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SCAR-Marine Biodiversity Information Network

BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

CHAPTER 5.24. ASTEROIDEA.

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THE BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

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5.24. Asteroidea

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1. Introduction

Asteroidea (Echinodermata), commonly known as sea stars or starfish, represent a diverse group of benthic invertebrates, with a long paleontological history. Sea stars have successfully colonised all depths of the world's oceans, including the Southern Ocean. Two hundred and thirty-five species of Asteroidea have been recorded from the Southern Ocean in the Register of Antarctic Marine Species (Danis & Jangoux 2014). This number, even relatively low compared to other, more diverse, invertebrate taxa from the Southern Ocean (i.e. Gastropoda, Isopoda, Amphipoda) represents an important fraction (ca. 12%) of the total number of known species of sea stars (Mah & Blake 2012). This means that, similarly to what is observed for Echinoidea and Crinoidea, two other classes of phylum Echinodermata, the Southern Ocean represents a species-rich region with regards to the global diversity of Asteroidea. In the specific, Antarctic sea stars include 25 families (out of the 39 total number of known families, [Mah 2014]) and 6 orders (out of the 10 total number of know orders (Mah 2014)). In terms of distribution of relative species richness values, sea star families are relatively homogeneous, with Asteriidae being the richest (including *ca* 19% of all Antarctic species), followed by Pterasteridae (including *ca* 13% of all Antarctic species), which are both cosmopolitan families.

Photo 1 *Freyella fragilissima* (Sladen, 1889), Larsen B (*Polarstern* ANT XXIII/8, PS69/720-2). Image: Gutt, J *et al.* (2010) © AWI/MARUM, University of Bremen, doi:10.1594/PANGAEA.702067

Sea stars are widely distributed throughout the Southern Ocean both geographically and bathymetrically, being found as deep as 6690 m (*Hymenaster blegvadi* Madsen, 1956; see NMNH 2014). Sea stars display various feeding strategies (omnivorous, deposit-feeding, suspension-feeding, or carnivorous) (Jangoux 1982). Direct development with brooding females is a characteristic of sea stars from the Antarctic region (Pearse & Bosch 1994). They are prominent members of Antarctic benthic communities amongst which they exert a major role as potential key species (Lawrence 2013), sometimes also acting as top-predators in the simplified and Paleozoic-like organisation of Antarctic trophic webs (Aronson & Blake 2001, Dayton 1972, Dayton *et al.* 1974).

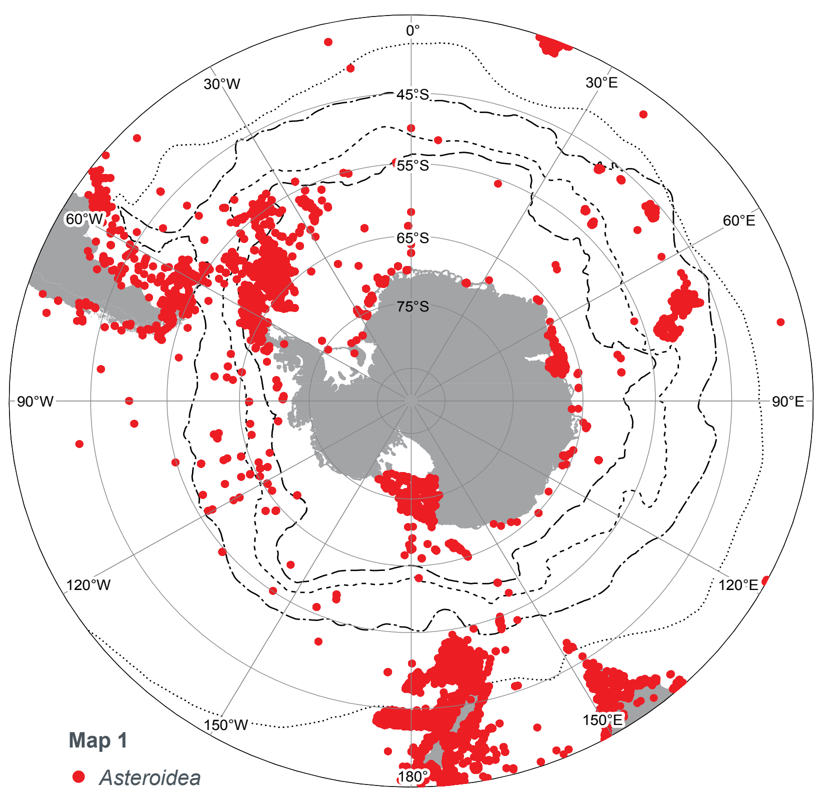
Although few Antarctic species are strictly stenobathic, depth is an important parameter in constraining the distribution of species at large scales areas (Brey & Gutt 1991, De Ridder *et al.* 1992, Jacob *et al.* 2003, Griffiths 2010). In addition, biotic factors of the water column (seasonality of primary and secondary production) and physical parameters (depth and co-varying factors, currents, sea ice cover, iceberg scouring, sea-floor morphology, and sediment characteristics) may affect the abundance, richness, or diversity of Antarctic sea stars (Saiz *et al.* 2008, Moya *et al.* 2012). The co-varying and interrelated contributions of these parameters to Asteroidea distribution might have differential influences according to the habitat (e.g., shallow waters, deep continental shelf, or abyssal plains) and, of course, also vary with the scale of the analysis being performed (temporal, spatial, and taxonomic) (Gutt *et al.* 2012).

2. Objectives

The specific objectives of this chapter was to use online data (taxonomic and biogeographic) to highlight existing trends in the spatial distribution of Antarctic sea stars, and compare them to a previous data compilation carried out by Hedgpeth (1969). The major sources of data are described in the methodology section (3). Data which was not openly available through recognised information system was not considered. Hence, another objective of this chapter was to identifiy data gaps in terms of historical biogeographic information as well as recent data. Even recent literature on Antarctic sea stars does not offer precise information on the distribution of these organisms, and authors seem

Table 1 Available taxonomic and biogeographic data. Breakdown numbers of living taxa as described in the Register of Antarctic Marine Species (RAMS) (Danis & Jangoux 2014), and number of occurrence records in biodiversity.aq (in brackets) (Van de Putte *et al.* 2014). (Figures from May 15, 2012).

Order	Family	genera	valid species (excl. synonyms)	nominal species (incl. synonyms)
Forcipulatida [628]				
	Pedicellasteridae [8]	2	6	8
	Asteriidae [436]	15	44	60
	Heliasteridae [69]	1	2	3
	Stichasteridae [115]	4	6	6
Brisingida [30]				
	Brisingidae [25]	3	3	3
	Freyellidae [5]	3	9	9
Spinulosida [205]				
	Echinasteridae [205]	3	13	18
Valvatida [1563]				
	Asterinidae [27]	6	6	11
	Ganeriidae [228]	6	23	26
	Goniasteridae [239]	11	15	21
	Leilasteridae [0]	1	2	2
	Odontasteridae [527]	3	16	32
	Poraniidae [241]	4	7	12
	Solasteridae [298]	4	16	22
Paxillosida [540]				
	Astropectinidae [338]	10	17	29
	Ctenodiscidae [98]	1	2	2
	Goniopectinidae [0]	1	0	1
	Luidiidae [0]	1	1	1
	Porcellanasteridae [25]	5	12	13
	Pseudarchasteridae [62]	1	1	1
	Radiasteridae [0]	1	1	2
Velatida [336]				
	Korethrasteridae [50]	2	3	3
	Myxasteridae [0]	1	0	0
	Pterasteridae [286]	4	31	40



Asteroidea Map 1 distribution of data used in the framework of the present study.

to neglect the online publication of raw biogeographic data. As new data will become available it will be integrated in the digital version of the present atlas (http://atlas.biodiversity.aq) (see "The dynamic Biogeographic Atlas project" Chapter 11, this volume).

3. Methods

3.1. Record data

Asteroid occurrence data were compiled from various online resources (Ocean Biogeographic Information System (OBIS), Global Biodiversity Information Facility (GBIF), biodiversity.aq, Antarctic Biodiversity Information Facility (ANTABIF), Scientific Committee on Antarctic Research – Marine Biodiversity Information Network (SCAR-MarBIN) into a dedicated Antarctic Asteroidea working Database, and augmented with a series of original datasets generated from a series of historic sample collections, which can be consulted online through biodiversity.aq's Integrated Publishing Toolkit (IPT) instance (ipt.biodiversity.aq) (Danis *et al.* 2013, Danis & Jangoux 2013, Danis *et al.* 2012, Danis & Jangoux 2012, Danis *et al*. 2008 a,b,c). Using the 'TaxonMatch' function, taxonomy was matched against the Register of Antarctic Marine Species (De Broyer *et al.* 2014), the World Asteroidea database (Mah 2014) and World Register of Marine Species (WoRMS Editorial Board, 2014), to ensure that synonymies or misspellings were removed. Occurrence duplicates were removed from the database, as well as poorly georeferenced records, following the guidelines from the OBIS Nodes manual (IOC, 2012). This augmented database holds a total of 29,487 occurrence records, and will be made available through the Integrated Publishing Toolkit of the biodiversity.aq initiative (Van de Putte *et al.* 2014).

In the original Hedgpeth (1969) folio, a general biogeographic maps is provided, depicting 3 conspicuous distributional patterns for the sub-Antarctic and Antarctic regions: the first one is circumpolar, mainly around the continent, but including South Georgia, the second being circumpolar, including the Magellanic region, and the last one being circumpolar (or partly), and including the sub-Antarctic region. The folio also includes seven distribution maps for 42 genera (representing 166 species) (divided according to distribution patterns), including their bathymetric range. All genera found south of the Polar Front (PF) have been mapped, except those found in less than four stations and those of universal distribution usually found at depths below 1000 m.

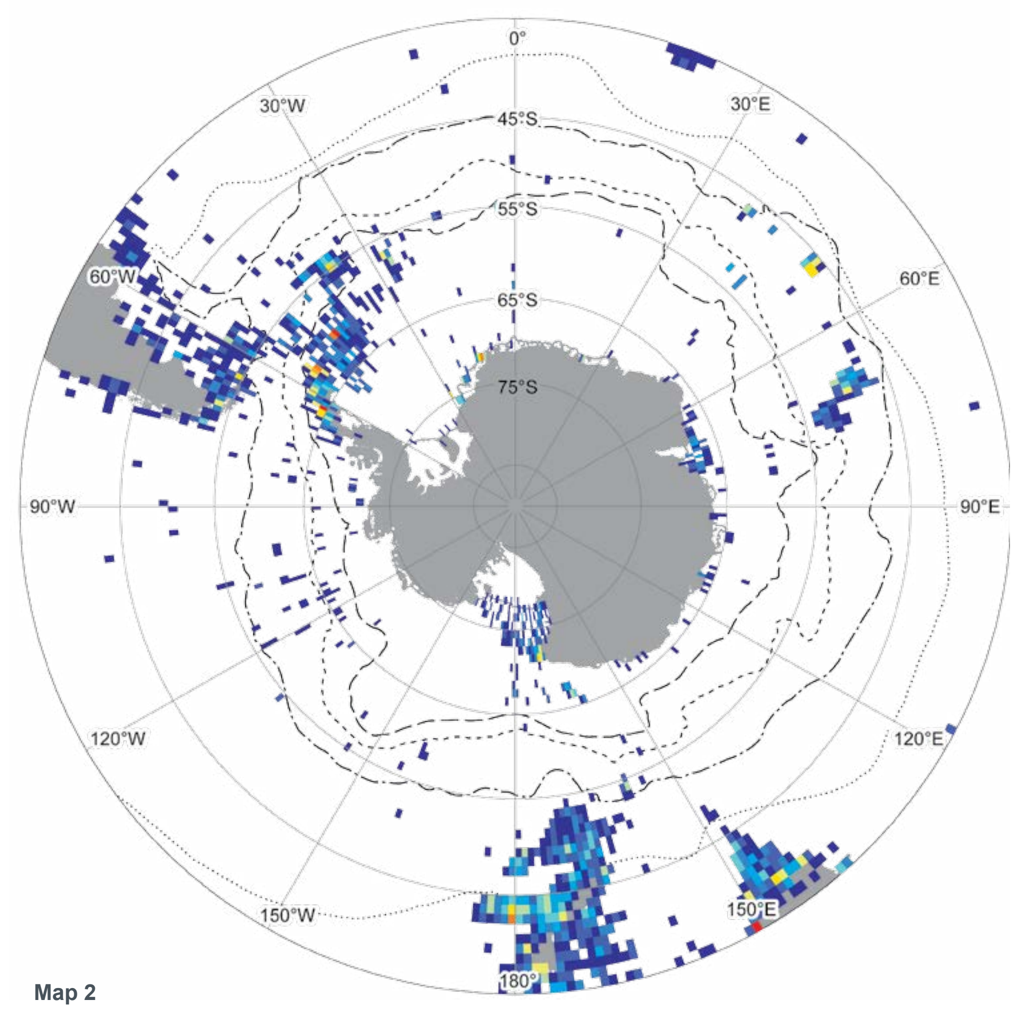
Recent genetic studies reveal a significant discrepancy in several asteroid groups between taxonomy and phylogenies both at species and genus level (Mah & Blake 2012). Therefore, one may expect that the systematics of Antarctic asteroids will experience some changes in coming decades. This stresses the importance of maintaining online taxonomies, as well as shifting synthesis efforts such as the present volume towards dynamic systems (see Chapter "The dynamic Biogeographic Atlas project", this volume) that will accommodate new data and classifications in near real-time.

