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ORIGINAL PAPER

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, *Pillsburiaster 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 Argentinian 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), Saucède 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

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(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), Martinez and Brogger (2012), Martinez 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); Martinez (2016), Martinez and Penchaszadeh, (2017), Martinez et al. (2018; 2020), Wilkie and Brogger (2018), Carames et al. (2019), Flores et al. (2019), Martins 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), Berecoechea 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, 1996b, 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), Guillaumot 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).

Biogeographical approach

Five biogeographical entities were defined to analyze the Antarctic and near waters influence: Argentinian deep waters (ADW), Malvinas/Falkland Islands (M/FI), Scotia

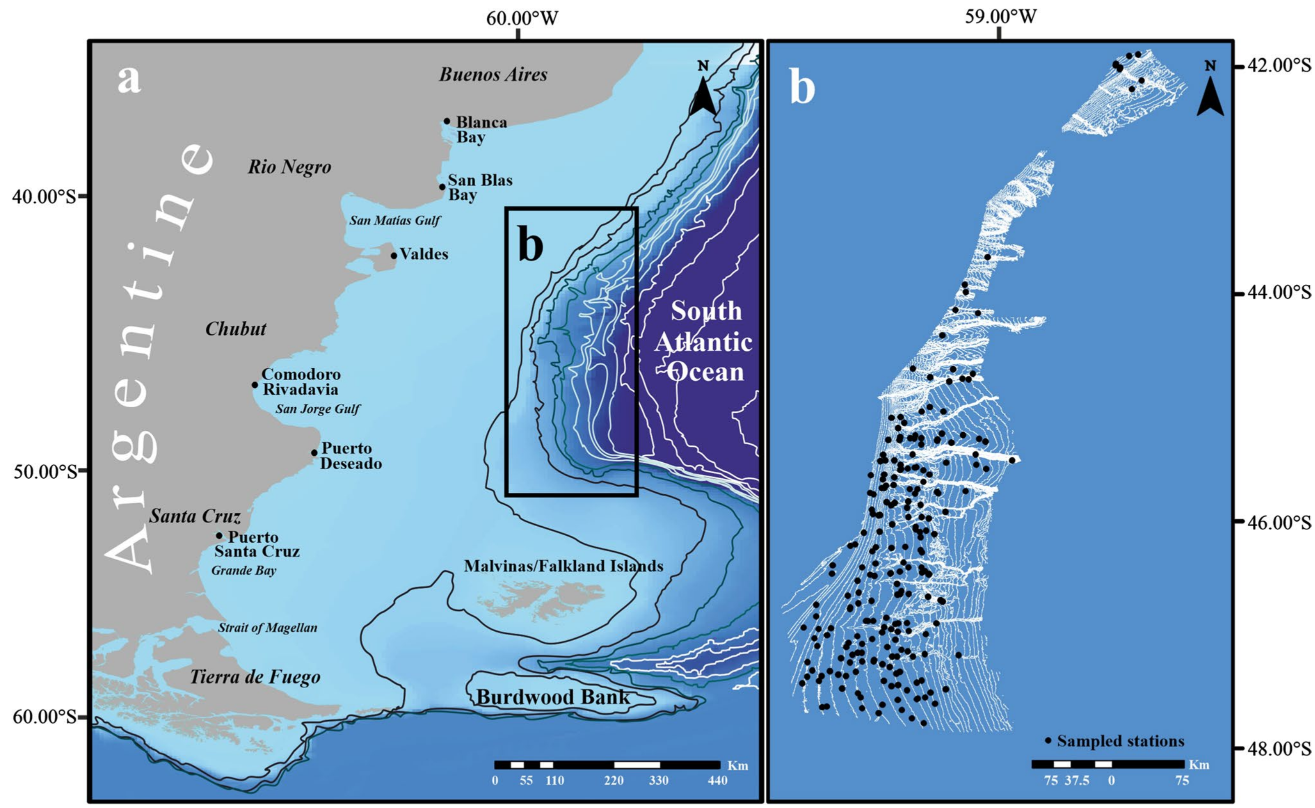

Fig. 1 Area of study. **a** General view with the sampled area labeled as **b**. **b** Sampled area; stations are represented by black dots

