Census of Antarctic Marine Life
SCAR-Marine Biodiversity Information Network

BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

CHAPTER 5.22. SHRIMPS (CRUSTACEA: DECAPODA).

Basher Z., Costello M., 2014.

In: De Broyer C., Koubbi P., Griffiths H.J., Raymond B., Udekem d'Acoz C. d', et al. (eds.). Biogeographic Atlas of the Southern Ocean. Scientific Committee on Antarctic Research, Cambridge, pp. 190-194.

EDITED BY:
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SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

THE BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

The “Biogeographic Atlas of the Southern Ocean” is a legacy of the International Polar Year 2007-2009 (www.ipy.org) and of the Census of Marine Life 2000-2010 (www.coml.org), contributed by the Census of Antarctic Marine Life (www.caml.aq) and the SCAR Marine Biodiversity Information Network (www.scarmarbin.be; www.biodiversity.aq).

The “Biogeographic Atlas” is a contribution to the SCAR programmes Ant-ECO (State of the Antarctic Ecosystem) and AnT-ERA (Antarctic Thresholds- Ecosystem Resilience and Adaptation) (www.scar.org/science-themes/ecosystems).

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Published by:

The Scientific Committee on Antarctic Research, Scott Polar Research Institute, Lensfield Road, Cambridge, CB2 1ER, United Kingdom (www.scar.org).

Publication funded by:

- The Census of Marine Life (Albert P. Sloan Foundation, New York)
- The TOTAL Foundation, Paris.

The “Biogeographic Atlas of the Southern Ocean” shared the *Cosmos Prize* awarded to the Census of Marine Life by the International Osaka Expo’90 Commemorative Foundation, Tokyo, Japan.

Publication supported by:

- The Belgian Science Policy (Belspo), through the Belgian Scientific Research Programme on the Antarctic and the “biodiversity.aq” network (SCAR-MarBIN/ANTABIF)
- The Royal Belgian Institute of Natural Sciences (RBINS), Brussels, Belgium
- The British Antarctic Survey (BAS), Cambridge, United Kingdom
- The Université Pierre et Marie Curie (UPMC), Paris, France
- The Australian Antarctic Division, Hobart, Australia
- The Scientific Steering Committee of CAML, Michael Stoddart (CAML Administrator) and Victoria Wadley (CAML Project Manager)

Mapping coordination and design: Huw Griffiths (BAS, Cambridge) & Anton Van de Putte (RBINS, Brussels)

Editorial assistance: Henri Robert, Xavier Loréa, Charlotte Havermans, Nicole Moortgat (RBINS, Brussels)

Printed by: Altitude Design, Rue Saint Josse, 15, B-1210 Brussels, Belgium (www.altitude-design.be)

Lay out: Sigrid Camus & Amélie Blaton (Altitude Design, Brussels).

Cover design: Amélie Blaton (Altitude Design, Brussels) and the Editorial Team.

Cover pictures: amphipod crustacean (*Epimeria rubrieques* De Broyer & Klages, 1991), image © T. Riehl, University of Hamburg; krill (*Euphausia superba* Dana, 1850), image © V. Siegel, Institute of Sea Fisheries, Hamburg; fish (*Chaenocephalus* sp.), image © C. d’Udekem d’Acoz, RBINS; emperor penguin (*Aptenodytes forsteri* G.R. Gray, 1844), image © C. d’Udekem d’Acoz, RBINS; Humpback whale (*Megaptera novaeangliae* (Borowski, 1781)), image © L. Kindermann, AWI.

Online dynamic version :

A dynamic online version of the Biogeographic Atlas is available on the SCAR-MarBIN / AntaBIF portal : atlas.biodiversity.aq.