The biogeographic maps provided in this section show occurrence records for 11 asteroid species, which were selected using the following criteria:

1. Sufficient datamass and spatial distribution of data: selected species are well documented in terms of distribution data, and record are widespread in the Southern Ocean (i.e. not concentrated in a single quadrant
2. Known latitudinal amplitude: general distribution information is available for the selected species

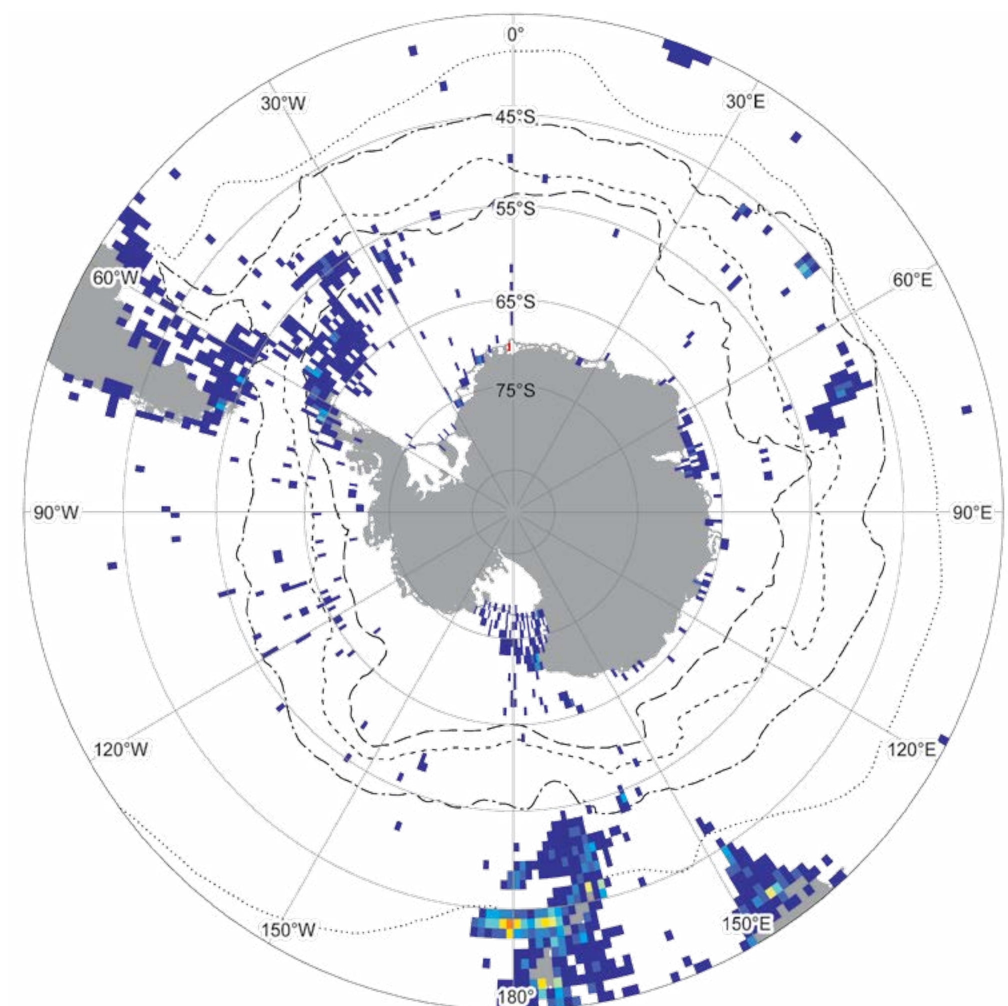
Until a dynamic version of this Atlas is published online, it is certain that maps could quickly become out of date. In this chapter, species-level distribution maps are provided for the following species:

1. Pterasteridae
   a. *Diplopteraster verrucosus* (Sladen, 1882)
   b. *Pteraster affinis* Smith, 1876
2. Ganeriidae
   a. *Cycethra verrucosa* (Philippi, 1857)
3. Goniasteridae
   a. *Hippasteria phrygiana* (Parelius, 1768)
   b. *Notioceramus anomalus* Fisher, 1940
4. Odontasteridae



Map 2

1 - 5	16 - 20	31 - 35	46 - 50
6 - 10	21 - 25	36 - 40	51 - 55
11 - 15	26 - 30	41 - 45	



Map 3

1 - 19	57 - 75	113 - 130	168 - 186
20 - 38	76 - 93	131 - 149	187 - 204
39 - 56	94 - 112	150 - 167	

Asteroidea Maps 2-3 Map 2 Richness patterns for Asteroidea in the Area of Interest. Number of different nominal species are aggregated and counted in 1°x1° grid cells. See color scale for details. Sampling effort for Asteroidea in the Area of Interest. Number of different latitude/longitude combinations (stations) are aggregated and counted in 1°x1° grid cells. See color scale for details.

a. *Odontaster penicillatus* (Philippi, 1870)
b. *Acodontaster hodgsoni* (Bell, 1908)
c. *Odontaster validus* Koehler, 1906
5. Poraniidae
a. *Porania (Porania) antarctica* E.A. Smith, 1876
6. Astropectinidae
a. *Bathybiaster loripes* Sladen, 1889
7. Solasteridae
a. *Paralophaster antarcticus* (Koehler, 1912)

3.2. Coverage area

The area considered in the present chapter extends from latitude 45°S to the Antarctic shoreline at a minimum latitude of 78.92°S. The area covers the Southern Ocean, including the Antarctic continental shelf and sub-Antarctic islands, as well as the southern tip of South America and the Campbell Plateau south of New-Zealand. This large-scale study includes areas with contrasting oceanographic features.

The sampling effort is clearly uneven in the different zones, due to various historical reasons, and/or to the presence of challenging logistic conditions, or presence of research stations. While certain areas have long been regularly investigated: the Ross Sea, Campbell Plateau south of New Zealand, South-east Australia and Tasmania, Adélie Land, Amery Basin, Weddell Sea, Antarctic Peninsula, Scotia Arc, and Tierra del Fuego, other areas such as the Bellingshausen and Amundsen Seas, the Enderby plain, or the South Indian basin are still clearly under-sampled (Clarke *et al.* 2007, Saiz *et al.* 2008, Griffiths 2010, Moya *et al.* 2012) and constitute a limit to our knowledge of the Antarctic marine benthos (Gutt *et al.* 2004, Griffiths 2010, Ingels *et al.* 2012). Map 1, which combines distribution data for all records reported in the major online biodiversity information systems (OBIS: www.iobis.org, GBIF: www.gbif.org, biodiversity.aq: www.biodiversity.aq, ANTABIF: www.antabif.be and SCAR-MarBIN: www.scarmarbin.be) clearly displays these knowledge gaps.

4. Asteroid diversity

4.1. Richness pattern

The number of distinct species names (i.e. richness) aggregated in 1°x1° grid cells varies from 1 to 55 (Map 2). The highest values were found in the Antarctic Peninsula and along the Scotia Arc, in the eastern Weddell Sea, in SubAntarctic islands (Marion, Crozet, Kerguelen) and in the eastern sector of the Ross Sea.
However, the uneven sampling effort in the Southern Ocean (Griffiths *et al.* 2010) implies that richness patterns should be considered with caution, especially regarding potential centers of origin. The stations count (displaying the sampling intensity) varied from 1 to 204 stations in 1°x1° grid cells (Map 3). Unsurprisingly, the patterns of sampling intensity follows that of the overall sampling effort for benthic biodiversity in the Southern Ocean and, as discussed in Griffiths *et al.* (2011), is strongly linked to the presence of research stations, and proximity of research vessels tracks. In a set of large sections of the Southern Ocean, little to no data is available, or is not related to sampling intensity which is known to be intense (e.g., the Ross Sea), indicating that much efforts is still needed to either intensify sampling in those area or to improve data accessibility. By visualizing Maps 2 and 3, areas simultaneously displaying both high species richness, and low sampling effort can be identified. These areas include the Scotia Arc and the Magellanic region, sub-Antarctic islands located between 30°E and 90°E of longitude and a remarkable potential hotspot in the eastern Weddell Sea. These areas (as well as those for which no data is available) certainly deserve further strategic sampling to improve our knowledge and understanding of the biogeography of asteroids in the Southern Ocean.

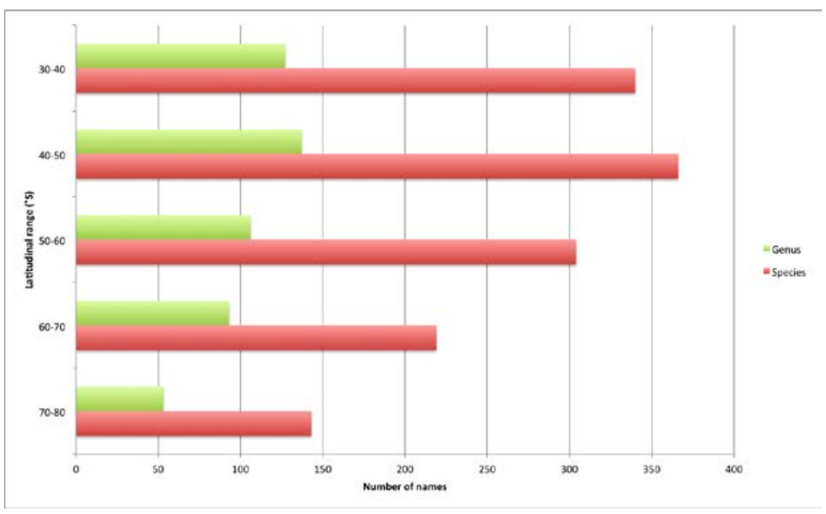


Figure 1 Overall latitudinal gradient of asteroid richness (number of species (red) and genus (green) names).

