 38°13’18”N, 26°36’12”W, 1996.07.27, 30 m; 1 spm, TL = 205 mm); DBUA-ECH 402 (in front of the Marina, Ponta Delgada, SMG, AZO, *c*. 39°00’44”N, 27°57’28”W, 1997.04.18, 12 m; 1 spm, TL = 115 mm); DBUA-ECH 404 (Vila do Porto, SMA, AZO, *c*. 36°56’42”N 25°’08’50”W, 2011.07.22; 1 spm, TL = 105 mm); DBUA-ECH 405 (Santa Cruz, FLS, AZO, 39°27’17.79”N, 31°07’30.48”W, 2011.04.23, intertidal; 20 spms, TL = 70–190 mm).

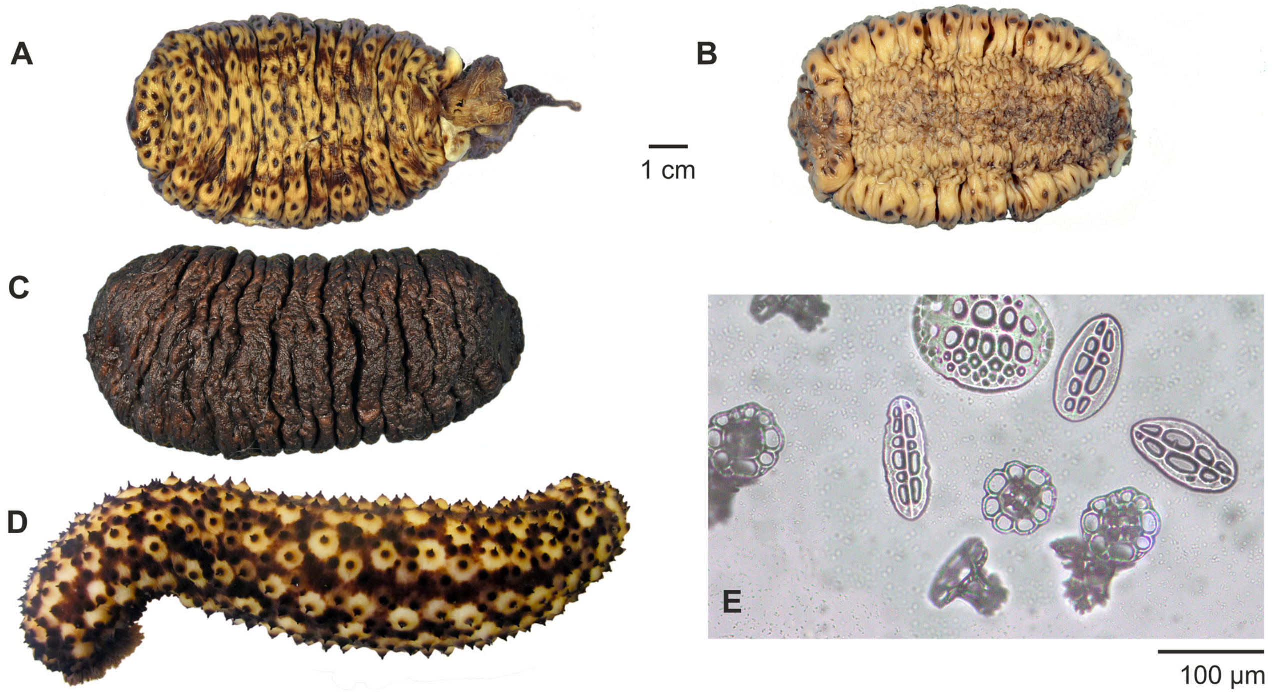

FIGURE 36. *Holothuria* (*Platyperona*) *sanctori* Delle Chiaje, 1823 (DBUA-ECH 320: A, B, E; DBUA-ECH 402: C; DBUA-ECH 405: D; DBUA-ECH 398: E). Dorsal view (A, C); ventral view (B); specimen, when alive (D); ossicles (E).

Description: body arched dorsally, flattened ventrally. Body wall thick, extremely rigid when contracted. Mouth subventral and anus terminal. Dorsal surface crowded by numerous conical (somewhat rounded) papillae. Ventral surface densely cover by tube-feet organized in almost uniform manner. Cuvierian tubules well developed; many specimens eviscerated. Both buttons and disc tables with smooth round edges. Table discs slightly undulated with four central and eight distal holes; table with tetrabasal spires of moderate height, crowned by relatively short (somewhat blunt) teeth. Buttons flat with longitudinal ridge, flanked on each side by a row of holes; a second peripheral row of minute holes occasional present. Colour: dorsal surface from solid dark brown to completely covered with yellow rings (papillae tips always dark brown); ventral surface and tentacles uniformly brown.

Remarks: in general, *H. sanctori* presents a unique colour pattern among the shallow-water holothurians known from the Azores, in having large yellow rings covering its brown dorsal surface. However, *H. sanctori* can also present a uniform dark brown colour that can be easily distinguished by having a significantly thicker and rougher skin than *H. mammata* or *H. forskali*. Additionally, *H. sanctori* also differs from these shallow-water sea cucumbers by its well developed and relatively smooth ossicles.

Selenka (1867) described *Holothuria farcimen*, based on a single individual collected in the Azores deposited in the Cambridge Museum. Barrois (1888) remarked how abundant *H. sanctori* was on the coasts of São Miguel Island. Perrier (1902) criticised Barrois's identification, since the former believed *H. sanctori* to be restricted to the Mediterranean Sea and gave a full description of the material collected by *Talisman* at Ponta Delgada (São Miguel Island) under the name *H. farcimen*. Later, Koehler (1921b) examined specimens from the Azores, including those of *Talisman* and synonymised the Azorean species with *H. sanctori*.

Holothuria sanctori, is one of the most common elements of the Azorean shallow-water biota, particularly in relatively protected bays both natural [*e.g.,* Caloura, São Miguel Island; Lajes do Pico (Ávila *et al*. 2011)] or manmade (*e.g.,* marina of Ponta Delgada, São Miguel Island), where they can reach high densities (personal observation).

Subgenus *Holothuria* (*Vaneyothuria*) Deichmann, 1958

Holothuria (*Vaneyothuria*) *lentiginosa lentiginosa* Marenzeller, 1892

(Fig. 37)

Reports for the Azores:

Holothuria lentiginosa $^{\$}$Marenzeller, 1892: 66, 1893: 6–7, pl. 1, fig. 1, pl. 2, fig. 1; Deichmann 1954: 391; Cherbonnier 1958: 371, 1965: 13–14; Rowe 1969: 151, 152; Pereira 1997: 333; Pérez-Ruzafa *et al*. 1999: 56–57, fig. 1C; García-Diez *et al*. 2005: 51;

Holothuria lentiginosa lentiginosa Marenzeller—Miller & Pawson 1979: 914–915, figs. 4C–D.

Type locality: between Faial and Pico islands, Azores (38°31'19"N, 28°34'31"W).

See: Marenzeller (1893); Tommasi & de Oliveira (1976: 81–84, fig. 6); Miller & Pawson (1979); Thandar & Mjobo (2014: 246–247, fig. 3).

Occurrence: Northeast Atlantic, from Morocco to Angola waters (Hérouard 1929, Cherbonnier 1965), including the archipelagos of the Azores (Marenzeller 1892), Canaries (Rowe 1969), ?Cape Verde (Pérez-Ruzafa *et al*. 1999) and ?Gorringe seamount; reported elsewhere in the Alboran Sea (Mediterranean Sea; Borrero-Pérez *et al*. 2010); the subspecies *H. lentiginosa enodis* Miller & Pawson, 1979 was reported from the Gulf of Mexico and Caribbean in the West Atlantic and to ?Cape Verde archipelago (Pérez-Ruzafa *et al*. 1999) in the East Atlantic; the subspecies *H. lentiginosa brasiliensis* Tommasi & de Oliveira, 1976 is reportedly restricted to the waters between São Paulo and Rio de Janeiro, in Brazil.

Depth: (?12)100–275 (?316) m (Cherbonnier 1965, Pérez-Ruzafa *et al*. 1999, herein), though the tropical subspecies *H. lentiginosa enodis* was reported from depths as shallow as 8 m (Pérez-Ruzafa *et al*. 1999) and as deep as 450 m (Miller & Pawson 1979); AZO: (?130)208–275(?316) m.

Habitat: sand, coralligenous, detritic to rock (Ruzafa *et al*. 1992b).

Larval stage: probably planktotrophic (inferred from the genus, see McEdward & Miner 2001).

Material examined: DBUA-ECH 388 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'30"N, 25°20'49"W, 2009.09.24, 208 m; 1 spm, TL = 125 mm); DBUA-ECH 389 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'30"N, 25°20'49"W, 2009.09.24, 208 m; 3 spm, TL = 120–150 mm); DBUA-ECH 391(off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'31"N, 25°20'14"W, 2011.07.15, 275 m; 1 spm, TL = 140 mm).

Description: body almost cylindrical, flattened ventrally. Body wall soft and relatively thick. Mouth subventral with 20 peltate tentacles (cauliflower-like); anal opening dorsal. On each side of the body one dorsal and one lateral longitudinal row of seven to ten well-developed large conical papillae. Lateral papillae slightly larger than the dorsal papillae. Ventral surface with numerous tube feet in three longitudinal rows, the central one divided at the mid-line. Table discs not smooth (with small external projections); table with tetrabasal spires of moderate width and height, crowned by numerous teeth. Buttons smooth, frequently contorted and with obliterated or incomplete perforations; buttons frequently with small knobs. Colour: lateral surface of the body cream white with numerous small dark brown spots (tube feet); towards the dorsal mid-line dorsal surface becomes gradually light brown (DBUA 388) or brown (DBUA 391); brown somewhat irregular and inconspicuous spots at the base of the dorsal papillae (with cream coloured tips); lateral papillae cream coloured as the body; ventrally, outer longitudinal row white with dark brown spots around the tube feet, inner row light brown with dark brown spots also around the tube feet; tentacles cream coloured.

Remarks: Marenzeller (1892, 1893) described a new species of sea cucumbers based on a partially damaged and eviscerated animal (160 mm TL) taken in Azorean waters, between Pico and Faial islands, at about 130 m deep (*Hirondelle*, sta 226). However, the accompanying echinoderms found in the same dredge indicate that the station's depth likely was much shallower than the reported 130 m (see remarks under *Pawsonia saxicola* and *Thyone inermis*). Regardless, *H. lentiginosa* was not seen in the Azores for more than 100 years. The *Third International Workshop of Malacology and Marine Biology* offered a rare opportunity to survey the least known waters of the archipelago, by dredging depths between the maximum scuba diving (≈30–60 m) and the typical depths explored by the oceanographic cruises (≥150–250 m). Two of the least known littoral holothurians were captured: *H. lentiginosa* and *Parastichopus regalis* (Cuvier, 1817) (see remarks under this species) from depths between 208 and 275 m.

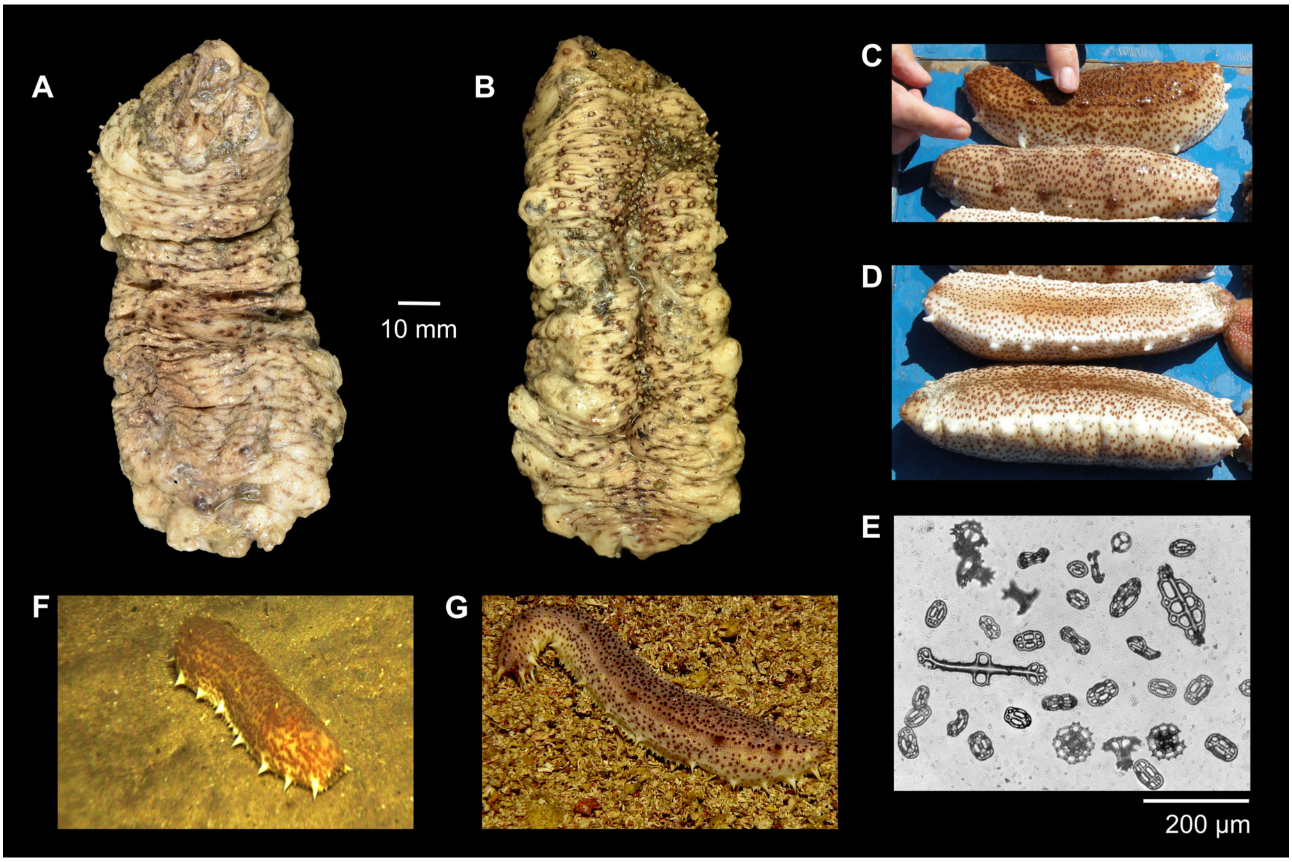

FIGURE 37. *Holothuria* (*Vaneyothuria*) *lentiginosa lentiginosa* Marenzeller, 1892 (DBUA-ECH 388: A–E). Dorsal view (A, C); ventral view (B, D); specimen, when alive (C, D); ossicles (E); holothurians most likely belonging to *H. lentiginosa in situ* in Azores (EMEPC–LUSO, 37°43'15"N, 25°48'24"W, 2009.10.08, 316 m: F) and Gorringe Bank (EMEPC–LUSO, 36°42'46"N, 11°10'02"W, 2009.09.13, 145 m: G).

The new material agrees in most aspects with the original description and illustrations by Marenzeller (1892, 1893), except for the presence of a double row of well-developed dark brown dorsal papillae in our individuals. However, the poor preservation of the type specimen could account for this small difference. In the examined material both colour and size of the dorsal papillae became quite imperceptible (retracted) during preservation (96%

ethanol) (Figs. 37A, B). Furthermore, Miller & Pawson (1979) commented that colour could be lost in preserved specimens. No greenish-yellow hue was observed in the lateral surface of the specimens, a feature observed by Cherbonnier (1958) in animals from Sierra Leone. Nevertheless, the dorsal dark spots presented by material from the Azores (Figs. 37C, D) were rather small and inconspicuous when compared with the figures presented by Miller & Pawson (1979) for *H. lentiginosa enodis*. The Azorean animals also presented a well-developed dorsolateral longitudinal row of papillae (though becoming greatly retracted during preservation), which is apparently absent in the Caribbean subspecies. This species can be easily distinguished from other sea-cucumbers belonging to this genus recorded in the archipelago by its colour pattern. For example, *H. sanctori* can present (Fig. 36D) the same colour range as this species but arranged in a quite different pattern, *i.e.* dark brown with yellowish rings in opposition to cream with small dark brown spots, respectively.

In the West Atlantic *H. lentiginosa* was divided in two subspecies: *H. lentiginosa brasiliensis* described by Tommasi & de Oliveira (1976) from south Brazilian waters and *H. lentiginosa enodis* described by Miller & Pawson (1979) to the Caribbean waters. The Brazilian subspecies was described based on colour differences, as the animals presented a darker colour with large dark dorsal blotches. The ossicles in the Brazilian subspecies agreed with Marenzeller's original description. On the other hand, the Caribbean variety was raised fundamentally on ossicle morphology differences, as Miller & Pawson (1979) considered colour differences or papillae distribution as minor variations. Surprisingly, Pérez-Ruzafa *et al.* (1999) recorded both *H. lentiginosa lentiginosa* and *H. lentiginosa enodis* from Cape Verde shallow waters (12–22 m and 8–20 m depth, respectively) without offering any description of the examined material. The new material from the Azores (type area) herein examined reinforces Miller & Pawson (1979)'s opinion that colour variation should not be used as a diagnostic character as it is subject to local variation and may not survive the preservation process. Thus, the status of the *H. lentiginosa* subspecies should be re-addressed, comparing material throughout its geographical distribution on both sides of the Atlantic. Additionally, in 2009 during the expedition by EMEPC, ROV *Luso* captured footage portraying two holothurians likely to belong to this species, one south of São Miguel Island in the Azores (L09D20R, 37°43'15"N. 25°48'24W", 316 m; see Fig. 37F) and another in Gorringe Seabank (sta L09D09L1, 36°42'46"N, 11°10'2.30"W, 145 m; see Fig. 37G).

Family Mesothuriidae Smirnov, 2012

Genus *Mesothuria* Ludwig, 1894

Mesothuria maroccana Perrier, 1898

Reports for the Azores:

Mesothuria murrayi grandipes $^{\$}$Hérouard, 1923: 15–17, pl. 4, figs. 7–9;

Mesothuria maroccana Perrier, 1898—Grieg 1932: 4, pl. 1, fig. 1; $^{\$}$Gebruk 2008: 50, 51; Gebruk *et al.* 2012: 301–303, figs. 9A, B, 10; Rogacheva *et al.* 2013: 592, fig. 17D.

Type locality: Morocco (32°04'00"N, 10°42'46"W).

See: Perrier (1902: 312–317, pl. 16, figs. 32–35); Deichmann (1930: 97–98, pl. 7, figs. 2–7); Gebruk *et al.* (2012); Rogacheva *et al.* (2013).

Occurrence: North Atlantic, from off Virginia, south to the Gulf of Mexico and the Caribbean, eastwards from the area between Greenland and Iceland to the Gulf of Gibraltar, including the Mid-Atlantic Ridge from the Charlie-Gibbs Fracture Zone to the Azores (Gebruk 2008, Gebruk *et al.* 2012).

Depth: 700–3,465 m (Gebruk 2008, Gebruk *et al.* 2012); AZO: 1,740(?1,600)–2,968 m (Hérouard, 1923, Gebruk 2008).

Habitat: muddy sand, mud to hard substrates (Hérouard 1923; Rogacheva *et al.* 2013).

Remarks: Hérouard (1923) assigned material collected in Azorean waters (*Princesse-Alice*: sta 536: 37°54'00"N, 24°43'15"W, 2178 m; *Hirondelle II*: sta 3150: 38°01'N, 25°21'W, 1,740 m) to *'Mesothuria murrayi* Théel var. *grandipes*'. On revising Hérouard's variety, Deichmann (1930) dismissed many of the diagnostic characters selected by the previous author as intraspecific or ontogenic variation. Deichmann believed that the Atlantic variety '*grandipes*' was identical with Perrier's *M. maroccana*. Later authors such as Hansen (1956) and Gebruk *et al.* (2012) agreed with Deichmann. Nevertheless, these authors stated that a future revision was essential given the limited present knowledge of these species' natural variability. Additionally, Gebruk (2008) identified the *M. maroccana* among the material taken in northern Azorean waters, further substantiating the presence of this species in the Azorean deep waters.

Mesothuria milleri Gebruk & Solís-Marín, *in* Gebruk *et al*., 2012

Reports for the Azores:
non *Holothuria verrilli* Théel, 1886b—$Marenzeller 1893: 7–9, pl. 1, fig. 2, pl. 2, fig. 2 [misidentification];
non *Allantis intestinalis verrilli* Théel, 1886b—$Hérouard 1902: 18–21, pl. 1, figs. 3–6 [misidentification];
non *Mesothuria verrilli* Théel, 1886b—$Perrier 1902: 307–312, figs. 3–4, pl. 16, figs. 22–31 [misidentification]; $Hérouard 1923: 10–13 [misidentification]; Mortensen 1927a: 381–382, figs. 224.4–5; Deichmann 1930: 93–94, pl. 6, figs. 1–8; Nobre 1938: 152; Harvey *et al*. 1988: 184; Pérez-Ruzafa *et al*. 1992b: 144; García-Diez *et al*. 2005: 51 [all these are based on previous misidentifications];
Mesothuria milleri $Gebruk & Solis-Marin, *in* Gebruk *et al*., 2012: 274–283, fig. 4; Gebruk *et al*. 2014: 170.

Type locality: Porcupine Seabight, NE Atlantic (51°31'06"N, 12°59'00"W).

See: Gebruk (2012).

Occurrence: Northeast Atlantic, from Iceland and the Rockall Trough south to West Africa, including the archipelagos of the Azores and Canaries (Gebruk *et al*. 2012).

Depth: 455–4,400 m (Gebruk *et al*. 2012), most common between 1,430 and 1,530 m (Gebruk *et al*. 2014); AZO: 1,258–2,155(?3,018) m (Gebruk *et al*. 2012).

Habitat: soft substrates (mud; Perrier 1902).

Larval stage: lecithotrophic (Gebruk *et al*. 2012).

Remarks: Gebruk *et al*. (2012: 281) reviewed the historical material identified as *M. verrilli* (Théel, 1886b) from the East Atlantic, and concluded that, due to the incomplete initial description by Théel, this Caribbean species was historically confused with other similar species, particularly with *M. intestinalis* (Ascanius, 1805). Moreover, Gebruk and co-authors found a third new species among the historical material, which they described as *M. milleri*. The re-identified specimens by Gebruk and co-workers included specimens from *Talisman* taken within Azorean waters and previously identified by Perrier (1902) as *M. verrilli*. Additionally, by examining animals of different sizes, Gebruk *et al*. (2012) characterized different ontological trends in each species ossicles, and recognized *M. milleri* in the descriptions by Marenzeller (1893) and Hérouard (1902, 1923). Both authors recorded *M. verrilli* from the Azores (see also remarks under *M. intestinalis*).