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

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
DR03.0108	−46.71	−59.50	1086	LO103.08	−45.71	−60.03	464
DR03.0209	−44.77	−59.44	1393	LO103.09	−45.53	−59.73	851
DR03.0210	−41.97	−57.97	310	LO104.08	−45.72	−59.78	843
DR03.08	−47.18	−59.36	1270	LO104.09	−45.49	−59.47	1122
DR03.1008	−46.95	−59.95	782	LO105.08	−45.53	−59.74	836
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
DR04.0210	−41.98	−57.97	521	LO107.09	−45.28	−59.54	1043
DR04.1008	−46.97	−59.89	837	LO108.08	−45.54	−59.86	778
DR04.1208	−45.83	−59.80	926	LO108.09	−45.32	−59.69	870
DR05.0209	−44.66	−59.76	1002	LO109.09	−45.27	−59.18	1359
DR05.0210	−42.01	−57.93	775	LO11.1207	−45.96	−59.68	909
DR05.1008	−46.97	−59.79	917	LO112.09	−45.03	−59.49	1241
DR05.1208	−45.65	−59.66	1320	LO113.09	−45.00	−59.61	1180
DR06.0209	−44.70	−59.23	2062	LO114.08	−45.74	−59.29	1334
DR06.0210	−42.02	−57.94	476	LO118.08	−45.29	−59.55	1037
DR06.1008	−47.28	−59.96	901	LO12.1207	−45.59	−59.61	1093
DR06.1208	−46.03	−59.94	732	LO120.08	−45.24	−59.32	1233
DR07.0108	−46.37	−59.84	783	LO121.09	−45.09	−59.95	445
DR07.0209	−44.74	−59.32	1432	LO122.09	−45.26	−59.87	717
DR07.1208	−45.68	−59.93	780	LO123.09	−45.27	−59.75	839
DR08.0108	−45.50	−59.87	845	LO127.09	−44.66	−59.40	1341
DR08.0210	−42.20	−57.83	1061	LO131.09	−44.36	−59.50	1255
DR08.1008	−47.19	−59.94	809	LO133.08	−45.30	−59.12	1353
DR09.0209	−44.14	−59.38	1640	LO134.08	−45.23	−59.50	1105
DR09.0210	−42.12	−57.74	1054	LO14.08	−45.08	−59.87	745
DR09.1008	−47.19	−59.90	782	LO14.09	−45.59	−60.01	472
DR09.1208	−45.86	−59.69	1077	LO16.08	−45.28	−59.88	695
DR10.0209	−44.17	−59.18	1530	LO17.08	−45.47	−60.00	424
DR10.1008	−47.19	−59.76	815	LO2.1207	−45.94	−60.05	533
DR10.1208	−46.12	−59.57	1023	LO20.09	−45.75	−60.13	219
DR11.0108	−45.41	−59.76	863	LO21.09	−45.69	−60.00	623
DR11.0209	−43.98	−59.29	1399	LO22.10	−45.95	−60.06	480
DR11.1008	−47.17	−59.65	927	LO24.08	−45.83	−59.99	685
DR11.1208	−45.97	−59.62	1067	LO25.08	−45.90	−60.12	319
DR12.0108	−45.18	−59.89	805	LO26.09	−45.94	−60.11	342
DR12.0209	−43.68	−59.10	1551	LO28.09	−46.09	−60.05	597
DR12.1008	−46.90	−59.55	1055	LO29.09	−46.10	−60.19	262
DR14.1208	−45.96	−59.80	852	LO33.09	−46.23	−60.09	561
DR15.0108	−45.41	−59.21	1900	LO34.10	−46.72	−60.24	570
DR16.0108	−45.31	−59.42	1547	LO36.08	−46.55	−59.90	734

Table 1 (continued)

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	LO80.08	−46.77	−60.31	520
LO58.08	−47.21	−60.39	545	LO80.09	−46.76	−60.31	519
LO58.09	−47.24	−60.31	585	LO80.10	−46.41	−59.68	832
LO59.08	−47.33	−59.87	787	LO81.08	−46.88	−60.17	651
LO59.09	−47.64	−60.56	461	LO81.09	−46.88	−60.15	643
LO60.08	−47.44	−59.89	761	LO81.10	−46.08	−59.64	899
LO60.09	−47.43	−60.73	394	LO82.09	−46.85	−59.99	723
LO61.08	−47.62	−60.03	680	LO82.10	−45.88	−59.81	844
LO61.09	−47.32	−60.64	428	LO83.09	−46.90	−59.81	886
LO62.08	−47.74	−59.77	745	LO84.08	−46.64	−59.87	744
LO62.10	−47.45	−59.95	727	LO84.09	−47.05	−59.91	784
LO63.08	−47.57	−59.72	779	LO85.09	−46.44	−59.65	865
LO63.09	−47.36	−60.35	567	LO86.08	−46.52	−60.24	480
LO63.10	−47.58	−59.89	725	LO86.09	−46.47	−59.62	883
LO64.08	−47.42	−59.72	847	LO87.08	−46.48	−60.10	619
LO64.09	−47.52	−60.24	603	LO87.10	−45.76	−59.74	865
LO65.09	−47.65	−60.20	595	LO88.08	−46.46	−59.95	693
LO66.09	−47.69	−60.06	654	LO88.09	−46.46	−59.96	690
LO67.09	−47.66	−59.85	730	LO88.10	−45.55	−59.66	896
LO67.10	−47.56	−59.65	850	LO89.08	−46.41	−59.80	784
LO68.09	−47.56	−59.71	814	LO89.10	−45.61	−59.92	758

Table 1 (continued)

