Species composition of sea stars (Echinodermata: Asteroidea) in the Patagonian Argentinian deep sea, including seven new records: connectivity with sub-Antarctic and Antarctic fauna

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Abstract
The main target of this paper is to improve the knowledge of the species composition of sea stars in Patagonian Argentine deep sea reaching depths of 2062 m. In addition, these results offer us the opportunity to analyze the possible connections between Argentinian marine fauna and adjacent Antarctic areas that have become a topic of interest in the past few years. This work is based on Atlantic Projects’ surveys carried out on an atypical and especially vulnerable marine ecosystems (canyons created from craters collapse by gas leaks). These are profusely impacted by frequent fishing activities, being one of the most important and international fishing grounds, where 887 records (1878 specimens) of 41 species of asteroids were collected in 217 stations ranging from 219 to 2062 m in depth. Seven of those species are proposed as new records: (Diplasterias octoradiata (Studer 1885), Plutonaster bifrons (Wyville Thomson, 1873), Radiaster elegans Perrier, 1881, Anseropoda antarctica Fisher, 1940, Pilloshuriaster calvus Mah, 2011, Paralophaster lorioli (Koehler, 1907), Pteraster flabellifer Mortensen 1933). After refining the database built from literature and open-access databases such as OBIS and AntBIF, the new Argentinian asteroids deep-water checklist contains 2198 records from 64 asteroids species including the 7 new records proposed. Most of these 64 species (89.06%) are present in Antarctic-adjacent waters, and after the study of their occurrences at traditional biogeographic entities, our results support the hypothesis that Argentinian waters (in the case of the class Asteroidea) should be considered part of the sub-Antarctic entity.

Keywords Asteroids · Asteroidea · Argentine · Antarctica

Introduction
The distribution of Argentinian marine fauna and their connection with adjacent areas has become a topic of interest in the last few years. Regarding the north, a good study of these connections can be found in Alvarado and Solís-Marín (2013) and, within this field, the study undertaken by Brogger et al. (2013a) in Argentinean waters. Regarding the south, some authors have tried to explain how species distribution areas can help to analyze the existence of biogeographical entities (regions or provinces) in the Southern Ocean, mainly based on their occurrence (Hedgpeth 1969; Rodriguez et al. 2007; Griffiths et al. 2009; De Broyer et al. 2014; Figuerola et al. 2017; Weir and Stanworth 2019, among others). In the case of echinoderms, the most recent studies have been carried out by Martin-Ledo and Lopez Gonzalez (2014), Danis et al. (2014), Eleaume et al. (2014), Saimède et al. (2014), and Moreau et al. (2017, 2018, 2019, 2021), among others. The study area is located in the Southwest Atlantic. It extends over 200 miles from the exclusive economic zone of Argentinian waters and reaches a depth of 2062 m. This zone is known as the Patagonian fishing area, owing to the fishing activities undertaken here by many countries, among them Spain (del Rio et al. 2012). These fishing activities are related to the area’s high biodiversity, which is mainly due to the nutrient-rich upwelling during spring and summer as a consequence of the confluence of two ocean currents: the warm, subtropical Brazilian current (BC), which flows from the north, and the cold, deeper current from the Malvinas/Falkland Islands (M/FI) from the south. The latter could be considered a branch of the Antarctic Circumpolar Current...
(ACC) (Piola and Rivas 1997; Piola and Matano 2001; Rivas et al. 2006; Campagna et al. 2007). In addition, the bottom morphology shows a canyon system with very special features since it was created from the collapse of a series of pockmarks (craters produced by gas leaks).

In this context, the Spanish General Secretariat of Fisheries charged the Spanish Institute of Oceanography (Instituto Español de Oceanografía, IEO), with the undertaking of a series of multidisciplinary research surveys (focused on slope and canyon systems: Atlantis Project; del Rio et al. 2012) aimed at studying the potential existence of vulnerable marine ecosystems (VMEs), where echinoderms, among others, represent one of the most abundant and frequent taxa in the area.

Most studies on echinoderms from this area are restricted to the Argentinian shelf or near the slope, such as Bernasconi (1934, 1935, 1937, 1941a, 1941b, 1943, 1962a, 1962b, 1963, 1964a, 1964b, 1965, 1966a, 1972, 1973a, 1980), Tablado (1982), and Tablado and Maytia (1988), and more recent studies, such as Brogger et al. (2010, 2013b), Martínez and Brogger (2012), Martínez et al. (2015), Souto et al. (2014), Brogger and O’Hara (2015), Di Giorgio et al. (2015), Arribas et al. (2016), Epherra et al. (2015, 2017), Hunter et al. (2016); Martínez (2016), Martínez and Penchasazdeh (2017), Martínez et al. (2018; 2020), Wilkie and Brogger (2018), Carames et al. (2019), Flores et al. (2019), Martín and Tavares (2019), and Gil et al. (2020). With regard to the class Asteroidea, few papers have been published recently: Romanelli and Tablado (2011), Pérez et al. (2017), Cossi et al. (2017), Arribas et al. (2017), Bercocechua et al. (2017), Rivadeneira et al. (2017), Fraysse et al. (2018), Rivadeneira et al. (2020) and Fraysse et al. (2020), and Moreau et al. (2018, 2021). However, some asteroids were found in deeper areas that were recorded on research cruises, such as the Challenger, Vema, and Walter Herwig, with results published by Sladen (1882, 1883) and Bernasconi (1965, 1966b, 1973b) respectively.

The objectives of the present work are to review the asteroid diversity in the study area considering: (1) the wide depth range covered by the Atlantis project compared with previous studies, (2) the potential record of new species occurrences, with better descriptions of species depth ranges, and (3) quantifying the number of common species shared with Antarctic waters describing potential connections between these two areas.

Material and methods

Field sampling

Sampling was done during Atlantis Projects’ surveys (13 multidisciplinary research expeditions) on board the Miguel Oliver vessel from 2007 to 2010 (Fig. 1). Different equipment was used: rock dredge (0.8 m wide and 0.3 m high; mesh size 10 mm), mega box corer dredge, and LOFOTEN trawl (31.20 m × 17.70 m; mesh size 35 mm).

Fauna was collected at 480 stations; however, only 217 stations were taken into account (219 m to 2062 m depth) because the present study is restricted to the slope and canyons system (Table 1).

Identification and taxonomy

Asteroids were sorted and fixed in 70% ethanol. Identification was based on morphological characters according to: Clark and Downey (1992), Clark (1962), Bernasconi (1934, 1935, 1937, 1941a, 1943, 1957, 1961, 1962a, 1962b, 1963, 1964a, 1964b, 1965, 1966a, 1966b, 1967, 1972, 1973a, 1980), Tablado (1982), Tablado and Maytia (1988), McKnight (2006), Mah (2011, 2018), and the original descriptions. Asteroids’ classifications were checked in World Register of Marine Species (WoRMS: Mah 2022), and new record species AphiaID (urn:lsid:marinespecies.org:taxname) were included for consulting and referring to synonymies. Morphological notations follow Clark and Downey (1992).

Datasets

After species identification, the results were georeferenced and included in a dataset.

Several publicly available datasets were used for species distribution analysis: Ocean Biogeographic Information System (OBIS), Antarctic Biodiversity Information Facility (AntBIF), Museo Argentino de Ciencias Naturales (MACN), and online USNM Invertebrate Zoology Collection database. On the other hand, other records were include coming from literature such as Mah (2011), Mah and Blake (2012), Souto et al. (2014), Moreau et al. (2018), Guillaumeot et al. (2020), and Moreau et al. (2021). These records were assessed to determine their reliability on the basis of two criteria: (1) records published in scientific journals and (2) records or human observations from international surveys or institutions and identified by experts of recognized standing. The reliable records were included together with Atlantic surveys ones that were curated following a polygon built (ArcGIS 10.7) delimiting the area of study to the appropriated countries borders and depth range (nodes: 37.69°S, 69.37°W; 37.69°S, 48.97°W; 55.78°S, 68.60°W; 55.67°S, 63.48°W; 49.81°S, 63.54°W; 49.63°S, 48.97°W).
Arc (SA), sub-Antarctic Islands, including Bouvet Island, Prince Edward Islands, Crozet Islands and Kerguelen Islands (SAI), and Antarctica (A) following Griffiths et al. (2009), based on Moore et al. (1999).