Mesothuria murrayi Théel, 1886a

Reports for the Azores:
Mesothuria murrayi (Théel, 1886)—p.p.?$Hérouard 1902: 23–24; García-Diez *et al*. 2005: 51; $Gebruk 2012: 303–307, fig. 11.

Type locality: Juan Fernandez (33°42'S, 78°18'W), Pacific.

See: Théel (1886a: 185, pl. 10, figs. 16–18, as *Holothuria murrayi*); Gebruk (2012).

Occurrence: cosmopolitan, in the Atlantic and Pacific; in the Atlantic reliable records from off Florida and the Azores (Gebruk 2012).

Depth: 245–6,650 m (AZO: ?1,660–1,940 m; Gebruk (2012).

Habitat: soft substrate (clay to ooze; Théel 1886a, Hansen 1975).

Remarks: Hérouard (1902) reported two individuals of *M. murrayi* from the archipelago, collected by *Princesse Alice* (sta 719: 39°11'N, 30°24'15"W, 1,600 m). Later, Deichmann (1930) re-examined one of the specimens and assigned it to a different species, *M. rugosa* (see below). Deichmann believed that *M. murrayi* was restricted to the Pacific waters and all Atlantic material assigned to this species would prove to be either *M. maroccana* or *M. rugosa*. However, Gebruk (2012) has recently identified *M. rugosa* in the Atlantic, including a specimen collected by *Princesse Alice* in the Azores (sta 863: 39°22'00"N, 26°55'45"W), not listed in Hérouard's (1902) report. Nevertheless, the complex taxonomy of *M. murrayi* and other closely related species such as *M. maroccana* and *M. rugosa* shows that this group of species is in need of a thorough revision.

Mesothuria rugosa Hérouard, 1912

Reports for the Azores:

p.p. *Mesothuria murrayi* (Théel, 1886)—$Hérouard 1902: 23–24;
Mesothuria rugosa Hérouard, 1912—$Deichmann 1930: 98–99, pl. 8, figs. 1–6.

Type locality: off Cape Verde (16°12'30"N, 24°43'45"W).

See: Hérouard (1912: 1–3, fig. 1; 1923: 19–21, pl. 1, figs. 11–21, pl. 2, figs. 1, 2); Deichmann (1930); Benavides-Serrato *et al*. (2012: 206); Gebruk (2012: 308–309, figs. 9, 12).

Occurrence: North Atlantic, from Caribbean waters eastwards to the Azores and Cape Verde (Hérouard 1912, Deichmann 1930).

Depth: 460–3,890 m (Benavides-Serrato *et al*. 2012); AZO: 1,600 m (Hérouard 1902).

Habitat: soft substrates (Hérouard 1902).

Remarks: Deichmann (1930) re-examined one of the two specimens collected by *Princesse Alice* southeast of Flores Island (sta 719: 39°11'00"N, 30°24'15"W, 1,600 m) and identified by Hérouard (1902) as *Mesothuria murrayi*. She compared with her specimens of *M. rugosa* from the Caribbean waters and found them to be identical. Considering the intricate taxonomy of this species together with other closely related species such as *M. maroccana* and *M. murrayi*, some authors have expressed doubts about the validity of this species (*e.g.,* Gebruk 2012). However, present knowledge on the intraspecific variation in these species is still scarce and thus an extensive revision on these species is pending.

Genus *Zygothuria* Perrier, 1898

Zygothuria lactea (Théel, 1886a)

Reports for the Azores:

Holothuria lactea $Théel, 1886a: 183–184, pl. 10, figs. 9, 15;
Mesothuria lactea Théel, 1886a—$Hérouard 1902: 21–23, pl. 1, figs. 17–19, 1923: 13–15, pl. 4, figs. 1–3; Mortensen 1927a: 382–383, figs. 226–227; Nobre 1938: 152–153; García-Diez *et al*. 2005: 51;
Zygothuria (*Holothuria*) *lactea* Théel, 1886a—Perrier 1902: 322–327, pl. 17, figs. 1–10;
Mesothuria (*Zygothuria*) *lactea* (Théel, 1886)—Benavides-Serrato *et al*. 2012: 208–209;
Zygothuria lactea (Théel, 1886)—$Gebruk 2012: 310–321, figs. 13, 14.

Type locality: off New Zealand, Pacific (37°34'S, 179°22'W).

See: Théel (1886a); Benavides-Serrato *et al*. (2012); Gebruk *et al*. (2012).

Occurrence: cosmopolitan, in the Atlantic, Pacific, Indian and Southern Oceans; in the west Atlantic reported from New England to the Gulf of Mexico and the Caribbean, in the east reported from Iceland eastwards from the Rockall Trough south to NW Africa, including the Azores, Madeira, Canaries and Cape Verde (Perrier 1902, Hérouard 1923, Gebruk *et al*. 2012); reported elsewhere in the South Atlantic (25°27'S, 6°10'W; Gebruk *et al*. 2012).

Depth: 484–5,100 m (Benavides-Serrato *et al*. 2012); AZO: 1,165–2,102 m (Hérouard 1902).

Habitat: soft sediments, muddy sand, mud to clay (Hérouard 1902).

Larval stage: lecithotrophic (Gebruk *et al*. 2012).

Remarks: the true geographical distribution and depth range of *Zygothuria lactea* is unknown, particularly in the Western Atlantic, given that historically this species was confused with other closely related species [*e.g., Z. oxysclera* (Perrier, 1899), see Gebruk *et al*. 2012]. In the Azores, *Z. lactea* is extremely abundant between 1,200 and 2,000 m (Hérouard 1902).

Order Persiculida Miller *et al*., 2017

Genus *Benthothuria* Perrier, 1898

Benthothuria funebris Perrier, 1898

Reports for the Azores:
Benthothuria funebris Perrier, 1899—$Gebruk 2008: 50, 51.

Type locality: off Cape Blanc, NW Africa.

See: Perrier (1902: 365–371); Rogacheva *et al*. (2013: 591, figs. 17B, 19B).

Occurrence: East Atlantic, from Greenland eastwards from the Rockall Trough (Gage *et al*. 1985) south to Angola (Jones *et al*. 2014), including the Azores (Gebruk 2008).

Depth: 782–3,757 m (Rogacheva *et al*. 2013); AZO: 2,954–2,968 m (Gebruk 2008).

Habitat: soft sediment, from mud to sand (with shells and corals; Perrier 1902); may be able to swim (Rogacheva *et al*. 2013).

Remarks: Recently, Gebruk (2008) identified the species *B*. *funebris* among material collected at the north border of the Azorean EEZ (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55’N, 30°20’W, 2,954–2,968 m).

Family Pseudostichopodidae Miller *et al*., 2017

Genus *Pseudostichopus* Théel, 1882

Pseudostichopus peripatus (Sluiter, 1901)

Reports for the Azores:
non *Pseudostichopus occultatus* Marenzeller, 1893—$Hérouard 1902: 14–15, pl. 2, figs. 4–14 [misidentification]; Nobre 1938: 156–157 [based on Hérouard 1902]; García-Diez *et al*. 2005: 51 [based on Hérouard 1902];
Pseudostichopus marenzelleri $Hérouard, 1923: 25; Mortensen 1927a: 387;
Pseudostichopus lapidus $Hérouard, 1923: 26–28, pl. 4, fig. 5; Mortensen 1927a: 387;
Meseres peripatus Sluiter—$O’Loughlin 2002: 307–309, fig. 2f;
Pseudostichopus peripatus (Sluiter, 1901)—$O’Loughlin & Ahearn 2005: 174–175, figs. 1f, 10f–h, 11i–l, 12g–h; Gebruk *et al*. 2014: 168–169.

Type locality: Indonesia.

See: O’Loughlin (2002); O’Loughlin & Ahearn (2005); Rogacheva *et al*. (2013: 593, fig. 18D).

Occurrence: deep-water cosmopolitan, in the Atlantic, Pacific and Indian Oceans, in the West Atlantic from Caribbean north to off Massachusetts, eastwards from Greenland south to the Azores area (O’Loughlin 2002, O’Loughlin & Ahearn 2005).

Habitat: soft sediments; covers itself with Globigerine foraminifera (Hérouard 1923).

Depth: 134–5,453 m (O’Loughlin & Ahearn 2005); AZO: (?2,871)4,020–4,400 m (Hérouard 1923).

Remarks: Hérouard (1902) firstly identified *Princesse Alice* material collected in Azorean waters as *Pseudostichopus occultatus*. In a later report, Hérouard (1923) realized that the specimens belonged to two new different species, which he described as *P. lapidus* and *P. marenzelleri*. O’Loughlin (2002) placed both species in the synonymy of *P. peripatus*. However, O’Loughlin (2002) examined a specimen of *P. marenzelleri* collected within Azores waters (36°58’N, 26°20’W, 2,871–2,917 m, ?unreported) present in the collection of the Muséum National d’Histoire Naturelle (Paris) and found significant differences to a point to consider its determination as *P. peripatus* as uncertain. Regardless, later O’Loughlin & Ahearn (2005) confirmed the synonymy of both *P. marenzelleri* and *P. lapidus* with *P. peripatus.*

Order Synallactida Miller *et al*., 2017

Family Deimatidae Théel, 1882

Genus *Deima* Théel, 1879

Species *Deima validum* Théel, 1879

Deima validum validum Théel, 1879

Reports for the Azores:
Deima validum Théel, 1879—$^{\$}$Gebruk 2008: 50, 51.

Type locality: Pacific (36°10'N, 178°00'E).

See: Hansen (1975: 16–23, figs. 1, 109, pl. 9, fig. 1, pl. 13, figs. 1–2); Rogacheva *et al*. (2013: 595, fig. 18E).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian Oceans; in the Caribbean deep waters to off Rio de Janeiro (Brazil; Hansen 1975), eastwards from south of the Charlie Gibbs Fracture Zone (Mid-Atlantic Ridge; Rogacheva *et al*. 2013) and the Rockall Trough (Tyler *et al.* 1985a) to southern African deep waters (19°13'S; Bohn 2006); the subspecies *D. validum pacificum* Ludwig, 1894 is restricted to the East Pacific (Hansen 1975).

Depth: 724–5,424 m (Rogacheva *et al*. 2013); AZO: 2,954–2,968 m (Gebruk 2008).

Habitat: epibenthic deposit-feeder on soft sediments, from clay to *Globigerina* ooze (Hanse 1975, Rogacheva *et al*. 2013).

Larval stage: possibly direct (non-brooding) or lecithotrophic (Tyler *et al.* 1985a).

Remarks: historically, the cosmopolitan *Deima validum validum* was reported from waters between the Azores and the Iberian continental shores (*e.g.,* Hérouard 1902, as *Deima atlanticum*). Only recently Gebruk (2008) reported this species within the archipelago's waters, among material collected at the Azorean EEZ's northern border (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m).

Genus *Oneirophanta* Théel, 1879

Oneirophanta mutabilis mutabilis Théel, 1879

Reports for the Azores:
Oneirophanta mutabilis Théel, 1879—$^{\$}$Gebruk 2008: 50, 51.

Type locality: Between Marion and Crozet Islands (46°46'S, 45°31'E).

See: Théel (1879: 6–7, pl. 1, figs. 4–6); Hansen (1975: 24–32, figs. 2–5).

Occurrence: cosmopolitan, in the Atlantic, Pacific, Indian and Southern Oceans; from the Rockall Trough (Gage *et al.* 1985) south to the waters between the Azores and the Iberian Peninsula (Hérouard 1923, Gebruk 2008); reported elsewhere off Uruguay, South Atlantic (36°44'S, 46°16'W; Théel 1882); *O. mutabilis affinis* Ludwig, 1893 is restricted to the East Pacific (Hansen 1975).

Depth: 1,804–6,000 m (Hérouard 1923, Tyler *et al.* 1985a), mostly deeper than 3,200 (Gage *et al*. 1985); AZO: 2,954–3,050 m (Gebruk 2008).

Habitat: epibenthic on soft sediments, from sandy clay to ooze (Hansen 1975).

Larval stage: possibly direct or lecithotrophic (Tyler *et al.* 1985a).

Remarks: historically, the cosmopolitan *Oneirophanta mutabilis mutabilis* was recorded in the waters near the Azores, between the archipelago and the European continental shores (*e.g.,* Perrier 1902, as *Oneirophanta mutabilis*). Recently, Gebruk (2008) reported this species within the archipelago waters (*G.O. Sars*, *MAR–ECO* cruise, sta 40/367: 42°55'N, 30°20'W, 2,954–2,968 m; sta 46/372: 42°46'N, 29°16'W, 3,005–3,050 m). The somehow discontinuous distribution of this cosmopolitan species in the Atlantic may reflect an artefact produced by insufficient sampling as a consequence of the great depths in which the species is usually found.

Family Stichopodidae Haeckel, 1896

Genus *Parastichopus* H.L. Clark, 1922

Parastichopus regalis (Cuvier, 1817)

(Fig. 38)

Reports for the Azores:
Eostichopus regalis (Cuvier, 1817)—$^{\$}$Wirtz & Debelius 2003: 263;
Stichopus regalis (Cuvier, 1817)—$^{\$}$Wirtz 2009: 48.

Type locality: Mediterranean Sea.

See: Tortonese (1965: 66–68, figs. 24, 25, as *S. regalis*).

Occurrence: Mediterranean Sea and east Atlantic, from the British Islands south to Angola (Mortensen 1927a, Cherbonnier 1965), including the Azores (Wirtz & Debelius 2003), Madeira (Augier 1985) and Canaries (Perrier 1902); reported elsewhere in the Caribbean and the Gulf of Mexico (Deichmann 1954).

Depth: 5–800 m (Tortonese 1965), mostly at depths above 50 m (Ramón *et al*. 2010); AZO: 40–275 m (Wirtz & Debelius 2003, herein).

Habitat: soft sediments (sand to mud; Tortonese 1965).

Commercial value: edible (Ramón *et al*. 2010).

Material examined: DBUA-ECH 386 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'30"N, 25°20'49"W, 2009.09.24, 208 m; 1 spm, TL = 136 mm); DBUA-ECH 387 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'30"N, 25°20'49"W, 2009.09.24, 208 m; 1 specimen, TL = 140 mm); DBUA-ECH 390 (off Praia da Amora, Ponta Garça, SMG, AZO, 37°42'31"N, 25°20'14"W, 2011.07.15, 275 m; 1 specimen, TL = 185 mm).

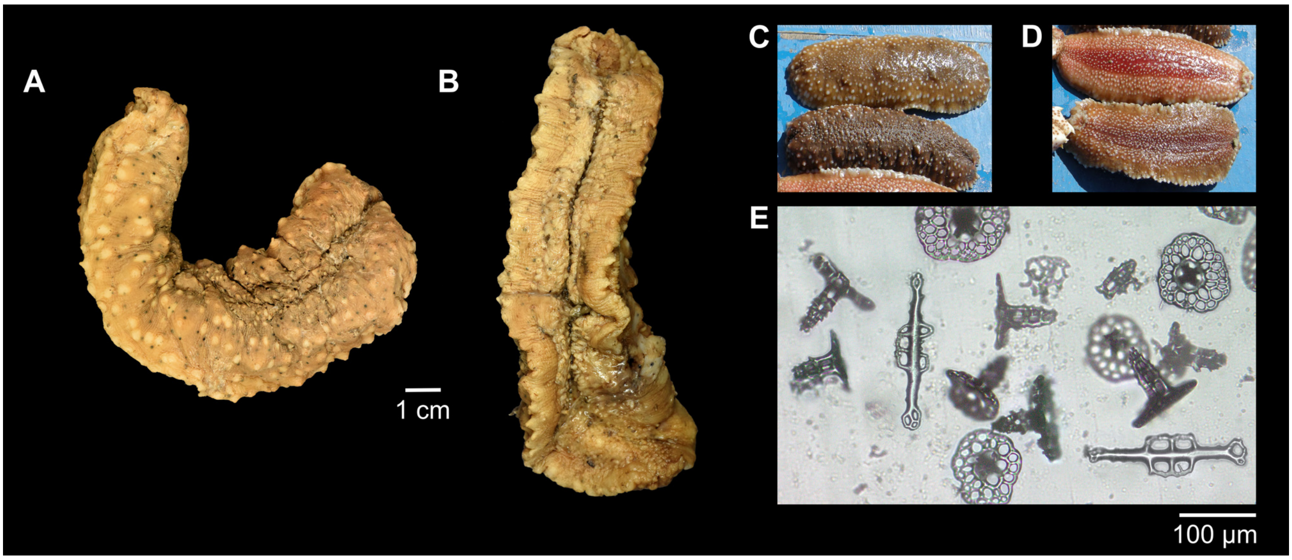

FIGURE 38. *Parastichopus regalis* (Cuvier, 1817) (DBUA-ECH 386). Dorsal view (A, C); ventral view (B, D); specimen, when alive (C, D); ossicles (E).

Description: Body dorsally arched but ventrally flattened, forming a distinct sole with numerous tube feet arranged in three rows (the central one divided in two). Lateral margin separating the ventral and dorsal surfaces of body with large papillae, which is continued anteriorly above the ventrally situated mouth. Ventral surface covered by well-developed conical papillae more or less arranged in longitudinal rows. Body wall relatively thick. Cuvierian tubules absent. Calcareous deposits mostly composed of tables and flattened rods. No buttons. Table disc relatively large, perforated (up to more than 60 holes decreasing in size towards the periphery) and with an irregular round edge; medium high tetrabasal spire with the rods connected by three to five sets of cross bars armed with lateral teeth at its distal part. Rods irregularly perforated. Colour: bivium brown to orange, papillae white or cream; sole with the outer row brown or orange slightly lighter than the bivium, inner double row orange or red. Colour (in ethanol): similar to the live colouration, except for the red and orange colours, which have turned to brown.

Remarks: *P. regalis* is one of the recent additions to the Azores marine fauna. The absence of this species in the historical collections from the Azores could be explained by the species preferential depth range. The preferred depth spectrum of *P. regalis* was seldom studied in the archipelago, between the maximum scuba diving (<30–60 m) and the typical depths explored by the oceanographic cruises (>150–250 m). Also, *P. regalis* appears to co-occur with *Holothuria lentiginosa* in the Azores, as both species were capture together among the material dredged off Ponta Garça in São Miguel Island (208–275 m depth) during the *Third International Workshop of Malacology and Marine Biology*. Though with similar colour patterns, these two species can be easily distinguished by the overall body shape, as *P. regalis* has a well-marked sole ventrally and numerous large white papillae forming a conspicuous lateral rim. In opposition, *H. lentiginosa* presents fewer dorsal or lateral papillae, which are either dyed dark or of same colour of body surface and is nearly cylindrical without distinct sole.

Family Synallactidae Ludwig, 1894

Genus *Paelopatides* Théel, 1886a

Paelopatides atlantica Hérouard, 1902

Reports for the Azores:

Paelopatides atlantica $^{\$}$Hérouard, 1902: 16–17, pl. 1, fig. 15; Mortensen 1927a: 388; Deichmann 1930: 106; García–Diez *et al*. 2005: 51; Gebruk *et al*. 2014: 167.

Type locality: Azores (38°08'00"N, 23°15'45"W).

See: Hérouard (1902).

Occurrence: endemic, only know from the Azores.

Depth: 4,020 m (AZO).

Remarks: *Paelopatides atlantica* is known only from the holotype, collected in Azorean waters by *Princesse Alice*.

Additional species erroneously reported from the Azores:

Class Crinoidea Miller, 1821

Erroneous—*Democrinus rawsonii* (Pourtalès, 1874)

Reports for the Azores:

non *Rhizocrinus rawsoni* Pourtalès, 1874—Carpenter 1883b: 173–175, 1884: 262–269, pl. 9, figs. 3–5, pl. 10, figs. 3–20, pl. 53, figs. 7, 8 [misidentification of *Democrinus parfaiti*]; Koehler 1909: 255–256 [misidentification of *Democrinus parfaiti*]; Pérès 1992: 256 [misidentification of *Democrinus parfaiti*];

non *Democrinus rawsonii* (Pourtalès, 1874)—*García–Diez et al*. 2005: 46 [based on Koehler 1909].

Type locality: Barbados.

See: A.M. Clark (1977: 177).

Occurrence: Western Atlantic, in the Caribbean waters.

Depth: 66–652 m.

Remarks: *Democrinus rawsonii* was recorded in the Azores based on the erroneous assumption that *D. parfaiti* was conspecific with this species (for details see remarks under *D. parfaiti*). In view of this, all reports of this comatulid in the archipelago should be considered as *D. parfaiti*.

Erroneous—*Endoxocrinus* (*Diplocrinus*) *wyvillethomsoni* (Thomson 1872a)

Reports for the Azores:

Endoxocrinus Wyvillethomsoni (Thomson, 1872a)—A.H. Clark 1911: 45–46;

Annacrinus wyvillethomsoni (Jeffreys, *nomen nudum*; Thomson, 1872a)—Macurda & Roux 1981: 169–219, pl. 7, figs. 1–10, pl. 8, figs. 1–9, pl. 9, figs. 1–12, pl. 10, figs. 1–9, pl. 11, figs. 1–8, pl. 12, figs. 1–12, pl. 13, figs. 1–10, pl. 14, figs. 1–9;

Endoxocrinus (*Diplocrinus*) *wyvillethomsoni* (Jeffreys, 1870)—Mironov *et al*. 2014: 117.

Type locality: off Portugal (39°42’N, 9°43’W).

See: Macurda & Roux (1981); David *et al.* (2006: 39–40, figs. 17, 19b, 20d).

Occurrence: Northeast Atlantic, from the Bay of Biscay to Morocco, including the archipelagos of Madeira and Canaries (A.H. Clark 1911, 1923).

Depth: 1,214(?900)–2,070 m (David *et al.* 2006).

Habitat: on various substrates and under a variety of hydrodynamic conditions (Roux 1985, David *et al.* 2006).

Remarks: we do not know on what basis A.H. Clark (1911) listed the Azores among the localities where *Endoxocrinus wyvillethomsoni* could be found. Surprisingly, he remarks that ?Bell may have confused Ferne Islands (British Channel) with Faial Island (Azores), since this species was not known to occur in the former area. Thus, the presence of *E. wyvillethomsoni* in the archipelago seems to be a result of A.H. Clark’s interpretation on a possible mistype by Bell. In later works by the same author (*e.g*., A.H. Clark 1923), the Azores was never again included in the geographical range of this species. A subsequent reference to the archipelago by Macurda & Roux (1981) was based on A.H. Clark (1911) instead of A.H. Clark (1923) cited by the authors. Overall, to our knowledge no specimens belonging to *E. wyvillethomsoni* from the Azores were ever documented and thus its historical inclusion in the fauna of the archipelago should be considered erroneous. Additionally, Jeffreys (*in* Carpenter & Jeffreys 1871) was the first author to name this deep-water crinoid. However, in a review by Macurda & Roux (1981), Jeffrey’s name was considered *nomen nudum*. For this reason, they appointed a later reference by Thomson (1872a: 767–769) in which this species is fully described, a view followed herein.