ST	LAT	LON	D
LO9.09	−45.54	−59.80	805
LO9.10	−45.47	−60.04	313
LO9.1207	−45.71	−60.01	567
LO90.08	−46.45	−59.68	845
LO90.09	−46.65	−59.90	727
LO91.08	−46.47	−59.62	890
LO91.09	−46.64	−59.80	788
LO91.10	−45.63	−60.02	448
LO92.08	−46.24	−59.95	692
LO92.09	−46.26	−59.69	849
LO93.08	−46.23	−59.82	765
LO93.09	−46.14	−59.69	855
LO93.10	−45.24	−59.73	824
LO94.08	−46.28	−59.68	856
LO94.09	−46.07	−59.73	842
LO94.10	−45.13	−59.83	779
LO95.09	−45.92	−59.47	1195
LO95.10	−45.04	−59.68	968
LO96.08	−46.10	−59.70	859
LO97.08	−46.05	−59.73	846
LO98.09	−45.74	−59.54	1106

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

Table 2 Species recorded, their taxonomic position, abundance, and occurrence stations of each species

Order	Family		Species	A	Stations
Forcipulatida	Asteriidae	**Aa**	*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
		Db	*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
		Dbr	*Diplasterias brucei* Koehler, 1907	25	DR07.0209, DR16.1208, LO108.08, LO20.09, LO29.09, LO33.09, LO37.08, LO66.09, LO69.08, LO76.09, LO85.09
		Do	***Diplasterias octoradiata*** **Studer, 1885**	2	LO92.09, LO93.09
		La	*Lethasterias australis* Fisher, 1923	117	DR01.0209, DR03.1008, DR05.1208, DR08.0108, DR15.0108, DR16.1208, LO10.1207LO108.08, LO108.09, LO14.08, LO16.08, 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, LO90.09, LO93.10, LO98.09
		Lr	*Labidiaster radiosus* Loven in Lütken, 1871	2	LO10.1207, LO21.09
		Pm	*Psalidaster mordax* Fisher, 1940	52	DR01.1008, DR03.0209, DR03.1008, LO1.1207LO108.08, LO122.09, LO22.10, LO36.10, LO51.08, LO57.09, LO58.09, LO59.08, LO59.09, LO61.09, LO63.09, LO65.09, LO72.09, LO73.09, LO73.10, LO77.08, LO81.08, LO81.09, LO85. 09, LO87.08, LO87.10, LO88.09, LO94.09
		Ss	*Smilasterias scalprifera* Sladen, 1889	10	LO120.08, LO14.08, LO72.08, LO84.09, LO92.09, LO94.09
Notomyotida	Benthopectinidae	**Chp**	*Cheiraster planeta* Sladen, 1889	174	DR02.0209, DR02.1008, DR03.1008, DR03.1208, DR09.1208, DR12.0108, DR12.1008, DR16.1208, DR17.0108, LO10.1207, LO101.09, 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, LO61.08, LO61.09, LO62.08, LO63.09, LO64.09, LO65.09, LO66.09, LO67.09, LO70.08, LO70.09, LO71.09, LO71.10, LO72.09, LO73.08, LO73.09, LO73.10, LO81.08, LO81.09, LO83.09, LO84.08, LO87.08, LO88.08, LO88.09, LO90.09, LO91.09, LO93.08, LO93.09, LO96.08
Paxillosida	Astropectinidae	**Bthl**	*Bathybiaster loripes* Sladen, 1889	51	DR01.0210, DR02.0210, DR05.0210, DR06.0210LO134.08, 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, LO63.08, LO66. 09, LO70.08, LO75.09, LO80.09, LO86.08, LO88.10, LO9.1207, LO90.08
		Lk	*Leptychaster kerguelenensis* E. A. Smith, 1876	93	DR01.0209, DR02.0209, DR03.0209, DR04.1008, DR04.1208, DR05.1008, DR05.1208, DR07.0209, DR09.1208, DR10.0209, DR11.0108, DR15.0108, DR16.1208, LO10.1207LO108.08, 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, LO88.08, LO88.09, LO88.10, LO89.10, LO92.09, LO93.09, LO94.09, LO96.08, LO98.09
		Pb	***Plutonaster bifrons*** **Wyville Thomson, 1873**	9	DR17.0108, LO100.09, 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	426	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, DR16.1208, DR17.0108, LO1.1207, LO10.1207, LO103.08, LO103.09, LO104.08, LO104.09, LO105.08, LO107.08, LO107.09, LO108.08, LO14.09, LO2.1207, LO21.09, LO22.10, LO25.08, LO26.09, LO28.09, 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, LO59.08, LO59.09, LO60.09, LO61.08, LO61.09, LO62.08, LO63.08, LO65.09, LO66.09, LO67.09, LO68.09, LO69.09, LO7.09, LO70.08, 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, LO79.09, LO80.08, LO80.09, LO81.08, LO82.09, LO83.09, LO84.08, LO84.09, LO85.09, LO86.08, LO86.09, LO87.08, LO88.09, LO9.1207, LO90.09, LO91.09, LO92.08, LO92.09, LO93.09, LO94.08, LO95.09
	Pseudarchasteridae	**Pd**	*Pseudarchaster discus* Sladen, 1889	5	DR03.0108, DR04.0209, LO61.09
	Radiasteridae	**Re**	***Radiaster elegans* Perrier, 1881**	1	DR09.1208