Results

Studied area checklist and new records

A total of 1878 specimens, belonging to 41 asteroid species (Table 2), were found where Ctenodiscus australis were the most frequent and abundant (22.68%; 50.23%), followed by Cheiraster planeta (9.31%; 28.57%) and Henricia studeri (12.83%; 28.57%).

Twenty-four species expanded their bathymetric range (Table 3), and seven species are proposed as new records for Argentinian waters, which are summarized below (Fig. 2, 3; Online Resource 1).

Phylum Echinodermata Klein 1778  
Class Asteroidea Blainville 1830

Order Forcipulatida Perrier 1884  
Family Asteriidae Gray 1840

Genus Diplasterias Perrier 1891  
Diplasterias octoradiata (Studer 1885), new record (Fig. 2a–c)  
AphiaID: 172655  
Diagnosis Arms 7–9, rarely 5, 6, 10. Abactinal surface rigid, skin pustular, skeleton continuous and delicate with spines numerous with a crossed pedicellariae wreath (Fig. 2a). Superomarginal spines with a wreath of crossed pedicellariae (Fig. 2b). Adambulacral plates without crossed pedicellariae, straight and predominantly monacanthid (Fig. 2c).  
Distribution Malvinas/Falkland Islands, The Scotia Arc, Ross Sea, Wilkes Land. Present study: Argentine. New record: 2 specimens (Online Resource 1).  
Bathymetric range 7–866 m (Ahearn 1995; USNM1087183 from Invertebrate Collection Database, NMNH). Present study: 849–855 m.  
Remarks Diplasterias octoradiata and Diplasterias radiata (Koehler 1923) (7–10 arms) could be confused because of their arms number overlap; however, the number of adambulacral spines are different: D. radiata are diplacanthid, and D. octoradiata are monacanthid.

Order Paxillosida Perrier 1884  
Family Astropectinidae Gray 1840

Fig. 1 Area of study. a General view with the sampled area labeled as b. b Sampled area; stations are represented by black dots.
Table 1 Geographical positions (LAT, latitude; LON, longitude) and depth (D) of the stations (ST) from Atlantis Project (Argentine slope and canyons system)