Erroneous—*Monachocrinus recuperatus* (Perrier, 1885a)

Reports for the Azores:

Monachocrinus perrieri (Koehler & Vaney, 1910)—A.M. Clark 1980: 189, 1982b: 126;
Monachocrinus recuperatus (Perrier, 1885a)—A.M. Clark 1980: 189, 1982b: 126.

Type locality: between Azores and the Iberian Peninsula (44°20’00”N, 17°10’46”W).

See: Roux *et al*. (2002: 823, fig. 7e); Mironov *et al*. (2014: 115).

Occurrence: rare species, known only from waters between the Azores and the Iberian Peninsula, Morocco (Koehler & Vaney 1910) and South Africa (Mironov *et al*. (2014).

Habitat: soft sediments (mud; Koehler & Vaney, 1910).

Depth: 1,620–4,850 m (Mironov *et al*. 2014).

Remarks: in a preliminary note on the crinoid material collected by the *Travailleur* and *Talisman*, Koehler & Vaney (1910) described a new species from Moroccan waters (30°03’00”N, 11°41’46”W) *Monachocrinus perrieri* (= *Bathycrinus perrieri*) and mentioned *Monachocrinus recuperatus* (= *Bathycrinus recuperatus*) from waters between the Azores and Iberian Peninsula (44°20’00”N, 17°10’46”W). Gislén (1951) working on the material collected by the *Swedish Deep-Sea Expedition* reported material belonging to *Monachocrinus perrieri* from waters west of the Azores (40°35’N–40°34’N, 35°24’W–35°52’W). Both species are now considered conspecific (Mironov *et al.* 2014). On what authority A.M. Clark (1980, 1982b) extended the geographic distribution of *M. recuperatus* to the Azores it is not clear. In spite of the close proximity of the historical records to the archipelago (both east and west) to our knowledge no specimens were actually recovered within the Azorean EEZ. Though it is more than likely that this species does occur in the Azorean deep waters, at present the inclusion of this species in the Azorean fauna must be considered erroneous.

Class Ophiuroidea Gray, 1840

Erroneous—*Amphiura chiajei* Forbes, 1843

Reports for the Azores:

Amphiura chiajei Forbes, 1843—Mortensen 1927a: 212–213, figs. 117, 120.1–2; Grieg 1932: 37; Nobre 1938: 84, fig. 41.1; Tortonese 1965: 224–227, figs. 105–106; Fenaux 1970: 262–271, figs. 1–5; Moyse & Tyler 1995: 67, fig. 12.7; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

Type locality: Aegean Sea, Mediterranean Sea.

See: Forbes (1843: 150, pl. 14, figs. 8–13); Madsen (1970: 167–168, figs. 4–5a); Paterson (1985: 87–88, fig. 34).

Occurrence: Mediterranean Sea and Northeast Atlantic, from Scandinavia to the southern coast of Angola (Mortensen 1927a, 1936, Tortonese 1965), including the Canaries (Bacallado *et al*. 1985) and Madeira (Jesus & Abreu 1998).

Depth: 2–1,250 m (Cherbonnier 1970, Koukouras *et al*. 2007).

Habitat: soft sediments (sand, mud to silt) and among algae (Koukouras *et al*. 2007, Tortonese 1965); lives buried in the sediment with the arms extended above the surface feeding on deposited material (Picton 1993).

Larval stage: lecithotrophic (Fenaux 1970).

Remarks: both Mortensen (1927a) and Grieg (1932) have listed the Azores under the geographical range of *Amphiura chiajei*. However, to the best of our knowledge no specimen belonging to this species was ever recorded from the archipelago. In view of this, the inclusion of *A. chiajei* in the Azorean fauna by those authors appears to be a misprint and should be dismissed as erroneous.

Erroneous—*Bathypectinura heros* (Lyman, 1879)

Reports for the Azores:

Bathypectinura heros (Lyman, 1879)—Paterson 1985: 95–96, fig. 38; Borrero-Pérez *et al*. 2008: 199–200, figs. 17G, H; Benavides-Serrato *et al*. 2011: 336–337; Smirnov *et al*. 2014: 208.

Type locality: Aru, Indonesia (5°41'S, 134°04'E).

See: Lyman (1879: 48–49, pl. 14, figs. 389–391); Madsen (1973: 133–142).

Occurrence: cosmopolitan, found in most oceans except the Arctic and Southern Oceans; in the Atlantic is found in the west from off North Carolina to the Caribbean and in the east from the Bay of Biscay to Angola, including Cape Verde (Madsen 1973).

Depth: 240–3,150 m (Madsen 1973, Hernández-Herrejon *et al*. 2008).

Habitat: soft substrates, from mud to clay; feeds on organic detritus, foraminiferans and *Sargassum*; capable of active swimming (Madsen 1973, Pawson 1982).

Remarks: Paterson (1985) listed the Azores in the geographical distribution of *Bathypectinura heros* as the southern limit in the NE Atlantic ignoring records further south reported, for example, by Madsen (1977), a work referred by the author. Paterson himself identified specimens belonging to *B. heros*, among material retrieved in NW Africa, at lower latitudes than the archipelago. Subsequent inclusions of the archipelago in this species geographical range were based on Paterson (1985). We could not find the original record for the Azores. Confirmed records of this species derive from the *Michael Sars* cruise just southwest of the Azorean waters (sta 53: 34°59'N, 33°01'W, 2,615–2,865 m) (Mortensen 1927a, as *Bathypectinura elata*; Grieg 1932, as *Pectinura elata*). Taking in account the species wide geographical range in the North Atlantic it is likely that it occurs in the Azores, however, in our opinion the presence of this species inside the archipelago waters still needs to be confirmed.

Erroneous—*Ophiacantha anomala* Sars, 1872

Reports for the Azores:

Ophiacantha cuspidata Lyman, 1878—Gage *et al*. 1983: 291; García-Diez *et al*. 2005: 49; Smirnov *et al*. 2014: 195–196.

Type locality: Norway.

See: Sars (1872: 12–15); Paterson (1985: 24–34, fig. 14, as *Ophiacantha anomala*; 41–42, fig. 18, as *Ophiacantha cuspidata*); Stöhr (2005: 551–552, figs. 4A–H); Martynov & Litvinova (2008: 96, figs. 7B–J).

Occurrence: Atlantic, from the east coast of the USA to Greenland eastwards from Iceland and Scandinavia as far south as Ascension Island (Koehler 1914a, Mortensen 1933a, Paterson 1885).

Depth: 140–2,460 m (Paterson 1985).

Habitat: soft to hard substrates (Lyman 1882, Koehler 1909).

Larval stage: brooded within the gonads until postlarvae stage is reached (Stöhr 2005); adults are also known to be hermaphrodite (Mortensen 1936).

Remarks: Gage *et al*. (1983) mentioned the presence of *Ophiacantha cuspidata* in an area 'off Azores' (a species recently found to be conspecific with the North Atlantic *O. anomala*; see Martynov & Litvinova 2008). Gage and co-authors were probably referring to Koehler (1909) who reported two specimens collected by *Princesse Alice* at a station located in the Mid-Atlantic Ridge, just outside the Azorean EEZ (sta 1420: 42°52'N–42°53'N, 28°30'45"W, 2,460 m). García-Diez *et al*. (2005) also erroneously placed this station within the 200 miles radius surrounding the archipelago, and thus included this species in their review of the Azorean fauna. Regardless of the widespread distribution in the North Atlantic, no material belonging to either *O. cuspidata* or *O. anomala* was yet documented inside the Azorean EEZ.

Erroneous—*Ophiacantha brevispina* Koehler, 1898

Reports for the Azores:
Ophiacantha brevispina Koehler, 1898—Bartsch 1987: 120–121, figs. 16, 17.

Type locality: Bay of Biscay (46°27'00″N, 4°09'46″W).

See: Koehler (1898: 56–57, pl. 8, figs. 43, pl. 9, fig. 44).

Occurrence: Northeast Atlantic, from the Bay of Biscay to Dakar in Senegal (Koehler 1898, Bartsch 1987), including Madeira (Jesus & Abreu 1998).

Depth: 90–417 m (Bartsch 1987).

Habitat: soft sediment, sand to muddy sand (Cadenat 1938).

Remarks: few specimens of *Ophiacantha brevispina* have been found since Koehler (1898) described this species. Cadenat (1938) identified numerous animals from an area that the author referred as Cape Blanc and Cape Verde as *Ophiacantha* sp., though none of the specimens came from the later archipelago but from Dakar. Regardless Cadenat remarked that these brittle stars were quite close to what Koehler described as *Ophiacantha brevispina*. Later, Bartsch (1987) recorded *O. brevispina* from the same region as the previous author. Bartsch erroneously listed the Azores under geographical range of this species (citing Cadenat 1938), mistaking the Cape Verde Islands with the Azores.

Erroneous—*Ophiocomella pumila* Lütken, 1856

Reports for the Azores:
Ophiocoma pumila Lütken, 1856—Devaney 1970: 28, figs. 16, 37, 40, 44; Mladenov 1985: 285–295, figs. 1–3; Benavides-Serrato *et al*. 2011: 325–326.

Type locality: Bermuda.

See: H.L. Clark (1915: 293); Devaney (1970); Benavides-Serrato *et al*. (2011).

Occurrence: Atlantic tropical waters, in the west from the Caribbean to Brazil and Bermuda (Benavides-Serrato *et al*. 2011) and in the east from Senegal to the Gulf of Guinea (Koehler 1914b), including the Canaries (Hernández *et al*. 2013) and Cape Verde (H.L. Clark 1915).

Depth: 0–24 m (Benavides-Serrato *et al*. 2011), but can reach 375 m (Madsen 1970).

Habitat: among algae or in crannies in rocks and corals (H.L. Clark 1942).

Larval stage: planktotrophic larvae (three months at 26–27.5°C; Mladenov 1985).

Remarks: we could not trace the original report in which led Devaney (1970) to include the Azores in the geographical distribution of *Ophiocoma pumila*. It seems likely that it is a product of a mistake hence we consider the inclusion of this tropical species in the archipelago as erroneous.

Erroneous—*Ophiogeron edentulus* Lyman, 1878

Reports for the Azores:
non *Ophiogeron edentulus* Lyman, 1878—Lyman 1882: 237, pl. 12, figs. 16–18 [misidentification of *O. granulatus*].

Type locality: Fiji Islands (19°02'S, 177°10'E), Pacific Ocean.

See: Lyman (1878: 161, pl. 7, figs. 187–189; 1882).

Occurrence: known only from type material collected in the Fiji Islands (South Pacific).

Habitat: soft bottoms (red clay).

Depth: 2,471 m.

Remarks: see remarks under *Ophiogeron granulatus*.

Erroneous—*Ophiomitrella clavigera* (Ljungman, 1865)

Reports for the Azores:

non *Ophiomitrella clavigera* (Ljungman, 1864)—Mortensen 1927a: 186–187, fig. 103 [based on invalid synonymy]; Marques 1980: 102 [based on Mortensen 1927a]; Paterson 1985: 71, fig. 28 [based on Mortensen 1927a]; Harvey *et al*. 1988: 170 [based on Paterson 1985]; García-Diez *et al*. 2005: 49 [based on Mortensen 1927a].

Type locality: Norway.

See: Mortensen (1933a: 39–41, fig. 23); Paterson (1985).

Occurrence: North Atlantic, in the west from the Northern American coasts to Greenland and in the east from Iceland and Scandinavia to the British waters (Mortensen 1933a, Paterson 1985).

Depth: 166–1,952 m (Paterson 1985, Harvey *et al*. 1988).

Habitat: coral epibiont and also known from muddy sand (Farran 1913).

Larval stage: brooding, protandric hermaphrodite (Mortensen 1920).

Remarks: *Ophiomitrella clavigera* was included in the Azorean fauna based on the erroneous assumption that *O. cordifera* was conspecific with this species (for details see remarks under *Ophiomitrella cordifera*).

Erroneous—*Ophiomusium africanum* Koehler, 1909

Reports for the Azores:

Ophiomusium africanum Koehler, 1909—Paterson 1985: 147, fig. 58.

Type locality: Cape Verde.

See: Koehler (1909: 159–160, pl. 1, fig. 10, pl. 29, figs. 5–6).

Occurrence: known only from the type material collected in archipelago of Cape Verde.

Depth: 219 m.

Habitat: sand and coralline algae.

Remarks: *Ophiomusium africanum* is known only from type specimen described by Koehler (1909) and collected by *Princesse Alice* in Cape Verde. Paterson (1985) comment that this species 'was only recorded from the Azores' is clearly a mistake.

Erroneous—*Ophiomyxa pentagona* (Lamarck, 1816)

Reports for the Azores:

Ophiomyxa pentagona (Lamarck, 1816)—Cherbonnier & Sibuet 1972: 396; Marques 1980: 103.

Type locality: Mediterranean Sea.

See: Tortonese (1965: 217–218, fig. 101).

Occurrence: Northeast Atlantic and Mediterranean Sea, from Northern Spain to Senegal, including the Canaries and Cape Verde (Koehler 1906, Tortonese 1965, Madsen 1970).

Depth: 35–1,095 m in the Atlantic, but common in littoral-sublittoral Mediterranean waters (Tortonese 1965, Madsen 1970, Cherbonnier & Sibuet 1972).

Habitat: hard to soft substrata, including *Posidonia* and *Caulerpa* meadows (Tortonese 1965).

Remarks: Cherbonnier & Sibuet (1972) and Marques (1980) listed this species for the archipelago of the Azores. Though it is not entire unlikely that this species occurs in Azorean waters considering its wide distribution throughout the Northeast Atlantic, we could not trace the original report. We believe that Cherbonnier & Sibuet (1972) inclusion of the Azores in the distribution of this species was due to a mistake.

Erroneous—*Ophiophrixus spinosus* (Storm, 1881)

Reports for the Azores:
Ophiophrixus spinosus (Storm, 1881)—Paterson 1985: 21–22, fig. 12: 169.

Type locality: Norway.

See: Mortensen (1927a: 171–172, figs. 96–97); Paterson (1985).

Occurrence: Northeast Atlantic, from the Denmark Strait and off SE of Iceland to off NW African waters (Koehler 1906b, Mortensen 1933a).

Depth: 40–1,383 m (Harvey *et al*. 1988).

Habitat: soft bottoms, sand, mud to ooze (Farran 1913).

Larval stage: viviparous (Kasyanov *et al*. 1998).

Remarks: Koehler (1906b) reported *Ophiophrixus spinosus* (as *Ophiobyrsa hystricis*) from off the coast of Morocco (*Talisman*, sta 20, 1883: 33°43'N, 9°01'46″W, 1,105 m), a species previously known from Icelandic and Scandinavian waters. Mortensen (1927a) referred to this record as between Madeira and NW Africa, which later changed to 'off Madeira' (Mortensen 1933a). Paterson (1985) placed the southern limit of this species not in Morocco or Madeira, but in the Azores, which is clearly a mistake, that was repeated in subsequent literature.

Erroneous—*Ophiopsila aranea* Forbes, 1843

Reports for the Azores:
Ophiopsila aranea Forbes, 1843—Koehler 1909: 182, 1921b: 95–96, fig. 63; Mortensen 1927a: 180–181, fig. 101: Tortonese 1965: 253–255, fig. 116; Madsen 1970: 222, fig. 40; Pérez-Ruzafa *et al*. 2002: 282–283; Micael & Costa 2010: 322; Micael *et al*. 2012: 3.

Type locality: Mediterranean Sea.

See: Forbes (1843: 149, pl. 14, figs. 1–7); Koehler (1921b); Mortensen (1927a).

Occurrence: Mediterranean Sea and East Atlantic, in the Atlantic from the British Islands to the Gulf of Guinea (Mortensen 1927a, Madsen 1970), including Madeira, the Selvagens, Canaries, Cape Verde, and the Seine Seamount (Koehler 1906b, 1909, Pérez-Ruzafa *et al*. 2002, 2003).

Depth: 8–185 m (Koehler 1909, Pérez-Ruzafa *et al*. 2002).

Habitat: on coralligenous and detritic bottoms, among algae and sea-grass prairies or hidden in crevices (Tortonese 1965).

Remarks: Koehler (1906b) reported material belonging to *Ophiopsila aranea* collected by *Talisman* in several stations located in the Bay of Biscay, Madeira and Cape Verde. Later, Koehler (1909) listed a specimen collected by *Princesse Alice* from Seine Seamount (sta 2034: 33°47'40"N, 14°21'W, 185 m). However, in the discussion of the geographical distribution of *O. aranea*, Koehler (1909) stated that this Mediterranean species was collected in the Azores by *Talisman* and taken again by *Princesse Alice* in the same waters. It is clear that Koehler mistook the stations' location from both cruises, an error overlooked in subsequent literature.

Erroneous—*Ophiothamnus affinis* Ljungman, 1872

Reports for the Azores:
Ophiothamnus affinis Ljungman, 1872—Nobre 1938: 75–76.

Type locality: Portugal (38°10'N, 9°25'W).

See: Ljungman (1872: 622); Paterson (1985: 73, fig. 27); Bartsch (1987: 125–126, figs. 25–26).

Occurrence: North Atlantic, in west recorded from Florida and in the east from the Bay of Biscay to the Western Sahara coast (NW Africa) and Madeira (Koehler 1909, 1914a, Bartsch 1987).

Depth: 1,425–1,935 m (Paterson 1985), though in the West Atlantic it was recorded at depths of 229–491 m (Koehler 1914a).

Habitat: soft sediment (sand; Koehler 1914a).

Remarks: Nobre (1938) listed a specimen of *Ophiothamnus affinis* collected by *Talisman* and *Travailleur* between the Azores and Portugal continental shores, at 38°23'N, 31°10'W (probably using the Paris Meridian) and at a depth of 500 m without referring to a specific station. The coordinates given by the author seem to refer to station 123 conducted by *Talisman* in 1883, placing the specimen well inside the Azorean waters. However, Koehler (1906b) did not report any material of *O. affinis* or *Ophioleda minima* (as Nobre already acknowledged these species to be conspecific) from that particular station. Furthermore, Koehler (1906a, 1906b, 1914a) described *Ophioleda minima* on the basis of specimens collected by *Travailleur* and *Talisman* in Northern Spanish waters at a depth of 1,037–1,350 m, not between the Azores and Portugal as Nobre seemed to claim. In spite of the wide distribution of *O. affinis* in the North Atlantic, the presence of this species in the archipelago is still to be confirmed.

Erroneous—*Ophiothrix cotteaui* (de Loriol, 1900)

Reports for the Azores:

Ophiothrix cotteaui (de Loriol, 1900)—Madsen 1970: 215–216, figs. 36a–b.

Type locality: Liberia.

See: Madsen (1970).

Occurrence: East Atlantic, from Portugal and the Gulf of Cadiz to Angola (Koehler 1906b, 1914b, Cadenat 1938, Marques 1980), including Madeira (Koehler 1906b).

Depth: *c.* 0–820 m (Madsen 1970, Marques 1980).

Habitat: soft sediments, on the branches of gorgonian corals (Cadenat 1938, Madsen 1970).

Remarks: Koehler (1906a, b) described a new species, *Ophiothrix indigna*, based on material collected by *Talisman* from the Gulf of Cadiz (sta 36, 1882: 35°35'00"N, 6°21'46"W, *c.* 150 m) and Madeira waters (sta 55, 1882: 32°41'20"N, 16°37'46"W, 370 m). In a review of the West African ophiuroids, Madsen (1970) concluded that *O. indigna* should be considered a junior synonymy of *O. cotteaui* as it merely represented adults of the later. However, by a lapse Madsen placed *O. indigna*'s type locality in the Azores.

Class Asteroidea de Blainville 1830

Erroneous—*Astropecten bispinosus* (Otto, 1823)

Reports for the Azores:

Astropecten bispinosus (Otto, 1823)—Ludwig 1897: 16–31, pl. 2, fig. 6, pl. 6, fig. 6; Koehler 1921b: 46–47, fig. 33, 1924: 191–192; Mortensen 1927a: 56; Parenzan 1934: 211–216, fig. 7; Nobre 1938: 51–52, figs. 23, 24; Madsen 1950: 181–182; Tortonese 1965: 140–141, fig. 62; Micael & Costa 2010: 322; Micael *et al*. 2012: 5.

Type locality: Mediterranean Sea.

See: Koehler (1921b); Tortonese (1965).

Occurrence: Mediterranean Sea, reported elsewhere in the Portuguese continental shores (Northeast Atlantic; Koehler 1921a, Nobre 1938).

Depth: shallow waters (Koehler 1921a).

Habitat: sandy bottoms and *Zostera* prairies (Koehler 1921a).

Remarks: the first report of *Astropecten bispinosus* in the Azores appears in Ludwig (1897). This author believed that *A. platyacanthus* was just a variation of *A. bispinosus*, and in his review of the Mediterranean sea stars, listed Barrois (1888)'s record in the synonymy list of later species. This caused subsequent authors, such as Koehler (1921b), to include the Azores in this species geographical range without acknowledging the synonymy or the re-examination of Barrois (1888)'s material. The debate whether *A. platyacanthus* is a variety of *A. bispinosus* seems to have ended with the publication of Zulliger & Lessios (2010) as they are now considered as two valid species (Mah

2017). Nevertheless, A.M. Clark & Downey (1992) considered both species to be endemic to the Mediterranean waters, believing that all the reports from the Atlantic were based on misidentifications or doubtful locality data. The lack of documented material from the Azorean waters appears to support these authors, and thus we consider the Azorean reports as erroneous.

Erroneous—*Astropecten irregularis pentacanthus* (Delle Chiaje, 1827)

Reports for the Azores:

non *Astropecten pentacanthus* (Philippi, 1837)—Simroth 1888: 231 [misidentified *A. hermatophilus*];
Astropecten irregularis pentacanthus (Delle Chiaje, 1827)—Koehler 1914b: 273, 1924: 196–199 [based on Simroth 1888]; Madsen 1950: 169–170 [based on Ludwig 1897].

Type locality: Mediterranean Sea.

See: Tortonese (1965: 132–137).

Occurrence: Endemic to the Mediterranean Sea (A.M. Clark & Downey 1992); possibly also present in the East Atlantic (Gorringe Seamount and Madeira; Zulliger & Lessios 2010; Pérès 1964); other subspecies of are also known in the Atlantic from Scandinavia to South Africa (A.M. Clark & Downey 1992).