Order	Family		Species	A	Stations
Valvatida	Asterinidae	**Ansa**	***Anseropoda antarctica* Fisher, 1940**	25	DR01.0108, DR04.0209, DR11.1208, LO10.1207, LO103.09, LO14.08, LO33.09, LO69.08, LO8.09, LO89.10
		As	*Asterina stellifera* Möbius, 1859	6	DR10.0209, DR16.1208, LO33.09, LO93.08
		Tm	*Tremaster mirabilis* Verrill, 1880	27	DR01.1008, DR04.0210, DR04.1008, DR04.1208, DR07.0108, DR07.0209, DR09.1208, DR15.0108, LO10.1207LO16.08, LO93.08
	Ganeriidae	**Cyv**	*Cycethra verrucosa* Philippi, 1857	2	DR01.0209, DR01.1008
		Pd	*Perknaster densus* Sladen, 1889	16	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**	2	LO10.1207, LO4.1207
		Cp	*Ceramaster patagonicus*.Sladen, 1889	4	DR04.1008, DR06.1008, DR09.1008
		Hf	*Hippasteria falklandica* Fisher, 1940	12	DR03.0108, LO14.08, LO33.09, LO8.09, LO9.1207
		Hp	*Hippasteria phrygiana*.Parelius, 1768	35	DR04.0209, DR06.0210, DR08.1008, DR15.0108, LO24.08, LO33.09, LO36.08, LO4.1207, LO60.09, LO61.09, LO65.09, LO71.08, LO78.10, LO8.09, LO86.08, LO88.08, LO88.09, LO9.1207
		Pc	***Pillsburiaster calvus* Mah, 2011**	77	DR01.0108, DR01.1008, DR01.1008, DR03.0108, DR03.1008, DR04.1208, DR05.0209, DR07.0108, DR07.0209, DR11.0209, DR11.1008, DR11.1208, DR12.0209, DR12.1008, DR14.1208, DR15.0108, LO102.08, LO108.08, LO11.1207, LO12.1207, LO122.09, LO37.10, LO4.1207, LO86.09, LO92.09, LO93.08, LO93.09, LO94.09, LO94.10, LO96.08, LO98.09
	Odontasteridae	**Ae**	*Acodontaster elongatus* Sladen, 1889	19	LO10.1207, LO108.08, LO5.10, LO56.10, LO58.08, LO60.09, LO61.09, LO62. 10, LO93.10, LO94.10
		Op	*Odontaster penicillatus* Philippi, 1870	44	DR01.1008, DR04.1008, DR06.0209, DR06.1208, DR08.1008, DR11.0209, DR11.1208, LO10.1207, LO107.08, LO108.08, LO121.09, LO17.08, LO49.08, LO55.09, LO60.08, LO61.09, LO85.09, LO86.08, LO9.1207, LO92.08, LO92.09, LO94.10
	Poraniidae	**Gra**	*Glabraster antarctica* E. A. Smith, 1876	5	DR06.0210, LO61.09

Table 2 (continued)