Recommended citation:

For the volume:

De Broyer C., Koubbi P., Griffiths H.J., Raymond B., Udekem d’Acoz C. d’, Van de Putte A.P., Danis B., David B., Grant S., Gutt J., Held C., Hosie G., Huettmann F., Post A., Ropert-Coudert Y. (eds.), 2014. Biogeographic Atlas of the Southern Ocean. Scientific Committee on Antarctic Research, Cambridge, XII + 498 pp.

For individual chapter:

(e.g.) Crame A., 2014. Chapter 3.1. Evolutionary Setting. In: De Broyer C., Koubbi P., Griffiths H.J., Raymond B., Udekem d’Acoz C. d’, *et al*. (eds.). Biogeographic Atlas of the Southern Ocean. Scientific Committee on Antarctic Research, Cambridge, pp. xx-yy.

ISBN: 978-0-948277-28-3.

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5.22. Shrimps (Crustacea: Decapoda)

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1. Introduction

Decapod shrimps are ubiquitous in the world oceans, with most species in tropical and subtropical regions and a marked decline towards temperate and polar regions (e.g. Boschi 2000; Van Dover 2000; Bauer 2004). They have a wide distribution around the Antarctic continent and to abyssal depths in the Southern Ocean (Clarke 1990; Tiefenbacher 1990b, a; Briggs 1995; Komai *et al.* 1996; Arntz *et al.* 1999; Gorny 1999; Thatje & Arntz 2004; Boschi & Gavio 2005; Thatje *et al.* 2005a; Ahyong 2009; Griffiths 2010; Dambach *et al.* 2012; Griffiths *et al.* 2013; Linse *et al.* 2013). Historically, Antarctic shrimps may have persisted through several glaciation events by surviving in the deep-sea during glacial maxima and recolonizing the continental shelf as ice shelves retreated during interglacials (Brandt 1999, 2005). They may be able to tolerate extremely low sea-water temperatures through their ability to regulate magnesium levels in the haemolymph (Frederich *et al.* 2001; Wittmann *et al.* 2010); a capacity that is lacking in other crabs and lobsters (Gorny *et al.* 1992; Frederich *et al.* 2000).

Although predominantly benthic, they also occur in the water column and in symbiotic relationships (Bauer 2004). Their feeding habits range from deposit feeding to carnivory (e.g., Lagardère 1977; Cartes *et al.* 2002; Fanelli & Cartes 2004), and they can contribute significantly to the processing and recycling of materials at the seabed (Coull & Bell 1983; Field 1983; Cartes *et al.* 2007). Some shrimps species comprised 20% of the weight and occurred in 70% of the diet of Weddell seals (Green & Burton 1987). Thus if widespread and abundant they could play a significant role in Antarctic food webs.

This chapter illustrates the distribution of decapod shrimp species in the Southern Ocean, defined here as the region south of the Antarctic Polar Front, and comment on their ecology. The data were compiled from the literature and the authors' unpublished data, and have been published through the SCAR-MarBIN portal (De Broyer & Danis 2013).