4.2. Latitudinal gradient

The asteroid species richness slightly increases from the 30-40°S to 40-50°S latitude ranges, and then steadily decreases towards the south, approximately by a factor 2 between the maximum and minimum values (Figure 1). Map

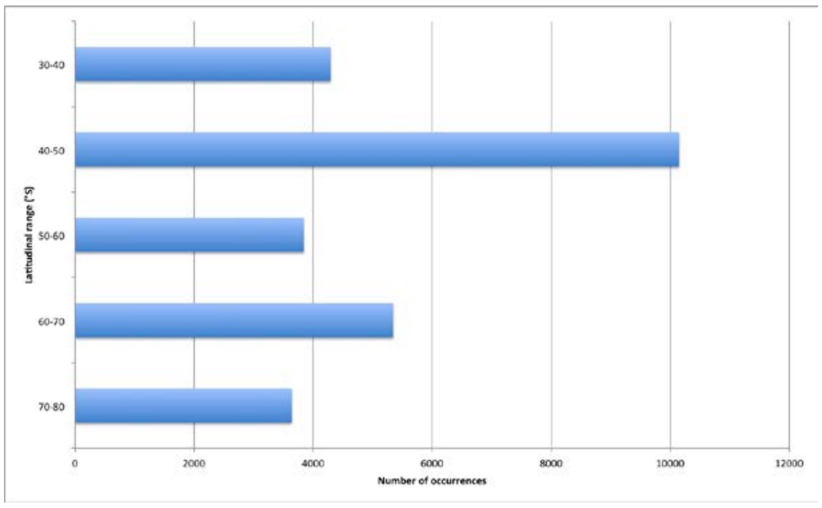


Figure 2 Latitudinal gradient of occurrence records in the database.

3 shows the distribution of occurrence data along the same gradient (data richness). The 40-50°S latitude range displays the highest number of records (about twice as many as in the other latitude ranges). This might be the reason for the initial increase in species richness between the first two latitude ranges. If this hypothesis is verified, the observed latitudinal gradient in asteroid richness would match the global latitudinal gradient in taxonomic marine diversity that decreases continuously from the tropics to the poles (Crame 2004). This trend is not absolute: it varies with the considered group but also with the geomorphology and nature of the sea floor. For example, in deep-water gastropods, diversity increases towards the south (Schrödl *et al.* 2011). Another explanation for the observed pattern of species richness along the latitudinal gradient can be found in regional characteristics of Southern Ocean oceanography modulating the global decreasing gradient, or differences in the scales used in the present study. The observed trends are similar when the asteroid richness is considered at the genus level: a slight increase between 30-50°S followed by a steady decrease towards the high latitudes. The magnitude of the variation is comparable to that observed for species, and the species/genus ratio is remarkably stable along the gradient (2.35 in the 60-70°S range to 2.87 in the 50-60°S).

4.3. Depth gradient

Depth gradients in asteroid richness (Fig. 3) show that the highest number of species and genera occurs between the surface and 1000 m depth. Below 1000 m, species richness drops, roughly by a factor 2, while genus richness drops by ca. 30%. The gradient shows that the Antarctic continental shelf,

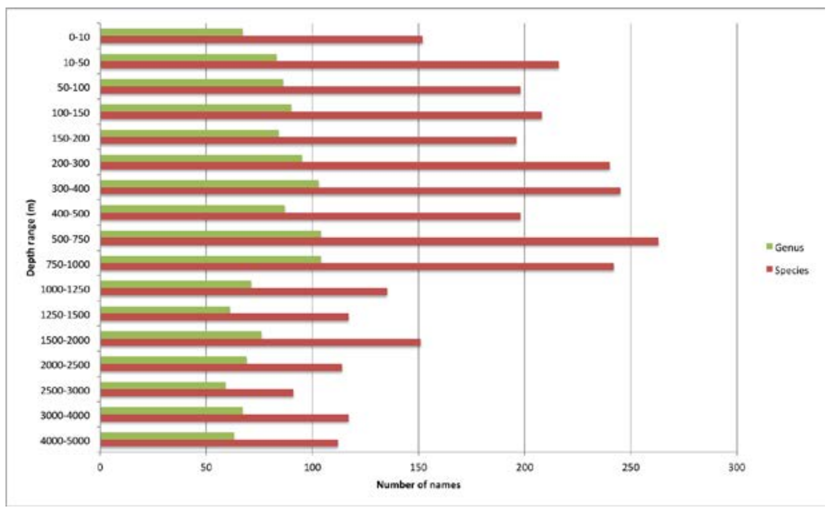


Figure 3 Overall depth gradient of asteroid richness (number of nominal taxa: species (red) and genus (green))

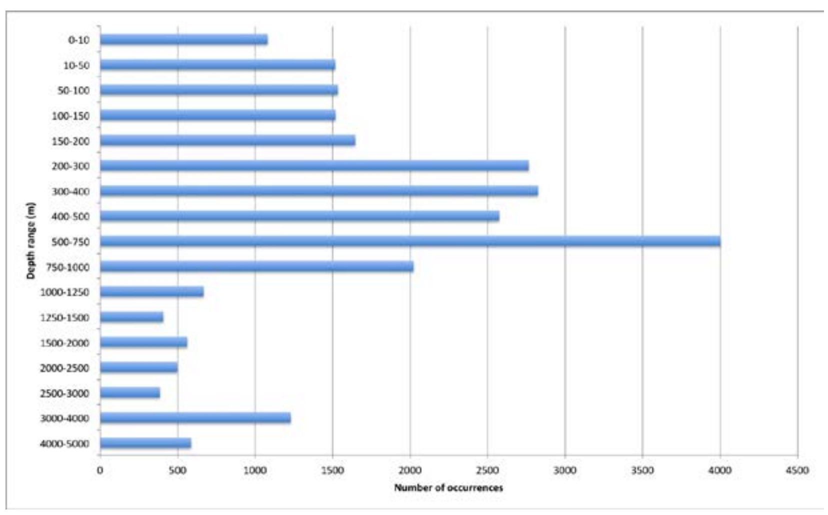


Figure 4 Depth gradient of occurrence records in the database.

which represents about 11% of continental shelf areas worldwide, encompasses the main part of asteroid richness, which then decreases with depth increase. Figure 4 shows the data richness along the same depth gradient. Interestingly, data availability increases with depth, until maximal values (ca. 4000 records) are found between 500-750 m, then abruptly decreases below 1000 m, by a factor 4. This indicates a potentially strong sampling discrepancy. Figure 5 reveals the existence of a saturation relationship between species richness and data mass (number of occurrence records) measured in the various depths categories, showing that more sampling is needed in deeper areas of the ocean to gain a full insight (i.e. reaching saturation) over the biodiversity of asteroids. Increasing sampling efforts in the deep sea would allow encompassing true deep-sea diversity as suggested for other taxa (Brandt *et al.* 2007, Linse *et al.* 2007). Genus richness gradients are less pronounced than that of species, and again species by genera ratios are remarkably constant (from 1.64 for depths ranging from 2000-2500 m to 2.60 for depths ranging from 10-50 m).

Most considered species were found to have very wide bathymetric ranges, although some caution should be taken as a significant part of the bathymetric data was not available from the various data sources and was therefore computed using high-resolution bathymetric charts (IOC 2013). Nevertheless, given the bottom physionomy of the deep Southern Ocean, the bias due to the use of computed depths is probably higher for data pertaining to the shallower areas. All considered species were reported in deep-sea locations (down to depths ranging from 4000 to 5300 m). From the point of view of their latitudinal ranges, two species, *Diplopteraster verrucosus* and *Hippasteria phrygiana* weren't reported further south than 68°S, while the other species were found down to 78°S.

5. Biogeographic patterns

5.1. Species latitudinal range

Figure 6 displays the latitudinal distribution (minimal and maximal latitudes) for 316 asteroid species. Figure 7 shows the proportion of asteroids, which are found in the different biogeographic zones, or patterns (High Antarctic, Antarctic and Sub-Antarctic, Sub-Antarctic, Antarctic to Temperate, Cold Temperate). The combined information between the two figures shows that most asteroid species display an Antarctic and sub-Antarctic distribution (37%), while asteroids exclusively found in the High Antarctic, sub-Antarctic and Cold Temperate zones display comparable proportions (between 17 and 19%) and asteroids from Antarctic to Temperate regions display the lowest proportion (9%). Forty-four species (i.e. 9%) have a wide latitudinal distribution that covers temperate to Antarctic waters: they extend on both sides of the sub-Antarctic area between 45°S and 60°S, i.e. within the fluctuations of the Polar Front position. Accordingly, 91% of species display restricted patterns attesting the structuring of asteroid diversity along latitudinal belts.

5.2 Distribution of 11 selected species

Distribution maps (Maps 4 to 14) are shown for 11 representative species of asteroids (see section 2.1, present chapter for technical details).

As detailed above, the species mapped in this section were chosen in function of various biological and data-related parameters.

The broad distributions of the 11 selected species are listed here below.

Diplopteraster verrucosus (Sladen, 1882): reported in South America, Scotia Arc, Antarctic Peninsula (North and East), and sub-Antarctic islands (Marion, Crozet and Kerguelen). No data has been reported for the Davis, Dumont d'Urville, Ross, Amundsen or Bellingshausen seas. Also not reported from the New-Zealand or Tasmanian plateaus.

Pteraster affinis Smith, 1876: reported in South America, Scotia Arc, Antarctic Peninsula (including West), eastern Weddell sea, sub-Antarctic islands (Marion, Crozet and Kerguelen), Ross Sea. Not reported from New Zealand plateau, Davis, Dumont d'Urville, Amundsen and Bellingshausen seas.

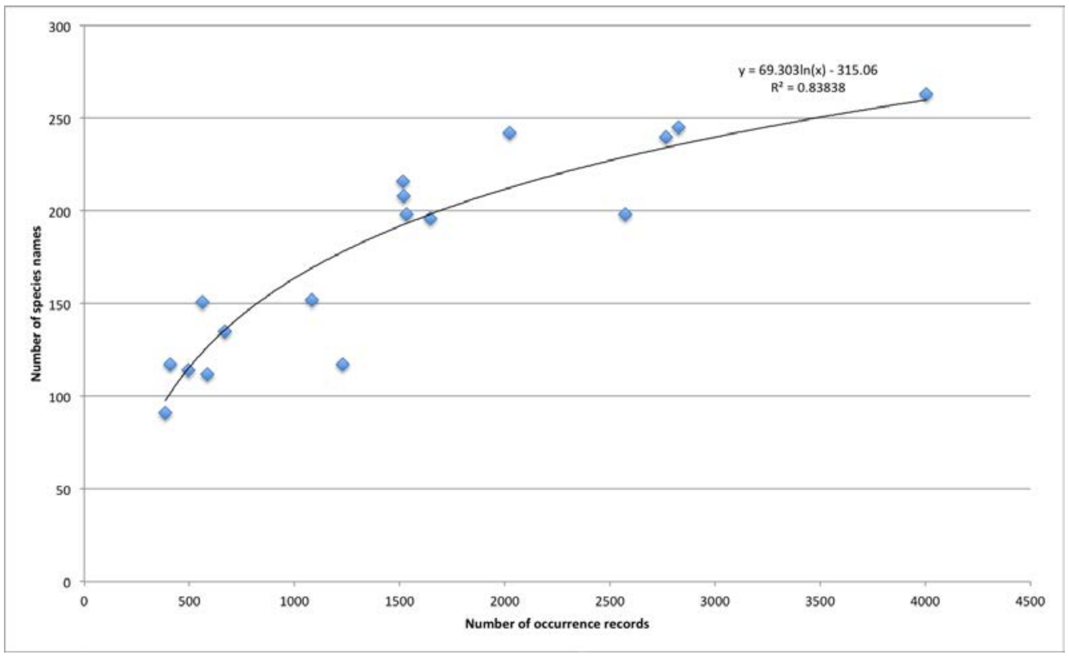


Figure 5 Relationship between the number of species names and the number of occurrences in the database along the depth gradient.