Order	Family		Species	A	Stations
	Solasteridae	**Lphs**	*Lophaster stellans* Sladen, 1889	103	DR01.0108, DR01.1008, DR03.0108, DR04.0209, DR04.1008, DR04.1208, DR05.0209, DR07.0108, DR07.0209, DR08.0108, DR08.1008, DR09.1008, DR10.0209, DR11.1208, DR12.0108, LO1.1207, LO10.1207LO108.09, LO122.09, 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
		<u>**Plhl**</u>	<u>***Paralophaster lorioli*** **Koehler, 1907**</u>	1	DR12.0209
		Sr	*Solaster regularis* Sladen, 1889	54	DR01.1008, DR04.0210, DR05.0210, DR07.0108, DR07.0209, DR12.1008, DR15.0108, LO10.1207, LO108.08, LO121.09, 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	2	DR01.1008, DR07.0209
		Hrp	*Henricia pagenstecheri* Studer, 1885	82	DR01.1008, DR03.1008, DR04.1008, DR07.0209, DR09.0209, DR15.0108, DR16.0108, LO10.1207LO108.08, LO11.1207, LO122.09, LO14.08, LO16.08, LO36.08, LO4.1207, LO47.08, LO49.08, LO55.09, LO56.08, LO57.08, LO57.10,, LO59.08, LO59.09, LO61.09, LO69.09, LO71.08, LO85.09, LO86.09, LO87.10, LO88.08, LO88.09, LO91.08, LO92.09,
		Hrs	*Henricia studeri* Perrier, 1891	243	DR01.1008, DR04.0209, DR04.0210, DR04.1008, DR04.1208, DR05.0209, DR05.1008, DR06.0210, DR06.1008, DR06.1208, DR07.0209, DR08.1008, DR09.1008, DR09.1208, DR10.1008, DR10.1208, DR11.1208, DR14.1208, DR16.1208, LO10.1207, LO102.08, LO103.09, LO104.08, LO105.08, LO106.08, LO107.08, LO108.08, LO108.09, LO109.09, LO122.09, LO36.08, LO39.09, LO4.1207, LO45.08, LO63.10, LO64.08, LO67.10, LO68.09, LO69.09, LO70.09, LO75.09, LO76.09, LO77.09, LO78.10, LO79.09, LO79.10, LO8.09, LO80.10, LO81.10, LO82.10, LO84.09, LO87.10, LO88.09, LO88.10, LO89.10, LO9.1207, LO92.08, LO92.09, LO93.08, LO93.09, LO94.08, LO94.09, LO96.08,
		Hdf	*Henricia diffidens* Koehler, 1923	17	DR01.0209, DR09.1008, LO114.08, LO60.09, LO77.08, LO86.08, LO88.09, LO9.09,
Velatida	Pterasteridae	**Dc**	*Diplopteraster clarki* Bernasconi, 1937	6	LO78.10, LO79.10, LO85.09, LO87.10, LO89.10, LO9.10
		Dv	*Diplopteraster verrucosus* Sladen, 1882	24	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, LO80.09, LO84.08, LO92.08
		Hyp	*Hymenaster pergamentaceus* Sladen, 1882	3	LO68.09, LO69.09
		Pta	*Pteraster affinis* Smith, 1876	44	DR04.0210, DR04.1008, DR12.1008, LO10.1207LO106.08, LO107.08, LO108. 08, LO108.09, LO14.08, LO36.08, LO37.10, LO4.1207, LO47.08, LO5.10, LO58.08, LO61.09, LO65.09, LO66.09, LO71.09, LO73.09, LO77.09, LO8.09, LO 85.09, LO91.09, LO92.08, LO93.09
		<u>**Ptm**</u>	<u>***Pteraster flabellifer*** **Sladen, 1882**</u>	1	LO79.10
		Pts	*Pteraster stellifer* Sladen, 1882	15	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

Table 3 New bathymetric records

Species	Now	Present study
Acodontaster elongatus (Sladen, 1889)	64–641	116–824
Anteliaster australis Fisher, 1940	79–480	135–1551
Asterina stellifera (Möbius, 1859)	0–500	561–1530
Cheiraster planeta (Sladen, 1889)	370–675	116–1820
Cycethra verrucosa (Philippi, 1857)	2–675	139–1369
Diplasterias brandti (Bell, 1881)	0–1120	108–1369
Diplopteraster clarki Bernasconi, 1937	82–177	136–861
Diplopteraster verrucosus (Sladen, 1882)	0–950	108–1640
Henricia diffidens (Koehler, 1923)	110–463	394–1369
Henricia obesa (Sladen, 1889)	111–645	111–1432
Henricia pagenstecheri (Studer, 1885)	2.5–550	139–1900
Henricia studeri (Perrier, 1891)	30–770	139–1543
Hippasteria phrygiana (Parelius, 1768)	20–1275	394–1900
Hymenaster pergamentaceus Sladen, 1882	1784–5223	785–814
Labidiaster radiosus Loven in Lütken, 1871	0–641	109–772
Leptychaster kerguelenensis E. A. Smith, 1876	17–182	116–1900
Lethasterias australis Fisher, 1923	81–539	111–1900
Perknaster densus Sladen, 1889	53–670	425–1543
Smilasterias scalprifera (Sladen, 1889)	79–1077	111–1233
Tremaster mirabilis Verrill, 1880	145–1060	119–1900
Species	Now	Present study

Increment of the bathymetric range of species. New geographical records are not included