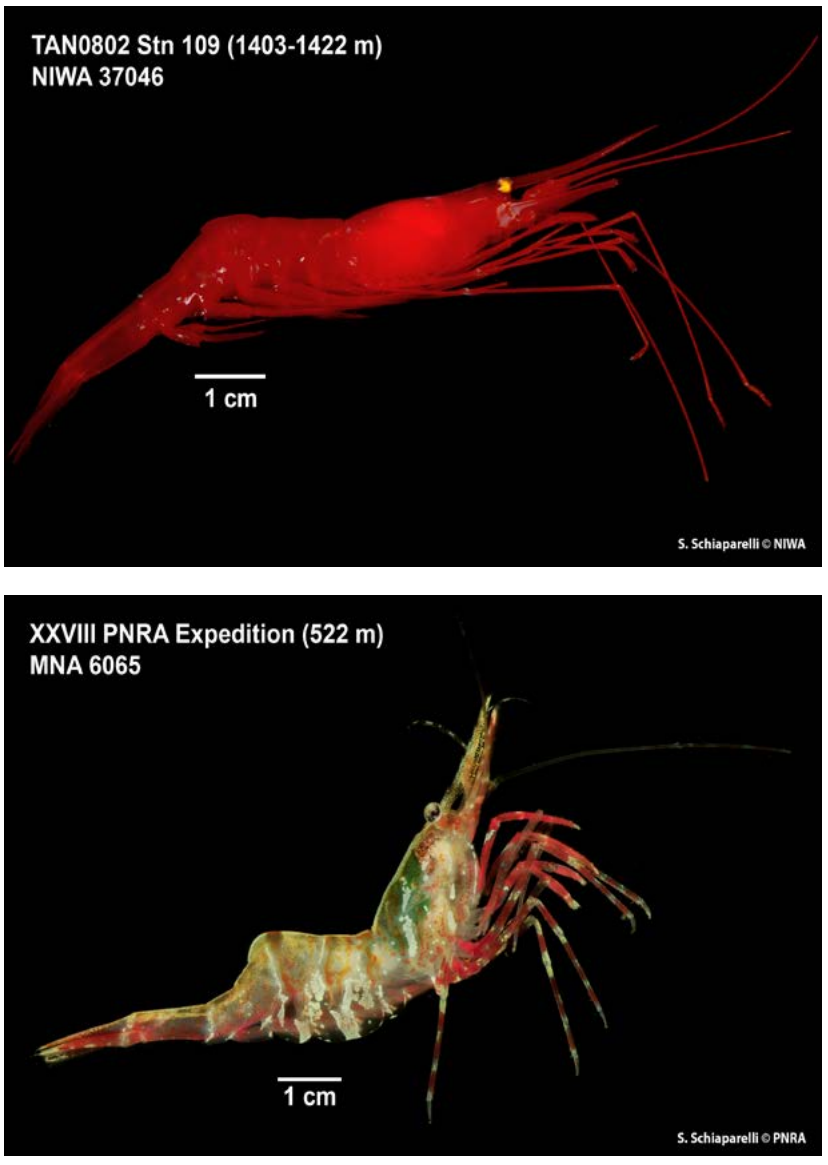


Photo 1. *Nematocarcinus lanceopes* (Bate, 1888) (above) *and Chorismus antarcticus* (Pfeffer, 1887) (below).

2. Biodiversity

Two Antarctic caridean shrimp species, *Chorismus antarcticus* (Pfeffer, 1887) and *Notocrangon antarcticus* (Pfeffer, 1887), were first discovered during the German Polar Commission expedition to South Georgia in 1882–1883 (Thatje & Arntz 2004). Since then, 19 publications have reported new species and records of shrimps from the Southern Ocean (Yaldwyn 1965; Zarenkov 1968; Makarov 1970; Vinuesa 1977; Boschi *et al.* 1981; Kirkwood 1984; Wasmer 1986; Iwasaki & Nemoto 1987; Tiefenbacher 1990b; Branch *et al.* 1991; Gorny 1999; Boschi 2000; Arntz 2003; Retamal & Gorny 2003; Thatje 2003; Komai & Segonzac 2005; Ahyong 2009; De Grave & Fransen 2011; Nye *et al.* 2013). To date, 23 shrimp species belonging to 14 genera and 10 families have been reported from the Antarctic region (Table 1). There are approximately 4,050 decapod shrimp species reported world-wide (De Grave & Fransen 2011). Twenty of the Antarctic species belong to the infraorder Caridea, which is globally the second most species–rich decapod group after Brachyuran crabs (De Grave & Fransen 2011), and about half of these species belong to just three families; Acanthephyridae, Hippolytidae and Pasiphaeidae(Fig.1).