Depth: shallow water to 929 m, particularly abundant between 50 to 400 m (Tortonese 1965).

Habitat: soft sediments, on biogenic detritus to sandy silt bottoms, and *Zostera* and *Posidonia* prairies (Koukouras *et al.* 2007).

Larval stage: planktotrophic (inferred from A. *irregularis irregularis*, see McEdward & Miner 2001).

Remarks: Simroth (1888) was responsible for the only record of *Astropecten pentacanthus* known from the Azores. Later, Döderlein (1917) re-assigned Simroth material to *A. hermatophilus*, the only *Astropecten* species known to occur in the Azores with certainty (see remarks under *Astropecten hermatophilus*).

Erroneous—*Calyptraster coa* Sladen, 1882

Reports for the Azores:

Calyptraster coa Sladen, 1882—Walenkamp 1979: 64–72, figs. 19, 23–25, pl. 14, figs. 1–4.

Type locality: Pernambuco, Brazil (09°10'S, 34°50'W).

See: Sladen (1889: 489–491, pl. 78, figs. 1–2, pl. 79, figs. 1–3); A.M. Clark & Downey (1992: 308–309, figs. 49f, h, pl. 75, figs. A–B).

Occurrence: Western Atlantic, from the Bahamas and Florida south to Brazil (*c.* 09°S; Sladen 1889, Walenkamp 1979).

Depth: 260–993 m (A.M. Clark & Downey 1992).

Habitat: soft sediment (mud, Sladen 1889).

Remarks: see remarks under *Calyptraster personatus*.

Erroneous—*Ctenodiscus crispatus* (Bruzelius, 1805)

Reports for the Azores:

Ctenodiscus crispatus (Bruzelius, 1805)—García-Diez *et al*. 2005: 47; Micael & Costa 2010: 322; Micael *et al*. 2012: 5.

Type locality: ?Lund.

See: A.M. Clark & Downey (1992: 109–110, figs. 20a–b, d, pl. 28A–C).

Occurrence: circumpolar Arctic, in the western Atlantic south in the cold current below the Gulf Stream to Cape Hatteras (though rare south of Cape Cod, Massachusetts) and in the east to Trondheim (Norway) and the cold area of the Faeroe Channel (A.M. Clark & Downey 1992).

Depth: 10–1,890 m (A.M. Clark & Downey 1992).

Habitat: deposit-feeder on soft sediments (mud, sand to clay; Shick *et al*. 1981, A.M. Clark & Downey 1992).

Larval stage: direct development (Shick *et al*. 1981).

Remarks: the report for the Azores is based on the assumption that the '*Asterias polaris* Gray' identified by Perrier (1896a) among the material collected by *Hirondelle* in the Azores is a synonym of *Ctenodiscus crispatus*. Analysing the related bibliography, we disagree and thus consider the record of *C. crispatus* from the archipelago as erroneous (see remarks under *Asterias rubens* and *Leptasterias polaris*).

Erroneous—*Dytaster semispinosus* (Perrier, 1894)

Reports for the Azores:
Dytaster semispinosus (Perrier, 1894)—A.M. Clark & Downey 1992: 55; Dilman 2014: 26.

Type locality: off Galicia (44°29'00"N, 13°31'46"W).

See: A.M. Clark & Downey (1992).

Occurrence: known only from abyssal waters between the Azores and the Bay of Biscay (Perrier 1894, Koehler 1909).

Depth: 4,275–5,005 m (Perrier 1894, Koehler 1909).

Habitat: soft sediments (Koehler 1909).

Remarks: A.M. Clark & Downey (1992) placed *Dytaster semispinosus* within the Azorean waters, though this species was never collected in the archipelago, but between the Azores and the European continental shores by *Talisman* (Perrier 1894, as *Crenaster semispinosus*) and by *Princesse Alice* (Koehler 1909, as *Dytaster parvulus*).

Erroneous—*Freyastera benthophila* (Sladen, 1889)

Reports for the Azores:
Freyella benthophila Sladen, 1889—Cherbonnier & Sibuet 1972: 388.

Type locality: Pacific Ocean.

See: Sladen (1889: 641–643, pl. 111, figs. 5–8); Downey (1986: 36–38, fig. 18); A.M. Clark & Downey (1992: 480, figs. 74a–b, pl. 112, figs. C–D).

Occurrence: cosmopolitan deep-sea, in the Atlantic reported only to the east side, from the Bay of Biscay westwards to the Mid-Atlantic Ridge and to southern African waters (Cherbonnier & Sibuet 1972, Sibuet 1972, Downey 1986).

Depth: 4,163–5,000 m (Sibuet 1975, Downey 1986).

Habitat: soft substrates (red clay; Sladen 1889).

Remarks: *Freyastera benthophila* (Sladen, 1889) was reported in the Azores by Cherbonnier & Sibuet (1972), based on the material collected by *Albatross* during the *Swedish Deep Sea Expedition*. However, the original record mentioned a station half way between continental Europe and the Azores, as was referred by Downey (1986) and A.M. Clark & Downey (1992). Though it is likely that this cosmopolitan deep-water species will prove to occur within the Azorean EEZ, it needs to be confirmed by actual records.

Erroneous—*Freyella recta* Koehler, 1907a

Reports for the Azores:
Freyella recta Koehler, 1907a—Grieg 1932: 31; Mortensen 1927a: 122.

Type locality: Mid-Atlantic Ridge (31°45'30"N, 42°42'30"W).

See: Koehler (1909: 127–129, pl. 21, fig. 7, pl. 22, fig. 4, pl. 3, figs. 3–5); A.M. Clark & Downey (1992: 485–486, fig. 73).

Occurrence: known with certainty from the type material collected only from the Mid-Atlantic Ridge (A.M. Clark & Downey 1992).

Depth: 3,465 m (Koehler 1909).

Habitat: soft bottoms (*Globigerina* ooze; Koehler 1909).

Remarks: *Freyella recta* is known only with certainty from the type material (A.M. Clark & Downey 1992). This species was described by Koehler (1907a, 1909) based on a poorly preserved specimen taken by *Princesse Alice* in the Mid-Atlantic Ridge, about 600 miles southwest from the Azorean waters. Later reports from the archipelago by Mortensen (1927a) and Grieg (1932) erroneously placed the record of *Princesse Alice* cruise in the archipelago.

Erroneous—*Henricia sanguinolenta* (Müller, 1776)

Reports for the Azores:
Henricia sanguinolenta (Müller, 1776)—Koehler 1921b: 31, fig. 23; Mortensen 1927a: 118–121; Nobre 1938: 39–40, fig. 14.

Type locality: south coast of Norway.

See: Madsen (1987: 209–218, figs. 1, 2a–b, 4–9); A.M. Clark & Downey (1992: 396–397, figs. 60o–p, pl. 93, fig. F, pl. 95, figs. H, I).

Occurrence: Northeast Atlantic, from north boreal and arctic waters south to Northumberland (*c.* 55°N) and Kattegat in the east and to Cape Cod in the west (Madsen 1987); reported elsewhere from the Canaries (Hernández *et al*. 2013); possibly extending the North Pacific waters (Madsen 1987).

Depth: 0–200 m, though rarely below 50 m (A.M. Clark & Downey 1992).

Habitat: mainly on hard substrata (A.M. Clark & Downey 1992).

Larval stage: lecithotrophic (brooder; A.M. Clark & Downey 1992).

Remarks: in the historical literature, the inclusion of *Henricia sanguinolenta* in the Azorean marina fauna was based on the assumption that *H. oculata* was a junior synonymous of the former species (see remarks under *Henricia oculata*).

Erroneous—*Hydrasterias ophidion* (Sladen, 1889)

Reports for the Azores:
non *Hydrasterias ophidion* Sladen—A.H. Clark 1949: 375 [misidentified *H. sexradiata*].

Type locality: south of Halifax, Nova Scotia (42°08'N, 63°39'W).

See: Sladen [1889: 581–582, pl. 99, figs. 3–4, pl. 103, figs. 3–4, as *Asterias* (*Hydrasterias*) *ophidion*]; A.M. Clark & Downey (1992: 409, figs. 62a–b, pl. 97, figs. C–F).

Occurrence: Western Atlantic, from the New England Seamounts south of Nova Scotia eastwards to the Mid-Atlantic Ridge and south to South America (A.M. Clark & Downey 1992).

Depth: 2,286–2,330 m (A.M. Clark & Downey 1992).

Habitat: soft bottoms (mud; Sladen 1889).

Larval stage: direct development (A.M. Clark & Downey 1992).

Remarks: the western Atlantic *Hydrasterias ophidion* was reported from the Azores by A.H. Clark (1949) based on his identification of the material collected by *Atlantis* (sta 20: 37°50'30"N, 26°00'00"W, 2,562 m). Later, Dilman (2014) attributed A.H. Clark's records to *H. sexradiata*, a known native to the Azorean deep waters.

Erroneous—*Leptasterias* (*Hexasterias*) *polaris* (Müller & Troschel, 1842)

Reports for the Azores:
Leptasterias (Hexasterias) polaris (Müller & Troschel, 1842)—Pereira 1997: 336;
Leptasterias polaris (Müller & Troschel, 1842)—Micael & Costa 2010: 321.

Type locality: Greenland.

See: Fisher (1930: 60–61, pl. 30, figs. 1, 1a–c, 2, 2a–2d, pl. 32, figs. 3, 3a, pl. 35, figs. 1–3); A.M. Clark & Downey (1992: 441–442).

Occurrence: circumpolar Arctic; in the Atlantic, from Labrador and Greenland south to George's Bank (Fisher 1930, A.M. Clark & Downey 1992).

Depth: 0–360 m (A.M. Clark & Downey 1992).

Habitat: juveniles and small adults can be found on rocky substrates in shallow water, below lowest water of spring tides; large adults occupy cobble to sandy and muddy areas at greater depths (Rochette *et al*. 1994).

Larval stage: brooding (Hamel & Mercier 1995).

Remarks: Perrier (1896a) reported *L. polaris* (as *Asterias polaris*) from the Azorean rocky intertidal, which later Koehler (1924) re-identifed to *Asterias rubens*. Later references of this species to the archipelago were based on Perrier's original report. Nonetheless, the sea surface temperatures in the Azores reach an average minimum of 14°C in the winter (Bashmachnikov *et al*. 2004) clearly providing an inhospitable environment far too warm to sustain a viable population of this Arctic species (see Hamel & Mercier 1995). The same conclusion can be reached on the possible presence of *C. crispatus* in the archipelago, *i.e.* it is unlikely that this stenothermal boreo-arctic species (see Shick *et al*. 1981) could maintain a viable population in the rocky shores of the Azores.

Erroneous—*Pteraster alveolatus* Perrier, 1894

Reports for the Azores:

Pteraster alveolatus Perrier, 1894: 183–184, pl. 13, fig. 1; Mortensen 1927a: 102; Cherbonnier & Sibuet 1972: 380; A.M. Clark & Downey 1992: 327, figs. 51a–e; Dilman 2014: 36.

Type locality: between the Azores and European continental shores (42°19'N, 21°15'46"W).

See: A.M. Clark & Downey (1992).

Occurrence: known only from the type locality (Clark & Downey 1992).

Depth: 4,060 m (Perrier 1894).

Habitat: soft sediments (ooze; Perrier 1894).

Remarks: Perrier (1894) described *Pteraster alveolatus* based on a specimen collected by *Talisman* NE of the Azores. At the time, Perrier attributed this species to the Azores fauna, disregarding the true location of the station, a mistake repeated in subsequent literature.

Erroneous—*Thoracaster cylindratus* Sladen, 1883

Reports for the Azores:

Thoracaster cylindratus Sladen, 1883—A.M. Clark & Downey 1992: 105–106, fig. 18f, pl. 26, figs. D–G.

Type locality: between the Canaries and Cape Verde (22°18'N, 21°02'W).

See: Madsen (1961: 82–92, figs. 10–11, pl. 5, pl. 6, figs. 1–7); A.M. Clark & Downey (1992).

Occurrence: cosmopolitan, in the Atlantic, Pacific and Indian deep waters; in the West Atlantic from the Gulf of Mexico and the Caribbean, southwards to Brazil (A.M. Clark & Downey 1992); in the East Atlantic from SW of Ireland (Porcupine Seabight) southwards to off Liberia (Madsen 1961).

Depth: 2,540(?2,315)–5,990 m (A.M. Clark & Downey 1992).

Habitat: soft bottoms, calcareous clay to *Globigerina* ooze (Madsen 1961).

Remarks: A.M. Clark & Downey (1992) have listed the Azores under the geographical range of *Thoracaster cylindratus*. However, this species was never collected within the Azorean EEZ. Perrier (1885c, 1894) identified a specimen of this species (= *Pseudaster cordifer*) among the material collected by *Talisman* almost 500 km northeast of São Jorge Island (sta 134, 1883: 42°19'N, 23°36'W). Later, Koehler (1909) reported this species on two of *Princesse Alice* stations to the waters east and northeast of the Azores (sta 1306: 37°16'00"N, 20°11'45"W; sta 753: 39°50'00"N, 17°57'45"W). It is likely that *T. cylindratus* occurs in the Azores considering the wide distribution of this species in the Atlantic and the proximity of above mentioned records. The presence of this species within the archipelago's waters, however, is still to be confirmed.

Class Echinoidea Leske, 1778

Erroneous—*Anabrissus damesi* (Agassiz, 1881)

Reports for the Azores:
Brissus damesi Agassiz, 1881: 197–200, pl. 30a, figs. 15–16; H.L. Clark, 1925: 218–219.

Type locality: Brazil (9°05'S to 9°10'S, 34°49'W to 34° 53'W).

See: Agassiz (1881); Mortensen (1951b: 362–362, figs. 168–169, pl. 26, figs. 4–6, pl. 41, figs. 12, 13, 15).

Occurrence: known only from a specimen collected in Brazilian waters.

Depth: 640 m.

Habitat: soft substrates (mud).

Remarks: in the batch of the original description of *Anabrissus damesi* (= *Brissus damesi*), Agassiz (1881) included a specimen from Faial Island (H.M.S. *Challenger*, sta. 75: 38°37'N, 28°30'W, 92–824 m), which was described by H.L. Clark (1925) as a very small juvenile form (<10 mm) with no petals and no genital pores. The animal lacked important diagnostic characters and was later considered as unidentifiable by Mortensen (1951b). Thus, the presence of this species in the archipelago is still to be confirmed and the known material of this species is still restricted to the type material from Brazil waters.

Erroneous—*Arbaciella elegans* Mortensen, 1910

Reports for the Azores:
non *Arbaciella elegans* Mortensen 1910—Marques 1983: 5 [misidentified juvenile of *A. lixula*]; Pereira 1997: 334 [based on Marques 1983]; Haddad & Barreiros 2008: 9 [based on Marques 1983]; Micael & Costa 2010: 322 [based on Marques 1983]; Micael *et al.* 2012: 3. [based on Marques 1983].

Type locality: African west coast (Setté Cama, Gabon).

See: Mortensen (1910, 1935); Koehler (1914b).

Occurrence: East Atlantic, Western tropical Africa from Cape Blanc to the Gulf of Guinea and Angola (Koehler 1914b, Mortensen 1925).

Depth: shallow water (Koehler 1914b).

Remarks: on erecting *Arbaciella elegans*, Mortensen (1910) observed the striking resemblance with young *Arbacia* species, particularly *A. lixula* and *A. lixula africana*, similar enough to cast doubts about the validity of this species (see also Mortensen 1935). Size at first sex maturity (presence of open gonopores), gross morphology, and colouration (which is strikingly colourful in comparison to that of juveniles of *A. lixula*) were the main features used to differentiate this taxon. Revising Azorean material (Museu Bocage—Natural History Museum, Lot no. 20743, Ponta Delgada harbour, São Miguel Island) identified by Marques (1980) as *Arbaciella elegans*, Kroh *et al.* (2011) employed genetic tools and re-visited the ontogenic development of *Arbacia lixula*. They found that *A. lixula* juveniles (the identity of which was confirmed by DNA analysis) are identical in morphology to what previous authors (*e.g.,* Gautier-Michaz 1955, 1958; Molinier & Picard 1956; Regis 1982) have considered as *Arbaciella elegans* in the Mediterranean and the northeastern Atlantic. Kroh *et al.* (2011) thus rejected the records of the *Arbaciella elegans* from these areas (including the Azores) as misidentifications of juveniles of *A. lixula*, reducing the distribution of *Arbaciella elegans* to its type area (tropical West African coasts). In addition, they cautioned that *Arbaciella elegans* as such may not be a distinct taxon and that it might turn out that all *Arbaciella* are juvenile *Arbacia* specimens (in the case of West Africa of *A. lixula africana*) upon DNA-analysis of material from the type region.

Erroneous—*Calymne relicta* Thomson, 1877

Reports for the Azores:
Calymne relicta—Agassiz 1881: 155–157, pl. 34, figs. 1–13, pl. 39, figs. 24–26, pl. 40, figs. 63–65, pl. 43, fig. 24, pl. 44, figs. 47, 48.

Type locality: North of the Bermuda.

See: Mortensen (1950: 129–131, fig. 115); Saucede *et al*. (2009).

Occurrence: North Atlantic deep sea**,** north of the Bermuda, NW of Ampere Seamount and the Newfoundland Basin (Saucède *et al*. 2009).

Habitat: on soft bottoms (muddy sand; Saucede *et al*. 2009).

Depth: 3,720–4,860 m (Saucède *et al*. 2009).

Remarks: on reviewing the material from H.M.S. *Challenger*, H.L. Clark (1925) noticed that the specimens reported by Agassiz (1881) as coming from Faial Island were mislabelled, being from Bermuda's waters in reality.

Erroneous—*Echinometra lucunter lucunter* (Linnaeus, 1758)

Reports for the Azores:

Echinometra subangularis Desmoulins—Agassiz 1872: 234.

See: Mortensen (1943a: 357–368, figs. 172–175, pl. 41, figs. 1–5, pl. 42, figs. 12–14, pl. 43, figs. 1–13, pl. 44, fig. 9, pl. 64, figs. 17, 20–24); Pawson (1978: 20–23, figs. 8–10).

Occurrence: Atlantic, from North Carolina and Bermuda, southwards to Brazil (Mortensen 1943a, Schultz 2006), and eastwards from Cape Verde to Angola (H.L. Clark 1925, Mortensen 1936); the subspecies *E. lucunter polypora* is restricted to Ascension and St. Helena islands (Pawson 1978).

Depth: 0–45 m (Mortensen 1943a).

Habitat: hard substrates (bioeroder; Mortensen 1943a).

Larval stage: planktotrophic (Mortensen 1921).

Fossil record: *Ericichnus bromleyi*, a relatively recent described ichnospecies portraying groove-borings found in a Pliocene fossiliferous outcrop in Malbusca (Santa Maria Island) is thought to be made by the sea urchin *Echinometra lucunter* (see Santos *et al.* 2015).

Commercial value: edible (Lawrence 2007).

Remarks: Agassiz (1872) listed the Azores under the geographical range of *Echinometra lucunter* (under the name *Echinometra subangularis*), which is clearly a misprint. The author never mentioned the archipelago again, whether listing the examined specimens' locations or discussing the distribution range for this species. This tropical species does not occur in the present-day shallow waters of the Azores and no specimens were ever reported from the area.

Erroneous—*Gracilechinus elegans* (Düben & Koren, 1846)

Reports for the Azores:

Echinus elegans (Düben & Koren, 1846)—Mortensen 1927a: 303–304, fig. 139, 1943a: 61–65, fig. 19, pl. 12, figs. 1–8, pl. 13, fig. 1, pl. 14, figs. 1–6; Nobre 1938: 116–117; Gage *et al*. 1985: 185; Mironov 2006: 110; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

Type locality: Bergen, Norway.

See: Düben & Koren (1844: 272–274, pl. 10, figs. 40–42, as *Echinus elegans*); Mortensen (1943a); Mironov (2006).

Occurrence: Mediterranean Sea and Northeast Atlantic (Mecho *et al*. 2014); from Iceland and Scandinavia as far south as Cape Spartel, in the North African coast (Mortensen 1903, 1927a, b); also reported from the Antialtair Seamount (Mironov 2006).

Depth: 50–1,710 m (Mironov 2006).

Habitat: soft sediment; bioeroder (deep-water corals; Stevenson & Rocha 2012).

Larval stage: planktotrophic (Emlet 1995).

Remarks: Mortensen (1927a) listed the Azores under the geographical range of this species. However, to our knowledge no material belonging to *Gracilechinus elegans* was ever recorded from the Azores. Mortensen report seems to be a result of a mistake, which was repeated in later bibliography.

Erroneous—*Homolampas fragilis* (Agassiz, 1869)

Reports for the Azores:
non *Homolampas fragilis* (Agassiz)—A.H. Clark 1949: 376, 377. [misidentified *A. atlantica*]

Type locality: Caribbean.

See: Mortensen (1950: 266–272, pl. 7, figs. 5–6, pl. 13, figs. 5, pl. 25, figs. 1,4, 13, 15–18); Benavides-Serrato *et al*. (2012: 118).

Occurrence: Western Atlantic, known only from the Gulf of Mexico and the Caribbean (Mortensen 1950).

Depth: 550–3,550 m (Mortensen 1950).

Habitat: infaunal, in soft bottoms (Pawson *et al.* 2009).

Remarks: A.H. Clark (1949) reported this species from the Azores, based fragments of two medium-sized specimens retrieved by *Atlantis*, west of São Miguel Island (cruise 152, sta 20: 37°50'30"N, 26°00'00"W, 2,562 m). Later, Serafy (1974) re-examined one of the specimens and assigned it to his newly described species, *Araeolampas atlantica*. The second specimen of H.L. Clark was not mentioned by Serafy, but it seems likely that this also was an *Araeolampas*, since *H. fragilis* does not reach a size larger than 35 mm (Serafy 1974) and confirmed records of *H. fragilis* are restricted to the West Atlantic.

Erroneous—*Holanthus expergitus expergitus* (Lovén, 1874)

Reports for the Azores:
Hemiaster expergitus Lovén, 1874—Agassiz 1881: 186; Mortensen 1907: 97–107, figs. 16–18, pl. 2, figs. 1, 4, 18, 20, pl. 4, figs. 6–8, 10–12, pl. 15, figs. 9, 16–18, 24, 26, 30–31, 35, 38, 44–45, 47–48, 50, 1927a: 323–324, figs. 186, 187.1, 1950: 387–389; Koehler 1909: 247; Gage *et al*. 1985: 186; Koukouras *et al*. 2007: 82.

Type locality: Portugal (38°07'N, 9°18'W).

See: Lovén (1874: 13–17); Mortensen (1907); Mironov (2014: 127).