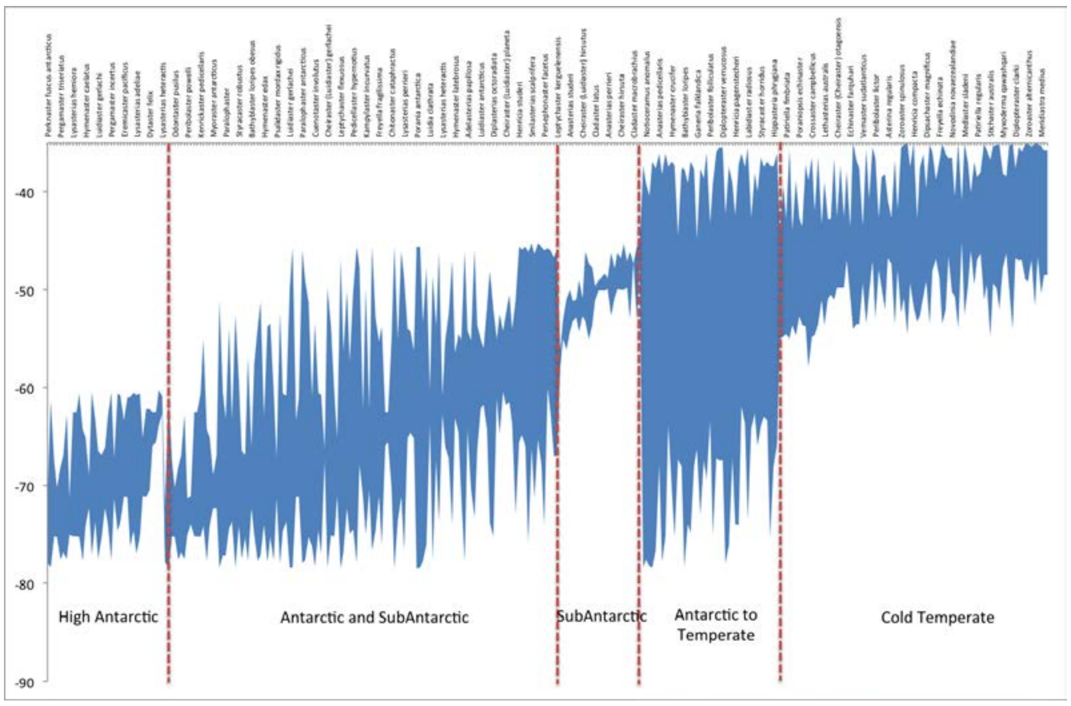


Figure 6 Latitudinal distribution for 316 asteroid species recorded south of 35°S. Species are ranked from left to right according to the value of their average latitude. They are grouped in broad biogeographic zones: High Antarctic (maximum latitude <60°S, 79 species), Antarctic and sub-Antarctic (minimum latitude <60°S AND maximum latitude <45°S, 176 species), sub-Antarctic (minimum latitude >60°S AND maximum latitude <45°S, 90 species), Antarctic to Temperate (maximum latitude >45°S AND minimum latitude <60°S, 44 species) and Cold Temperate (maximum latitude >45°S AND minimum latitude <45°S, 87 species). Details are presented in Table 3: see Appendix 3 at the end of volume.

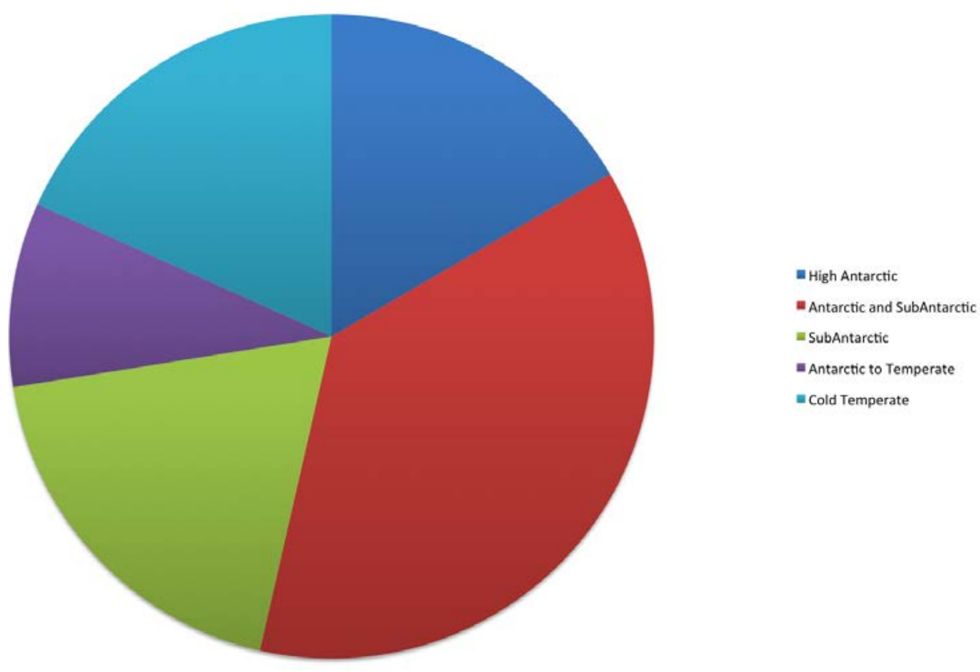
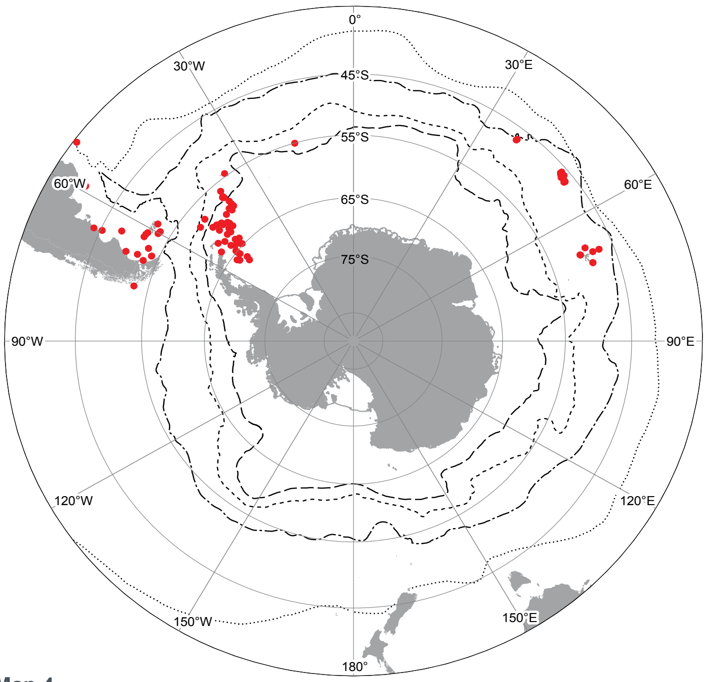
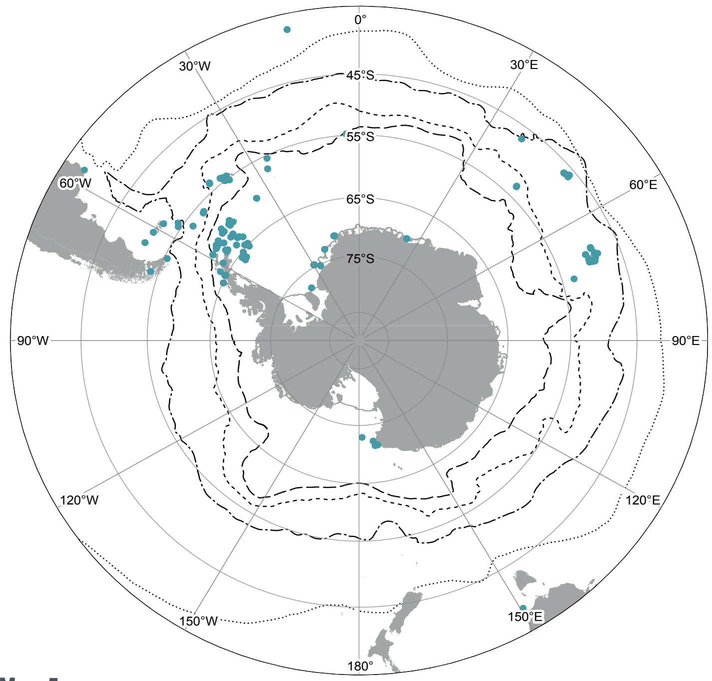


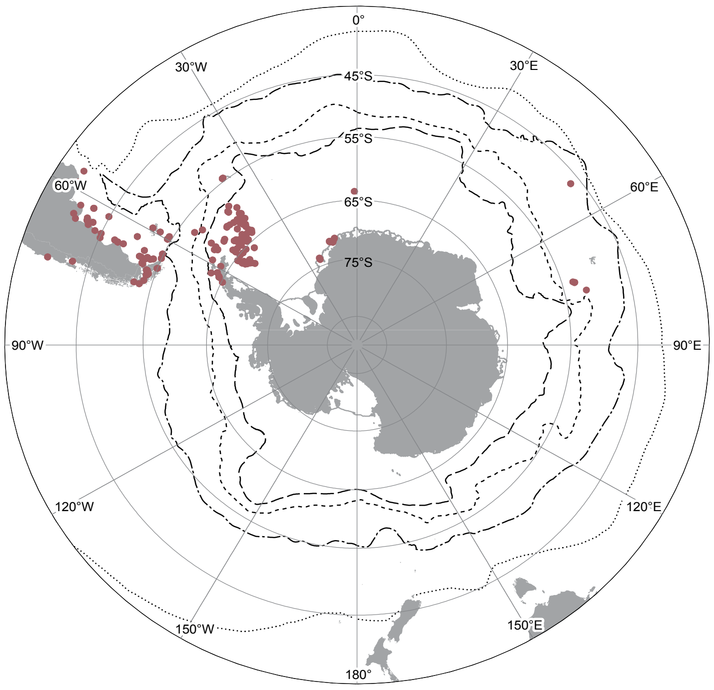
Figure 7 proportion of the 316 asteroid species with occurrence records from the various biogeographic zones as defined in Figure 6.