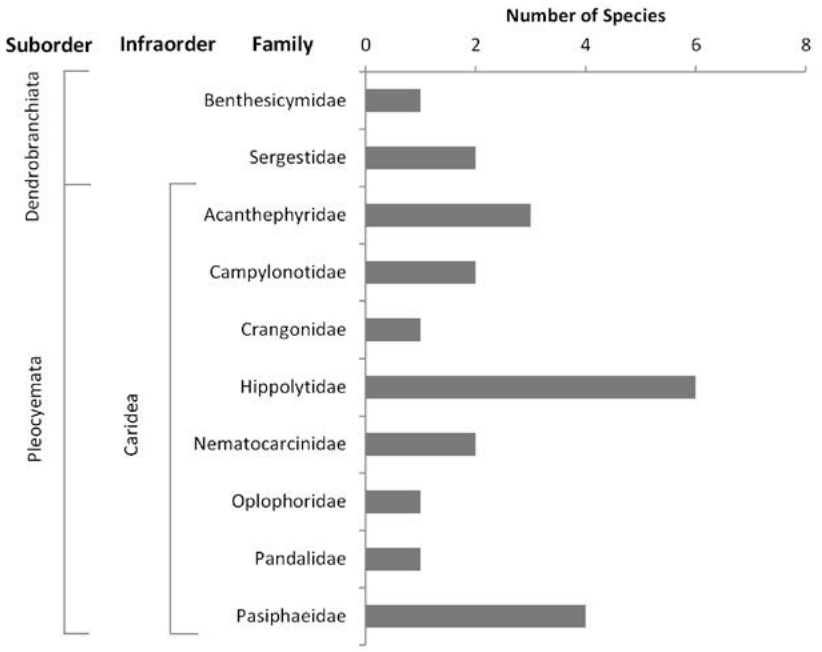


Figure 1. Number of species in the families of decapod shrimps in the Antarctic, south of the Antarctic Polar Front.