Occurrence: Mediterranean Sea and North Atlantic (Tortonese 1965), from the Davis Strait to the Caribbean and eastwards from Iceland to Namibia, including Cape Verde (Mortensen 1907, 1927a, b, 1950, Chesher 1966, Mironov 2014); other subspecies are reported from the Pacific and Indian Oceans (Serafy & Fell 1985).

Depth: 380–4,833 m (Serafy & Fell 1985), though mainly at depths below than 1,000 m (Grieg 1932).

Habitat: buried about 12 cm from the surface of soft sediment (sand, mud to ooze; Farran 1913, Grieg 1932).

Remarks: Lovén (1871) stated that he had found a new *Hemiaster* among the material collected at the Josephine Bank. Later, in the description of the species Lovén (1974) corrects to 'c. Lisbon', Portugal (*Josephine*: 38°07'N, 9°18'W, 970 m). Agassiz (1881) commented that H.M.S. *Challenger* also collected specimens of a *Hemiaster* near Lovén's type locality, which Agassiz referred to as 'near the Azores'. However, none of the two H.M.S. *Challenger* stations were located near the archipelago, but in Canaries (sta 8, off Gomera) and Brazilian waters (sta 126: 10°46'S, 36°08'W) instead. In the species distributional overview Agassiz (1881) does not mention the Azores and place Lovén's and H.M.S. *Challenger* specimens where they were originally recorded. Whether subsequent references to the archipelago are related with the initial misprint by Agassiz or to another (unreported) record, we were unable to verify.

Erroneous—*Hygrosoma luculentum* (Agassiz, 1879)

Reports for the Azores:
non *Phormosomum luculentum* Agassiz—Koehler 1895a: 224, 1895b: 228 [misidentified *Hygrosoma petersii*].

Type locality: Pacific.

See: Mortensen (1935: 215–219, 123, 124, pl. 21, pl. 22, figs. 1–2, pl. 78, figs. 22–23).

Occurrence: Pacific and Indian Oceans (Mortensen 1935).

Depth: 400–2,000 m (Mortensen 1935).

Remarks: in his preliminary notes, Koehler (1895a: 224; 1895b: 228) identifies specimens taken in Azorean waters by *Hirondelle* and *Princesse Alice* as the Indo-Pacific *H. luculentum*. Later, Koehler changed his previous determination first in 1889 to *P. uranus* (Koehler, 1898) and finally in 1909 to *Hygrosoma petersii* (see also remarks under *H. petersii*).

Erroneous—*Psammechinus microtuberculatus* (Blainville, 1825)

Reports for the Azores:

non *Echinus microtuberculatus* Blainville, 1825—Barrois 1888: 109 [misidentified of *P. miliaris*];

non *Psammechinus microtuberculatus* (Blainville, 1825)—Nobre 1938: 111–112 [based on Barrois 1888]; Marques 1983: 5 [juvenile *Paracentrotus lividus*]; Castro & Viegas 1983: 24 [misidentified of *P. miliaris*]; Pereira 1997: 334 [based on previous misidentifications]; Haddad & Barreiros 2008: 9 [based on previous misidentifications]; Micael & Costa 2010: 323 [based on previous misidentifications]; Micael *et al*. 2012: 4 [based on previous misidentifications].

Type locality: Mediterranean Sea.

See: Mortensen (1943a: 139–147, figs. 56c, 58c, 59b, 60a, 61, 62, 63a, pl. 10, figs. 6–9, pl. 17, figs. 6–9, pl. 58, figs. 10, 16–18, 22).

Occurrence: restricted to the Mediterranean Sea (Mortensen 1943a).

Depth: 4–100 m (Tortonese 1965).

Habitat: on rocky substrates and *Posidonia* prairies to muddy substrates where it feeds on animal matter (Mortensen 1943a).

Larval stage: planktotrophic (Emlet 1995).

Remarks: see remarks under *Psammechinus miliaris*.

Erroneous—*Salenocidaris profundi profundi* (Duncan, 1877)

Reports for the Azores:

Salenia profundi Duncan, 1877—Mortensen 1927a: 289, fig. 164;

Salenocidaris profundi (Duncan, 1877)—Mortensen 1935: 354–357, pl. 85, figs. 1, 2, 29, 30, 35, 36, pl. 86, figs. 1, 2;

Salenocidaris profundi profundi (Duncan, 1877)—García-Diez *et al*. 2005: 50; Mironov 2014: 123.

Type locality: ?Cape of São Vicente, Portugal.

See: Duncan (1877: 256–257, as *Salenia profundi*); Mortensen (1935).

Occurrence: Northeast Atlantic, from Iceland (Faroe-Iceland banks) and the Bay of Biscay to the Canaries (Mortensen 1935); reported elsewhere from Tristan da Cunha and Indonesia (Mironov 2014).

Depth: 1,700–3,470 m (Mironov 2014).

Habitat: soft sediments (Grieg 1932).

Remarks: the geographic distribution of *Salenocidaris profundi* in the Atlantic is poorly understood due to frequent misidentifications in the literature. Some authors such as H.L. Clark (1925) considered the possibility of this species being conspecific with other Atlantic species, such as *S. varispina* and *S. hastigera*. Mortensen (1935) stated that the latter species was restricted to the Pacific and transferred all reports of *S. hastigera* in the Atlantic to *S. profundi*. Recently, Mironov (2006, 2014) confirmed the occurrence of *S. hastigera* in the Atlantic including the Azores. If all the reports for the archipelago are traced back to original records by Koehler (1895a, 1895b, 1898, 1909) no record of *S. profundi sensu stricto* remains in the archipelago. See remarks under *S. hastigera*.

Erroneous—*Spatangus purpureus* Müller, 1776

Reports for the Azores:

Spatangus purpureus Müller, 1776—Agassiz 1881: 171; Bell 1892: 165–167, pl. 16, fig. 10; Mortensen 1907: 123–128, pl. 2, figs. 8, 12, 14, 16, pl. 16, figs. 1–2, 5–10, 22, 24–25, 27, 29, 31–32, 34, 1927a: 328–329, fig. 190; Koehler 1914b: 279, 1921b: 129–130, figs. 89–90; H.L. Clark 1917: 234; Nobre 1938: 127–128, fig. 55; Harvey 1956: 67; Micael *et al*. 2012: 4.

See: Mortensen (1951b: 10–14); Schultz (2006: 427–428, figs. 802–804).

Occurrence: Northeast Atlantic and Mediterranean Sea (Tortonese 1965), from Iceland and Scandinavia along European and African coasts to Senegal (Mortensen 1951b); possibly also occurring in Cape Verde and Angola (Mortensen 1951a).

Depth: 0–900 m (Koehler 1914b).

Habitat: soft substrates, preferably on coarse sand or gravel, in which it lies wholly buried where it feeds on all sorts of bottom particles and organisms (Mortensen 1927a).

Larval stage: planktotrophic (*c.* 3 weeks; Mortensen 1913).

Remarks: Agassiz (1881) identified the species *Spatangus purpureus* among the material collected by H.M.S. *Challenger* (sta 75: 38°37'N, 28°30'W, 92–165 m) in Azorean waters (no description was given). However, the existence of such specimen(s) could not be confirmed by H.L. Clark (1925) or Mortensen (1951b). Furthermore, the only other H.M.S. *Challenger* specimen identified by Agassiz (1881) as belonging to this species (off Bermuda) later proved to be a misidentification (see Mortensen 1907). Thus, the presence in the Azores of *S. purpureus* remains unconfirmed.

Erroneous—*Spatangus raschi* Lovén, 1869

Reports for the Azores:

Spatangus raschi Lovén, 1869—Agassiz 1872: 159, 1881: 171; Bell 1892: 167–168, pl. 16, fig. 11; Mortensen 1907: 129–130, pl. 1, figs. 4–5, pl. 2, fig. 19, pl. 16, figs. 17, 23, 28; H.L. Clark 1917: 235; Mortensen 1927a: 329–330, figs. 192–193; Grieg 1932: 42–43.

Type locality: ?Norway.

See: Lovén (1869: 733–735, pl. 13); Mortensen (1927a); Schultz (2006: 429, fig. 805).

Occurrence: Northeast Atlantic, from Iceland and Scandinavia to Cap Bojador (NW Africa; Mortesen 1907, 1927b, 1951b).

Depth: 146–1,500 m (Farran 1913).

Habitat: surface deposit feeder on mud to detritic substrates (Farran 1913, Nichols 1959).

Remarks: Agassiz (1872) reported *Spatangus raschi* from the archipelago based on a specimen present in the collection of the Breslau Museum. However, Mortensen (1951b) stated that there was no record of any *S. raschi* specimens from the Azores ever been housed at the museum. Thus, the presence of this species in the archipelago is still to be confirmed.

Class Holothuroidea de Blainville, 1834

Erroneous—*Holothuria* (*Holothuria*) *dakarensis* Panning, 1939

Reports for the Azores:

non *Holothuria dakarensis* Panning, 1939—Rowe 1969: 153, 154 [misidentified];

Holothuria (*Holothuria*) *dakarensis* Panning, 1939—Pérez-Ruzafa *et al.* 1992b: 154–155, 1999: 57, 2002: 287–288 [based on Rowe 1969].

Type locality: Dakar (Senegal).

See: Cherbonnier (1950); Borrero-Pérez *et al.* (2009); Pawson *et al.* (2010: 37–38, fig. 30); Prata *et al.* (2014).

Occurrence: Atlantic, in the west from off Georgia south to the Gulf of Mexico (Pawson *et al.* 2010) and Rio Grande do Norte (Brazil; Prata *et al.* 2014) and in the east from Dakar (Senegal) and Cape Verde to Angola (Cherbonnier 1950, 1965, Borrero-Pérez *et al.* 2009).

Depth: 1–54 m (Borrero-Pérez *et al.* 2009, Prata *et al.* 2014).

Habitat: under rocks on sand or mud (Borrero-Pérez *et al.* (2009).

Larval stage: probably planktotrophic (inferred from the genus; see McEdward & Miner 2001).

Remarks: in a review of the family Holothuriidae, Rowe (1969) listed the Azores under the geographical distribution of *Holothuria dakarensis*, a statement repeated by subsequent works. Pawson & Shirley (1977) believed that Rowe based his statement on material from Faial Island, deposited in the collection of the British Natural History Museum. On re-examination, the authors concluded the specimens belonged either to *H. mammata* or *H. tubulosa* rather than *H. dakarensis*. Furthermore, Borrero-Pérez *et al*. (2009) showed that *H. dakarensis* was historically confused with *H. mammata*, restricting the geographical range of *H. dakarensis* in the East Atlantic to southern latitudes of the African coasts, from Senegal and Cape Verde to Angola.

Erroneous—*Holothuria* (*Holothuria*) *tubulosa* Gmelin, 1791

Reports for the Azores:
non *Holothuria tubulosa* Gmelin, 1790—Nobre 1924: 89, 1930: 23, 1938: 143–144, figs. 58.1, 69.1 [misidentification]; Pawson & Shirley 1977: 915 [based on previous misidentifications]; Marques 1983: 4, fig. 8 [misidentification]; Pereira 1997: 333 [based on previous misidentifications]; Morton *et al*. 1998: 98, 169, figs. 5.2T, 8.8R [misidentification]; Wirtz 2009a: 46 [misidentification]; Micael & Costa 2010: 323 [based on previous misidentifications]; Micael *et al*. 2010: 329 [based on previous misidentifications]; Micael *et al*. 2012: 4 [based on previous misidentifications].

Type locality: Mediterranean Sea.

See: Tortonese (1965: 53–56, figs. 16, 17); Borrero-Pérez *et al*. (2009).

Occurrence: Mediterranean Sea (Tortonese 1965).

Depth: 0–100 m (Tortonese 1965).

Habitat: sand, mud to gravel, on sea grass prairies (Tortonese 1965).

Larval stage: probably planktotrophic (inferred from the genus; see McEdward & Miner 2001).

Commercial value: edible (Sicuro & Levine 2011).

Remarks: see remarks under *H. mammata*.

Erroneous—*Holothuria* (*Rowethuria*) *arguinensis* Koehler & Vaney, 1906b

Reports for the Azores:
Holothuria arguinensis Koehler & Vaney, 1906b—Rowe 1969: 149, 150;
Holothuria (*Lessonothuria*) *arguinensis* Koehler & Vaney, 1906b—Pérez-Ruzafa *et al*. 1992b: 152–153.

Type locality: Mauritania.

See: Koehler & Vaney (1906b: 62–65 pl. 5, figs. 5–13, pl. 6, figs. 14–21); Massin (1993: 399, fig. 1); González-Wangüemert & Borrero-Pérez (2012); Domínguez-Godino *et al*. (2015).

Occurrence: East Atlantic, from Portuguese and Morocco coasts to the North of Senegal and Canaries (Massin 1993, Borrero-Pérez *et al*. 2010); reported elsewhere in the north of the Alboran Sea (Mediterranean Sea; González-Wangüemert & Borrero-Pérez 2012).

Depth: 0– 52 m (Pérez-Ruzafa *et al*. 1992b, Massin 1993).

Habitat: hard to soft substrates, macroalgal beds and seagrass meadows, tide pools (Pérez-Ruzafa *et al*. 1992b).

Larval stage: planktotrophic, with a late non-feeding doliolaria stage (*c*. 18 days at 27–28°C; Domínguez-Godino *et al*. 2015).

Commercial value: edible (Domínguez-Godino *et al*. 2015).

Remarks: in a review of the family Holothuriidae, Rowe (1969) listed the Azores under the geographical distribution of this species. We could not trace the original record and thus consider Rowe's statement as a mistake.

Erroneous—*Laetmogone wyvillethomsoni* Théel, 1879

Reports for the Azores:
non *Laetmogone wyvillethomsoni* Théel, 1879—Hérouard 1902: 31–32, pl. 4, figs. 10–16 [misidentification]; Mortensen 1927a: 361 [based on Hérouard 1902]; Grieg 1932: 5, 46 [based on Hérouard 1902].

Type locality: off Chile, Southern Pacific Ocean.

See: Hansen (1975: 54–57, fig. 20); O'Loughlin (2002: 321).

Occurrence: Southern Ocean and Antarctica (Hansen 1975).

Depth: 245–4,410 m (O'Loughlin 2002).

Habitat: soft substrates (Hansen 1975).

Remarks: Hansen (1975) believed that all historical reports of *Laetmogone wyvillethomsoni* from the Atlantic were misidentifications of closely similar species such as *L. violacea*. However, on re-examination of the specimens identified by Hérouard (1902) from the Azores, Hansen suggested that these animals belonged to a yet unnamed new species (see also remarks under *L. violacea*).

Erroneous—*Mesothuria intestinalis* (Ascanius, 1805)

Reports for the Azores:

Mesothuria intestinalis (Ascanius, 1805)—Mortensen 1927a: 381; Nobre 1938: 150–152; Deichmann 1954: 385–386; Tortonese 1965: 69–70, fig. 26; Pérez-Ruzafa *et al*. 1992b: 144; Micael & Costa 2010: 323; Micael *et al*. 2012: 4.

Type locality: Norway.

See: Gebruk *et al*. (2012: 291–300, figs. 1, 9C–D).

Occurrence: Mediterranean Sea and North Atlantic, from the Caribbean waters eastwards to the Gulf of Guinea, north to Scandinavian waters, including Canaries (Gebruk *et al*. 2012).

Depth: 20–2,480 m, infralitoral depths tend to be restricted to higher latitudes (Gebruk *et al*. 2012).

Habitat: muddy substrates, usually covers itself with shell fragments and other bottom material (Mortensen 1927a).

Larval stage: probably direct or lecithotrophic; hermaphroditic (Mortensen 1927a).

Remarks: historically, reports of *M. intestinalis* and *M. verrilli* are intermingled. For example, Hérouard (1902) considered *M. verrilli* as just a variety of *M. intestinalis*, and placed the material collected by *Princesse Alice* under the later. Hérouard decision led subsequent bibliography (*e.g.,* Mortensen 1927a; Nobre 1938) to include *M. intestinalis* in the Azorean fauna, disregarding the specific value of the variety. Later, Hérouard (1923) reconsidered *M. verrilli* as distinct species, an 'abyssal representative' of *M. intestinalis*. On reviewing *M. verrilli* historical material from the NE Atlantic (including the material taken by *Talisman* in Azorean waters), Gebruk *et al*. (2012) discovered a second species, *M. milleri*. Additionally, by studying ontological changes in *M. milleri* Gebruk recognized his new species in the *M. verrilli* descriptions by Marenzeller (1893) and Hérouard (1902, 1923). Coincidently, such age dependent variation is very close as well of what is known for *M. intestinalis*, leading to the possibility of both species being present among the material collected in the Azores by *Princesse Alice* and *Hirondelle*. Conversely, Gebruk *et al*. (2012) also remarked that *M. intestinalis* is easily distinguished from other *Mesothuria* species by having a sequential hermaphrodite gonad. This particularity was acknowledged by Hérouard (1923) at the time and used this diagnosing character to further substantiate the promotion of *M. verrilli* to a distinct species. Marenzeller (1893) described *Hirondelle*'s specimens as gonochoristic. Thus, the presence of *M. intestinalis* is still to be confirmed in the Azores in spite of its widespread distribution in the North Atlantic (see remarks under *M. milleri*).

Erroneous—*Mesothuria verrilli* (Théel, 1886b)

Reports for the Azores:

non *Holothuria verrilli* Théel, 1886b—Marenzeller 1893: 7–9, pl. 1, fig. 2, pl. 2, fig. 2 [misidentified *M. milleri*];

non *Allantis intestinalis verrilli* (Théel, 1886b)—Hérouard 1902: 18–21, pl. 1, figs. 3–6 [misidentified *M. milleri*];

non *Mesothuria verrilli* (Théel, 1886b)—Perrier 1902: 307–312, figs. 3–4, pl. 16, figs. 22–31 [misidentified *M. milleri*]; Hérouard 1923: 10–13 [misidentified *M. milleri*]; Mortensen 1927a: 381–382, figs. 224.4–5; Deichmann 1930: 93–94, pl. 6, figs. 1–8; Nobre 1938: 152; Harvey *et al*. 1988: 184; Pérez-Ruzafa *et al*. 1992b: 144; García-Diez *et al*. 2005: 51 [all these are based on previous misidentifications].

Type locality: off Ambergris Cay, Caribbean.

See: Théel (1886b: 6; as *Holothuria verrilli*); Gebruk *et al*. (2012: 268–274, fig. 2).

Occurrence: reliable records are restricted to Caribbean waters (Gebruk *et al*. 2012).

Depth: 700–2,683 m (Gebruk *et al*. 2012).

Habitat: soft bottoms (Gebruk *et al*. 2012).

Remarks: in the original description for this species, Théel (1886b) included diagnostic characteristics that could encompass other closely related species such as *M. intestinalis* and *M. milleri*. As a consequence, this species originally described for the Caribbean soon found its geographical range extended to the entire North Atlantic. Later reviews, such as Gebruk *et al.* (2012) have concluded that *M. verrilli* is restricted to the western Atlantic, and NE Atlantic records are most probably confusions with either *M. intestinalis* or *M. milleri*. Thus, reports of this species from the Azores should be dismissed as misidentifications.

Erroneous—*Molpadiodemas atlanticus* (Perrier, 1898)

Reports for the Azores:

Pseudostichopus atlanticus Perrier, 1898—Deichmann 1930: 87–88.

Type locality: between the Azores and European waters (42°19’00”N, 21°15’46”W).

See: Perrier (1902: 333–337, pl. 17, figs. 15–20, as *Pseudostichopus atlanticus*); O’Loughlin & Ahearn (2005: 153, figs. 3a, b, 4a–d, 6a, b); Bohn (2006: 16–19, figs. 9A, 10).

Occurrence: cosmopolitan, Atlantic and Pacific deep waters; from the Caribbean north to west of Greenland (O’Loughlin & Ahearn 2005), east to the West European Basin and south to Southern Africa (Bohn 2006).

Depth: 2,610– 5,415 m (O’Loughlin & Ahearn 2005, Bohn 2006).

Habitat: mud (Perrier 1902).

Remarks: see remarks under *Molpadiodemas villosus.*

Erroneous—*Molpadiodemas villosus* (Théel, 1886a)

Reports for the Azores:

non *Pseudostichopus villosus* Théel, 1886—[$]Hérouard 1902: 11–13, pl. 2, figs. 1–3, pl. 7, fig. 3 [misidentified]; Grieg 1932: 4 [based on Hérouard 1902]; García-Diez *et al*. 2005: 51 [based on Hérouard 1902].

Type locality: off Japan, Pacific (35°22’N, 169°53’E).

See: Théel (1886a: 170–171, as *Pseudostichopus villosus*); O’Loughlin & Ahearn (2005: 164–165, figs. 2a, e, 7d–f, 8q–t, 12a–d).

Occurrence: cosmopolitan; in the Atlantic from the North American Basin south to the Scotia Sea and Antarctica (O’Loughlin & Ahearn 2005).

Depth: 681–5,304 m (O’Loughlin & Ahearn 2005).

Habitat: soft sediments, from mud to ooze (O’Loughlin & Ahearn 2005).

Larval stage: a probable brooder (O’Loughlin & Ahearn 2005).

Remarks: Théel (1886a) remarked that among the material collected by H.M.S. *Challenger* off Chilean waters there were specimens closely resembling his newly described species *Molpadiodemas villosus* (= *Pseudostichopus villosus*), but which lacked tube feet. Perrier (1902) believed that those specimens belonged to his newly described species, *M. atlanticus*. More recently, O’Loughlin & Ahearn (2005) re-examined the material in question and confirmed Perrier’s assumption. In the same year of Perrier’s publication, Hérouard (1902) reported *Molpadiodemas villosus* (= *Pseudostichopus villosus*) from the archipelago based on the material collected by *Princesse Alice* (sta 652: 36°55’00”N, 22°22’45”W; 4,261 m). Coincidently, Hérouard’s description and figures presented an animal with a smooth surface, likewise close to the Chilean material taken by H.M.S. *Challenger* but not to *M. villosus*, which has a hairy like body surface. Deichmann (1930) compared her specimens of *M. atlanticus* from the Caribbean with Hérouard figures and concluded that they were identical. Perrier (1902) believed the distribution of ossicles could be used as a diagnostic character of *M. atlanticus* since *M. villosus* completely lacks ossicles in its tegument. *Princesse Alice* specimens completely lacked ossicles, except in the gonads. On the other hand, it is not uncommon for ossicles to dissolve during preservation, a problem Deichmann (1930) noted in her own *M. atlanticus* specimen.

She attributed this to the acidic nature of the alcohol used to preserve her material. Moreover, in O'Loughlin & Ahearn (2005)'s review stated that ossicles are not always present in this species.