| ST      | LAT   | LON   | D   | ST      | LAT   | LON   | D   |
|---------|-------|-------|-----|---------|-------|-------|-----|
| DR01.0108 | −46.66 | −59.62 | 980 | DR17.0108 | −45.46 | −58.88 | 1820 |
| DR01.0209 | −43.92 | −59.30 | 1369 | LO1.1207 | −46.27 | −60.12 | 533  |
| DR01.0210 | −41.90 | −57.85 | 338  | LO10.1207 | −45.55 | −59.87 | 772  |
| DR01.1008 | −46.94 | −60.01 | 761  | LO100.09 | −45.54 | −59.12 | 1383 |
| DR02.0209 | −44.73 | −59.61 | 1226 | LO101.08 | −45.76 | −59.54 | 1110 |
| DR02.0210 | −41.89 | −57.78 | 417  | LO101.09 | −45.51 | −59.20 | 1343 |
| DR02.1008 | −46.98 | −60.03 | 720  | LO102.08 | −45.72 | −59.72 | 896  |
| DR02.1208 | −45.83 | −59.80 | 922  | LO103.08 | −45.53 | −59.74 | 836  |
| DR03.0108 | −46.95 | −59.95 | 782  | LO105.08 | −45.27 | −59.68 | 875  |
| DR03.1208 | −45.83 | −59.80 | 922  | LO106.08 | −45.27 | −59.68 | 875  |
| DR04.0209 | −44.75 | −59.27 | 1543 | LO107.08 | −45.27 | −59.78 | 784  |
| DR04.1008 | −41.98 | −57.97 | 521  | LO108.09 | −45.28 | −59.54 | 1043 |
| DR04.1208 | −45.83 | −59.80 | 926  | LO109.09 | −45.32 | −59.69 | 870  |
| DR05.0209 | −44.66 | −59.76 | 1002 | LO110.09 | −45.27 | −59.18 | 1359 |
| DR05.0210 | −42.01 | −57.93 | 775  | LO112.09 | −45.27 | −59.68 | 909  |
| DR05.1008 | −46.97 | −59.79 | 917  | LO113.09 | −45.03 | −59.49 | 1241 |
| DR05.1208 | −45.65 | −59.66 | 1320 | LO114.09 | −45.00 | −59.61 | 1180 |
| DR06.0209 | −44.70 | −59.23 | 2062 | LO115.09 | −45.74 | −59.29 | 1334 |
| DR06.0210 | −42.02 | −57.94 | 476  | LO116.09 | −45.29 | −59.55 | 1037 |
| DR06.1008 | −47.28 | −59.96 | 901  | LO117.09 | −45.59 | −59.61 | 1093 |
| DR06.1208 | −46.03 | −59.94 | 732  | LO118.09 | −45.36 | −59.50 | 1255 |
| DR07.0108 | −46.37 | −59.84 | 783  | LO119.09 | −45.24 | −59.32 | 1233 |
| DR07.0209 | −44.74 | −59.32 | 1432 | LO120.09 | −45.09 | −59.95 | 445  |
| DR07.1008 | −45.68 | −59.93 | 780  | LO121.09 | −45.27 | −59.75 | 939  |
| DR07.1208 | −45.50 | −59.87 | 845  | LO122.09 | −45.27 | −59.94 | 1087 |
| DR08.0108 | −44.20 | −57.83 | 1061 | LO123.09 | −45.26 | −59.87 | 1043 |
| DR08.0210 | −47.19 | −59.94 | 809  | LO124.09 | −45.59 | −60.01 | 472  |
| DR08.1008 | −44.14 | −59.38 | 1640 | LO125.09 | −45.30 | −59.12 | 1353 |
| DR08.1208 | −42.12 | −57.74 | 1054 | LO126.09 | −45.23 | −59.50 | 1105 |
| DR09.0209 | −47.19 | −59.90 | 782  | LO127.09 | −45.48 | −59.87 | 1105 |
| DR09.0210 | −45.86 | −59.69 | 1077 | LO128.09 | −45.59 | −60.06 | 480  |
| DR10.0209 | −44.17 | −59.18 | 1530 | LO129.09 | −45.47 | −60.00 | 424  |
| DR10.0210 | −47.19 | −59.76 | 815  | LO130.09 | −45.94 | −60.05 | 533  |
| DR10.1008 | −46.12 | −59.57 | 1023 | LO131.09 | −45.75 | −60.13 | 219  |
| DR11.0108 | −45.41 | −59.76 | 863  | LO132.09 | −45.69 | −60.00 | 623  |
| DR11.0209 | −43.98 | −59.29 | 1399 | LO133.09 | −45.95 | −60.06 | 480  |
| DR11.1008 | −47.17 | −59.65 | 927  | LO134.09 | −45.83 | −59.99 | 685  |
| DR11.1208 | −45.97 | −59.62 | 1067 | LO135.09 | −45.90 | −60.12 | 319  |
| DR12.0108 | −45.18 | −59.89 | 805  | LO136.09 | −45.94 | −60.11 | 342  |
| DR12.0209 | −43.68 | −59.10 | 1551 | LO137.09 | −46.09 | −60.05 | 597  |
| DR12.1008 | −46.90 | −59.55 | 1055 | LO138.09 | −46.10 | −60.19 | 262  |
| DR14.1208 | −45.96 | −59.80 | 852  | LO139.09 | −46.23 | −60.09 | 561  |
| DR15.0108 | −45.41 | −59.21 | 1900 | LO140.09 | −46.72 | −60.24 | 570  |
| DR16.0108 | −45.31 | −59.42 | 1547 | LO141.09 | −46.55 | −59.90 | 734  |
| ST    | LAT   | LON   | D   | ST    | LAT   | LON   | D   |
|-------|-------|-------|-----|-------|-------|-------|-----|
| DR16.1208 | -45.86 | -59.95 | 760 | LO36.10 | -46.63 | -60.24 | 522 |
| LO37.08  | -46.70 | -60.12 | 631 | LO69.08 | -47.48 | -59.47 | 1051 |
| LO37.10  | -46.66 | -60.33 | 457 | LO69.09 | -47.49 | 59.81  | 785 |
| LO38.09  | -46.41 | -60.20 | 464 | LO7.09  | -45.42 | -60.02 | 350 |
| LO39.09  | -46.47 | -60.13 | 583 | LO70.08 | -47.07 | -60.32 | 582 |
| LO4.1207 | -45.84 | -59.92 | 780 | LO70.09 | -47.41 | -60.01 | 718 |
| LO40.08  | -46.94 | -60.72 | 273 | LO71.08 | -47.08 | -60.20 | 657 |
| LO45.08  | -46.37 | -60.09 | 620 | LO71.09 | -47.34 | -59.90 | 766 |
| LO47.08  | -47.63 | -60.52 | 479 | LO71.10 | -47.18 | -60.29 | 578 |
| LO47.10  | -46.94 | -60.48 | 475 | LO72.08 | -47.23 | -60.21 | 636 |
| LO48.09  | -46.74 | -60.61 | 245 | LO72.09 | -47.26 | -60.03 | 726 |
| LO48.10  | -46.84 | -60.61 | 290 | LO72.10 | -47.16 | -60.21 | 625 |
| LO49.08  | -47.41 | -60.58 | 459 | LO73.08 | -47.22 | -60.10 | 696 |
| LO5.10   | -45.28 | -59.98 | 405 | LO73.09 | -47.24 | -60.10 | 692 |
| LO50.09  | -46.95 | -60.59 | 374 | LO73.10 | -47.04 | -60.12 | 665 |
| LO50.10  | -47.03 | -60.62 | 371 | LO74.08 | -47.11 | -59.99 | 755 |
| LO51.08  | -47.37 | -60.69 | 415 | LO74.09 | -47.78 | -59.66 | 774 |
| LO51.09  | -47.01 | -60.51 | 469 | LO75.08 | -47.13 | -59.86 | 808 |
| LO52.08  | -47.24 | -60.69 | 393 | LO75.09 | -47.61 | -59.57 | 911 |
| LO52.09  | -47.10 | -60.60 | 427 | LO75.10 | -46.90 | -59.89 | 801 |
| LO53.09  | -46.93 | -60.69 | 274 | LO76.09 | -47.51 | -59.60 | 909 |
| LO54.08  | -47.56 | -60.22 | 611 | LO76.10 | -46.88 | -60.11 | 670 |
| LO55.08  | -47.47 | -60.38 | 549 | LO77.08 | -47.00 | -59.64 | 957 |
| LO55.09  | -47.11 | -60.34 | 565 | LO77.09 | -47.40 | -59.68 | 876 |
| LO56.08  | -47.33 | -60.26 | 612 | LO78.10 | -46.62 | -59.86 | 738 |
| LO56.09  | -47.02 | -60.25 | 618 | LO79.08 | -46.91 | -59.91 | 787 |
| LO56.10  | -47.36 | -60.56 | 462 | LO79.09 | -47.15 | -59.80 | 852 |
| LO57.08  | -47.35 | -60.42 | 542 | LO79.10 | -46.44 | -59.87 | 723 |
| LO57.09  | -47.16 | -60.25 | 612 | LO8.09  | -45.47 | -59.92 | 720 |
| LO57.10  | -47.32 | -60.49 | 495 | LO8.08  | -46.77 | -60.31 | 520 |
| LO58.08  | -47.21 | -60.39 | 545 | LO8.09  | -46.76 | -60.31 | 519 |
| LO58.09  | -47.24 | -60.31 | 585 | LO8.10  | -46.41 | -59.68 | 832 |
| LO59.08  | -47.33 | -59.87 | 787 | LO8.10  | -46.88 | -60.17 | 651 |
| LO59.09  | -47.64 | -60.56 | 461 | LO8.09  | -46.88 | -60.15 | 643 |
| LO60.08  | -47.44 | -59.89 | 761 | LO8.10  | -46.08 | -59.64 | 899 |
| LO60.09  | -47.43 | -60.73 | 394 | LO8.09  | -46.85 | -59.99 | 723 |
| LO61.08  | -47.62 | -60.03 | 680 | LO8.10  | -45.88 | -59.81 | 844 |
| LO61.09  | -47.32 | -60.64 | 428 | LO8.09  | -46.90 | -59.81 | 886 |
| LO62.08  | -47.74 | -59.77 | 745 | LO8.08  | -46.64 | -59.87 | 744 |
| LO62.10  | -47.45 | -59.95 | 727 | LO8.09  | -47.05 | -59.91 | 784 |
| LO63.08  | -47.57 | -59.72 | 779 | LO8.09  | -46.44 | -59.65 | 865 |
| LO63.09  | -47.36 | -60.35 | 567 | LO8.08  | -46.52 | -60.24 | 480 |
| LO63.10  | -47.58 | -59.89 | 725 | LO8.09  | -46.47 | -59.62 | 883 |
| LO64.08  | -47.42 | -59.72 | 847 | LO8.08  | -46.48 | -60.10 | 619 |
| LO64.09  | -47.52 | -60.24 | 603 | LO8.10  | -45.76 | -59.74 | 865 |
| LO65.09  | -47.65 | -60.20 | 595 | LO8.08  | -46.46 | -59.95 | 693 |
| LO66.09  | -47.69 | -60.06 | 654 | LO8.09  | -46.46 | -59.96 | 690 |
| LO67.09  | -47.66 | -59.85 | 730 | LO8.10  | -45.55 | -59.66 | 896 |
| LO67.10  | -47.56 | -59.65 | 850 | LO8.08  | -46.41 | -59.80 | 784 |
| LO68.09  | -47.56 | -59.71 | 814 | LO8.10  | -45.61 | -59.92 | 758 |
Genus *Plutonaster* Sladen 1889

*Plutonaster bifrons* (Wyville Thomson 1873), new record (Fig. 2d–g)

AphiaID: 123904

**Diagnosis** Quite long arms $R/r = 3.4/1–5.0/1$, with narrow tips, almost pointed. Abactinal surface with plates with rather thin paxillae, in transverse series (Fig. 2d). Abactinal paxillae with columns oval in cross-section, crowned with 15–25 short spines. Marginal plates, both superomarginal and inferomarginal with only one prominent conical spine, and otherwise covered with very minute spines (Fig. 2f). Actinal plates covered with minute spines or granules and often with a single conical spine (Fig. 2e). Adambulacral plates with 5–10 furrow spines of equal size, outside of which is a single large conical spine (Fig. 2g).

**Distribution** Mediterranean Sea, Northeast Atlantic Ocean (from Faroe Islands to Gulf of Guinea, including Canary Islands), Northwest Atlantic Ocean (from New Jersey (USA) to Venezuela). Present study: Argentine. New record: 9 specimens (Online Resource 1).