2.1. Geographic distribution

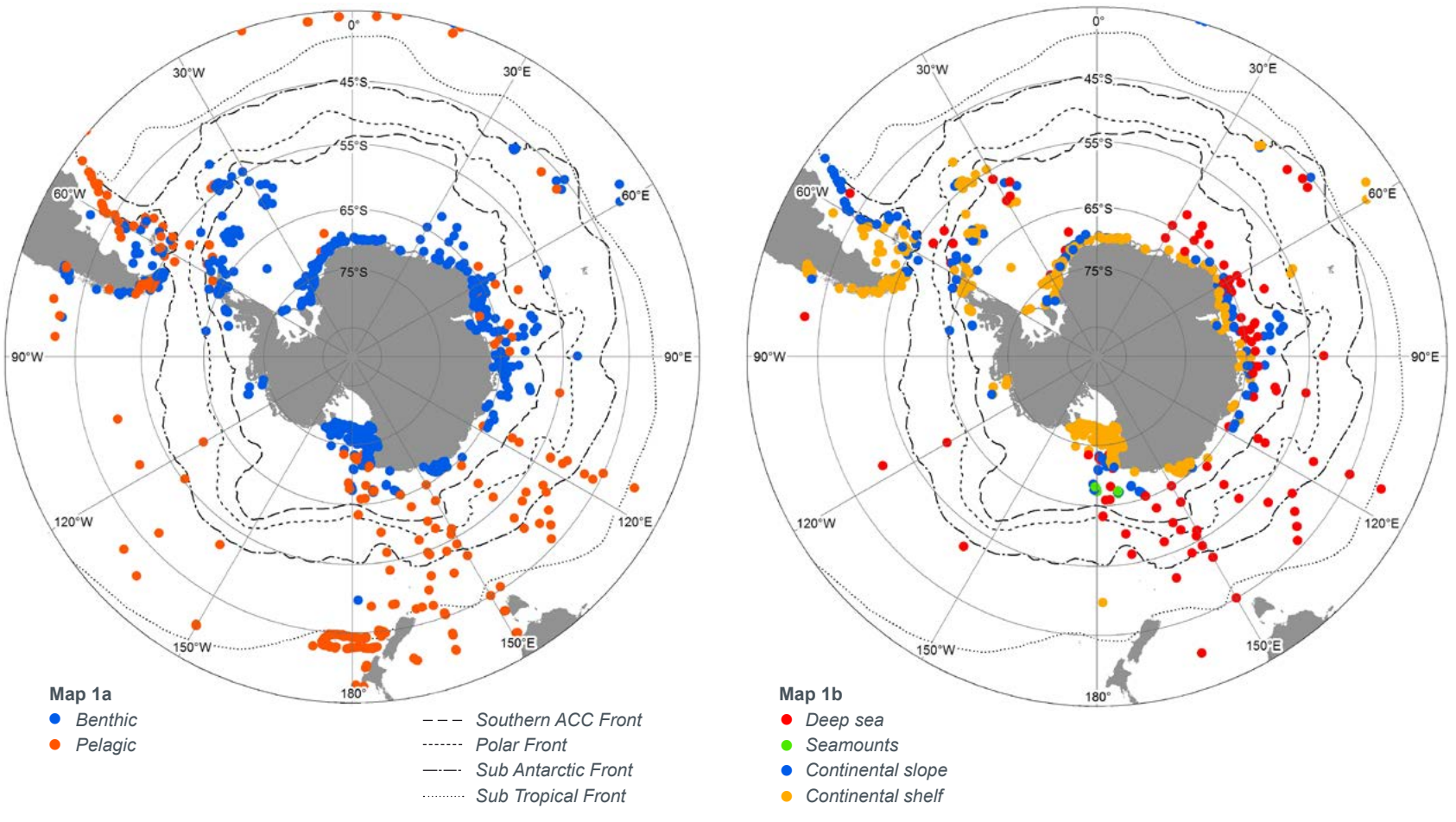
The Atlantic, Indian, and Pacific Ocean sectors of the Southern Ocean have 18, 16, and 15 decapod shrimp species respectively. Nine (40% of) species occur in all three sectors. Four species were only reported from the Atlantic sector, two to the Pacific sector and none to the Indian Ocean sector (Table 1). In the Atlantic sector, there were more benthic (56%) than pelagic (44%) species, whereas in the Pacific and Indian Ocean sectors pelagic species were more numerous (60 and 61%) (Map 1a, Table 1). The regions with the lowest numbers of shrimp records were the Amundsen Sea to the eastern Ross Sea, the Bellingshausen Sea, the western Weddell Sea, and East Antarctica from the Mawson Sea to the D'Urville Sea (Map 1).

The northern distribution boundary for more than half the Antarctic species was at about 55°S, coinciding with the Polar Front (Maps 1-9). The pelagic species' had wider geographic ranges than benthic ones. Some extended up to the tropical zones of Asia, Africa and South America, or even towards the Arctic seas (i.e. *Acanthephyra pelagica*) (Gorny 1999). *Pasiphaea acutifrons* has been reported around the Chilean coast and further north in the Pacific Ocean, off the coasts of Japan and Hawaii (Gorny 1999; Komai *et al.* 2012). *Nematocarcinus longirostris and Campylonotus vagans* are the only two benthic species whose range extended to the temperate waters north of the antiboreal region of South America. *Eualus kinzeri* and *E. amandae* were the only two species endemic to south of the Polar Front (Gorny 1999; Nye *et al.* 2013).

Table 1. The decapod shrimp species recorded south of the Antarctic Polar Front, including their occurrence in depth zones, whether adults are pelagic or benthic, present in the Atlantic (Atl, longitude 72°W–15°E), Indian (Ind, longitude 15°E–150°E), and Pacific (Pac, longitude 150°E–72°W) sectors, and maximum reported depth.