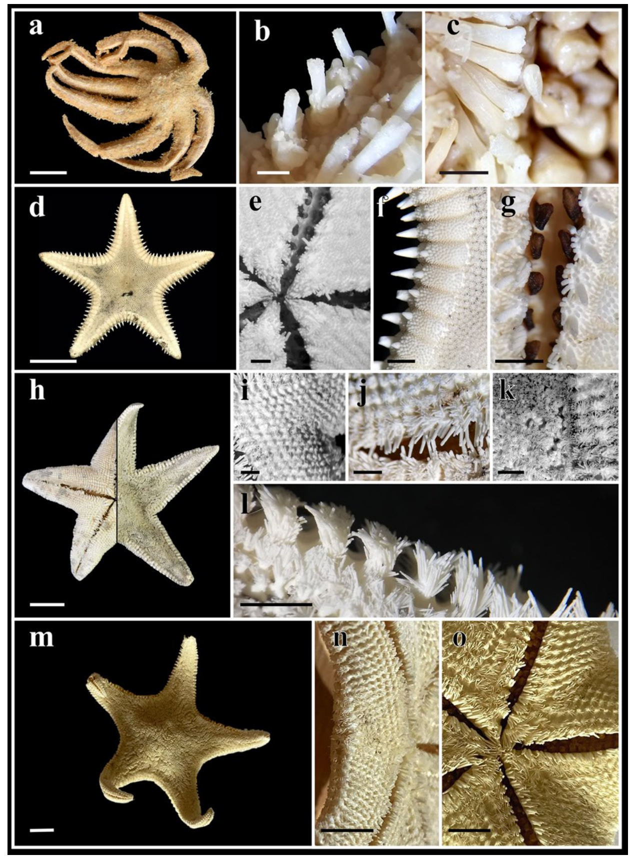

Fig. 2 Images to support diagnosis of: ***Diplasterias octoradiata***: **a** abactinal view, bar: 2 cm; **b** detail of marginal species, bar: 0.01 cm; **c** adambulacral spines, bar: 0.01 cm. ***Plutonaster bifrons***: **d** abactinal general view, bar: 1 cm; **e** actinal general view, bar: 0.02 cm; **f** marginal plates, bar: 0.02 cm; **g** adambulacral plates and furrow spines, bar: 0.20 cm. ***Radiaster elegans***: **h** abactinal (right side) versus actinal (left side) general view, bar: 1 cm; **i** detail of actinal plate arrangement, bar: 0.20 cm; **j** adambulacral plates and furrow spines, bar: 0.20 cm; **k** detail of abactinal paxillar plates, bar: 0.20 cm; **l** superomarginal plates and spines, bar: 0.20 cm. ***Radiaster tizardi***: **m** abactinal general view, bar: 1 cm; **n** marginal fringe, bar: 0.50 cm; **o** actinal general view (plate arrangement), bar: 0.50 cm

more than 70 adambulacral plates broader than length; *Radiaster notabilis* (Fisher 1913) (Batjan Islands Molucca Islands: Fisher 1913) presents scarce paxillae with 75 spines, and 13–14 adambulacral spines; *Radiaster rowei* H.E.S Clark & D. G. McKnight 2000 (New Zealand: Clark and McKnight, 2000; Mah et al. 2009); *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 *R. elegans* presents long arms and a small madreporite.

Order Valvatida Perrier 1884

Family Asterinidae Gray 1840

Genus *Anseropoda* Nardo 1834

Anseropoda antarctica Fisher 1940, **new record** (Fig. 3a–d).

AphiaID: 172707

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).

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

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

Remarks Four species (*A. antarctica* included) could be compared taking into account their distribution area: *Anseropoda rosacea* (Lamarck 1816) presents 16 arms: *Anseropoda macropora* Fisher 1913 (shallow waters) presents