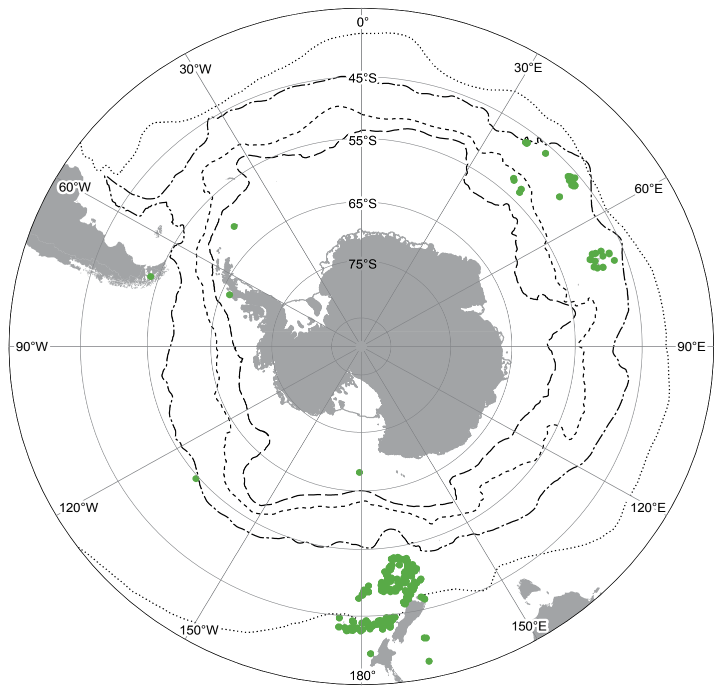
Map 4
● *Diplopterater verrucosus*



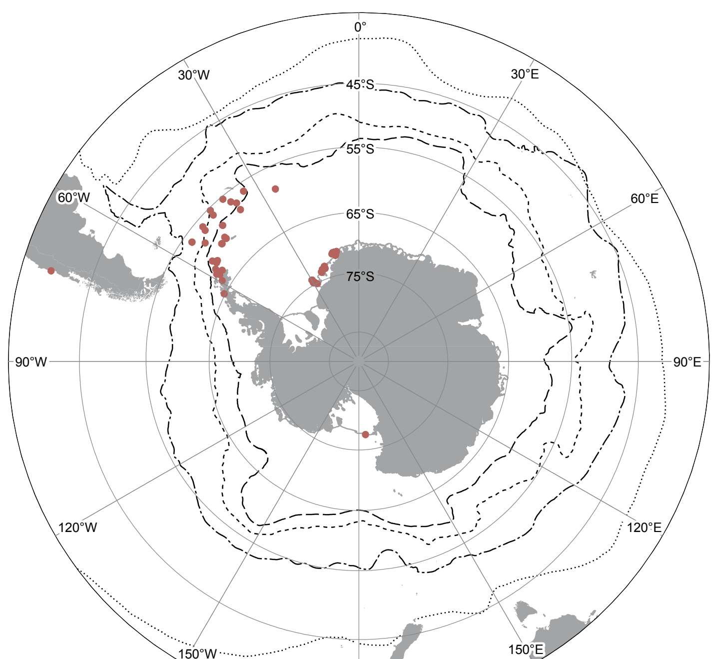
Map 5
● *Pteraster affinis*



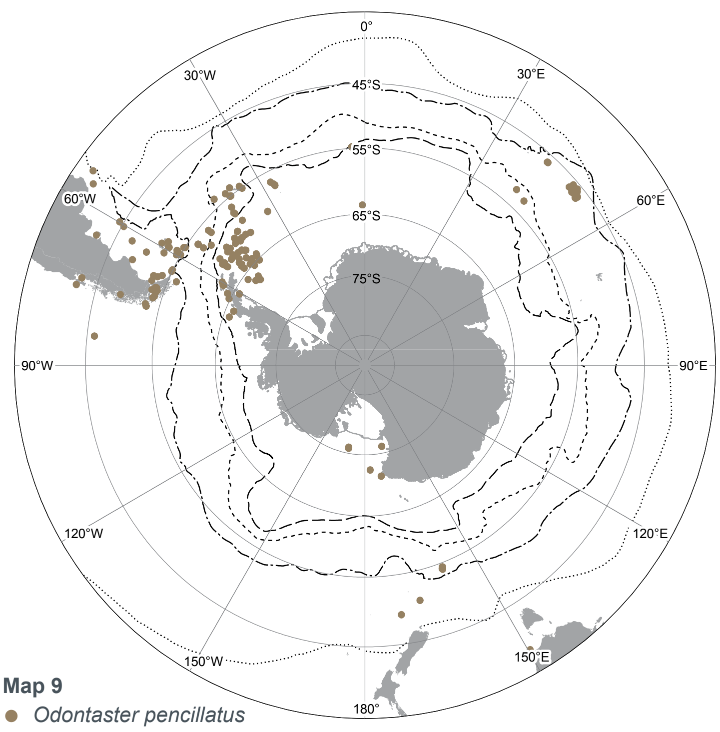
Map 6
● *Cycethra verrucosa*



Map 7
● *Hippasteria phrygiana*

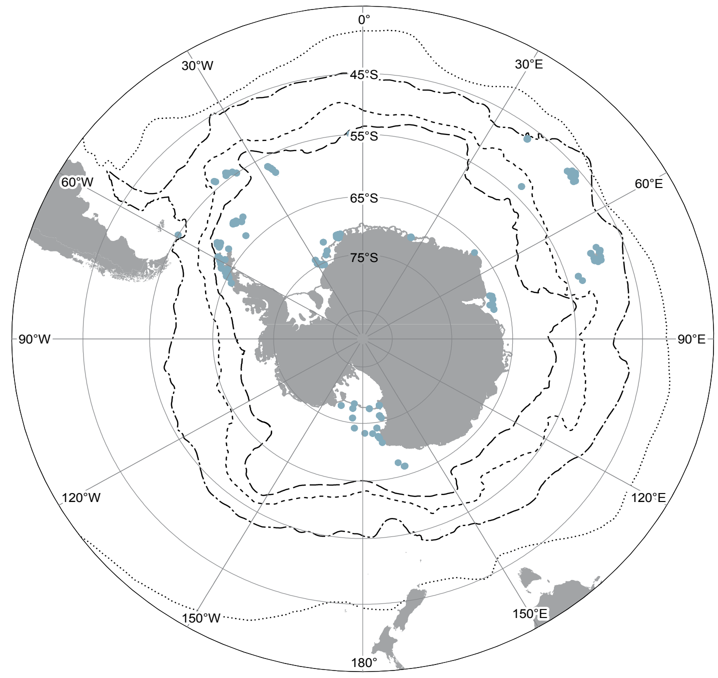


Map 8
● *Notioceramus anomalus*

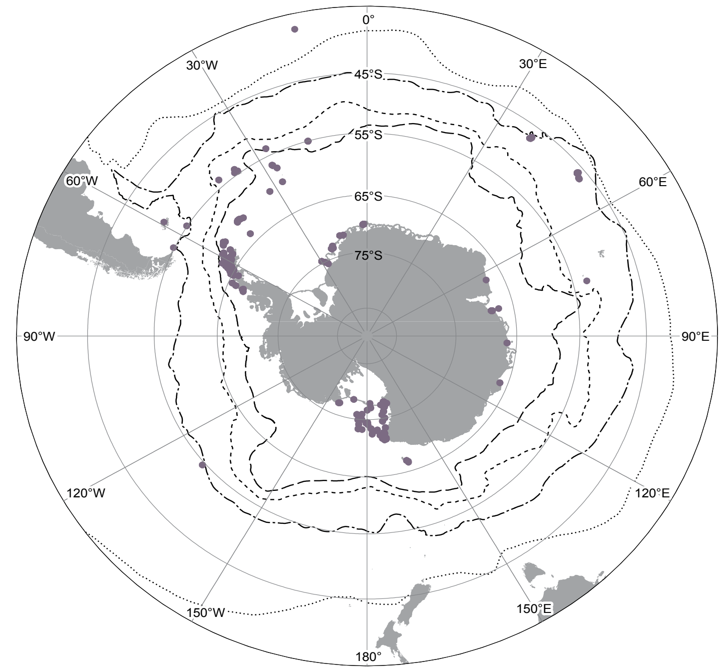


Map 9
● *Odontaster pencillatus*

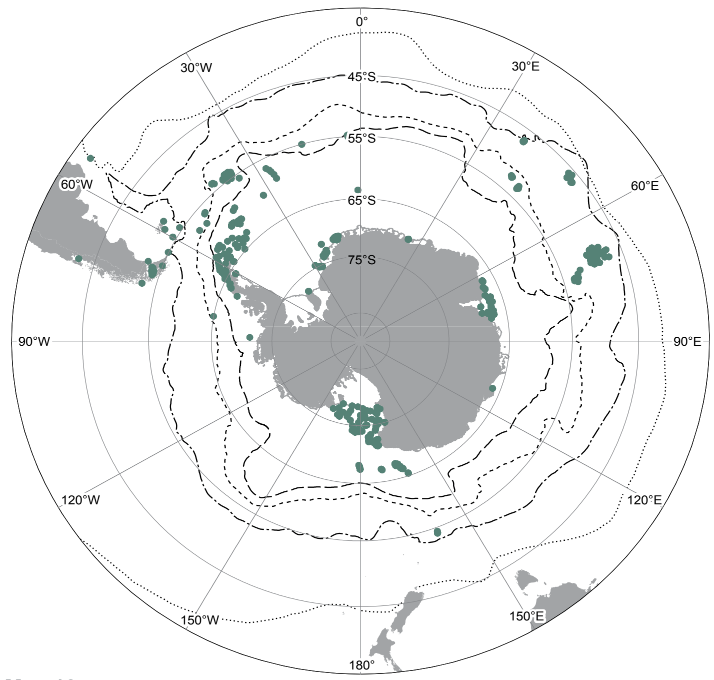
Asteroidea Maps 4-9 Map 4 Distribution map of *Diplopteraster verrucosus* (Asteroidea: Pterasteridae). Map 5 Distribution map of *Pteraster affinis* (Asteroidea: Pterasteridae). Map 6 Distribution map of *Cycethra verrucosa* (Asteroidea: Ganeriidae). Map 7 Distribution map of *Hippasteria phrygiana* (Asteroidea: Goniasteridae). Map 8 Distribution map of *Notoceramus anomalus* (Asteroidea: Goniasteridae). Map 9 Distribution map of *Odontaster penicillatus* (Asteroidea: Odontasteridae).



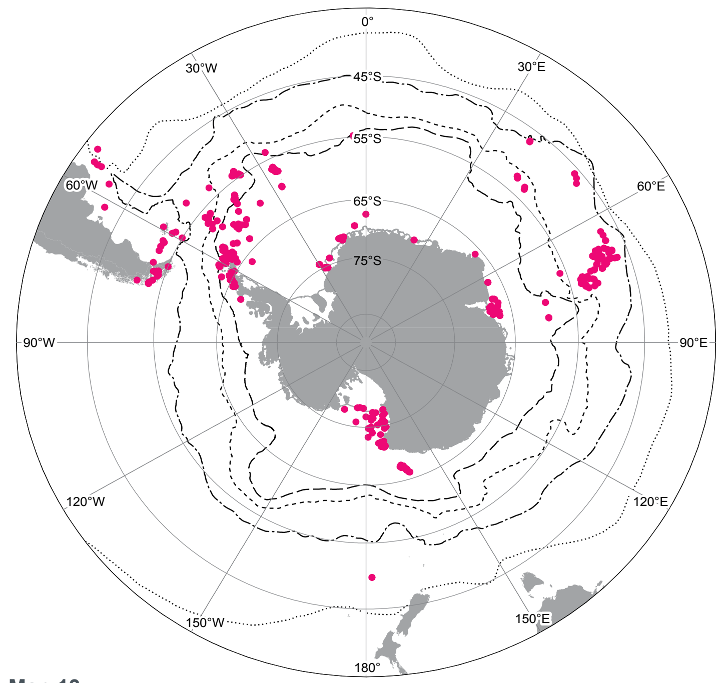
Map 10
● *Acodontaster hodgsoni*



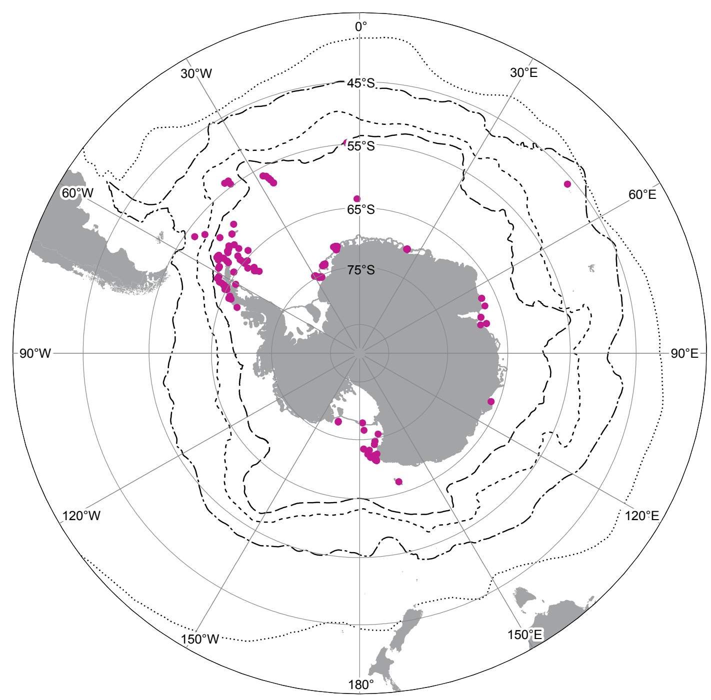
Map 11
● *Odontaster validus*



Map 12
● *Poranina (Poraniania) antarctica*



Map 13
● *Bathybiaster loripes*



Map 14
● *Paralophaster antarcticus*

Asteroidea Maps 10-14 Map 10 Distribution map of *Acodontaster hodgsoni* (Asteroidea: Odontasteridae). Map 11 Distribution map of *Odontaster validus* (Asteroidea: Odontasteridae). Map 12 Distribution map of *Porania (Porania) antarctica* (Asteroidea: Poraniidae). Map 13 Distribution map of *Bathybiaster loripes* (Asteroidea: Astropectinidae). Map 14 Distribution map of *Paralophaster antarcticus* (Asteroidea: Solasteridae).