Family	Species	Depth Zones	Habitat	Sectors			Maximum Depth (m)	References
				Atl	Ind	Pac		
Acanthephyridae	*Acanthephyra pelagica* (Risso, 1816)	Shelf, Slope, Deep-sea	Pelagic	•	•	•	3635	1-5
	Hymenodora gracilis (Smith, 1886)	Shelf, Deep-sea	Pelagic		•	•	3733	2, 4, 5, 8
	Hymenodora glacialis (Buchholz, 1874)	Deep-sea	Pelagic	•	•	•	3925	4, 5
Benthesicymidae	*Gennadas kempi* (Stebbing, 1914)	Slope, Deep-sea	Pelagic	•	•		3143	2, 3, 6, 5
Campylonotidae	*Campylonotus vagans* (Bate, 1888)	Shelf	Benthic	•	•	•	506	5, 7-13 , 21, 34
	Campylonotus arntzianus (Thatje, 2003)	Shelf	Benthic	•			589	33, 34
Crangonidae	*Notocrangon antarcticus* (Pfeffer, 1887)	Shelf, Slope	Benthic	•	•	•	2350	5, 15-24, 34
Hippolytidae	*Chorismus antarcticus* (Pfeffer, 1887)	Shelf, Slope	Benthic	•	•	•	860	5, 15, 17-22, 24-26, 34
	Chorismus tuberculatus (Bate, 1888)	Shelf, Slope	Benthic	•			815	5, 8-10, 27
	Eualus kinzeri (Tiefenbacher, 1990)	Slope	Benthic	•			782	5, 15, 28
	Eualus amandae (Nye, 2013)	Slope, Deep -sea	Benthic	•			2401	32
	Lebbeus antarcticus (Hale, 1941)	Shelf, Slope	Benthic	•	•		2087	5, 7, 15, 22, 24, 32
	Lebbeus n. sp. (S. Ahyong, unpublished)	Slope, Seamount	Benthic			•	1235	20
Nematocarcinidae	*Nematocarcinus lanceopes* (Bate, 1888)	Shelf, Slope, Deep-Sea, Seamount	Benthic	•	•	•	3432	5,7, 8, 15, 18, 19, 20-22, 24, 34
	Nematocarcinus longirostris (Bate, 1888)	Shelf, Slope, Deep-sea	Benthic		•	•	3635	2, 5, 8, 24
Oplophoridae	*Systellaspis braueri* (Balss, 1914)	Shelf, Slope	Pelagic	•		•	1130	4, 5, 6, 31
Pandalidae	*Austropandalus grayi* (Cunningham, 1871)	Shelf	Benthic	•	•		413	5, 7-9, 11-13, 24, 26, 29, 30
Pasiphaeidae	*Pasiphaea acutifrons* (Bate, 1888)	Shelf, Slope Deep-sea	Pelagic	•	•	•	1560	2, 5, 7-9, 11 -13, 26
	Pasiphaea cf. *ledoyeri* (Hayashi, 2006)	Slope, Seamount	Pelagic			•	1587	20
	Pasiphaea scotiae (Stebbing, 1914)	Slope, Deep-sea	Pelagic	•	•	•	3660	2, 3, 5, 6, 20
	Pasiphaea berentsae (Kensley, Tranter & Griffin, 1987)	Shelf	Pelagic		•	•	1150	35
Sergestidae	*Eusergestes arcticus* (Krøyer, 1855)	Shelf, Slope, Deep-sea	Pelagic	•	•	•	3935	2, 3, 5, 29
	Petalidium foliaceum (Bate, 1888)	Slope, Deep-sea	Pelagic	•	•		3935	2, 3, 5, 6, 8, 22