**Bathymetric range** 100–3587 m (Mortensen 1927; USNM E-31521 from Invertebrate Collection Database, NMNH). Present study 1037–1820 m.

**Remarks** Related to *Plutonaster agassizi* (Verrill 1880), *P. bifrons* shows a narrow and pointed arms with a terminal plate as long as wide, since *P. agassizi* ones are rounded, their tips are blunt, and their superomarginal plates curve inward. In contrast, the superomarginal armament of *P. bifrons* has spines on all plates and relatively long and pointed. *P. agassizi* does not present spines, at least from the distal side, and, if present, they are short, rigid, or conical.

Family Radiasteridae Fisher 1916

Genus *Radiaster* Perrier 1881

*Radiaster elegans* Perrier 1881, new record (Fig. 2h–l)

AphiaID: 152510

**Diagnosis** Arms long $R/r = 3.5/1$, with small madreporite (Fig. 2h). Marginal plates with double series of spines larger than abactinal and actinal plates (Fig. 2k, 2l). Transverse series of actinal plates (Fig. 2i) different from the adambulacral ones (Fig. 2j). Oral plates markedly enlarged so that each jaw has a double keel of numerous suboral spines.

**Distribution** Caribe Sea, Venezuela. Present study: Argentine. New record: 1 specimen (Online Resource 1).

**Bathymetric range** 604–1446 m (USNM E19305, Oregon II expedition 1970, USNM E 31524 from Invertebrate Collection Database, NMNH). Present study 1077 m.

**Remarks** There are five *Radiaster* species (including *R. elegans*): *Radiaster elegans* Perrier 1881 [Gulf of Mexico (USNM E 31,524) from Leeward I. to north of Guayana (Clark and Downey, 1992)]. It presents long arms and small madreporite; *Radiaster gracilis* (H.L. Clark, 1916) (New Zealand and Australia, Tasmania: Mah et al. 2009) presents...
| Order     | Family          | Species                              | A Stations                                                                 |
|-----------|-----------------|--------------------------------------|-----------------------------------------------------------------------------|
| Forcipulatida | Asteriidae | Anteliaster australis Fisher, 1940  | 35 DR04.1008, DR07.0108, DR12.0209, DR14.1208, LO10.1207, LO102.08, LO108.08, LO122.09, LO29.09, LO33.09, LO37.10, LO50.10, LO56.08, LO62.08, LO63.09, LO63.10, LO72.08, LO79.08, LO87.08, LO87.10, LO88.09, LO9.1207, LO92.09 |
|           |                 | Diplasterias brandti Bell, 1881      | 22 DR01.0209, DR04.0210, LO105.08, LO121.09, LO14.08, LO39.09, LO45.08, LO50.09, LO53.09, LO57.09, LO58.08, LO58.09, LO67.09, LO71.09, LO72.09, LO83.09 |
|           |                 | Diplasterias brucei Koehler, 1907    | 25 DR07.0209, DR16.1208, LO108.08, LO20.09, LO29.09, LO33.09, LO37.08, LO77.09, LO80.09, LO80.10, LO81.08, LO82.09, LO82.10, LO86.08, LO88.08, LO89.10, LO9.1207, LO92.09, LO93.10, LO98.09 |
|           |                 | Diplasterias octoradiata Studer, 1885| 2 LO92.09, LO93.09 |
| La        | Lethasterias australis Fisher, 1923 | 117 DR15.0108, DR16.1208, LO10.1207, LO108.08, LO108.09, LO122.09, LO2.1207, LO21.09, LO26.09, LO28.09, LO33.09, LO36.10, LO38.09, LO39.09, LO45.08, LO50.09, LO52.08, LO59.09, LO62.08, LO63.09, LO66.09, LO67.09, LO68.09, LO69.08, LO71.08, LO71.09, LO72.10, LO73.09, LO73.10, LO74.09, LO75.08, LO77.09, LO80.09, LO80.10, LO81.08, LO82.09, LO82.10, LO86.08, LO88.08, LO89.10, LO9.1207, LO92.09, LO93.10, LO98.09 |
|           | Labidiaster radiosus Loven in Lütken, 1871 | 2 LO10.1207, LO21.09 |
| Pm        | Psalidaster mordax Fisher, 1940  | 52 DR01.0209, DR03.1008, DR05.1208, DR08.0108, DR15.0108, DR16.1208, DR01.0209, DR03.1008, DR03.1208, DR09.1208, DR12.0108, DR12.1008, DR16.1208, DR17.0108, LO10.1207, LO108.08, LO108.09, LO123.09, LO21.09, LO28.09, LO34.10, LO36.08, LO37.08, LO39.09, LO45.08, LO49.08, LO52.09, LO54.08, LO55.09, LO56.08, LO56.09, LO57.08, LO57.09, LO58.08, LO58.09, LO59.09, LO60.09, LO61.09, LO62.08, LO63.09, LO64.09, LO65.09, LO66.09, LO67.09, LO67.09, LO70.08, LO70.09, LO71.09, LO71.10, LO72.09, LO73.08, LO73.09, LO73.10, LO74.09, LO75.08, LO77.09, LO80.09, LO80.10, LO81.08, LO82.09, LO82.10, LO86.08, LO88.08, LO89.10, LO9.1207, LO90.09, LO93.10, LO98.09 |
| Ss        | Smilasterias scalprifera Sladen, 1889 | 10 LO120.08, LO14.08, LO72.08, LO84.09, LO92.09, LO94.09 |
|           |                  |                                      | 174 DR02.0209, DR02.1008, DR03.1008, DR03.1208, DR09.1208, DR12.0108, DR12.1008, DR16.1208, DR17.0108, LO10.1207, LO108.08, LO108.09, LO123.09, LO21.09, LO28.09, LO34.10, LO36.08, LO37.08, LO39.09, LO45.08, LO49.08, LO52.09, LO54.08, LO55.09, LO56.08, LO56.09, LO57.08, LO57.09, LO58.08, LO58.09, LO59.09, LO60.09, LO61.09, LO62.08, LO63.09, LO64.09, LO65.09, LO66.09, LO67.09, LO67.09, LO70.08, LO70.09, LO71.09, LO71.10, LO72.09, LO73.08, LO73.09, LO73.10, LO74.09, LO81.09, LO81.09, LO83.09, LO84.08, LO87.08, LO88.08, LO88.09, LO90.09, LO99.09, LO99.09, LO93.08, LO93.09, LO96.08 |
| Paxillosida | Asteropectinidae | Bathybiaster loripes Sladen, 1889 | 51 DR01.0209, DR02.0210, DR05.0210, DR06.0210, LO134.08, LO33.09, LO34.10, LO38.09, LO45.08, LO48.10, LO50.09, LO51.09, LO52.08, LO54.08, LO55.08, LO56.09, LO57.08, LO58.09, LO59.09, LO60.09, LO61.09, LO62.08, LO63.09, LO64.09, LO65.09, LO66.09, LO67.09, LO67.09, LO70.08, LO70.09, LO71.09, LO71.10, LO72.09, LO73.08, LO73.09, LO73.10, LO81.09, LO81.09, LO83.09, LO84.08, LO87.08, LO88.08, LO88.09, LO90.09, LO99.09, LO99.09, LO93.08, LO93.09, LO96.08 |
|           |                  |                                      | 93 DR05.0210, DR02.0209, DR09.0209, DR12.0108, DR15.0108, DR16.1208, LO10.1207, LO108.08, LO108.09, LO123.09, LO33.09, LO36.10, LO4.1207, LO45.08, LO57.09, LO58.08, LO58.09, LO59.09, LO61.09, LO66.09, LO67.09, LO71.08, LO73.08, LO75.10, LO82.09, LO88.09, LO88.09, LO89.10, LO92.09, LO93.09, LO94.09, LO96.09, LO98.09 |
| Lk        | Leptychaster kerguelenensis E. A. Smith, 1876 | 9 DR17.0108, LO101.09, LO101.08, LO101.09, LO112.09, LO118.08, LO127.09, LO133.08 |
| Ph        | Plutonaster bifrons Wyville Thomson, 1873 | 9 DR17.0108, LO101.09, LO101.08, LO101.09, LO112.09, LO118.08, LO127.09, LO133.08 |
Table 2 (continued)