Cycethra verrucosa Philippi, 1857): reported in South America, Scotia Arc, Antarctic Peninsula, and sub-Antarctic islands (Marion, Crozet and Heard). No data has been reported from the Kerguelen Islands nor for the Davis, Dumont d'Urville, Ross, Amundsen or Bellingshausen seas. Also not reported from the New-Zealand or Tasmanian plateau.

Hippasteria phrygiana (Parelius, 1768): few occurrences from South America, Signy, Western Antarctic Peninsula, Ross Sea, reported from sub-Antarctic islands (Marion, Crozet, Kerguelen and Heard) abundantly reported from the New-Zealand plateau. Not reported from the Davis, Dumont d'Urville, Amundsen or Bellingshausen seas.

Notioceramus anomalus Fisher, 1940: most records concentrated in the Scotia Arc, Western Antarctic Peninsula and eastern Weddell Sea. Absent from all other areas considered in this study.

Odontaster penicillatus (Philippi, 1870): reported from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula, sub-Antarctic islands). Not reported from the Weddell, Davis, Dumont d'Urville, Amundsen and Bellingshausen seas.

Acodontaster hodgsoni (Bell, 1908): reported from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula, sub-Antarctic islands), and also from the Weddell Sea. Not reported from the Davis, Dumont dt'Urville, Amundsen and Bellingshausen seas.

Odontaster validus Koehler, 1906: reported from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula, sub-Antarctic islands). Not reported from the Weddell, Davis, Dumont d'Urville, Amundsen and Bellingshausen seas.

Porania (Porania) antarctica Smith, 1876: widespread records from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula, sub-Antarctic islands), and also from the Weddell, Davis, Ross and Bellingshausen seas. Not reported from the Dumont d'Urville and Amundsen seas.

Bathybiaster loripes Sladen, 1889: records from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula, sub-Antarctic islands), and also from the Weddell, Ross and Bellingshausen seas. Not reported from the Davis, Dumont d'Urville, Amundsen and Bellingshausen seas.

Paralophaster antarcticus (Koehler, 1912): records from most considered areas from this study (South America, Scotia Arc, Antarctic Peninsula), and also from the Weddell, Ross and Bellingshausen seas. Not reported from sub-Antarctic islands or the Davis, Dumont d'Urville, Amundsen and Bellingshausen seas.

6. Discussion and Conclusions

This chapter gives an overview of the current knowledge on Antarctic sea stars biogeography, with a special focus on using distribution data already available through Open Access systems. The accessibility of raw data arising from Antarctic research is a requirement from the Antarctic Treaty, Art III.1.c: *"In order to promote international cooperation in scientific investigation in Antarctica, as provided for in Article II of the present Treaty, the Contracting Parties agree that, to the greatest extent feasible and practicable […] scientific observations and results from Antarctica shall be exchanged and made freely available."*

Distribution patterns have emerged from the analysis of the data compiled for this chapter, which have been compared to information available from the literature (see e.g. Hedgpeth 1969, Clark and Downey 1992). There are more records available from the literature from the last decade, which were purposedly not considered in this study, as they are not published in recognised biodiversity information systems, such as biodiversity.aq, the Global Biodiversity Information Facility (GBIF) or the Ocean Biogeographic Information System (OBIS), and are therefore not discoverable, open, linked, useful, and safe collections of data, organised and curated as described in the common vision developped by Polar scientific data managers (Parsons *et al.* 2011). This gap will need to be filled by devoting special efforts to publish this data online and which will be incoporated in the dynamic version of this Biogeographic Atlas, further expanding our knowledge and our scope for scientific integration. However this points out the need to push further the relentless efforts to ensure that the publication of scientific data is recognised as a priority, as highlighted by Danis & Griffiths (2009).

Table 2 Distribution data (maximum and minimum depths and latitudes) from the present study and as reported in previous studies (combined maximum and minimum depths, distribution), see superscripts legend below for details.

Family	Species Name	Present Study				Literature		
		Min Depth (m)	Max Depth (m)	Min Lat	Max Lat	Min Depth (m)	Max Depth (m)	Distribution
Pterasteridae	*Diplopteraster verrucosus*	4	4009	-67,47	-35,50	74 [1]	270 [1]	Coast of Argentina south to Tierra del Fuego, Burdwood Bank, Falkland Plateau [1]
Pterasteridae	*Pteraster affinis*	12	5346	-75,24	-37,31	0 [2]	603 [2]	Argentina, south to Falkland-Magellan region, Marion Island, Weddell Sea [1]
Ganeriidae	*Cycethra verrucosa*	0	5242	-73,89	-39,10	0 [1] [2]	540 [2]	Southern Brazil, south to the Falkland- Magellan region, Magellan Strait and north to Chile [1]
Goniasteridae	*Hippasteria phrygiana*	12	4359	-68,12	-37,40	320 [1]	980 [1]	Lambert's Bay to Cape Point, South Africa [1]
Goniasteridae	*Notioceramus anomalus*	71	4124	-77,56	-39,10	0 [3]	342 [3]	Clarence Island, Weddell Quadrant, Antarctica [3]
Odontasteridae	*Odontaster penicillatus*	0	5242	-76,14	-37,40	8 [1]	350 [1]	Argentina, south to Falkland-Magellan region, and Chile [1]
Odontasteridae	*Acodontaster hodgsoni*	21	4324	-78,38	-45,63	4 [3]	540 [2]	Circum South-Polar, N to South Georgia (forma *stellatus* from Enderby Land E to Queen Mary Land [3]
Odontasteridae	*Odontaster validus*	2	4549	-78,40	-37,31	0 [2]	941 [2]	Circumpolar Antarctic, N to South Georgia and Bouvet Island [3]
Poraniidae	*Porania (Porania) antarctica*	1	5242	-78,47	-45,63	4 [2]	3200 [2]	Uruguay south to Falkland-Magellanic area, also northwards to Chile and Calbuco, probably eastward to Marion Island [1]
Astropectinidae	*Bathybiaster loripes*	1	4737	-78,34	-37,63	0 [2]	500 [1]	S. Brazil south to Falkland-Magellanic area; also S. Chile [1]
Solasteridae	*Paralophaster antarcticus*	4	5242	-77,90	-45,95	99 [4]	750 [4]	Bellingshausen Sea and probably circum S-polar, South Georgia [4]

[1]: Clark and Downey (1992); [2]: Hedgpeth (1969); [3]: Clark (1993); [4]: Clark (1996)

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▶ Appendix 3 at the end of volume

Appendix 3: Asteroida (Chap. 5.24)

Table 3 Latitudinal distribution for 316 asteroid species recorded south of 35°S, as shown in Figure 6. Species are grouped in broad biogeographic zones: High Antarctic (maximum latitude <60°S, 79 species), Antarctic and Sub-Antarctic (between latitude <60°S AND latitude <45°S, 176 species), Sub-Antarctic (between latitude >60°S AND latitude <45°S, 90 species), Antarctic to Temperate (between latitude >45°S AND latitude <60°S, 44 species) and Cold Temperate (between latitude >45°S AND latitude <55°S, 87 species)"