(1):Boschi *et al.* (1981); (2): Iwasaki & Nemoto (1987); (3): Tiefenbacher (1994); (4): Wasmer (1986); (5): Gorny (1999); (6): Tiefenbacher (1991); (7): Arntz *et al.* (1999); (8): Bate (1888); (9): Boschi *et al.* (1981); (10): Boschi (1997); (11): Holthuis (1952); (12): Milne-Edwards (1891); (13): Retamal (1974); (14): Miers (1881), (15): Gorny (1992); (16): Gorny (1994); (17): Gorny (1998); (18): Gutt *et al.* (1991); (19): Gutt *et al.* (1994); (20): Authors' unpublished data; (21): Arntz (2003); (22): Hale (1941); (23): Makarov (1970); (24): Zarenkov (1968); (25): Branch *et al.* (1991); (26): Vinuesa (1977); (27): Spivak (1997); (28): Tiefenbacher (1990b); (29): Doflein & Balss (1912); (30): Mutschke & Gorny (1999); (31): Foxton (1970); (32): Nye *et al.* (2013); (33): Thatje (2003); (34): Lovrich *et al.* (2005); (35): Wasmer (1993)



Shrimps Map 1a,b Map of the Southern Ocean showing all individual records of (a) Antarctic benthic (blue) and pelagic (red) shrimp species, and (b) their recorded depth zone and occurrence on seamounts (see Table 1 for details). The Southern Ocean fronts in all maps follow Sokolov & Rintoul (2009).

2.2. Depth distribution

For this study the continental shelf, slope and deep-sea (or abyssal) zones were defined as between 0-1000 m depth, 1000-3000 m, >3000 m, respectively. Shrimps have been recorded from the shallow continental shelf to the abyssal zone in the Southern Ocean (Fig. 2, 3). Two-thirds of the pelagic species, but only one-sixth of the benthic ones, were recorded in all depth zones (i.e. eurybathic distribution) (Table 1). The Acanthephyridae family covered the widest depth range, from 122 m to 3934 m (Fig. 2). Species found deeper than 500 m had a wider depth range compared to species occurring in shallow waters (<500 m). The pelagic species exhibited wider geographic and depth ranges than the benthic species (Map 1a; Fig. 3). Iwasaki & Nemoto (1987) similarly found that deep-water pelagic species tended to be distributed from sub-tropical regions southwards. Species richness decreased with depth; with 19, 17, and 9 species in the continental shelf, slope and abyssal zones (Map 1b, Fig. 3, Table 1).

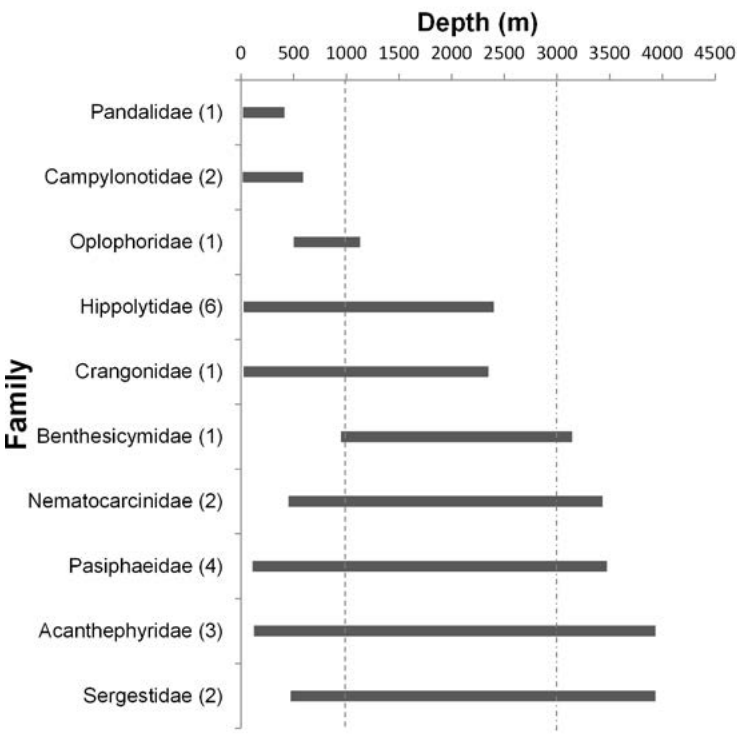


Figure 2. Depth ranges of the decapod shrimp families. In parentheses are the numbers of species per family in this study. Dashed lines show the average depth of the continental shelf edge and the start of the deep sea at 1000 m and 3000 m respectively.