| Order       | Family      | Species                        | A Stations                                                                 |
|-------------|-------------|--------------------------------|-----------------------------------------------------------------------------|
| Ctenodiscidae | Ctna        | Ctenodiscus australis          | Loven in Lütken, 1871                                                      |
|             |             |                                | DR01.0210, DR02.0209, DR02.0210, DR03.0210, DR03.08, DR03.1008, DR04.1008, DR04.1208, DR05.0209, DR06.0210, DR06.1008, DR08.0108, DR09.0210, DR09.1008, DR09.1208, DR10.1208, DR11.1008, DR12.0108, DR12.1008, DR16.0108, DR17.0108, LO1.1207, LO10.1207, LO1003.08, LO1004.08, LO1004.09, LO1005.08, LO1007.08, LO1007.09, LO1008.08, LO14.09, LO12.0207, LO21.09, LO22.10, LO25.08, LO26.09, LO29.09, LO33.09, LO36.08, LO36.10, LO37.08, LO40.08, LO45.08, LO47.08, LO48.09, LO49.08, LO50.09, LO51.09, LO52.08, LO52.09, LO53.09, LO55.08, LO55.09, LO56.08, LO57.08, LO57.09, LO58.08, LO58.09, LO61.09, LO62.08, LO62.09, LO63.08, LO65.09, LO66.09, LO69.09, LO70.09, LO71.08, LO71.09, LO72.08, LO72.09, LO73.08, LO73.10, LO74.08, LO74.09, LO75.08, LO75.09, LO76.09, LO76.10, LO77.09, LO79.08, LO80.08, LO80.09, LO81.08, LO82.09, LO83.08, LO84.08, LO84.09, LO85.09, LO86.08, LO86.09, LO88.08, LO88.09, LO9.1207, LO90.09, LO91.09, LO92.08, LO92.09, LO93.09, LO94.08, LO95.09 |
|             |             | Pseudarchasteridae             | Pseudarchaster discus Sladen, 1889                                          |
|             |             |                                | DR03.0108, DR04.0209, LO61.09                                               |
| Radiasteridae | Re          | Radiaster elegans             | Perrier, 1881                                                               |
|             |             |                                | DR09.1208                                                                   |
| Valvatida   | Ansa        | Anseropoda antarctica         | Fisher, 1940                                                                |
|             |             |                                | DR01.0108, DR04.0209, DR11.1208, LO10.1207, LO1003.09, LO14.08, LO33.09, LO69.08, LO8.09, LO89.10, LO92.09, LO93.09, LO94.09, LO94.10 |
|             | As          | Asterina stellifera Môbius    | 1859                                                                        |
|             |             |                                | DR10.0209, DR16.1208, LO33.09, LO93.08                                      |
|             | Tm          | Tremaster mirabilis Verrill   | 1880                                                                        |
|             |             |                                | DR01.1008, DR04.0210, DR04.1008, DR04.1208, DR07.0108, DR07.0209, DR09.1208, DR15.0108, LO10.1207, LO16.08, LO93.08 |
| Ganeriidae  | Cyv         | Cycethra verrucosa            | Philippi, 1857                                                              |
|             |             |                                | DR01.0209, DR01.1008                                                        |
|             | Pd          | Perknaster densus             | Sladen, 1889                                                                |
|             |             |                                | DR02.0209, DR08.0210, DR09.1208, DR11.1008, DR16.1208, LO107.08, LO113.09, LO131.09, LO95.10, LO98.09 |
| Goniasteridae | Cla        | Cladaster analogus            | Fisher, 1940                                                                |
|             |             |                                | LO10.1207, LO14.1207                                                        |
|             | Cp          | Ceramaster patagonicus        | Sladen, 1889                                                                |
|             |             |                                | DR04.1008, DR06.1008, DR09.1008                                              |
|             | Hf          | Hippasteria falklandica       | Fisher, 1940                                                                |
|             | Hp          | Hippasteria phrygiana         | Parelius, 1768                                                              |
|             |             |                                | DR04.0209, DR06.0210, DR08.1008, DR15.0108, LO24.08, LO33.09, LO60.09, LO61.09, LO65.09, LO71.08, LO78.10, LO8.09, LO86.08, LO88.08, LO88.09, LO9.1207 |
|             | Pd          | Pillsburiaster calvus         | Mah, 2011                                                                   |
|             |             |                                | DR01.0108, DR01.1008, DR03.0108, DR03.1008, DR04.1208, DR05.0209, DR07.0108, DR07.0209, DR11.0209, DR11.1208, DR12.0209, DR12.1008, DR14.1208, DR15.0108, LO1002.08, LO1008.08, LO11.1207, LO12.0107, LO12.1207, LO122.09, LO37.10, LO4.1207, LO86.09, LO92.09, LO93.08, LO94.09, LO94.10, LO96.08, LO98.09 |
| Odontasteridae | Ae          | Acodontaster elongatus        | Sladen, 1889                                                                |
|             |             |                                | LO10.1207, LO1008, LO5.10, LO56.10, LO58.08, LO60.09, LO61.09, LO62.10, LO93.10, LO94.10 |
|             | Op          | Odontaster penicillatus       | Philippi, 1870                                                              |
|             |             |                                | DR01.1008, DR04.1008, DR06.1208, DR08.1008, DR11.1208, LO10.1207, LO107.08, LO1008.08, LO121.09, LO17.08, LO49.08, LO55.09, LO60.08, LO61.09, LO85.09, LO86.08, LO9.1207, LO92.08, LO92.09, LO94.08, LO95.10 |
| Poraniidae  | Gra         | Glabaster antarctica         | E. A. Smith, 1876                                                          |
|             |             |                                | DR06.0210, LO61.09                                                          |
| Order       | Family       | Species                                      | A Stations                                                                 |
|------------|--------------|----------------------------------------------|----------------------------------------------------------------------------|
| Solasteridae | Lphs         | Lophaster stellans Sladen, 1889              | DR01.0108, DR01.1008, DR03.0108, DR04.0209, DR04.1008, DR04.1208, DR05.0209, DR07.0108, DR08.0108, DR09.1008, DR10.0209, DR11.1208, DR12.0108, LO1.1207, LO10.1207/LO108.09, LO12.09, LO2.1207, LO33.09, LO36.08, LO36.10, LO4.1207, LO45.08, LO47.08, LO49.08, LO52.09, LO58.08, LO59.09, LO60.09, LO61.09, LO65.09, LO71.09, LO8.09, LO80.09, LO86.08, LO87.08, LO88.09, LO89.10, LO9.1207 |
|            | Plhl         | *Paralophaster lorioli* Koehler, 1907         | DR12.0209                                                                  |
|            | Sr           | Solaster regularis Sladen, 1889              | DR01.1008, DR04.0210, DR05.0210, DR07.0108, DR07.0209, DR12.1008, LO10.1207, LO108.08, LO12.09, LO14.08, LO16.08, LO2.1207, LO33.09, LO36.10, LO39.09, LO4.1207, LO47.08, LO5.10, LO51.09, LO53.09, LO61.09, LO77.08, LO89.08, LO89.10, LO9.1207, LO91.09, LO91.10, LO93.08, LO94.08 |
| Spinulosida| Echinasteridae| Hro *Henricia obesa* Sladen, 1889              | DR01.1008, DR07.0209                                                        |
|            | Hrp          | *Henricia pagenstecheri* Studer, 1885         | DR01.1008, DR03.1008, DR04.1008, DR07.0209, DR09.0209, DR15.0108, DR16.0108, LO10.1207/LO108.08, LO11.1207, LO12.09, LO14.08, LO16.08, LO2.1207, LO33.09, LO36.10, LO39.09, LO4.1207, LO47.08, LO5.10, LO51.09, LO53.09, LO61.09, LO77.08, LO89.08, LO89.10, LO9.1207, LO91.09, LO91.10, LO93.08, LO94.08 |
|            | Hrs          | *Henricia studeri* Perrier, 1891             | DR01.1008, DR04.0210, DR04.1008, DR04.1208, DR05.0209, DR05.1008, DR06.0210, DR06.1008, DR06.1208, DR07.0209, DR08.1008, DR09.1008, DR09.1208, DR11.1208, DR12.1208, DR16.1208, LO10.1202, LO103.09, LO104.08, LO105.08, LO106.08, LO107.08, LO108.08, LO108.09, LO109.09, LO12.09, LO16.08, LO36.08, LO4.1207, LO47.08, LO5.10, LO51.09, LO53.09, LO59.09, LO60.08, LO69.09, LO71.08, LO89.05, LO89.06, LO89.10, LO99.08, LO92.09 |
|            | Hdf          | *Henricia diffidens* Koehler, 1923            | DR01.0209, DR09.1008, LO114.08, LO60.09, LO77.08, LO86.08, LO89.09, LO9.09, LO91.08, LO92.09, LO93.08, LO94.09, LO96.08 |
| Velatida   | Pterasteridae| Dc Diplopteraster clarki Bernasconi, 1937     | LO78.10, LO79.10, LO85.09, LO87.10, LO89.10, LO9.10 |
|            | Dv           | Diplopteraster verrucosus Sladen, 1882        | DR03.0209, DR03.0210, DR09.0209, DR09.1008, DR11.1208, LO10.1207, LO104.09, LO2.1207, LO21.09, LO34.10, LO47.08, LO47.10, LO51.09, LO59.09, LO60.09, LO66.09, LO75.09, LO76.09, LO77.09, LO78.10, LO79.09, LO89.10, LO89.10, LO89.08, LO89.10, LO9.1207, LO92.08, LO92.09, LO93.08, LO94.09, LO94.08, LO94.09, LO96.08, LO96.08 |
|            | Hyp          | Hymenaster pergamentaceus Sladen, 1882        | LO68.09, LO69.10 |
|            | Pta          | Pteraster affinis Smith, 1876                | DR04.0210, DR04.1008, DR12.1008, LO10.1207/LO108.08, LO107.08, LO108.08, LO108.09, LO14.08, LO36.08, LO37.10, LO4.1207, LO47.08, LO5.10, LO58.09, LO61.09, LO65.09, LO66.09, LO71.09, LO73.09, LO77.09, LO89.08, LO89.09, LO85.09, LO91.09, LO92.08, LO93.09 |
|            | Ptm          | Pteraster flabellifer Sladen, 1882            | DR04.0209, DR05.1208, LO104.08, LO108.09, LO34.10, LO57.09, LO60.09, LO75.09, LO80.10, LO9.10, LO93.09 |
|            | Pts          | Pteraster stellifer Sladen, 1882              | DR04.0209, DR05.1208, LO104.08, LO108.09, LO34.10, LO57.09, LO60.09, LO75.09, LO80.10, LO9.10, LO93.09 |