Nominal species	Authority_accepted	Region
Acodontaster marginatus	(Koehler, 1912)	High Antarctic
Dytaster felix	Koehler, 1907	High Antarctic
Eremicaster pacificus	(Ludwig, 1905)	High Antarctic
Freyella attenuata	Sladen, 1889	High Antarctic
Henricia parva	Koehler, 1912	High Antarctic
Hymenaster caelatus	Sladen, 1882	High Antarctic
Lophaster densus	Fisher, 1940	High Antarctic
Luidia clathrata	(Say, 1825)	High Antarctic
Paralophaster godefroyi	(Koehler, 1912)	High Antarctic
Pergamaster incertus	(Bell, 1908)	High Antarctic
Abyssaster planus	(Sladen, 1883)	Antarctic and Sub-Antarctic
Acodontaster conspicuus	(Koehler, 1920)	Antarctic and Sub-Antarctic
Acodontaster hodgsoni	(Bell, 1908)	Antarctic and Sub-Antarctic
Acodontaster waitei	(Koehler, 1920)	Antarctic and Sub-Antarctic
Adelasterias papillosa	(Koehler, 1906)	Antarctic and Sub-Antarctic
Anseropoda antarctica	Fisher, 1940	Antarctic and Sub-Antarctic
Anteliaster australis	Fisher, 1940	Antarctic and Sub-Antarctic
Astropectinidae	Gray, 1840	Antarctic and Sub-Antarctic
Cheiraster (Luidiaster) antarcticus	(Koehler, 1907)	Antarctic and Sub-Antarctic
Cheiraster (Luidiaster) gerlachei	Ludwig, 1903	Antarctic and Sub-Antarctic
Cheiraster (Luidiaster) planeta	(Sladen, 1889)	Antarctic and Sub-Antarctic
Cheiraster gerlachei	Ludwig, 1903	Antarctic and Sub-Antarctic
Cheiraster planeta	(Sladen, 1889)	Antarctic and Sub-Antarctic
Chitonaster cataphractus	Sladen, 1889	Antarctic and Sub-Antarctic
Chitonaster johannae	Koehler, 1908	Antarctic and Sub-Antarctic
Cryptasterias turqueti	(Koehler, 1906)	Antarctic and Sub-Antarctic
Cuenotaster involutus	(Koehler, 1912)	Antarctic and Sub-Antarctic
Cycethra verrucosa mawsoni	A.M. Clark, 1962	Antarctic and Sub-Antarctic
Diplasterias brucei	(Koehler, 1908)	Antarctic and Sub-Antarctic
Diplasterias meridionalis	(Perrier, 1875)	Antarctic and Sub-Antarctic
Diplasterias octoradiata	(Studer, 1885)	Antarctic and Sub-Antarctic
Freyastera tuberculata	(Sladen, 1889)	Antarctic and Sub-Antarctic
Freyella fragilissima	Sladen, 1889	Antarctic and Sub-Antarctic
Granaster nutrix	(Studer, 1885)	Antarctic and Sub-Antarctic
Henricia smilax	(Koehler, 1920)	Antarctic and Sub-Antarctic
Henricia studeri	Perrier, 1891	Antarctic and Sub-Antarctic
Hippasteria hyadesi	(Parelius, 1768)	Antarctic and Sub-Antarctic
Hymenaster densus	Koehler, 1908	Antarctic and Sub-Antarctic
Hymenaster edax	Koehler, 1908	Antarctic and Sub-Antarctic
Hymenaster latebrosus	Sladen, 1882	Antarctic and Sub-Antarctic
Hymenaster sacculatus	Sladen, 1882	Antarctic and Sub-Antarctic
Hyphalaster scotiae	Koehler, 1907	Antarctic and Sub-Antarctic
Kampylaster incurvatus	Koehler, 1920	Antarctic and Sub-Antarctic
Kenrickaster pedicellaris	A.M. Clark, 1962	Antarctic and Sub-Antarctic
Labidiaster annulatus	Sladen, 1889	Antarctic and Sub-Antarctic
Leptychaster flexuosus	(Koehler, 1920)	Antarctic and Sub-Antarctic
Leptychaster kerguelenensis	E. A. Smith, 1876	Antarctic and Sub-Antarctic
Leptychaster magnificus	(Koehler, 1912)	Antarctic and Sub-Antarctic
Lonchotaster tartareus	Sladen, 1889	Antarctic and Sub-Antarctic
Lophaster gaini	Koehler, 1912	Antarctic and Sub-Antarctic
Luidiaster antarcticus	(Koehler, 1907)	Antarctic and Sub-Antarctic
Luidiaster gerlachei	Ludwig, 1903	Antarctic and Sub-Antarctic
Lysasterias adeliae	(Koehler, 1920)	Antarctic and Sub-Antarctic
Lysasterias belgicae	(Ludwig, 1903)	Antarctic and Sub-Antarctic
Lysasterias chirophora	(Ludwig, 1903)	Antarctic and Sub-Antarctic
Lysasterias digitata	A.M. Clark, 1962	Antarctic and Sub-Antarctic
Lysasterias hemiora	Fisher, 1940	Antarctic and Sub-Antarctic
Lysasterias heteractis	Fisher, 1940	Antarctic and Sub-Antarctic
Lysasterias joffrei	(Koehler, 1920)	Antarctic and Sub-Antarctic
Lysasterias perrieri	(Studer, 1885)	Antarctic and Sub-Antarctic
Macroptychaster accrescens	(Koehler, 1920)	Antarctic and Sub-Antarctic
Myoraster antarcticus	(Koehler, 1912)	Antarctic and Sub-Antarctic
Neosmilaster georgianus	(Studer, 1885)	Antarctic and Sub-Antarctic
Neosmilaster steineni	(Studer, 1885)	Antarctic and Sub-Antarctic
Notasterias armata	(Koehler, 1911)	Antarctic and Sub-Antarctic
Notasterias bongraini	(Koehler, 1912)	Antarctic and Sub-Antarctic
Notasterias haswelli	Koehler, 1920	Antarctic and Sub-Antarctic
Notasterias pedicellaris	(Koehler, 1907)	Antarctic and Sub-Antarctic
Notasterias stolophora	Fisher, 1940	Antarctic and Sub-Antarctic
Odinella nutrix	Fisher, 1940	Antarctic and Sub-Antarctic
Odontaster meridionalis	(E. A. Smith, 1876)	Antarctic and Sub-Antarctic
Odontaster pusilus	Koehler, 1907	Antarctic and Sub-Antarctic
Paralophaster antarcticus	(Koehler, 1912)	Antarctic and Sub-Antarctic
Paralophaster lorioli	(Koehler, 1907)	Antarctic and Sub-Antarctic
Pedicellaster hypernotius	Sladen, 1889	Antarctic and Sub-Antarctic
Pentoplia felli	(H.E.S. Clark, 1971)	Antarctic and Sub-Antarctic
Pergamaster synaptorus	(Bell, 1908)	Antarctic and Sub-Antarctic
Pergamaster triseriatus	H.E.S. Clark, 1963	Antarctic and Sub-Antarctic
Peribolaster macleani	Koehler, 1920	Antarctic and Sub-Antarctic
Peribolaster powelli	Koehler, 1920	Antarctic and Sub-Antarctic
Perknaster antarcticus	(Koehler, 1906)	Antarctic and Sub-Antarctic
Perknaster aurantiacus	Koehler, 1912	Antarctic and Sub-Antarctic
Perknaster aurorae	(Koehler, 1920)	Antarctic and Sub-Antarctic
Perknaster charcoti	(Koehler, 1912)	Antarctic and Sub-Antarctic
Perknaster densus	Sladen, 1889	Antarctic and Sub-Antarctic
Perknaster fuscus	Sladen, 1889	Antarctic and Sub-Antarctic
Perknaster fuscus antarcticus	(Koehler, 1906)	Antarctic and Sub-Antarctic
Perknaster sladeni	(Perrier, 1891)	Antarctic and Sub-Antarctic
Persephonaster facetus	(Koehler, 1907)	Antarctic and Sub-Antarctic
Porania (Porania) antarctica	E. A. Smith, 1876	Antarctic and Sub-Antarctic
Porania antarctica	E. A. Smith, 1876	Antarctic and Sub-Antarctic
Porania antarctica glaber	Sladen, 1889	Antarctic and Sub-Antarctic
Porania magellanica	Studer, 1876	Antarctic and Sub-Antarctic
Pseudarchaster discus	Sladen, 1889	Antarctic and Sub-Antarctic
Psilaster charcoti	(Koehler, 1906)	Antarctic and Sub-Antarctic
Pteraster affinis lebruni	Perrier, 1891	Antarctic and Sub-Antarctic
Pteraster gibber	(Sladen, 1882)	Antarctic and Sub-Antarctic
Pteraster hirsutus	(Sladen, 1882)	Antarctic and Sub-Antarctic
Pteraster rugatus	Sladen, 1882	Antarctic and Sub-Antarctic
Pteraster stellifer	Sladen, 1882	Antarctic and Sub-Antarctic
Remaster gourdoni	Koehler, 1912	Antarctic and Sub-Antarctic
Rhopiella hirsuta	(Koehler, 1920)	Antarctic and Sub-Antarctic
Saliasterias brachiata	Koehler, 1920	Antarctic and Sub-Antarctic
Smilasterias scalprifera	(Sladen, 1889)	Antarctic and Sub-Antarctic
Solaster longoi	Stampanato & Jangoux, 1993	Antarctic and Sub-Antarctic
Solaster regularis subarcuatus	Sladen, 1889	Antarctic and Sub-Antarctic
Styracaster armatus	Sladen, 1883	Antarctic and Sub-Antarctic
Styracaster robustus	Koehler, 1908	Antarctic and Sub-Antarctic
Tremaster mirabilis	Verrill, 1880	Antarctic and Sub-Antarctic
Acodontaster elongatus granuliferus	(Koehler, 1912)	Sub-Antarctic
Anasterias laevigata	(Hutton, 1879)	Sub-Antarctic
Anasterias mawsoni	(Koehler, 1920)	Sub-Antarctic
Anasterias perrieri	(E. A. Smith, 1876)	Sub-Antarctic
Anasterias studeri	Perrier, 1891	Sub-Antarctic
Calyptraster vitreus	Bernasconi, 1972	Sub-Antarctic
Ceramaster grenadensis patagonicus	(Sladen, 1889)	Sub-Antarctic
Ceramaster lennoxkingi	McKnight, 1973	Sub-Antarctic
Ceramaster patagonicus australis	H.E.S. Clark, 2001	Sub-Antarctic
Cheiraster (Luidiaster) hirsutus	(Studer, 1884)	Sub-Antarctic
Cheiraster (Luidiaster) hirsutus	(Studer, 1884)	Sub-Antarctic
Cladaster latus	Fisher, 1940	Sub-Antarctic

Cladaster macrobrachius	H.L. Clark, 1923	Sub-Antarctic
Diplopteraster semireticulatus	(Sladen, 1882)	Sub-Antarctic
Freyella drygalskii	Döderlein, 1927	Sub-Antarctic
Henricia fisheri	A.M. Clark, 1962	Sub-Antarctic
Henricia leviuscula spiculifera	(H.L. Clark, 1901)	Sub-Antarctic
Henricia ralphae	Fell, 1958	Sub-Antarctic
Henricia spinulifera	(H.L. Clark, 1901)	Sub-Antarctic
Solaster dianae	Downey, 1971	Sub-Antarctic
Acodontaster capitatus	(Koehler, 1912)	Antarctic to Temperate
Acodontaster elongatus	(Sladen, 1889)	Antarctic to Temperate
Anasterias antarctica	(Lütken, 1857)	Antarctic to Temperate
Anasterias pedicellaris	Koehler, 1923	Antarctic to Temperate
Astropecten brasiliensis	Müller & Troschel, 1842	Antarctic to Temperate
Bathybiaster loripes	Sladen, 1889	Antarctic to Temperate
Bathybiaster loripes obesus	Sladen, 1889	Antarctic to Temperate
Ceramaster patagonicus	(Sladen, 1889)	Antarctic to Temperate
Cladaster analogus	Fisher, 1940	Antarctic to Temperate
Cosmasterias lurida	(Philippi, 1858)	Antarctic to Temperate
Crossaster penicillatus	Sladen, 1889	Antarctic to Temperate
Ctenodiscus australis	Lütken, 1871	Antarctic to Temperate
Ctenodiscus procurator	Sladen, 1889	Antarctic to Temperate
Cycethra verrucosa	(Philippi, 1857)	Antarctic to Temperate
Diplasterias brandti	(Bell, 1881)	Antarctic to Temperate
Diplodontias singularis	(Müller & Troschel, 1843)	Antarctic to Temperate
Diplopteraster verrucosus	(Sladen, 1882)	Antarctic to Temperate
Eremicaster crassus	(Sladen, 1883)	Antarctic to Temperate
Eremicaster vicinus	Ludwig, 1907	Antarctic to Temperate
Ganeria falklandica	Gray, 1847	Antarctic to Temperate
Gaussaster antarcticus	(Sladen, 1889)	Antarctic to Temperate
Henricia obesa	(Sladen, 1889)	Antarctic to Temperate
Henricia pagenstecheri	(Studer, 1885)	Antarctic to Temperate
Hippasteria falklandica	Fisher, 1940	Antarctic to Temperate
Hippasteria phrygiana	(Parelius, 1768)	Antarctic to Temperate
Hymenaster crucifer	Sladen, 1882	Antarctic to Temperate
Hymenaster pellucidus	Thomson, 1873	Antarctic to Temperate
Hyphalaster inermis	Sladen, 1883	Antarctic to Temperate
Labidiaster radiosus	Lütken, 1871	Antarctic to Temperate
Lophaster stellans	Sladen, 1889	Antarctic to Temperate
Notioceramus anomalus	Fisher, 1940	Antarctic to Temperate
Odontaster penicillatus	(Philippi, 1870)	Antarctic to Temperate
Odontaster validus	Koehler, 1906	Antarctic to Temperate
Peribolaster folliculatus	Sladen, 1889	Antarctic to Temperate
Porania (Porania) antarctica magellanica	Studer, 1876	Antarctic to Temperate
Porania antarctica magellanica	Studer, 1876	Antarctic to Temperate
Psalidaster mordax	Fisher, 1940	Antarctic to Temperate
Pteraster affinis	Smith, 1876	Antarctic to Temperate
Smilasterias triremis	Sladen, 1889	Antarctic to Temperate
Solaster regularis	Sladen, 1889	Antarctic to Temperate
Styracaster horridus	Sladen, 1883	Antarctic to Temperate
Tremaster mirabilis novaecale-doniae	Jangoux, 1982	Antarctic to Temperate
Allostichaster insignis	(Farquhar, 1895)	Cold Temperate
Allostichaster polyplax	(Muller & Troschel, 1844)	Cold Temperate
Anasterias directus	(Koehler, 1920)	Cold Temperate
Anasterias suteri	(deLoriol, 1894)	Cold Temperate
Anthenoides cristatus	(Sladen, 1889)	Cold Temperate
Asterina regularis	(Verrill, 1867)	Cold Temperate
Astromesites primigenius	(Mortensen, 1925)	Cold Temperate
Astrostole scabra	(Hutton, 1872)	Cold Temperate
Benthopecten munidae	H.E.S. Clark, 1969	Cold Temperate
Benthopecten pikei	H.E.S. Clark, 1969	Cold Temperate
Brisinga chathamica	McKnight, 1973	Cold Temperate
Ceramaster patagonicus pata-gonicus	(Sladen, 1889)	Cold Temperate
Cheiraster (Cheiraster) otagoensis	McKnight, 1973	Cold Temperate
Cheiraster otagoensis	McKnight, 1973	Cold Temperate
Coscinasterias calamaria	(Gray, 1840)	Cold Temperate
Coscinasterias muricata	Verrill, 1870	Cold Temperate