Conversely, Deichmann (1930) omitted data on the internal anatomy, probably because her own specimen had almost no internal organs, due to evisceration. The striking difference that separates *Princesse Alice* material from *M. atlanticus* is its simple non-branching sac-like gonad structure. The genus *Molpadiodemas* as it was re-diagnosed by O'Loughlin & Ahearn (2005) encompasses only holothurians with branching gonads, with tubules arising from a common source at end of a gonoduct, thus excluding *M. atlanticus* and invalidating Deichmann's (1930) suggestion. In contrast, O'Loughlin (2002) believed *Princesse Alice*'s *M. villosus* belonged to the highly variable species *Pseudostichopus peripatus*, a close similar species known to occur in the Azores. Unlike *M. atlanticus* the unbranching gonad structure poses no diagnostic problem. However, O'Loughlin (2002) noted that Hérouard's description encompassed far too large individuals (up to 170 mm), with no distinctive lateroventral margin, and as result the author marked the record as uncertain. Regardless, and in spite of the presence of both *M. atlanticus* and *M. villosus* in the vicinity of the Azorean, the presence of both species in the archipelago is still to be confirmed.

Erroneous—*Pseudostichopus occultatus* Marenzeller, 1893

Reports for the Azores:

non *Pseudostichopus occultatus* Marenzeller, 1893—$^{\$}$Hérouard 1902: 14–15, pl. 2, figs. 4–14 [misidentified *P. peripatus*]; Nobre 1938: 156–157 [based on Hérouard 1902]; García-Diez *et al*. 2005: 51 [based on Hérouard 1902].

Type locality: Mediterranean Sea.

See: O'Loughlin & Ahearn (2005: 173–174); Mecho *et al*. (2014: 288–289, figs. 8A–D).

Occurrence: Mediterranean Sea, reported also from Cape Finisterre, Galicia (NE Atlantic; O'Loughlin & Ahearn 2005).

Depth: 363–2,250 m (O'Loughlin & Ahearn 2005, Mecho *et al*. 2014).

Habitat: mud (Marenzeller 1893).

Remarks: Hérouard (1902) reported *Pseudostichopus occultatus* based on the material collected by *Princesse Alice* at two stations in Azorean waters (sta 527: 38°08'00"N, 23°15'45"W; sta 650: 36°54'00"N, 20°46'15"W). Later, Hérouard (1923) transferred these specimens to two newly described species *P. lapidus* (sta 527) and *P. marenzelleri* (sta 650). Both species are considered synonyms of *P. peripatus*.

Erroneous—*Psychroplanes obsoleta* (Hérouard, 1899)

Reports for the Azores:

Peniagone (*Kolga*) *obsoleta* (Hérouard, 1899)—Perrier 1902: 276.

Type locality: between the Azores and the European continent (39°50'N, 17°57'45"W).

See: Hérouard (1899: 170, fig. 1; 1902: 41–42, pl. 6, figs. 11–15, pl. 8, figs. 16–18, as *Kolga obsoleta*); Hansen (1975: 134–135, fig. 56).

Occurrence: known from the Mid-Atlantic near the equator and the deep waters between the Azores and the European shores (Hansen 1975); reported elsewhere in the east of the Japanese Trench (Pacific; Gebruk *et al*. 2014).

Depth: 4,275–6,096 m (Gebruk *et al*. 2014).

Habitat: soft sediments (Hérouard 1923).

Remarks: Perrier (1902) mentioned *Psychroplanes obsoleta* among the species reported by Hérouard from the Azores. However, Hérouard (1902) clearly states that the specimens came from waters between the Azores and the European mainland (*Princesse Alice*, sta 753: 39°50'00"N, 17°57'45"W, 4,360 m). It is possible that *P. obsoleta* may occur in the abyssal waters of the Azores, considering the known geographical and bathymetric distribution of this species, but at present no records from the archipelago exist.

Erroneous—*Synaptula hydriformis* (Lesueur, 1824)

Reports for the Azores:

non *Synaptula hydriformis* (Lesueur, 1824)—?§Hérouard 1923: 147 [misidentification]; García-Diez *et al*. 2005: 52 [based on Hérouard 1902].

Type locality: Guadalupe, Caribbean.

See: Lesueur (1824: 162–163, as *Holothuria hydriformis*); Deichmann (1954: 407); Laguarda-Figueras *et al*. (2001: 38–39, figs. 18A–D).

Occurrence: Western Atlantic, from Brazil, northwards to Bermuda including the Gulf of Mexico and the Caribbean (Deichmann 1954).

Depth: shallow waters, 1–7 m (Laguarda-Figueras *et al*. 2001).

Habitat: among algae, in mangrove swamps and reef lagoons (H.L. Clark 1942).

Larval stage: viviparous (Deichmann 1954).

Remarks: Hérouard (1923) tentatively attributed poorly preserved material (mainly muscle fragments, with no calcareous deposits) collected by *Princesse Alice* in the Azores (sta 1349: 38°35'00"N, 28°05'45"W), at a depth of 1,250 m to the tropical species *Synaptula hydriformis*. The depth distribution of this species is restricted to the first few meters, which makes the Azorean reported depth highly unlikely.

Discussion

Overall, the echinoderm fauna in the Azores mirrors in a 'microcosm' important issues surrounding this diverse invertebrate group at a biogeographical, ecological, and taxonomical level. For example, the differences in the number of species between classes found in the archipelago are similar to differences seen in other areas (see Pérez-Ruzafa *et al.* 2013) including the nearby Canary Islands (Hernández *et al*. 2013). The Canaries have one of the best-studied echinoderm faunas among the NE Atlantic archipelagos, particularly in shallow waters. Hernández *et al*. (2013) reported a total of 127 species in this archipelago and claimed that the number was higher than those reported from other archipelagos. Our results show that the Azores surpass the Canary Islands by 45 species. However, we agree with Hernández and co-authors in considering that the differences are probably a direct result of differences in sampling efforts. To our knowledge, Azorean deep waters have been more extensively sampled (see Fig. 2) than those of other NE Atlantic archipelagos. Moreover, from a historical point of view, between the late 19th century and early 20th century, most of the material collected in the Azores area was extensively studied by important echinoderm scholars at the time (*e.g.,* Koehler, Mortensen, and Perrier), echoing the 'rule of thumb' that the distribution of a species is strongly biased by the specific research effort in the same area. To illustrate, over 34 echinoderm species alone were described based on specimens collected in the Azores. Notwithstanding, the Azorean faunal lists appear old and out-dated, with many of the reported species being last collected in the area over 100 years ago.

Our results also indicate that species living in the archipelago at depths bellow 50 m are mostly associated with sediments. However, the known habitats for these species are based on biased data, as the majority of the deep-water fauna of the Azores is known from dredging, sometimes over large distances. Furthermore, obvious logistic problems arise when sampling rocky outcrops at depths below 100 m. Nonetheless, the increasing use of ROVs offers new information on the species *in situ*, their environment, ecology, and behaviour (*e.g.,* Roux 1980; Rogacheva *et al*. 2012, 2013). For example, footage recorded by ROV systems has shown that several holothurian species rarely captured with traditional methods are active swimmers (*e.g.,* Rogacheva *et al*. 2012).

Available checklists from the archipelago portray a far more diverse shallow-water echinoderm fauna than one obtained by the present study. Pereira (1997) listed 41 shallow-water echinoderm species for the Azores (<200 m); Micael & Costa (2010) 48 species and, recently, Micael *et al*. (2012) 49 species (≤50 m). The differences among these publications apparently are related to the number of accepted records in each of the bibliographic references acknowledged by the authors. For example, our data show that from the 49 echinoderm species listed by Micael *et al*. (2012) for the Azores, 20 species correspond to misidentifications, synonymies or dubious records. Differences between our results and the above are also related to the definition of shallow-water fauna. Here, we consider shallow-water species only those documented in Azorean waters ≤50 m, whereas the previous authors included any species recorded in shallow waters anywhere in their geographical range, though only in deeper water within the archipelago. For example, the sea star *Luidia sarsii sarsii* Düben & Koren, *in* Düben, 1845, has a remarkable bathymetric range of 9–1,300 m (A.M. Clark & Downey 1992). However, in its southern geographical range it tends to occur only in deep waters (Picton 1993). In the Azores, this species was recorded at depths of 100–200 m and thus is not included in the shallow-water biota of the archipelago herein. For this reason, from the 29 echinoderm species that Micael *et al*. (2012) reported as shallow-water species for the Azores (<50 m), our data show that only 23 occur in the Azores in depths shallower than 50 m.

Another source of discrepancies is the uncritical acceptance of any report from the Azores. In the present study, only species with at least one documented specimen from the Azores are accepted. For example, Koehler (1909) recorded *Ophiopsila aranea* Forbes, 1843, from the Azores based on the material collected by *Princesse Alice* and *Talisman*, though neither ship reportedly collected any animals in the Azores, only in Madeira and Cape Verde waters. We also do not consider species such as *Eucidaris tribuloides* (Lamarck, 1816), based on the unlikelihood that the documented specimens are representatives of an established local population. Koehler (1895a, 1898) reported this tropical species from the Azores based on a small specimen from 130 m. It was never again collected in the area, and Lares & McClintock's (1991) study on the effects of temperature on this species' physiology and biology indicated that it is very unlikely that this tropical species could maintain a viable population in the colder Azorean waters (see as well Madeira *et al.* 2011). Furthermore, it occurs predominantly in shallow waters in its native range. Thus, the individual reported by Koehler may represent a solitary vagrant or was misidentified, and does not represent a real element of the Azorean biota.

As in any other volcanic oceanic island/seamount system, the marine shallow-water fauna of the Azores derives primarily from episodic arrival of settlers that manage to establish a viable population in the archipelago. Among the recent records, two specimens of the tropical, long-spined sea urchin *Diadema africanum* Rodríguez *et al*., 2013, were recorded by Minderlein & Wirtz (2014) off Santa Maria, the southernmost island. This shallow-water sea urchin plays a major role in the structure of the shallow benthic environment of the eastern Atlantic and was classified as a key-herbivore species in the Canaries, where it controls single-handedly the algal assemblages in this archipelago (Tuya *et al*. 2004). This species was previously not known from waters north of the Madeira Archipelago, and we believe that it represents a recent arrival to the archipelago. Thus, the inclusion of *D. africanum* in the shallow-water fauna of the Azores should be considered with caution until further data can confirm the establishment of a population. In contrast, the small sea star *Asterina gibbosa* (Pennant, 1777) was one of the first echinoderm species recorded from the Azores in the late 19th century. However, through the history of zoological studies in the archipelago, we can only find a total of four reports of this species: 1) Barrois (1888) claimed they were quite common on the coast of Faial Island; 2) A.M. Clark & Downey (1992) reported a batch of specimens from the Azores in the Natural History Museum (London), with no further collection data; 3) a photograph taken in 1985 by one of the authors (Frias Martins) of a specimen in the intertidal of São Miguel Island, and 4) Morton *et al*. (1998) observed this sea star in the low intertidal and subtidal of the Azores. The near absence of records for the Azores cannot be explained alone by the cryptic behaviour of this small NE Atlantic sea star. Thus, it appears that local populations of *Asterina gibbosa* could be subject to major fluctuations on Azorean rocky shores. Micael *et al*. (2012) suggested that this species has locally disappeared. Whether this 'disappearance' from the coastal areas of the archipelago is definitive, only time will tell.

The remarkable small number of echinoderm species recorded in the shallow waters of the Azores appears to be related to five contributing factors: limited coastal area, low habitat diversity, absence of extended soft-bottom environments, isolation-by-distance, and the recent volcanic origin of the archipelago. Pérez-Ruzafa *et al.* (2013) showed that the number of echinoderm species is highly dependent of the coastal length. The Azores lack extensive margins of shallow waters; coastal areas contribute less than 1% to the total EEZ area (da Silva & Pinho 2007). Most of the Azorean shallow waters are concentrated around the islands and around a few shallow-water seamounts. The insular platforms are narrow and characterized by steep slopes, in which the sea bottom quickly drops to abyssal depths a short distance from the coast (Ávila *et al*. 2008; Quartau *et al*. 2014) thus imposing significant constraints on the distribution of shallow-water organisms (da Silva & Pinho 2007). Furthermore, most shores are exposed to strong swell (Wallenstein & Neto 2006) with very few protected bays (small and scattered throughout the islands) and even fewer marine lagoons (*e.g.,* Fajã de Santo Cristo; Morton *et al*. 1998). Thus, habitat diversity in the Azores is low, with no documented shallow-water coral reefs, mangroves, nor seagrass, and few places of high sedimentation (in waters <50 m depth), such as muddy or maerl/rumble like bottoms. In the long term, the relatively high exposure of the Azorean coastline together with tropical storms that occasionally reach the archipelago, could have contributed to the exclusion of rheophobic echinoderm species that might have reached the islands. The degree of isolation of the islands from potential nearby sources, about 842 km from the nearest island (Madeira) and 1,370 km from the European continental shores (Morton *et al*. 1998), increases if the main sea-surface currents in the North Atlantic are taken into account. The islands lie in an area of relatively weak eastward flow between the North Atlantic Drift and its southern branch, the Azores Current. The flow originates far to the west off the Grand Banks (Klein & Siedler 1989), thus potentially reducing immigration of new settlers. The Azores is one of the youngest archipelagos in the NE Atlantic, in which island ages range from *c*. 6 Ma (Santa Maria Island; Ramalho *et al*. 2017) to 0.27 Ma (Pico Island; Demand *et al*. 1982). Both active volcanism and earthquakes can have deleterious effects on the local echinoderm communities through the destruction of habitats, abrupt increases in temperature, smothering by ashes or by landslides, displacement by flood waves, gas poisoning, and water acidification (Lawrence 1996). Overall, the Azores Archipelago appears to be a hazardous place for the small echinoderm populations isolated on its shores.

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TABLE S1. List of echinoderms reported for the Azores Archipelago(AZO), with information regarding their geographical distribution (End: endemic; ATL: Atlantic; NATL: North Atlantic; SATL: South Atlantic; NEAT: Northeast Atlantic; EAT: East Atlantic; MED: Mediterranean; WAT: West Atlantic; MID: Mid–Atlantic; Cosmo: cosmopolitan; ART: Arctic; PAC: Pacific Ocean; IND: Indian Ocean), bathymetrical range in the Azores, habitat (Ep: epiphyte or epibiont; In: infaunal; Hy: chemosynthetic; Sb: soft bottoms; Hb: hard substrates; M: both or mix bottoms; BPl: benthopelagic; L: littoral (<50 m); C: circalittoral (50–700 m); B: bathyal (700–2000 m); A: abyssal (2000–4000 m); H: hadal (>4000 m)), type area, status in the Azores (F: frequently documented; H: historical, referred at one time in the bibliography; R: recent addition, after the year 2000; Cf: recently confirmed; Db: doubtful record; Er: erroneous) and first record reference for the archipelago. Erroneous records based on out-dated synonymy (*), erroneously reported for the Azores (**) or misidentifications (***).

Class Crinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Order Comatulida Clark, 1908						
Family Antedonidae Norman, 1865						
Genus *Antedon* de Fréminville, 1811						
Antedon bifida moroccana (Clark, 1914)	NEAT & MED	3–60(?130)	Ep, Hd; L–C	NW Africa	F	Barrois 1888
Genus *Leptometra* Clark, 1908						
Leptometra celtica? (M'Andrew & Barrett, 1857)	EAT	?700	Sb; C	British Isles	Db	Grieg 1932
Family Pentametrocrinidae Clark, 1908						
Genus *Pentametrocrinus* Clark, 1908						
Pentametrocrinus atlanticus (Perrier, 1883a)	NATL	1,165	Sb; C–A	Iberian Peninsula	H	Koehler 1909
Family Bourgueticrinidae Loriol, 1882						
Genus *Democrinus* Perrier, 1883b						
Democrinus parfaiti Perrier, 1883b	NEAT	1,550–1,919 (?2,950)	M; A	NW Africa	H	Carpenter 1883b
Er—*Democrinus rawsonii* (Pourtalès, 1874)	WAT	–	C	Caribbean	Er*	Carpenter 1883b
Family Bathycrinidae Bather, 1899						
Genus *Bathycrinus* Thomson, 1872a						
Bathycrinus gracilis Thomson, 1872a	NEAT	5,005	Sb; A–H	off W France	H	Koehler 1909
Genus *Monachocrinus* Clark, *in* Zittel 1913						
Er—*Monachocrinus recuperatus* (Perrier, 1885a)	EAT	–	Sb;B–H	NEAT (N44°20' W17°10'46")	Er**	Clark 1980
Order Cyrtocrinida Sieverts-Doreck, *in* Moore *et al.*, 1952						
Family Holopodidae Zittel, 1879						
Genus *Cyathidium* Steenstrup, 1847						

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TABLE S1. (Continued)

Class Crinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Cyathidium foresti Cherbonnier & Guille, 1972	NEAT	380–900 (?1,400)	Ep, Hb; C	AZO (N39°23’30″ W31°19’)	F	Cherbonnier & Guille 1972
Order Hyocrinida Rasmussen, 1978						
Family Hyocrinidae Carpenter, 1884						
Genus *Anachalypsicrinus* Clark, 1973						
Anachalypsicrinus nefertiti Clark, 1973	NEAT	2,200–2,810	Hb; A	British Isles	H	Roux 1980
Order Isocrinida Sieverts-Doreck, 1952						
Family Isselicrinidae Klikushkin, 1977						
Genus *Endoxocrinus* Clark, 1908						
Er—*Endoxocrinus* wyvillethomsoni (Thomson, 1872a)	NEAT	–	M; B	Iberian Peninsula	Er**	Clark 1911a

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Order Amphilepidida O'Hara *et al*. 2017						
Family Amphiuridae Ljungman, 1867						
Genus *Amphipholis* Ljungman, 1866						
Amphipholis squamata (Delle Chiaje, 1828)	Cosmo	0–1,229	Ep, M; L–B	MED	F	Ljungman 1872
Genus *Amphiura* Forbes, 1843						
Er—*Amphiura chiajei* Forbes, 1843	NEAT & MED	–	Sb; L–B	MED	Er	Mortensen 1927a
Amphiura otteri Ljungman, 1872	NATL	1,620–1,900	Sb; C–B	Iberian Peninsula	H	Lyman 1882
Amphiura richardi Koehler, 1896b	NEAT	1,165–1,494	M; B	AZO (N38°26’ W26°30’45”)	H	Koehler 1896b
Amphiura sarsi Ljungman, 1872	NEAT	55–1,098	Sb; C–B	AZO	Cf	Ljungman 1872
Amphiura grandisquama Lyman, 1869	Cosmo	599–880	M; L–A	Caribbean	H	Koehler 1896a
Family Ophiactidae Matsumoto, 1915						
Genus *Ophiactis* Lütken, 1856						
Ophiactis abyssicola (Sars, 1861)	Cosmo	726–1,998	M; C–H	Scandinavia	Cf	Koehler 1896a
Ophiactis canotia Lyman, 1879	End	1,830	Sb; B	AZO (N38°30’ W31°14’)	H	Lyman 1879
Ophiactis plana? Lyman, 1869	ATL	?650–?914	Ep, Sb; C–B	Caribbean	Db	Koehler 1909
Ophiactis nidarosiensis? Mortensen, 1920	ATL	?1,095	?Sb; C–?B	Scandinavia	Db	Koehler 1909
Ophiactis tyleri Stöhr & Segonzac, 2005	End	842–844	Hb; B	AZO (N38°18’58”W30°40’32”)	R	Stöhr & Segonzac 2005
Ophiactis virens (Sars, 1859)	NEAT & MED	≤50	Hb; L–C	MED	H	Marques 1983
Family Ophiolepididae Ljungman, 1867						
Genus *Ophiotypa* Koehler, 1897a						
Ophiotypa simplex Koehler, 1897a	Cosmo	3,665	Sb; B–H	IND	H	Cherbonnier & Sibuet 1972
Family Ophionereididae Ljungman, 1867						
Genus *Ophiochiton* Lyman, 1878						
Ophiochiton ternispinus Lyman, 1883	ATL	2,155–2,220	Sb; C–B	British Isles	H	Koehler 1906a
Genus *Ophionereis* Lütken, 1859						
Ophionereis reticulata? (Say, 1825)	WAT	?98–?560	M; L–C	Caribbean	Db	Koehler 1906b

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Family Ophiopholidae O'Hara *et al*. 2018						
Genus *Ophiopholis* Müller & Troschel, 1842						
Ophiopholis aculeata? (Linnaeus, 1767)	NATL & PAC	?	Ep, M; C	?	Db	Lyman 1965
Family Ophiopsilidae Matsumoto, 1915						
Genus *Ophiopsila* Forbes, 1843						
Er—*Ophiopsila aranea* Forbes, 1843	EAT & MED	–	Ep, M; L–C	MED	Er**	Koehler 1909
Family Ophiothamnidae O'Hara *et al*. 2018						
Genus *Histampica* Clark, 1970						
Histampica duplicata (Lyman, 1875)	Cosmo	1,095–2,178	M; C–A	Caribbean	H	Koehler 1896a
Genus *Ophiothamnus* Lyman, 1869						
Er—*Ophiothamnus affinis* Ljungman, 1872	NATL	–	Sb; C–B	Iberian Peninsula	Er**	Nobre 1938
Family Ophiotrichidae Ljungman, 1867						
Genus *Ophiothrix* Müller & Troschel, 1840a						
Er—*Ophiothrix cotteaui* (de Loriol, 1900)	EAT	–	Ep, Sb; L–C	W Africa	Er**	Madsen 1970
Ophiothrix fragilis (Abildgaard, *in* Müller, 1789)	EAT & MED	0–150	Ep, M; L–C	–	F	Ljungman 1872
Ophiothrix luetkeni Thomson, 1873	NEAT	?54–165 (?823)	Sb; C–B	British Isles	H	Lyman 1879
Order Euryalida Lamarck, 1816						
Family Asteronychidae Verrill, 1899						
Genus *Astrodia* Verrill, 1899						
Astrodia tenuispina (Verrill, 1884)	Cosmo	2,480	Ep; C–A	Off New England	H	Sibuet 1972
Family Euryalidae Gray, 1840						
Genus *Asteroschema* Oerstedt & Lütken, *in* Lütken, 1856						
Asteroschema inornatum Koehler, 1906a	NATL	1,478–2,300	Ep; B–A	Bay of Biscay	Cf	Koehler 1909
Order Ophiacanthida O'Hara *et al*., 2017						
Family Ophiacanthidae Ljungman, 1867						
Genus *Ophiacantha* Müller & Troschel, 1842						
Ophiacantha abyssicola Sars, 1872	NATL	880	M; L–A	Scandinavia	H	Koehler 1909