In underline, new records.
more than 70 adambulacral plates broader than length; \textit{Radiaster notabilis} (Fisher 1913) (Batjan Islands Molucca Islands: Fisher 1913) presents scarce paxillae with 75 spines, and 13–14 adambulacral spines; \textit{Radiaster rowei} H.E.S Clark & D. G. McKnight 2000 (New Zealand: Clark and McKnight, 2000; Mah et al. 2009); \textit{Radiaster tizardi} (Sladen 1882) (North Atlantic Ocean: from Ireland to off Sahara, Grand Bank: Terranova (Clark and Downey, 1992; Murillo et al. 2016) presents moderate arm length (R/r = 2.2/1–3.0/1) and a large madreporite (Fig. 2m–o), while \textit{R. elegans} presents long arms and a small madreporite.

Order Valvatida Perrier 1884

Family Asterinidae Gray 1840

\textit{Anseropoda antarctica} Fisher 1940, new record (Fig. 3a–d).

\text{AphiaID: 172707}

\textbf{Diagnosis} Arms 5. The abactinal plates scalar, thin and imbricate, covered with granuliform spines and inconspicuous papular pores (Fig. 3a, b). Actinal and abactinal plates in decreasing size toward the marginal ones. Abactinal plates form a carinal series. Small superomarginal plates covered by granules. Small inferomarginal plates protrude to form the edge and are also covered by granules. Actinolateral plates in regular oblique series (Fig. 3c). Adambulacral plates with 6 spines on the furrow and joined by a membrane (Fig. 3d).

\textbf{Distribution} Tierra de Fuego, The Scotia Arc, South Shetland Islands. Present study: Argentine. New record: 29 specimens (Online Resource 1).

\textbf{Bathymetric range} 123–3510 m (USNM 1,122,403; USNM 1122101 from Invertebrate Collection Database, NMNH). Present study 111–1543 m.

\textbf{Remarks} Four species (\textit{A. antarctica} included) could be compared taking into account their distribution area: \textit{Anseropoda rosea} (Lamarck 1816) presents 16 arms: \textit{Anseropoda macropora} Fisher 1913 (shallow waters) presents

\begin{table}[h]
\centering
\caption{New bathymetric records}
\begin{tabular}{lll}
Species & Now & Present study \\
\hline
\textit{Acodontaster elongatus} (Sladen, 1889) & 64–641 & 116–824 \\
\textit{Antielaster australis} Fisher, 1940 & 79–480 & 135–1551 \\
\textit{Asterina stellifera} (Möbius, 1859) & 0–500 & 561–1530 \\
\textit{Cheiraster planeta} (Sladen, 1889) & 370–675 & 116–1820 \\
\textit{Cycethra verrucosa} (Philippi, 1857) & 2–675 & 139–1369 \\
\textit{Diplasterias brandti} (Bell, 1881) & 0–1120 & 108–1369 \\
\textit{Diplopteraster clarki} Bernasconi, 1937 & 82–177 & 136–861 \\
\textit{Diplopteraster verrucosa} (Sladen, 1882) & 0–950 & 108–1640 \\
\textit{Henricia diffdens} (Koehler, 1923) & 110–463 & 394–1369 \\
\textit{Henricia obesa} (Sladen, 1889) & 111–645 & 111–1432 \\
\textit{Henricia pagenstecheri} (Studer, 1885) & 2.5–550 & 139–1900 \\
\textit{Henricia studeri} (Perrier, 1891) & 30–770 & 139–1543 \\
\textit{Hipppaster phyrgiana} (Parelius, 1784) & 20–1275 & 394–1900 \\
\textit{Hymenaster pergamentaceus} Sladen, 1882 & 1784–5223 & 785–814 \\
\textit{Lobidiaster radisson} Loew in Lütken, 1871 & 0–641 & 109–772 \\
\textit{Leptychaster kerguelensis} E. A. Smith, 1876 & 17–182 & 116–1900 \\
\textit{Lethasterias australis} Fisher, 1923 & 81–539 & 111–1900 \\
\textit{Perknaster densus} Sladen, 1889 & 53–670 & 425–1543 \\
\textit{Smilasterias scalprifera} (Sladen, 1889) & 79–1077 & 111–1233 \\
\textit{Tremaster mirabilis} Verrill, 1880 & 145–1060 & 119–1900 \\
\textbf{Species} & \textbf{Now} & \textbf{Present study} \\
\hline
\end{tabular}
\end{table}
Family Goniasteridae Forbes 1841

Genus *Pillsburiaster* Halpern 1970

*D. calvus* Mah 2011, new record (Fig. 3e–h).
AphiaID: 559190

**Diagnosis** Abactinal plates covered by granules (Fig. 3e). Papulae present at radial region (Fig. 3f). Superomarginal plates convex and nude between 50% and 90% of surface (Fig. 3h). Inferomarginal plates convex with a low percentage of nude surface. Two to three spines in the adambulacral plate and 2 separated by a space on subadambulacral plates. Four to five oral spines (Fig. 3g).