Cosmasterias dyscrita	H.L. Clark, 1916	Cold Temperate
Crossaster campbellicus	McKnight, 1973	Cold Temperate
Crossaster japonicus	(Fisher, 1911)	Cold Temperate
Crossaster multispinus	H.L. Clark, 1916	Cold Temperate
Diplodontias dilatatus	(Perrier, 1875)	Cold Temperate
Diplopteraster clarki	Bernasconi, 1937	Cold Temperate
Diplopteraster hurleyi	McKnight, 1973	Cold Temperate
Diplopteraster otagoensis	McKnight, 2006	Cold Temperate
Dipsacaster magnificus	(H.L. Clark, 1916)	Cold Temperate
Dipsachaster magnificus	(H.L. Clark, 1916)	Cold Temperate
Echinaster farquhari	Benham, 1909	Cold Temperate
Freyella echinata	Sladen, 1889	Cold Temperate
Gilbertaster anacanthus	Fisher, 1906	Cold Temperate
Henricia aucklandiae	Mortensen, 1925	Cold Temperate
Henricia compacta	(Sladen, 1889)	Cold Temperate
Henricia lukinsii	(Farquhar, 1898)	Cold Temperate
Hippasteria trojana	(Parelius, 1768)	Cold Temperate
Hymenaster carnosus	Sladen, 1882	Cold Temperate
Hymenaster estcourti	McKnight, 1973	Cold Temperate
Hymenaster pullatus	Sladen, 1882	Cold Temperate
Hymenodiscus aotearoa	(McKnight, 1973)	Cold Temperate
Lethasterias australis	Fisher, 1923	Cold Temperate
Lithosoma novaezealandiae	McKnight, 1973	Cold Temperate
Luidia neozelanica	Mortensen, 1925	Cold Temperate
Mediaster arcuatus	(Sladen, 1889)	Cold Temperate
Mediaster dawsoni	McKnight, 1973	Cold Temperate
Mediaster sladeni	Benham, 1909	Cold Temperate
Meridiastra medius	(O'Loughlin, Waters & Roy, 2003)	Cold Temperate
Myxoderma qawashqari	(Moyana & Larrain Prat, 1976)	Cold Temperate
Novodinia novaezealandiae	(H.E.S. Clark, 1962)	Cold Temperate
Odontaster aucklandensis	McKnight, 1973	Cold Temperate
Odontaster benhami	(Mortensen, 1925)	Cold Temperate
Paralophaster hyalinus	H.E.S. Clark, 1970	Cold Temperate
Patiriella fimbriata	Perrier, 1875	Cold Temperate
Patiriella regularis	(Verrill, 1867)	Cold Temperate
Pectinaster mimicus	(Sladen, 1889)	Cold Temperate
Pentagonaster pulchellus	Gray, 1840	Cold Temperate
Peribolaster lictor	Fell, 1958	Cold Temperate
Perissasterias monacantha	McKnight, 1973	Cold Temperate
Pillsburiaster aoteanus	McKnight, 1973	Cold Temperate
Plutonaster complexus	H.E.S Clark & D.G. McKnight, 2000	Cold Temperate
Plutonaster fragilis	H.E.S. Clark, 1970	Cold Temperate
Plutonaster hikurangi	H.E.S Clark & D.G. McKnight, 2000	Cold Temperate
Plutonaster jonathani	H.E.S Clark & D.G. McKnight, 2000	Cold Temperate
Plutonaster knoxi	Fell, 1958	Cold Temperate
Poraniopsis echinaster	Perrier, 1891	Cold Temperate
Porcellanaster caeruleus	Wyville Thomson, 1877	Cold Temperate
Proserpinaster neozelanicus	(Mortensen, 1925)	Cold Temperate
Pseudarchaster abernethyi	Fell, 1958	Cold Temperate
Pseudarchaster garricki	Fell, 1958	Cold Temperate
Pseudechinaster rubens	H.E.S. Clark, 1962	Cold Temperate
Psilaster acuminatus	Sladen, 1889	Cold Temperate
Pteraster bathamae	Fell, 1958	Cold Temperate
Pteraster robertsoni	McKnight, 1973	Cold Temperate
Radiaster gracilis	(H.L. Clark, 1916)	Cold Temperate
Sclerasterias mollis	(Hutton, 1872)	Cold Temperate
Smilasterias clarkailsa	O'Loughlin & O'Hara, 1990	Cold Temperate
Smilasterias irregularis	H.L. Clark, 1928	Cold Temperate
Solaster notophrynus	Downey, 1971	Cold Temperate
Solaster torulatus	Sladen, 1889	Cold Temperate
Stegnaster inflatus	(Hutton, 1872)	Cold Temperate
Stichaster australis	(Verrill, 1871)	Cold Temperate
Taranuiaster novaezealandiae	McKnight, 1973	Cold Temperate
Vemaster sudatlanticus	Bernasconi, 1965	Cold Temperate
Zoroaster alternicanthus	McKnight, 2006	Cold Temperate
Zoroaster spinulosus	Fisher, 1906	Cold Temperate

THE BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

Scope

Biogeographic information is of fundamental importance for discovering marine biodiversity hotspots, detecting and understanding impacts of environmental changes, predicting future distributions, monitoring biodiversity, or supporting conservation and sustainable management strategies.

The recent extensive exploration and assessment of biodiversity by the Census of Antarctic Marine Life (CAML), and the intense compilation and validation efforts of Southern Ocean biogeographic data by the SCAR Marine Biodiversity Information Network (SCAR-MarBIN / OBIS) provided a unique opportunity to assess and synthesise the current knowledge on Southern Ocean biogeography.

The scope of the Biogeographic Atlas of the Southern Ocean is to present a concise synopsis of the present state of knowledge of the distributional patterns of the major benthic and pelagic taxa and of the key communities, in the light of biotic and abiotic factors operating within an evolutionary framework. Each chapter has been written by the most pertinent experts in their field, relying on vastly improved occurrence datasets from recent decades, as well as on new insights provided by molecular and phylogeographic approaches, and new methods of analysis, visualisation, modelling and prediction of biogeographic distributions.

A dynamic online version of the Biogeographic Atlas will be hosted on www.biodiversity.aq.

The Census of Antarctic Marine Life (CAML)

CAML (www.caml.aq) was a 5-year project that aimed at assessing the nature, distribution and abundance of all living organisms of the Southern Ocean. In this time of environmental change, CAML provided a comprehensive baseline information on the Antarctic marine biodiversity as a sound benchmark against which future change can reliably be assessed. CAML was initiated in 2005 as the regional Antarctic project of the worldwide programme Census of Marine Life (2000-2010) and was the most important biology project of the International Polar Year 2007-2009.

The SCAR Marine Biodiversity Information Network (SCAR-MarBIN)

In close connection with CAML, SCAR-MarBIN (www.scarmarbin.be, integrated into www.biodiversity.aq) compiled and managed the historic, current and new information (i.a. generated by CAML) on Antarctic marine biodiversity by establishing and supporting a distributed system of interoperable databases, forming the Antarctic regional node of the Ocean Biogeographic Information System (OBIS, www.iobis.org), under the aegis of SCAR (Scientific Committee on Antarctic Research, www.scar.org). SCAR-MarBIN established a comprehensive register of Antarctic marine species and, with biodiversity.aq provided free access to more than 2.9 million Antarctic georeferenced biodiversity data, which allowed more than 60 million downloads.

The Editorial Team

Claude DE BROYER is a marine biologist at the Royal Belgian Institute of Natural Sciences in Brussels. His research interests cover structural and ecofunctional biodiversity and biogeography of crustaceans, and polar and deep sea benthic ecology. Active promoter of CAML and ANDEEP, he is the initiator of the SCAR Marine Biodiversity Information Network (SCAR-MarBIN). He took part to 19 polar expeditions.

Huw GRIFFITHS is a marine Biogeographer at the British Antarctic Survey. He created and manages SOMBASE, the Southern Ocean Mollusc Database. His interests include large-scale biogeographic and ecological patterns in space and time. His focus has been on molluscs, bryozoans, sponges and pycnogonids as model groups to investigate trends at high southern latitudes.

Cédric d'UDEKEM d'ACOZ is a research scientist at the Royal Belgian Institute of Natural Sciences, Brussels. His main research interests are systematics of amphipod crustaceans, especially of polar species and taxonomy of decapod crustaceans. He took part to 2 scientific expeditions to Antarctica on board of the *Polarstern* and to several sampling campaigns in Norway and Svalbard.

Bruno DANIS is an Associate Professor at the Université Libre de Bruxelles, where his research focuses on polar biodiversity. Former coordinator of the scarmarbin. be and antabif.be projects, he is a leading member of several international committees, such as OBIS or the SCAR Expert Group on Antarctic Biodiversity Informatics. He has published papers in various fields, including ecotoxicology, physiology, biodiversity informatics, polar biodiversity or information science.

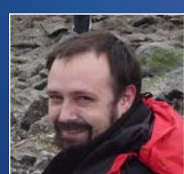
Susie GRANT is a marine biogeographer at the British Antarctic Survey. Her work is focused on the design and implementation of marine protected areas, particularly through the use of biogeographic information in systematic conservation planning.

Christoph HELD is a Senior Research Scientist at the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven. He is a specialist in molecular systematics and phylogeography of Antarctic crustaceans, especially isopods.

Falk HUETTMANN is a 'digital naturalist' he works on three poles (Arctic, Antarctic and Hindu-Kush Himalaya) and elsewhere (marine, terrestrial and atmosphere). He is based with the university of Alaska-Fairbank (UAF) and focuses primarily on effective conservation questions engaging predictions and open access data.

Philippe KOUBBI is professor at the University Pierre et Marie Curie (Paris, France) and a specialist in Antarctic fish ecology and biogeography. He is the Principal Investigator of projects supported by IPEV, the French Polar Institute. As a French representative to the CCAMLR Scientific Committee, his main input is on the proposal of Marine Protected Areas. His other field of research is on the ecoregionalisation of the high seas.

Ben RAYMOND is a computational ecologist and exploratory data analyst, working across a variety of Southern Ocean, Antarctic, and wider research projects. His areas of interest include ecosystem modelling, regionalisation and marine protected area selection, risk assessment, animal tracking, seabird ecology, complex systems, and remote sensed data analyses.



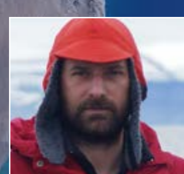
Anton VAN DE PUTTE works at the Royal Belgian Institute for Natural Sciences (Brussels, Belgium). He is an expert in the ecology and evolution of Antarctic fish and is currently the Science Officer for the Antarctic Biodiveristy Portal www. biodiversity.aq. This portal provides free and open access to Antarctic Marine and terrestrial biodiversity of the Antarctic and the Southern Ocean.

Bruno DAVID is CNRS director of research at the laboratory BIOGÉOSCIENCES, University of Burgundy. His works focus on evolution of living forms, with and more specifically on sea urchins. He authored a book and edited an extensive database on Antarctic echinoids. He is currently President of the scientific council of the Muséum National d'Histoire Naturelle (Paris), and Deputy Director at the CNRS Institute for Ecology and Environment.

Julian GUTT is a marine ecologist at the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, and professor at the Oldenburg University, Germany. He participated in 13 scientific expeditions to the Antarctic and was twice chief scientist on board Polarstern. He is member of the SCAR committees ACCE and AnT-ERA (as chief officer). Main focii of his work are: biodiversity, ecosystem functioning and services, response of marine systems to climate change, non-invasive technologies, and outreach.

Graham HOSIE is Principal Research Scientist in zooplankton ecology at the Australian Antarctic Division. He founded the SCAR Southern Ocean Continuous Plankton Recorder Survey and is the Chief Officer of the SCAR Life Sciences Standing Scientific Group. His research interests include the ecology and biogeography of plankton species and communities, notably their response to environmental changes. He has participated in 17 marine science voyages to Antarctica.

Alexandra POST is a marine geoscientist, with expertise in benthic habitat mapping, sedimentology and geomorphic characterisation of the seafloor. She has worked at Geoscience Australia since 2002, with a primary focus on understanding seafloor processes and habitats on the East Antarctic margin. Most recently she has led work to understand the biophysical environment beneath the Amery Ice Shelf, and to characterise the habitats on the George V Shelf and slope following the successful CAML voyages in that region.



Yan ROPERT COUDERT spent 10 years at the Japanese National Institute of Polar Research, where he graduated as a Doctor in Polar Sciences in 2001. Since 2007, he is a permanent researcher at the CNRS in France and the director of a polar research programme (since 2011) that examines the ecological response of Adélie penguins to environmental changes. He is also the secretary of the Expert Group on Birds and Marine Mammals and of the Life Science Group of the Scientific Committee on Antarctic Research.