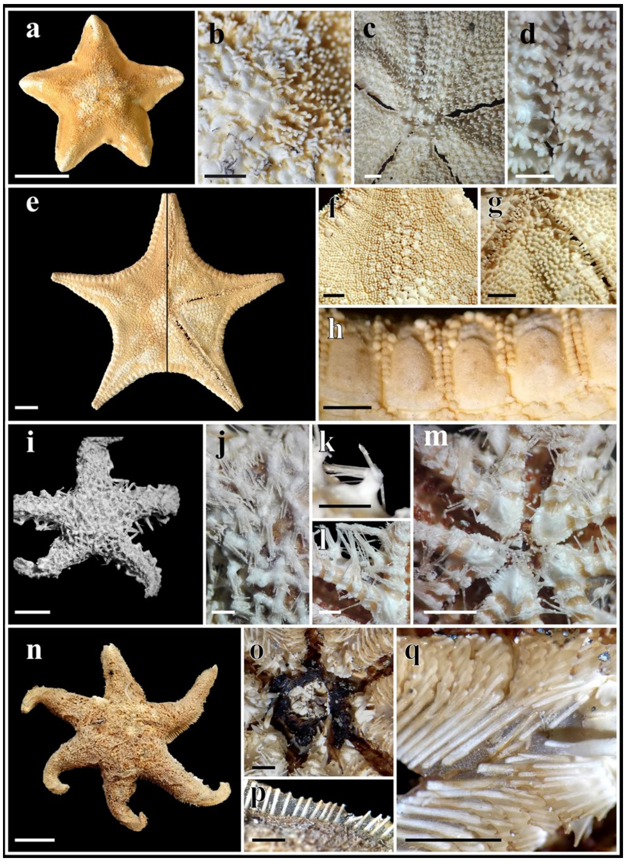

Fig. 3 Images to support diagnosis of: ***Anseropoda antarctica***: **a** abactinal general view, bar: 2 cm; **b** detail of abactinal plates, bar: 0.02 cm; **c** details of actinal plates, bar: 0.02 cm; **d** adambulacral plates and furrow spines, bar: 0.02 cm. ***Pillsburiaster calvus***: **e** abactinal (left side) versus actinal (right side) general view, bar: 1 cm; **f** detail of abactinal plates, bar: 0.20 cm; **g** adambulacral plates and spines of the furrow, bar: 0.20 cm; **h** superomarginal plates, bar: 0.20 cm. ***Paralophaster lorioli***: **i** abactinal general view, bar: 0.50 cm; **j** detail of abactinal plates, bar: 0.01 cm; **k** detail of superomarginal plates, bar: 0.01 cm; **l** detail of actinal plates, bar: 0.01 cm; **m** detail of oral plates, bar: 0.02 cm. ***Pteraster flabellifer***: **n** abactinal general view, bar: 1 cm; **o** detail of oral plates, bar: 0.20 cm; **p** marginal plates, bar: 0.20 cm; **q** adambulacral plates, bar: 0.20 cm

5 arms, 5 spines on the furrow, and *Anseropoda aotearoa* McKnight 1973 (New Zealand) presents 5 arms, 5–7 furrow spines, and only one series of subadambulacral spines, rarely two.

Family Goniasteridae Forbes 1841

Genus *Pillsburiaster* Halpern 1970

Pillsburiaster 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: Argentine. 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

Paralophaster 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: Argentine. 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 paxillae.

Order Velatida Perrier 1884

Family Pterasteridae Perrier 1875

Genus *Pteraster* Müller and Troschel 1842

Pteraster flabellifer Mortensen 1933, **new record** (Fig. 3n–q).

AphiaID: 178571

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, multitipped 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 adambulacral and 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; Orovitz and Tablado 1990; Bastida et al. 1992; Clark and Downey 1992; Gutt et al. 1999; Bremec et al. 2000; Rios et al. 2003; Zaixso 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
		23	*Lysasterias perrieri* (Studer, 1885)	NRSA
			Neosmilaster steineni (Studer, 1885)	NRSA
			Odinella nutrix Fisher, 1940	NRSA
			Odontaster roseus Janosik & Halanych, 2010	NRSA
			Paralophaster 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	NRSA
			Psilaster charcoti (Koehler, 1906)	NRSA
			Pteraster gibber (Sladen, 1882)	NRSA
			Remaster gourdoni Koehler, 1912	NRSA
			Acodontaster elongatus (sladen, 1889)	RSA
			Anteliaster australis Fisher, 1940	RSA
			Asterina stellifera (Möbius, 1859)	RSA
			Bathybiaster loripes Sladen, 1889	RSA
			Ceramaster patagonicus (Sladen, 1889)	RSA
	57		*Cheiraster planeta* (Sladen, 1889)	RSA
			Cladaster analogus Fisher, 1940	RSA
			Ctenodiscus australis Loven in Lütken, 1871	RSA
			Cycethra verrucosa (Philippi, 1857)	RSA
			Diplasterias brandti (Bell, 1881)	RSA
			Diplasterias 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
		34	*Henricia pagenstecheri* (Studer, 1885) *Henricia studeri* (Perrier, 1891)	RSA RSA
			Hippasteria falklandica Fisher, 1940	RSA
			Hippasteria phrygiana (Parelius, 1768)	RSA
41			*Hymenaster pergamentaceus* Sladen, 1882	RSA
			Labidiaster radiosus Loven in Lütken, 1871	RSA
			Leptychaster kerguelenensis E. A. Smith, 1876	RSA
			Lethasterias australis Fisher, 1923	RSA
			Lophaster stellans Sladen, 1889	RSA
			Odontaster penicillatus (Philippi, 1870)	RSA
			Perknaster densus Sladen, 1889	RSA
			Psalidaster mordax Fisher, 1940	RSA

Table 4 (continued)

	Species	Localization
	Pseudarchaster discus Sladen, 1889	RSA
	Pteraster affinis 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	NR
	Diplasterias octoradiata (Studer, 1885)	NR
	Paralophaster lorioli (Koehler, 1907)	NR
7	*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

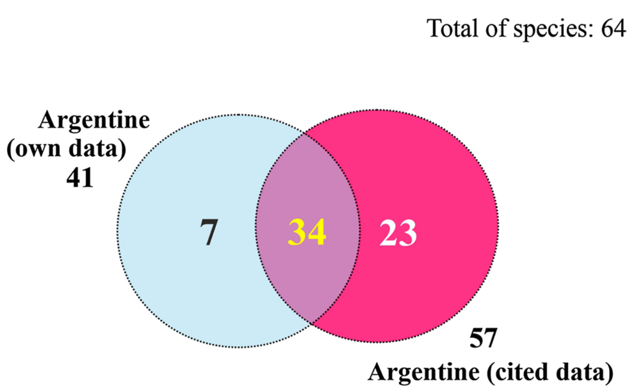

Fig. 4 Results from records reliability study. Analysis of 64 valid species after reliability study—new checklist for Argentinian waters. See species list in Table 4

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 gastropods (Fig. 5a). However, this argument could be based on a false premise since, in our study, only deep-sea asteroids were considered and many recorded species at M/FI usually live in shallower waters. In any case, authors who defend other hypotheses did not consider ADW and M/FI as independent entities.