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Ophiacantha aculeata Verrill, 1885a	NATL	2,954–2,968	Sb; B–A	Off Virginia	R	Martynov & Litvinova 2008
Er—*Ophiacantha anomala* Sars, 1872	ATL	–	M; C–A	Scandinavia	Er**	Gage *et al*. 1983
Ophiacantha aristata Koehler, 1895c	NEAT	1,095–1,740	Ep, Sb; B	Bay of Biscay	H	Koehler 1896a
Ophiacantha bidentata? (Bruzelius, 1805)	ART & NATL	?1,287	L–?H	Scandinavia	Db	Koehler 1898
Er—*Ophiacantha brevispina* Koehler, 1898	NEAT	–	Sb; C	Bay of Biscay	Er**	Bartsch 1987
Ophiacantha crassidens Verrill, 1885a	NATL	1,095–2,200	Sb; B–A	North Carolina	Cf	Koehler 1906a
Ophiacantha lineata Koehler, 1896b	NATL	1,165–1,378	Sb; C–A	AZO (N38°26’ W26°30’45”)	H	Koehler 1896b
Ophiacantha mesembria Clark, 1915	NWAT	2,870	Sb; C–A	Caribbean	H	Koehler 1898
Ophiacantha notata Koehler, 1906a	NEAT	850	B	Bay of Biscay	R	Stöhr & Segonzac 2005
Ophiacantha setosa (Bruzelius, 1805)	EAT & MED	?139–1,257	Ep, Sb; L–A	–	H	Koehler 1906b
Ophiacantha simulans Koehler, 1895c	NATL	1,919–3,018	Sb; B–A	Bay of Biscay	H	Koehler 1909
Ophiacantha smitti Ljungman, 1872	NATL	1,550	Sb; C–B	Iberian Peninsula	R	Stöhr & Segonzac 2005
Ophiacantha veterna Koehler, 1907a	NEAT	1,330–2,300	Sb; C–B	NEAT	Cf	Koehler 1921a
Genus *Ophiochondrus* Lyman, 1869						
Ophiochondrus armatus (Koehler, 1907a)	NATL	1,250	Ep; C–B	AZO (N38°35’30” W28°05’45”)	H	Koehler 1907a
Genus *Ophiomitrella* Verrill, 1899						
Er—*Ophiomitrella clavigera* (Ljungman, 1865)	NATL	–	Ep, Sb; C–B	Scandinavia	Er*	Mortensen 1927a
Ophiomitrella cordifera Koehler, 1896b	NEAT	1,143	Sb; C	AZO (N38°52’45” W28°06’)	H	Koehler 1896b
Family Ophiobyrsidae Matsumoto, 1915						
Genus *Ophiophrixus* Clark, 1911b						
Er—*Ophiophrixus spinosus* (Storm, 1881)	NEAT	–	Sb; L–B	Scandinavia	Er**	Paterson 1985
Family Ophiodermatidae Ljungman, 1867						
Genus *Bathypectinura* Clark, 1909						
Er—*Bathypectinura heros* (Lyman, 1879)	Cosmo	–	Sb; C–A	PAC	Er**	Paterson 1985
Genus *Ophioderma* Müller & Troschel, 1840a						

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Ophioderma longicauda? (Bruzelius, 1805)	NEAT & MED	?	Ep, M; L–C	–	Db	Lyman 1865
Family Ophiomyxidae Ljungman, 1867						
Genus *Ophioconis* Lütken, 1869						
Ophioconis forbesi (Heller, 1863)	NEAT & MED	98–130	M; L–C	MED	H	Koehler 1896a
Genus Ophiomyxa Müller & Troschel, 1840a						
Er—*Ophiomyxa pentagona* (Lamarck, 1816)	NEAT & MED	–	M; L–B	MED	Er**	Cherbonnier & Sibuet 1972
Ophiomyxa serpentaria Lyman, 1883	NEAT	599–1,095	M; C–A	Faeroes	H	Koehler 1909
Family Ophiocomidae Ljungman, 1867						
Genus *Ophiocomella* A.H. Clark, 1939						
Er—*Ophiocomella pumila* Lütken, 1856	ATL	–	Ep, Hb; L	Bermuda	Er**	Devaney 1970
Genus *Ophiocomina* Koehler, *in* Mortensen, 1920						
Ophiocomina nigra (Abildgaard, *in* Müller, 1789)	NEAT	6–30	M; L–B	?	F	Barrois 1888
Genus *Ophiotoma* Verrill, 1899						
Ophiotoma alberti (Koehler, 1896b)	NEAT	4,020	Sb; A–H	AZO (38°09'N; 23°15'45"W)	H	Koehler 1896b
Ophiotoma coriacea? Lyman, 1883	NATL	?3,465	Sb; B–H	Off New England	Db	Koehler 1909
Genus Ophiotreta Verrill, 1899						
Ophiotreta valenciennesi (Lyman, 1879)	Cosmo	711–1,442	M; C–B	PAC	Cf	Koehler 1896b
Order Ophioleucida O'Hara *et al*. 2017						
Family Ophiernidae O'Hara *et al*. 2017						
Subfamily Ophioleucinae Matsumoto, 1915						
Genus *Ophiernus* Lyman, 1878						
Ophiernus vallincola Lyman, 1878	Cosmo	1,732–1,919	Sb; B–A	AZO (N37°24'; W25°13')	H	Lyman 1878
Order Ophioscolecida O'Hara *et al*., 2017						
Family Ophioscolecidae Lütken, 1869						
Genus *Ophiomyces* Lyman, 1869						
Ophiomyces frutectosus Lyman, 1869	WAT	575–1,098	M; C–B	Caribbean	H	Ljungman 1872
Family Ophiomyxidae Ljungman, 1867						

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Genus *Ophiogeron* Lyman, 1878						
Er—*Ophiogeron edentulus* Lyman, 1878	PAC	–	Sb; A	PAC	Er***	Lyman 1882
Ophiogeron granulatus? (Lyman, 1883)	WAT	?1,250–?1,647	Sb; C	Caribbean	Db	Lyman 1882
Genus *Ophiophrura* Clark, 1911b						
Ophiophrura tripapillata (Stöhr & Segonzac, 2005)	NEAT	1,015	Hb; B	AZO (N37°50'56" W31°30'40")	R	Stöhr & Segonzac 2005
Order Ophiurida Müller & Troschel, 1840 *sensu* O'Hara *et al.*, 2017						
Genus *Anthophiura* Clark, 1911b						
Anthophiura ingolfi? Fasmer, 1930	NATL	?4,020	Sb; B–A	Iceland	Db	Koehler 1896b
Family Astrophiuridae Sladen, 1879						
Genus *Ophiophycis* Koehler, 1901						
Ophiophycis mirabilis Koehler, 1901	NEAT	1,131–1,201	Ep, Hb; B–A	AZO (N38°26' W26°30'45")	Cf	Koehler 1901
Family Ophiopyrgidae Perrier, 1893						
Genus *Amphiophiura* Matsumoto, 1915						
Amphiophiura convexa (Lyman, 1878)	Cosmo	3,665–4,360	Sb; A–H	PAC	H	Koehler 1909
Genus *Ophiopleura* Duncan, 1878						
Ophiopleura inermis (Lyman, 1878)	ATL	1,740	M; C–B	Off Tristan da Cunha	H	Koehler 1921a
Genus *Ophioplinthus* Lyman, 1878						
Ophioplinthus inornata (Lyman, 1878)	Cosmo	2,995–3,200	Sb; C–A	ATL (MID)	H	Koehler 1906b
Ophioplinthus pseudotessellata Martynov & Litvinova, 2008	End	2,954–2,968	?; A	N AZO (N42°55' W30°20')	R	Martynov & Litvinova 2008
Ophioplinthus tessellata (Verrill, 1894)	NATL	1,919–2,870	Sb; C–H	New England	H	Koehler 1896a
Family Ophiosphalmidae O'Hara *et al*. 2018						
Genus *Ophiomusium* Lyman, 1869						
Er—*Ophiomusium africanum* Koehler, 1909	Cape Verde	–	Sb; C	Cape Verde	Er**	Paterson 1985
Ophiomusium lymani Thomson, 1873	Cosmo	1,384–3,300	Sb; B–A	British Isles	H	Lyman 1878
Genus *Ophiosphalma* Clark, 1941						
Ophiosphalma armigerum (Lyman, 1878)	ATL	2,870–5,005	Sb; A–H	SATL	H	Koehler 1896b

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TABLE S1. (Continued)

Class Ophiuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Family Ophiuridae Müller & Troschel, 1840a						
Genus *Ophiocten* Lütken, 1855						
Ophiocten affinis? (Lütken, 1858)	NEAT	?	Sb; L–C	Scandinavia	Db	Simroth 1888
Ophiocten centobi Paterson *et al*., 1982	NEAT	1,680–2,837	Sb; B–A	Bay of Biscay	R	Stöhr & Segonzac 2005
Ophiocten hastatum Lyman, 1878	Cosmo	1,839–2,017	Sb; B–H	Southern Ocean	Cf	Lyman 1878
Genus *Ophioctenella* Tyler *et al*., 1995						
Ophioctenella acies Tyler *et al*., 1995	ATL	1,626–1,727	Hy; B–A	NATL (MID)	R	Stöhr & Segonzac 2005
Genus *Ophiura* Lamarck, 1801						
Ophiura albida Forbes, 1839	NEAT & MED	20–458	Sb; L–C	British Isles	H	Lyman 1869
Ophiura imprudens (Koehler, 1906a)	NEAT	560	Sb; C	AZO (MID) (N38°23' W31°10')	H	Koehler 1906a
Ophiura ljungmani (Lyman, 1878)	ATL	789–2,968	Sb; C–A	Brazil	F	Lyman 1878
Ophiura saurura (Verrill, 1894)	NATL	2,063–2,968	Sb; B–A	New England	R	Martynov & Litvinova 2008
Ophiura carnea carnea Lütken, 1858	NEAT & MED	599	M; L–A	Scandinavia	Cf	Koehler 1909
Ophiura mundata (Koehler, 1906a)	NATL	1,919–4,020	Sb; B–A	Canaries	H	Koehler 1906b
Ophiura concreta (Koehler, 1901)	EAT	2,845–2,995	Sb; A	Cape Verde	?Cf	Koehler 1906b
Ophiura irrorata? (Lyman, 1878)	Cosmo	3,005–3,050	Sb; C–H	South Africa	Db	Martynov & Litvinova 2008

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TABLE S1. (Continued)

Class Asteroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Order Velatida Perrier, 1884						
Family Myxasteridae Perrier, 1885						
Genus *Pythonaster* Sladen, *in* Thomson & Murray, 1885						
Pythonaster atlantidis Clark, 1948	NATL	3,200	A–H	AZO (N35°37’ W30°51’)	H	Clark 1948
Family Pterasteridae Perrier, 1875						
Genus *Calyptraste*r Sladen, 1882						
Er—*Calyptraster coa* Sladen, 1882	WAT	–	Sb; C–B	Brazil	Er*	Walenkamp 1979
Calyptraster personatus (Perrier, 1885)	ATL	2,871– 2,995	Sb; A–H	AZO (N38°38’ W25°05’46”)	H	Perrier 1894
Genus *Hymenaster* Thomson, 1873						
Hymenaster anomalus Sladen, 1882	WAT	2,954–3,050	Sb; A	SATL (MID)	R	Dilman 2008
Hymenaster giboryi Perrier, 1894	NATL	1,919–4,261	Sb; A–H	NATL	H	Koehler 1909
Hymenaster pellucidus Thomson, 1873	Cosmo	2,870–3,050	Sb; C–A	Faeroes	Cf	Perrier 1896a
Hymenaster roseus Koehler, 1907a	End	1,846–2,102 (?2,370)	Sb; A	AZO	H	Koehler 1909
Hymenaster tenuispinus Sibuet, 1976	NEAT	2,120	A	Off W France	H	Sibuet 1976
Genus *Pteraster* Müller & Troschel, 1842						
Er—*Pteraster alveolatus* Perrier, 1894	NEAT	–	Sb; A	NEAT	Er**	Perrier 1894
Pteraster personatus Sladen, 1891	NATL	1,846–2,870	Sb; C–A	British Isles	H	Koehler 1909
Superorder Forcipulatacea Blake, 1987						
Order Brisingida Fisher, 1928						
Family Brisingidae Sars, 1875						
Genus *Hymenodiscus* Perrier, 1884						
Hymenodiscus coronata (Sars, 1872)	NEAT & MED	919–2,870	Sb; C–A	Scandinavia	H	Perrier 1896a
Family Freyellidae Downey, 1986						
Genus *Freyastera* Downey, 1986						
Er—*Freyastera benthophila* (Sladen, 1889)	Cosmo	–	Sb; H	PAC	Er**	Cherbonnier & Sibuet 1975
Freyastera sexradiata (Perrier, 1885c)	NATL	4,020	Sb; H	NEAT	H	Koehler 1909
Genus *Freyella* Perrier, 1885d						

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TABLE S1. (Continued)

Class Asteroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Freyella elegans (Verrill, 1884)	ATL	2,063–3,050	Sb; B–A	Off New England	Cf	Cherbonnier & Sibuet 1975
Er—*Freyella recta* Koehler, 1907a	MID	–	Sb; A	MID	Er**	Grieg 1932
Order Forcipulatida Perrier, 1884						
Family Asteriidae Gray, 1840						
Genus *Asterias* Linnaeus, 1758						
Asterias rubens? Linnaeus, 1758	NEAT	?0	M; L–C	–	Db	Madeira *et al*. (2017b)
Genus *Coscinasterias* Verrill, 1867						
Coscinasterias tenuispina (Lamarck, 1816)	ALT & MED	0–12	M; L–C	–	F	Barrois 1888
Genus *Sclerasterias* Perrier, 1891						
'Sclerasterias' richardi? (Perrier, *in* Milne-Edwards, 1882)	MED	135	M; C	MED	Db	Madeira *et al*. (2017b)
Genus *Leptasterias* Verrill, 1866						
Er—*Leptasterias* (*Hexasterias*) *polaris* (Müller & Troschel, 1842)	NATL & PAC	–	M; L–C	Greenland	Er***	Perrier 1896
Genus *Marthasterias* Jullien, 1878						
Marthasterias glacialis (Linnaeus, 1758)	EAT & MED	0–35	M; L	–	F	Müller & Troschel 1842
Family Pedicellasteridae Perrier, 1884						
Genus *Hydrasterias* Sladen, 1889						
Er—*Hydrasterias ophidion* (Sladen, 1889)	WAT	–	Sb; A	Nova Scotia	Er***	Clark 1949
Hydrasterias sexradiata (Perrier, *in* Milne–Edwards, 1882)	NEAT	599–3,465	Sb; C–H	Iberian Peninsula	H	Koehler 1909
Family Stichasteridae Perrier, 1885b						
Genus *Neomorphaster* Sladen, 1889						
Neomorphaster margaritaceus (Perrier, *in* Milne–Edwards, 1882)	NEAT	938–2,102	M; C–B (?H)	Bay of Biscay	H	Perrier 1885c
Family Zoroasteridae Sladen, 1889						
Genus *Zoroaster* Thomson, 1873						
Zoroaster fulgens Thomson, 1873	ATL	2,870–3,050	Sb; C–H	Faeroes	Cf	Perrier 1885c
Superorder Valvatacea Blake, 1987						
Order Notomyotida Ludwig, 1910						

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TABLE S1. (Continued)

Class Asteroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Family Benthopectinidae Verrill, 1899						
Genus *Cheiraster* Studer, 1883						
Cheiraster (*Cheiraster*) *sepitus* (Verrill, 1885a)	NATL	1,165–3,706	Sb; B	Nova Scotia	H	Sladen 1889
Genus *Pectinaster* Perrier, 1885c						
Pectinaster filholi Perrier, 1885c	ATL	1,258	Sb; B–H	NW Africa	H	Perrier 1894
Order Paxillosida Perrier, 1884						
Family Astropectinidae Gray, 1840						
Genus Astropecten Gray, 1840						
Astropecten aranciacus? (Linnaeus, 1758)	EAT & MED	?	Sb; L–C	MED	Db	Madsen 1950
Er—*Astropecten bispinosus* (Otto, 1823)	MED	–	Sb; L	MED	Er*	Ludwig 1897
Astropecten hermatophilus Sladen, 1883	NEAT	10–165 (?823)	Sb; L–C (?B)	AZO (N38°38’ W28°28’30”)	Cf	Sladen 1883
Er—*Astropecten irregularis pentacanthus* (Delle Chiaje, 1827)	MED	–	Sb; L–B	MED	Er***	Simroth 188
Astropecten platyacanthus? (Philippi, 1837)	MED	?15–?20	Sb; L	MED	Db	Barrois 1888
Genus *Dytaster* Sladen, 1889						
Dytaster grandis grandis (Verrill, 1884)	NATL	2,954–5,005	Sb; B–H	NWATL	Cf	Sladen 1889
Dytaster insignis (Perrier, 1884)	ATL	2,844–3,670	Sb; A	Gulf of Mexico	H	Cherbonnier & Sibuet 1972
Dytaster intermedius Perrier, 1891	End	2,870	Sb; A	AZO (N41°40’41” W29°04’23”)	H	Perrier 1896a
Dytaster mollis (Perrier, 1885c)	End	2,560–2,995	Sb; A	AZO (N38°38’ W25°05’46”)	H	Perrier 1894
Er—*Dytaster semispinosus* (Perrier, 1894)	NEAT	–	Sb; H	Bay of Biscay	Er**	Clark & Downey 1992
Genus *Persephonaster* Wood–Mason & Alcock, 1891						
Persephonaster patagiatus (Sladen, 1889)	NATL	1,095–1,919	Sb; B–?A	Off Cape Verde	H	Perrier 1896
Persephonaster sphenoplax (Bell, 1892)	NEAT	845–1,187	M; B	British Isles	H	Koehler 1909
Genus *Plutonaster* Sladen, 1889						
Plutonaster agassizi notatus Sladen, 1889	NEAT	1,165–2,178	Sb; B–H	AZO (N38°30’ W31°14’)	Cf	Sladen 1889
Genus *Psilaster* Sladen, *in* Thomson & Murray, 1885						

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TABLE S1. (Continued)

Class Asteroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Psilaster andromeda andromeda? (Müller & Troschel, 1842)	NEAT	?140–?1,440	Sb; C–B	Scandinavia	Db	Perrier 1894
Family Ctenodiscidae Sladen, 1889						
Genus *Ctenodiscus* Müller & Troschel, 1842						
Er—*Ctenodiscus crispatus* (Bruzelius, 1805)	NATL & PAC	–	Sb; L–B	–	Er**	García-Diez *et al*. 2005
Family Luidiidae Sladen, 1889						
Genus *Luidia* Forbes, 1839						
Luidia ciliaris (Philippi, 1837)	NEAT & MED	?	M; L–C	MED	?Cf	Döderlein 1920
Luidia sarsii sarsii Düben & Koren, *in* Düben, 1845	NEAT & MED	?100–200	Sb; L–B	Scandinavia	H	Koehler 1909
Family Porcellanasteridae Sladen, 1883						
Genus *Hyphalaster* Sladen, 1883						
Hyphalaster inermis Sladen, 1883	Cosmo	2,995–3,200	Sb; A–H	PAC	H	Perrier 1885c
Genus *Porcellanaster* Thomson, 1877						
Porcellanaster ceruleus Thomson, 1877	Cosmo	2,995	Sb; B–H	off Delaware	H	Perrier 1885c
Genus *Styracaster* Sladen, 1883						
Styracaster armatus Sladen, 1883	Cosmo	2,995–4,020	Sb; A–H	PAC	H	Perrier 1885c
Styracaster elongatus Koehler, 1907a	Cosmo	4,020	Sb; A–H	NATL	H	Koehler 1909
Genus *Thoracaster* Sladen, 1883						
Er—*Thoracaster cylindratus* Sladen, 1883	Cosmo	–	Sb; A–H	NATL	Er**	Clark & Downey 1992
Family Pseudarchasteridae Sladen, 1889						
Genus *Paragonaster* Sladen, *in* Thomson & Murray, 1885						
Paragonaster subtilis (Perrier, 1881)	ATL	2,965–4,261	Sb; B–H	Gulf of Mexico	Cf	Perrier 1885c
Genus *Pseudarchaster* Sladen, 1889						
Pseudarchaster gracilis gracilis (Sladen, 1889)	NATL	903 –1,940	Sb; C–A	AZO (N37°24’ W25°13’)	Cf	Sladen 1889
Pseudarchaster parelii (Düben & Koren, 1846)	NATL	1,165–1,900	Sb; C–A	Scandinavia	H	Perrier 1885c
Superorder Spinulosacea Blake, 1987						
Order Spinulosida Perrier, 1884						
Family Echinasteridae Verrill, 1867						
Genus *Henricia* Gray, 1840						

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TABLE S1. (Continued)

Class Asteroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Henricia cylindrella? (Sladen, 1883)	NEAT	?1,482–?1,805	?Sb; A	British Isles	Db	Koehler 1909
Henricia oculata? (Pennant, 1777)	NEAT	?1,266–?1,557	M; L–?C	British Isles	Db	Perrier 1896a
Er—*Henricia sanguinolenta* (Müller, 1776)	NEAT	–	Hb; L	Scandinavia	Er*	Koehler 1921
Superorder Valvatacea Blake, 1987						
Order Valvatida Perrier, 1884						
Family Asterinidae Gray, 1840						
Genus *Asterina* Nardo, 1834						
Asterina gibbosa (Pennant, 1777)	EAT & MED	0	Hb; L–C	–	H	Barrois 1888
Family Chaetasteridae Sladen, 1889						
Genus *Chaetaster* Müller & Troschel, 1840b						
Chaetaster longipes (Bruzelius, 1805)	EAT & MED	30–165(?823)	M; L–B	?MED	Cf	Sladen 1889
Family Goniasteridae Forbes, 1841						
Genus *Ceramaster* Verrill, 1899						
Ceramaster granularis granularis (Retzius, 1783)	NATL	1,384	M; L–A	NATL	H	Perrier 1896a
Ceramaster grenadensis grenadensis (Perrier, 1881)	ATL & MED	1,095–1,557	Sb; C–A	Caribbean	H	Perrier 1885c
Genus *Plinthaster* Verrill, 1899						
Plinthaster dentatus (Perrier, 1884)	ATL	1,095–1,740	Ep, Sb; C–A	Caribbean	H	Perrier 1885c
Genus *Sphaeriodiscus* Fisher, 1910						
Sphaeriodiscus bourgeti (Perrier, 1885c)	NEAT	560	Sb; C	Cape Verde	H	Perrier 1885c
Family Odontasteridae Verrill, 1899						
Genus *Hoplaster* Perrier, *in* Milne–Edwards, 1882						
Hoplaster spinosus Perrier, *in* Milne–Edwards, 1882	EAT	1,829–2,595	Sb; A	British Isles	H	Sladen 1889
Family Ophidiasteridae Verrill, 1870						
Genus *Hacelia* Gray, 1840						
Hacelia attenuata Gray, 1840	NEAT & MED	1–165(?823)	M; L–C	–	Cf	Sladen 1889
Genus *Ophidiaster* Agassiz, 1836						
Ophidiaster ophidianus (Lamarck, 1816)	NEAT & MED	0–165(?823)	H; L–C	MED	F	Barrois 1888
Ophidiaster reyssi Sibuet, 1977	NEAT & MED	350	H; C	AZO (N39°33’ W31°17’30”)	H	Sibuet 1977