**Distribution** The Scotia Arc. Present study: Argentina. New record: 84 specimens (Online Resource 1).

**Bathymetric range** 339–357 m (Mah 2011). Present study 139–1900 m.

**Remarks** This genus was cited as *Pillsburiaster* sp. by Brogger et al. (2013c; report submarine canyons survey, II/III B/O Puerto Deseado at Rio de la Plata, Argentine), but the specimens were not identified as *P. calvus*; therefore, the present record will be first recorded in Argentinian waters. Genus *Pillsburiaster* includes 4 species that should be taken in account related to *P. calvus*, 1 species recorded in the South Atlantic Ocean, *Pillsburiaster geographicus* Halpern, 1970 (Mexico and Gulf of Guinea), and 3 in New Zealand, *Pillsburiaster aoteanus* McKnight 1973, *Pillsburiaster maini* McKnight 1973 and *Pillsburiaster indutilis* McKnight 2006. These species are distinguished on the basis of the arrangement of their papular areas.

Family Solasteridae Viguier 1878

Genus *Paralophaster* Fisher 1940

*P. lorioli* (Koehler 1907), new record (Fig. 3i–m).
AphiaID: 234937

**Diagnosis** Abactinal surface with isolated paxillae, each with a short peduncle bearing 6–8 elongated spines (Fig. 3i, j). Marginal plates no more than 12 in each series. Large marginal spines in cluster arrangement (Fig. 3k, l). The actinal surface presents a blunt tuber-shaped prominence, with 4–5 spines with denticulations at their ends. Adambulacral plates with 3 spines in the furrow. They have 6 spines on the oral plate at their free edge (Fig. 3m).

**Distribution** The Scotia Arc, Antarctic Peninsula, Kerguelen, Ross Sea. Present study: Argentina. New record: 1 specimen (Online Resource 1).

**Bathymetric range** 104–294 m (USNM E 13,476; USNM E 13,474 from Invertebrate Collection Database, NMNH). Present study 1551 m.

**Remarks** *Paralophaster lorioli* could be confused with *Paralophaster antarcticus* (Koehler 1912). *Paralophaster lorioli* has few marginal plates, no more than 12 in each series with arrangement of few marginal spines in cluster, while *P. antarcticus* has more than 12 marginal plates that carry many spines much larger than the adjacent papillae.

Order Velatida Perrier 1884

Family Pterasteridae Perrier 1875

*P. flabellifer* Mortensen 1933, new record (Fig. 3n–q).
AphiaID: 178571

5 arms, 5 spines on the furrow, and *Anseropoda aoteaoa* McKnight 1973 (New Zealand) presents 5 arms, 5–7 furrow spines, and only one series of subadambulacral spines, rarely two.
Diagnosis R/r = 1.9/1, 6 arms, abactinal membrane thin, 5–6 slender paxillar spines, small osculum surrounded by a serial of spines forming a ridge that are not embedded in a web (Fig. 3n). The marginal fringe is evident thanks to the stout marginal spines (Fig. 3p), 6–7 adambulacral spines in unequal series like a fan webbed (Fig. 3q), 7 oral spines half of their length webbed, one hyaline, multi-tipped suboral spine (Fig. 3o).

Distribution Only one record in Cape Town (South Africa) and Durban. Present study. Argentine. New record: 1 specimen (Online Resource 1).

Bathymetric range 272–366 m (Clark and Downey 1992). Present study 723 m.

Remarks: Pteraster flabellifer could be confused with Pteraster obscurus (Perrier 1891), Pteraster stellifer Sladen 1882, Pteraster affinis Smith 1876, or Pteraster militaris (OF Müller 1776). Pteraster obscurus present the 6–8 arms, but paxillar columns bear numerous spines (more than 6), and a thick web where adambulacrual oral spines are webbed for totality of their length; its area of distribution restricted to the north Atlantic (boreal belt). Related to the other remarkably similar species distributed around Atlantic Ocean, P. stellifer and P. affinis, both with 5 arms, are species from the South Hemisphere; however, P. stellifer has a parchment-like supradorsal membrane, large actinolateral spines, and unwebbed oral spines. Although P. militaris evenly could have 6 arms, its distribution is restricted to the North Hemisphere. In any case, Clark discusses about the possibility that these three species (P. affinis, P. flabellifer, and P. militaris) “may eventually prove to favor only a subspecific relationship” (Clark and Downey 1992), based on results reported in Clark (1962).

Argentinian deep-sea asteroids new checklist

The new Argentinian deep-sea checklist consists of 64 asteroids species that emerge from 2198 records: 887 records from Atlantis surveys and 1311 records from publicly available datasets and literature (Table 4, Fig. 4). These results include the seven new records proposed in the present work.

The geographical distribution of Argentinian Deep-sea asteroids

Of the 64 species included in the new Argentinian Asteroid checklist (Table 4), 7 are exclusive for ADW (Asterina stellifera, Hymenaster pergamentaceus, Lethasterias australis, Perissasterias polyacantha, Plutonaster bifrons, Pteraster flabellifer and Radiaster elegans), and the rest are shared with nearby areas: 23 with SA, SAI, and M/FI, and 2 (Henricia diffidens and Odontaster roseus) only with Antarctica (SA were not included) (Fig. 5a).

Discussion

Reliability of the databases and Argentinian new asteroid checklist

Concerning the species composition in the study area, 64 species should be considered valid records in this area (Bernasconi 1937, 1962a, 1963, 1964a, 1966b, 1973a, 1973b, 1979; Gutt and Starmans 1998; Tablado and Maytia 1988; Orozitz and Tablado 1990; Bastida et al. 1992; Clark and Downey 1992; Gutt et al. 1999; Bremec et al. 2000; Rios et al. 2003; Zaiixo 2004; Bertness et al. 2006; Mutschke and Rios 2006; Mah 2011; Mah and Blake, 2012; Brogger et al. 2013a; Souto et al. 2014; Arribas et al. 2016; Fraysse et al. 2018; Moreau et al. 2018, 2021; Guillaumot et al. 2020; National Museum of Natural History (NMNH: Research and Collections Information System, Smithsonian Institution), but only 41 were captured. Consequently, 23 of these species were not reported (Table 4; Fig. 4). These absences could be due to various reasons, including: (1) samplers’ limitations or (2) more likely their low frequency, which makes them difficult to be capture. The latter reason could be directly related to the special features of canyons, morphology, granulometry, or even other biotic factors such as species composition (del Rio et al. 2012). A deeper ecological study will be published in the near future providing more useful information that allows us to explain these absences.

The distribution areas of Argentinian asteroids and their Antarctic connections

The first study approach focuses on the number of shared species in ADW and the remainder of the four entities (provinces/regions) defined as M/FI, SA, SAI, and A (discussed in Griffiths et al. 2009, based on Moore et al. 1999) (Fig. 5).