Nevertheless, it is remarkable that 100% of the species from ADW recorded at SAI are included in the SA area (Fig. 5a), which endorses our idea of joining these two areas together as a sub-Antarctic area (Fig. 5d, e), and (under this bathyal context), as has been reported by Briggs and Bowen (2012) 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).

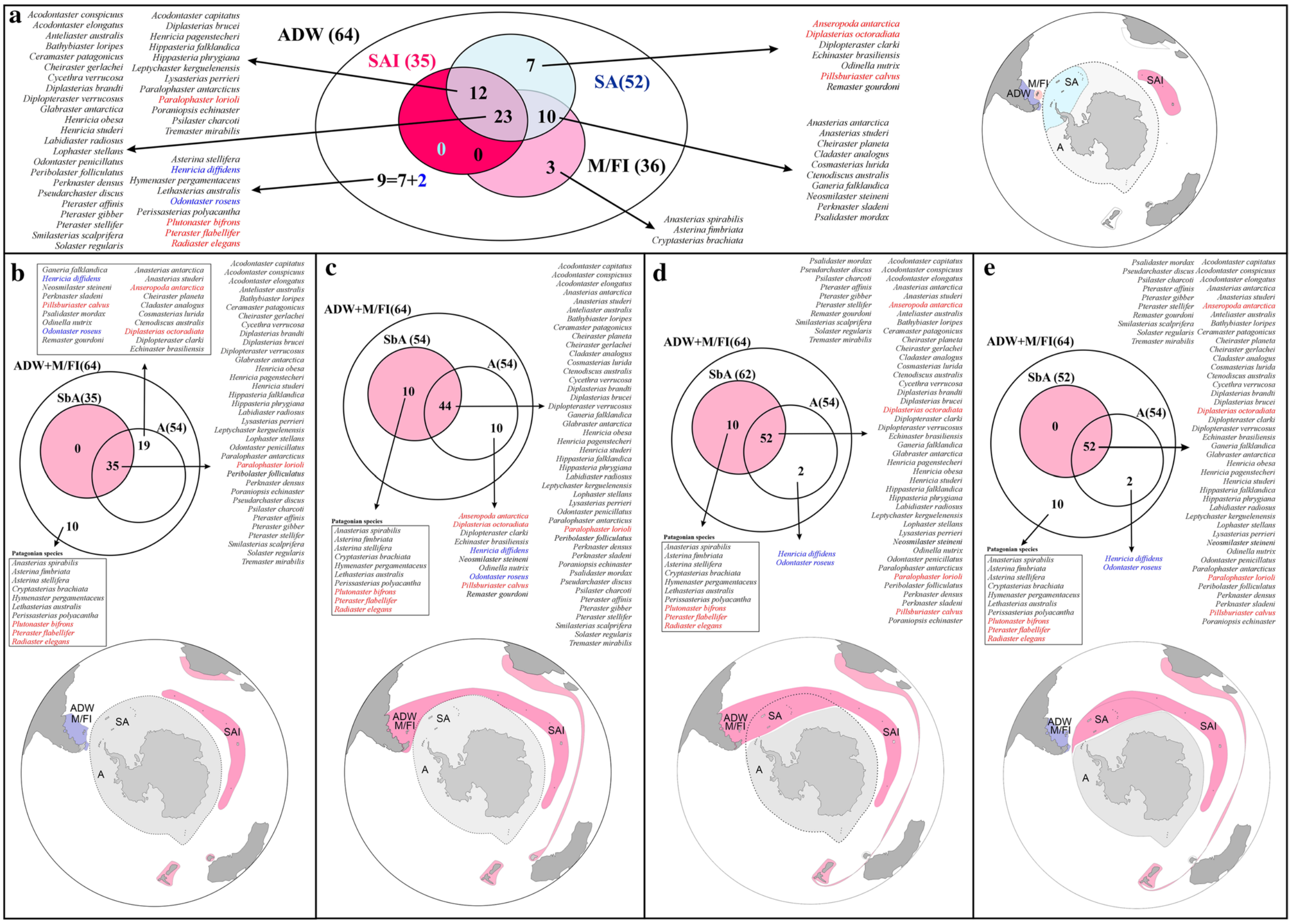

Fig. 5 Argentinian deep-sea asteroid distribution areas (ADW) and their Antarctic (A) connections. Preliminary biogeographical hypothesis following Griffiths et al. (2009). Based on: **a** Malvinas/Falkland Islands MFI), *Scotia* Arc (SA), and sub-Antarctic Islands (SI) are independent entities; **b** ADW and M/FI Patagonian and SA as Antarctic province; **c** ADW and M/FI sub-Antarctic, and SA as Antarctic province; **d** ADW, M/FI, and SA sub-Antarctic; **e** ADW and M/FI Patagonian and SA sub-Antarctic. In red, new records. In blue, species from ADW shared only with A

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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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