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TABLE S1. (Continued)

Class Echinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Subclass *Cidaroidea* Smith, 1984						
Order *Cidaroida* Claus, 1880						
Family *Cidaridae* Gray, 1825						
Genus *Cidaris* Leske, 1778						
Cidaris cidaris (Linnaeus, 1758)	NATL & MED	165–1,385	M; C–A	–	Cf	Koehler 1895a
Genus *Eucidaris* Pomel, 1883						
Eucidaris tribuloides? (Lamarck, 1816)	ATL	130	Hb; L–C	–	Db	Koehler 1895a
Genus *Stereocidaris* Pomel, 1883						
Stereocidaris ingolfiana? Mortensen, 1903	NATL	?2,050–?3,300	Sb; C–B	Denmark Strait	Db	Pérès 1992
Family *Histocidaridae* Lambert, 1900						
Genus *Histocidaris* Mortensen, 1903						
Histocidaris purpurata? (Thomson, 1872b)	NATL	?800	Sb; C–B	British Isles	Db	Pérès 1992
Subclass *Euechinoidea* Bronn, 1860						
Infraclass *Acroechinoidea* Smith, 1981						
Order *Diadematoida* Duncan, 1889						
Family *Diadematidae* Gray, 1855a						
Genus *Diadema* Gray, 1825						
Diadema africanum? Rodríguez *et al.*, 2013	EAT	8	Hb; L	Canaries Islands	Dd	Minderlein & Wirtz 2014
Genus *Centrostephanus* Peters, 1855						
Centrostephanus longispinus (Philippi, 1845)	NATL & MED	6–468	M; L–C	MED	F	Barrois 1888
Order *Pedinoida* Mortensen, 1939						
Family *Pedinidae* Pomel, 1883						
Genus *Caenopedina* Agassiz, 1869						
Caenopedina cubensis Agassiz, 1869	NATL	1,187	Sb; C–B	Caribbean	H	Koehler 1909
Infraclass *Carinacea* Kroh & Smith, 2010						
Superorder *Calycina* Gregory, 1900						
Order *Salenioida* Delage & Hérouard, 1903						
Family *Saleniidae* Agassiz, 1838						
Genus *Salenocidaris* Agassiz, 1869						
Salenocidaris hastigera (Agassiz, 1879)	Cosmo	793–2,440	C–A	PAC	Cf	Koehler 1895a

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TABLE S1. (Continued)

Class Echinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Er—*Salenocidaris profundi profundi* (Duncan, 1877)	NEAT	–		Iberian Peninsula	Er*	Mortensen 1927a
Salenocidaris varispina Agassiz, 1869	Cosmo	(?718)1,165–1,830	Sb; C–A	Caribbean	Cf	Agassiz 1881
Superorder *Echinacea* Claus, 1876						
Order *Arbacioida* Gregory, 1900						
Family *Arbaciidae* Gray, 1855						
Genus *Arbacia* Gray, 1835						
Arbacia lixula (Linnaeus, 1758)	ATL & MED	0–55	Hb; L	?	F	Drouët 1861
Genus *Arbaciella* Mortensen, 1910						
Er—*Arbaciella elegans* Mortensen, 1910	EAT	–	L	W Africa	Er***	Marques 1983
Order *Camarodonta* Jackson, 1912						
Infraorder *Echinidea* Kroh & Smith, 2010						
Family *Echinidae* Gray, 1825						
Genus *Echinus* Linnaeus, 1758						
Echinus melo Lamarck, 1816	NEAT & MED	200–475	M; L–B	–	Cf	Koehler 1909
Genus *Gracilechinus* Fell & Pawson, 1966						
Gracilechinus acutus? (Lamarck, 1816)	NEAT & MED	?380–?500	Sb; L–B	–	Db	Koehler 1898
Gracilechinus affinis (Mortensen, 1903)	NATL	1,482–2,252	Sb; B–A	Iceland	H	Koehler 1909
Er—*Gracilechinus elegans* (Düben & Koren, 1844)	NEAT & MED	Scandinavia	Sb; B	–	Er**	Mortensen 1927a
Gracilechinus alexandri (Danielssen & Koren, 1883)	NATL	1,165–1,940(?2,560)	Sb; B	Scandinavia	Cf	Koehler 1895b
Family *Parechinidae* Mortensen, 1903						
Genus *Paracentrotus* Mortensen, 1903						
Paracentrotus lividus (Lamarck, 1816)	NEAT & MED	0–40(?207)	Hb; L	–	F	Drouët 1861
Genus *Psammechinus* Agassiz & Desor, 1846						
Er—*Psammechinus microtuberculatus* (Blainville, 1825)	MED	–	M; L–C	MED	Er**	Barrois 1888
Psammechinus miliaris? (Müller, in Knorr, 1771)	NEAT	?10–?20	M; L–C	–	Db	Barrois 1888
Superfamily *Odontophora* Kroh & Smith, 2010						
Family *Echinometridae* Gray, 1855						
Genus *Echinometra* Gray, 1825						
Er—*Echinometra lucunter lucunter* (Linnaeus, 1758)	ATL	–	Hb; L	–	Er**	Agassiz 1872

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TABLE S1. (Continued)

Class Echinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Family *Toxopneustidae* Troschel, 1872						
Genus *Sphaerechinus* Desor, 1856						
Sphaerechinus granularis (Lamarck, 1816)	NEAT & MED	0–60	M; L–C	?	F	Drouët 1861
Infraorder *Temnopleuridea* Kroh & Smith, 2010						
Family *Trigonocidaridae* Mortensen, 1903						
Genus *Trigonocidaris* Agassiz, 1869						
Trigonocidaris albida Agassiz, 1869	Cosmo	349–550	M; C–B	Caribbean	H	Koehler 1895a
Genus *Genocidaris* Agassiz, 1869						
Genocidaris maculata Agassiz, 1869	ATL & MED	(?0)20–200(?823)	Sb; L–C	Caribbean	Cf	Agassiz 1881
Order *Echinothurioida* Claus, 1880						
Family *Echinothuriidae* Thomson, 1872b						
Genus *Araeosoma* Mortensen, 1903b						
Araeosoma fenestratum (Thomson, 1872b)	NATL	?900	Sb; C–B	Iberian Peninsula	R	Mironov 2006
Genus *Calveriosoma* Mortensen, 1934						
Calveriosoma hystrix (Thomson, 1872b)	NEAT	800–1,528	Sb; C–A	British Isles	H	Koehler 1895a
Genus *Hygrosoma* Mortensen, 1903						
Er—*Hygrosoma luculentum* (Agassiz, 1879)	PAC & IND	–	C–B	PAC	Er***	Koehler 1895a
Hygrosoma petersii (Agassiz, 1880)	ATL	1,165–2,870(?3,237)	Sb; C–A	Caribbean	?Cf	Koehler 1895a
Genus *Sperosoma* Koehler, 1897b						
Sperosoma grimaldii Koehler, 1897b	NEAT	1,213–2,107	Sb; C–A	AZO	Cf	Koehler 1897b
Genus *Tromikosoma* Mortensen, 1903						
Tromikosoma koehleri Mortensen, 1903	NATL	2,954–2,968	A	Davis Strait	R	Mironov 2008
Tromikosoma uranus? (Thomson, 1877)	NEAT	?1,830	?Sb; B–A	Off Iberian Peninsula	Db	Agassiz 1881
Family *Phormosomatidae* Mortensen, 1934						
Genus *Phormosoma* Thomson, 1872						
Phormosoma placenta placenta Thomson, 1872	NATL	1,257	Sb; C–A	British Isles	H	Mortensen 1927b
Infraclass *Irregularia* Latreille, 1825						
Superorder *Atelostomata* Zittel, 1879						
Order *Holasteroida* Durham & Melville, 1957						
Suborder *Meridosternata* Lovén, 1883						

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TABLE S1. (Continued)

Class Echinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Infraorder *Urechinina* Clark, 1946						
Family *Calymnidae* Mortensen, 1907						
Genus *Calymne* Thomson, 1877						
Er—*Calymne relicta* Thomson, 1877	NATL	–	Sb; A–H	Bermuda	Er**	Agassiz 1881
Order *Spatangoida* Agassiz, 1840						
Family *Hemiasteridae* Clark, 1917						
Genus *Holanthus* Lambert & Thiéry, 1924						
Er—*Holanthus expergitus expergitus* (Lovén, 1874)	NATL & MED	–	In; C–A	Iberian Peninsula	Er**	Agassiz 1881
Suborder *Brissidina* Stockley *et al.*, 2005						
Family *Brissidae* Gray, 1855						
Genus *Anabrissus* Mortensen, 1950						
Er—*Anabrissus damesi* (Agassiz, 1881)	WAT	–	Sb; L–C (?B)	Brazil	Er***	Agassiz 1881
Genus *Brissopsis* Agassiz, 1840						
Brissopsis lyrifera lyrifera (Forbes, 1841)	EAT & MED	130	Sb; L–B	British Isles	H	Koehler 1895a
Genus *Brissus* Gray, 1825						
Brissus unicolor (Leske, 1778)	ATL & MED	?7–45	Sb; L–?C	–	F	Barrois 1888
Family *Palaeotropidae* Lambert, 1896						
Genus *Palaeotropus* Lovén, 1874						
Palaeotropus josephinae Lovén, 1871	EAT	500–1600	M; C–B	AZO	H	Lovén 1874
Superfamily *Spatangoidea* Gray, 1825						
Family *Spatangidae* Gray, 1825						
Genus *Spatangus* Gray, 1825						
Er—*Spatangus purpureus* Müller, 1776	NEAT & EAT	–	In; L–B	?	Er**	Agassiz 1881
Er—*Spatangus raschi* Lovén, 1869	NEAT	–	Sb; C–B	Scandinavia	Er**	Agassiz 1872
Family *Loveniidae* Lambert, 1905						
Genus *Araeolampas* Serafy, 1974						
Araeolampas atlantica Serafy, 1974	NATL	2,585	In; A	Off Virginia	H	Serafy 1974
Subfamily *Echinocardiinae* Cooke, 1942						
Genus *Echinocardium* Gray, 1825						

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TABLE S1. (Continued)

Class Echinoidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area	Status	First record
Echinocardium cordatum (Pennant, 1777)	Cosmo	15–20	In; L–C	–	Cf	Marques 188
Echinocardium flavescens (Müller, 1776)	NEAT & MED	?15–?30	In; L–C	–	H	Tortonese 1965
Family *Maretiidae* Lambert, 1905						
Genus *Homolampas* Agassiz, 1874						
Er—*Homolampas fragilis* (Agassiz, 1869)	WAT	–	In; C–A	Caribbean	Er***	Clark 1949
Suborder *Paleopneustina* Markov & Solovjev, 2001						
Family *Paleopneustidae* Agassiz, 1904						
Genus *Peripatagus* Koehler, 1895b						
Peripatagus cinctus Koehler, 1895b	Cosmo	880–1,494	M; C–B	AZO (N38°47’40” W28°17’5”)	H	Koehler 1895b
Family *Schizasteridae* Lambert, 1905						
Genus *Aceste* Thomson, 1877						
Aceste bellidifera Thomson, 1877	ATL	1,360	In; B–H	Canaries Islands	H	Koehler 1909
Superorder *Neognathostomata* Smith, 1981						
Order *Clypeasteroida* Agassiz, 1872						
Suborder *Scutellina* Haeckel, 1896						
Infraorder *Laganiformes* Desor, 1847						
Family *Echinocyamidae* Lambert & Thiéry, 1914						
Genus *Echinocyamus* van Phelsum, 1774						
Echinocyamus grandiporus Mortensen, 1907	NATL	320–1,385	Sb; C–A	–	Cf	Koehler 1898
Echinocyamus pusillus (Müller, 1776)	NEAT & MED	0–207(?1,250)	Sb; L–?B	–	F	Drouët 1861
Echinocyamus scaber macrostomus Mortensen, 1907	NATL	1,560–2,178	Sb; B–A	–	H	Mortensen 1907

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TABLE S1. (Continued)

Class Holothuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area (AZO)	Status	First record
Order *Apodida* Brandt, 1835						
Family *Chiridotidae* Östergren, 1898						
Genus *Chiridota* Eschscholtz, 1829						
Chiridota abyssicola Marenzeller, 1892	End	2,870 m	Sb; A	AZO (N41°40'41" W26°44'09")	H	Marenzeller 1892
Family *Synaptidae* Burmeister, 1837						
Genus *Leptosynapta* Verrill, 1867						
Leptosynapta inhaerens (Müller, 1776)	NEAT & MED	0	In; L–C	Scandinavia	R	Wirtz 2009
Genus *Synaptula* Oersted, 1849						
Er—*Synaptula hydriformis* (Lesueur, 1824)	WAT	–	L	Caribbean	Er***	Hérouard 1923
Order *Dendrochirotida* Grube, 1840						
Family *Cucumariidae* Ludwig, 1894						
Genus *Abyssocucumis* Heding, 1942						
Abyssocucumis abyssorum (Théel, 1886a)	Cosmo	2,870	Sb; B–H	IND	H	Marenzeller 1892
Genus *Pawsonia* Rowe, 1970						
Pawsonia saxicola? (Brady & Robertson, 1871)	NEAT & MED	?130	M; L	British Isles	Db	Marenzeller 1892
Family *Phyllophoridae* Östergren, 1907						
Genus *Thyone* Jaeger, 1833						
Thyone inermis? Heller, 1868	NEAT & MED	?130–?1,385	In; L	MED	Db	Marenzeller 1892
Order *Elasipodida* Théel, 1882						
Family *Elpidiidae* Théel, 1882						
Genus *Amperima* Pawson, 1965						
Amperima furcata (Hérouard, 1899)	Cosmo	1,846–2,968	Sb, BPl; B–H	AZO (MID) (N39°11' W30°44'40")	Cf	Hérouard 1899
Genus *Ellipinion* Hérouard, 1923						
Ellipinion delagei (Hérouard, 1896)	NATL	1,165–1,494	Sb, BPl; B–A	AZO (N37°42'40" W25°05'15")	H	Hérouard 1896
Genus *Peniagone* Théel, 1882						
Peniagone azorica Marenzeller, 1892	NATL	1,385–4,020	Sb, BPl; B–A	AZO (N41°40'41" W26°44'09")	H	Marenzeller 1892

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TABLE S1. (Continued)

Class Holothuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area (AZO)	Status	First record
Peniagone diaphana (Théel, 1882)	Cosmo	5,005	Sb, BPl; B–H	PAC	H	Hérouard 1899
Peniagone longipapillata Gebruk, 2008	NEAT	2,954–3,050	BPl; A	MID	R	Gebruk 2008
Peniagone marecoi Gebruk, 2008	NATL	2,063–3,050	B–A	AZO (MID)(N42°46’ W29°16’)	R	Gebruk 2008
Genus *Penilpidia* Gebruk, 1988						
Penilpidia midatlantica Gebruk, 2008	MID	2,063–2,107	?BPl; A	AZO (MID)(N42°46’ W29°16’)	R	Gebruk 2008
Genus *Psychroplanes* Gebruk, 1988						
Er—*Psychroplanes obsoleta* (Hérouard, 1899)	Cosmo	–	Sb; H	NATL	Er**	Perrier 1902
Family Laetmogonidae Ekman, 1926						
Genus *Benthogone* Koehler, 1895c						
Benthogone rosea Koehler, 1896c	Cosmo	1,900	Sb; C–A	Bay of Biscay	H	Hérouard 1923
Genus *Laetmogone* Théel, 1879						
Laetmogone violacea Théel, 1879	Cosmo	1,442–?1,550	Sb; C–B	PAC	H	Perrier 1902
Er—*Laetmogone wyvillethomsoni* Théel, 1879	Southern Ocean	–	Sb; C–H	PAC	Er***	Hérouard 1902
Family Psychropotidae Théel, 1882						
Genus *Benthodytes* Théel, 1882						
Benthodytes gosarsi Gebruk, 2008	NATL	2,954–2,968	Sb, BPl; A	AZO (MID)(N42°55’ W30°20’)	R	Gebruk 2008
Benthodytes janthina Marenzeller, 1892	End	2,870	Sb; A	AZO (N41°40’41” W26°44’09”)	H	Marenzeller 1892
Benthodytes lingua Perrier, 1896	ATL	2,102–3,050	Sb; BPl; B–H	NW Africa	Cf	Hérouard 1902
Benthodytes sanguinolenta Théel, 1882	Cosmo	2,954–2,968	Sb; BPl; B–H	PAC	R	Gebruk 2008
Benthodytes typica Théel, 1882	Cosmo	2,063–3,300	Sb; BPl; B–H	NW Africa	Cf	Hérouard 1902
Benthodytes valdiviae Hansen, 1975	ATL	3,005–3,050	A	NW Africa	R	Gebruk 2008
Genus *Psychropotes* Théel, 1882						

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TABLE S1. (Continued)

Class Holothuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area (AZO)	Status	First record
Psychropotes depressa (Théel, 1882)	Cosmo	2,063–3,050	Sb, BPl; B–A	NW Africa	Cf	Perrier 1902
Psychropotes longicauda Théel, 1882	Cosmo	2,954–4,020	Sb, BPl; A–H	PAC	Cf	Hérouard 1896
Psychropotes semperiana Théel, 1882	Cosmo	5,005	Sb, BPl; A–H	SATL	H	Hérouard 1902
Order *Holothuriida* Miller *et al*., 2017						
Family *Holothuriidae* Burmeister, 1837						
Genus *Holothuria* Linnaeus, 1767						
Holothuria mexicana? Ludwig, 1875	WAT	?98	M; L	Gulf of Mexico	Db	Hérouard 1902
Er—*Holothuria dakarensis* Panning, 1939	ATL	–	M; L	W Africa	Er***	Rowe 1969
Holothuria mammata Grube, 1840	NEAT & MED	<30	M; L–C	MED	F	Nobre 1924
Er—*Holothuria tubulosa* Gmelin, 1791	MED	–	Sb; L–C	MED	Er***	Nobre 1924
Holothuria forskali Delle Chiaje, 1823	NEAT & MED	0–12	M; L–C	–	F	Marques 1983
Holothuria sanctori Delle Chiaje, 1823	NEAT & MED	0–30	M; L	MED	F	Selenka 1867
Er—*Holothuria arguinensis* Koehler & Vaney, 1906	NEAT & MED	–	M; L	NW Africa	Er**	Rowe 1969
Holothuria lentiginosa lentiginosa Marenzeller, 1892	NEAT & MED	(?130)208–275(?316)	M; C	AZO (N38°31’19” W28°34’31”)	Cf	Marenzeller
Family Mesothuriidae Smirnov, 2012						
Genus *Mesothuria* Ludwig, 1894						
Mesothuria maroccana Perrier, 1898	NATL	(?1,600)1,740–2,968	M; C–A	NW Africa	Cf	Hérouard 1923
Mesothuria milleri Gebruk & Solís-Marín, *in* Gebruk *et al*., 2012	NEAT	1,258–2,155 (?3,018)	Sb; C–H	British Isles	R	Gebruk *et al*. 2012
Er—*Mesothuria intestinalis* (Ascanius, 1805)	NATL & MED	–	Sb; L–A	Scandinavia	Er*	Mortensen 1927a
Mesothuria murrayi (Théel, 1886a)	Cosmo	?1,660–1,940	Sb; C–H	PAC	H	Gebruk *et al*. 2012
Mesothuria rugosa Hérouard, 1912	NATL	1,600	Sb; B–A	Cape Verde	H	Hérouard 1902
Er—*Mesothuria verrilli* (Théel, 1886b)			Sb; B–A	Caribbean	Er***	Marenzeller 1893
Genus *Zygothuria* Perrier, 1898						
Zygothuria lactea (Théel, 1886a)	Cosmo	1165–2,102	Sb; B–H	PAC	H	Théel 1886a
Order Persiculida Miller *et al*., 2017						
Genus *Benthothuria* Perrier, 1898						

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TABLE S1. (Continued)

Class Holothuroidea	Geographical Range	Bathymetry (AZO, m)	Habitat	Type area (AZO)	Status	First record
Benthothuria funebris Perrier, 1898	EAT	2,954–2,968	Sb,?BPl; B–A	NW Africa	R	Gebruk 2008
Family Molpadiodemidae Miller *et al*., 2017						
Genus *Molpadiodemas* Heding, 1935						
Er—*Molpadiodemas atlanticus* (Perrier, 1898)	Cosmo	–	Sb; A–H	NATL	Er***	Deichmann 1930
Er—*Molpadiodemas villosus* (Théel, 1886a)	Cosmo	–	Sb; B–H	PAC	Er***	Hérouard 1902
Family Pseudostichopodidae Miller *et al*., 2017						
Genus *Pseudostichopus* Théel, 1886						
Er—*Pseudostichopus occultatus* Marenzeller, 1893	MED	–	Sb; C–B	MED	Er***	Hérouard 1902
Pseudostichopus peripatus (Sluiter, 1901)	Cosmo	(?2,871)4,020–4,400	Sb; C–H	PAC	H	Hérouard 1902
Order Synallactida Miller *et al*., 2017						
Family Stichopodidae Haeckel, 1896						
Genus Parastichopus Clark, 1922						
Parastichopus regalis (Cuvier, 1817)	ATL & MED	40–275	Sb; L–B	MED	R	Wirtz & Debelius 2003
Family Synallactidae Ludwig, 1894						
Genus *Paelopatides* Théel, 1886						
Paelopatides atlantica Hérouard, 1902	End	4,020	H	AZO (N38°08' W23°15'45")	H	Hérouard 1902
Family Deimatidae Théel, 1882						
Genus *Deima* Théel, 1879						
Deima validum validum Théel, 1879	Cosmo	2,954–2,968	Sb; B–H	PAC	R	Gebruk 2008
Genus *Oneirophanta* Théel, 1879						
Oneirophanta mutabilis mutabilis Théel, 1879	Cosmo	2,954–3,050	Sb; A–H	IND	R	Gebruk 2008