Under the geographical/countries limits and depth range that frame the present work, ADW shares 89.06% of species with these areas, and only ten species should be considered “Patagonian species” (ADW + M/FI) (Fig. 5a, e framed species list), and they are not present outside of this traditionally named area. Three of them correspond to our proposed new records (discussed above), and the remaining seven are: Cryptasterias brachiata and Lethasterias australis, endemic in Patagonian waters; Hymenaster pergamentaceus and Asterina stellifera, frequent only in the Southwest Atlantic Ocean; Anasterias spirabilis and Asterina fimbriata, species...
### Table 4 Asteroid species recorded at Argentine

| Species | Localization |
|---------|--------------|
| *Acodontaster capitatus* (Koehler, 1912) | NRSA |
| *Acodontaster conspicuus* (Koehler, 1920) | NRSA |
| *Anasterias antarctica* (Lütken, 1857) | NRSA |
| *Anasterias spirabilis* (Bell, 1881) | NRSA |
| *Anasterias studeri* Perrier, 1891 | NRSA |
| *Asterina fimbriata* Perrier, 1875 | NRSA |
| *Cheiraster (Luidiaster) gerlachei* Ludwig, 1903 | NRSA |
| *Cosmasterias lurida* (Philippi, 1858) | NRSA |
| *Cryptasterias brachiata* Koehler, 1923 | NRSA |
| *Echinaster (Othilia) brasiliensis* Müller & Troschel, 1842 | NRSA |
| *Ganeria falklandica* Gray, 1847 | NRSA |
| *Lysasterias perrieri* (Studer, 1885) | NRSA |
| *Neosmilaster steinemi* (Studer, 1885) | NRSA |
| *Odinella nutrix* Fisher, 1940 | NRSA |
| *Oodontaster roseus* Janosik & Halanych, 2010 | NRSA |
| *Par abolaster antarcticus* (Koehler, 1912) | NRSA |
| *Peribolaster folliculatus* Sladen, 1889 | NRSA |
| *Perissasterias polyacantha* H.L. Clark, 1923 | NRSA |
| *Perknaster sladeni* (Perrier, 1891) | NRSA |
| *Poraniopsis echinaster* Perrier, 1891 | RSA |
| *Psilaster charcotti* (Koehler, 1906) | RSA |
| *Pteraster gibber* (Sladen, 1882) | RSA |
| *Remaster gourdoni* Koehler, 1912 | RSA |
| *Acodontaster elongatus* (sladen, 1889) | RSA |
| *Anteliaster australis* Fisher, 1940 | RSA |
| *Asterina stellifera* (Möbius, 1859) | RSA |
| *Bathybiaster liripes* Sladen, 1889 | RSA |
| *Ceramaster patagonicus* (Sladen, 1889) | RSA |
| *Cheiraster planeta* (Sladen, 1889) | RSA |
| *Cladaster analogus* Fisher, 1940 | RSA |
| *Ctenodiscus australis* Loven in Lütken, 1871 | RSA |
| *Cycethra verrucosa* (Philippi, 1857) | RSA |
| *Dipasterias brandti* (Bell, 1881) | RSA |
| *Dipasterias brucei* (Koehler, 1907) | RSA |
| *Diplopteraster clarki* Bernasconi, 1937 | RSA |
| *Diplopteraster verrucosus* (Sladen, 1882) | RSA |
| *Glabraster antarctica* (E. A. Smith, 1876) | RSA |
| *Henricia diffidens* (Koehler, 1923) | RSA |
| *Henricia obesa* (Sladen, 1889) | RSA |
| *Henricia pagenstecheri* (Studer, 1885) | RSA RSA |
| *Henricia studeri* (Perrier, 1891) | RSA RSA |
| *Hippasteria falklandica* Fisher, 1940 | RSA |
| *Hippasteria phrygiana* (Parelius, 1768) | RSA |
| *Hymenaster pergamentaceus* Sladen, 1882 | RSA |
| *Labidiaster radiosus* Loven in Lütken, 1871 | RSA |
| *Leptychaster kerguelenensis* E. A. Smith, 1876 | RSA |
| *Lethasterias australis* Fisher, 1923 | RSA |
| *Lophostellus stellans* Sladen, 1889 | RSA |
| *Odontaster penicillatus* (Philippi, 1870) | RSA |
| *Perknaster densus* Sladen, 1889 | RSA |
| *Psalidaster mordax* Fisher, 1940 | RSA |
living on the limit of the sub-Antarctic area; and *Perisasterias polyacantha*, which is frequent in Australia, rare in southern Africa, and very scarce in Argentine (Tablado and Maytia 1988; Brogger et al. 2013a).

Despite the number of ADW species present in the nearby waters, M/FI, SA, and SI altogether share only 35.93% of ADW species (Fig. 5a). However, when they were analyzed separately, we realized that ADW and SA share 81.25% of species, whereas M/FI shares a lower percentage (56.25%) despite their proximity (Fig. 5a). These results could support the idea that M/FI would be an independent entity, as supported by Figuerola et al. (2017) and Griffiths et al. (2009) in the case of Bryozoa. On the contrary, other authors defend the hypothesis that SA belongs to the Antarctic area [Longhurst 2007; Martin-Ledo and López-González 2014; Griffiths et al. 2009 (Pycnogonida; Bryozoa); Moreau et al 2017, among others] (Fig. 5b, 5c).

On the basis of the discussion presented above, only one hypothesis could adjust to our preliminary biogeographic results: ADW, M/FI, and SA should be considered sub-Antarctic, depending on whether SA could be a separated entity of Antarctica, based on the fact that ADW and SA share a greater number of species than any other (Fig. 5a) when the rest of the Antarctica region is included (Fig. 5d). Therefore, to confirm or refute this hypothesis (Rodríguez et al. 2007; Martin-Ledo and López-González 2014; Weir and Stanworth 2019; Moreau et al. 2017, among others), some considerations should be taken in account: (1) we should include more records from known surveys that did not incorporate public datasets (such as the BENTART projects, and others); (2) we need to analyze the benefit of including shallower species, or follow Watling et al. (2013), who opted for conducting their studies at the bathyal and abyssal provinces levels, depending on the focus; (3) and, finally, a deeper analysis should be carried out using different biogeographical methods that would be associated with environmental variables (our next target).

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Table 4 (continued)

| Species                      | Localization |
|------------------------------|--------------|
| *Pseudarchaster discus* Sladen, 1889 | RSA          |
| *Pteraster affine* Smith, 1876 | RSA          |
| *Pteraster stellifer* Sladen, 1882 | RSA          |
| *Smilasterias scalprifera* (Sladen, 1889) | RSA          |
| *Solaster regularis* Sladen, 1889 | RSA          |
| *Tremaster mirabilis* Verrill, 1880 | RSA          |
| *Anseropoda antarctica* Fisher, 1940 | RSA          |
| *Diplasterias octoradiata* (Studer, 1885) | NR          |
| *Paralophaster lorioli* (Koehler, 1907) | NR          |
| *Pillsburiaster calvus* Mah, 2011 | NR          |
| *Plutonaster bifrons* (Wyville Thomson, 1873) | NR          |
| *Pteraster flabellifer* Mortensen, 1933 | NR          |
| *Radiaster elegans* Perrier, 1881 | NR          |

NRSA Species not recorded in study area, RSA recorded in study area, NR new record

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Fig. 4 Results from records reliability study. Analysis of 64 valid species after reliability study—new checklist for Argentinian waters. See species list in Table 4
Supplementary Information

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Data availability

All data included in this paper will be sent to Antarctic Biodiversity Information Facility (AntBIF) after data are published. The material will be shared with different museums.

Code availability

Not applicable.

Declarations

Conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

Ethical approval

None.
Consent to participate  We obtained consent to participate.

Consent for publication  We obtained consent for publication.

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