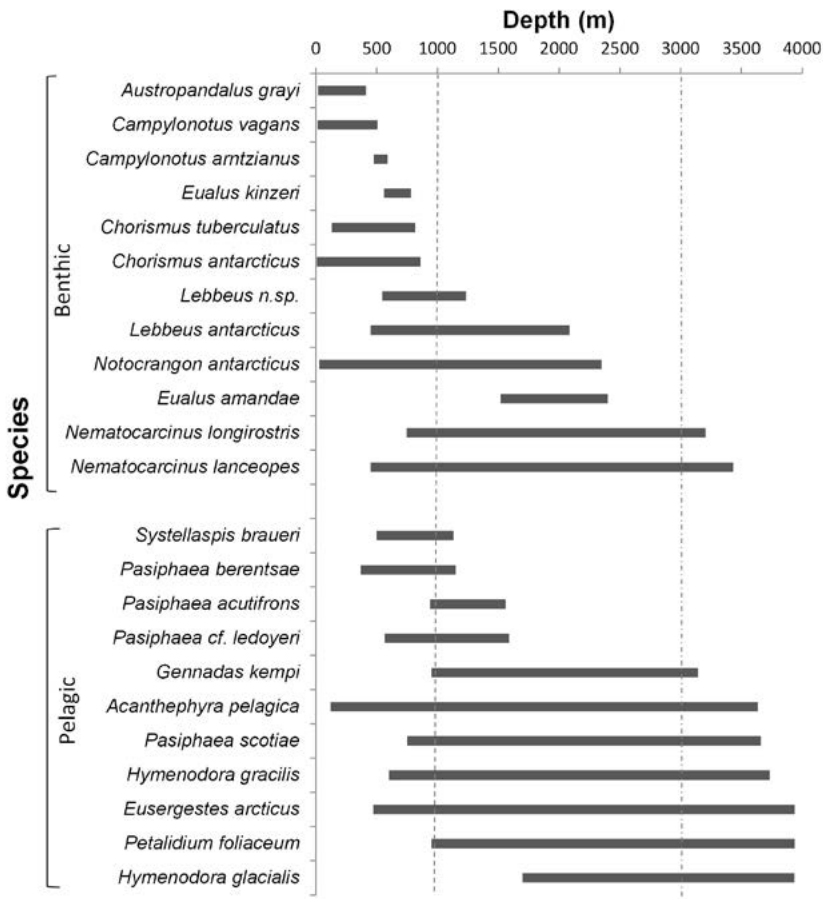


Figure 3. Depth ranges of the decapod shrimp species. Dashed lines show the average depth of the continental shelf edge and the start of the deep sea at 1000 m and 3000 m respectively.

3. Ecology

In situ observations of benthic shrimp species in the Antarctic show they may be associated with a wide range of habitats (Gorny 1999; Authors' unpublished data). Caridean shrimps are mostly associated with debris, sponges, or sediments covered with detritus. The maximum density of benthic shrimps recorded in seabed camera surveys is 9 individuals*m^{-2} in the Weddell Sea (Gutt et al. 1991) but only 4 individuals*m^{-2} in the Ross Sea (Authors' unpublished data). *Nematocarcinus lanceopes* (Photo 1) is solitary and lives on or above the substratum; *Notocrangon antarcticus* (Photo 1) tends to be partially buried in muddy sediments; and *Chorismus antarcticus* is associated with sponges (Gutt et al. 1991), bryozoans, and other sessile epifauna (Authors' unpublished data).

Detailed studies of Antarctic shrimps have focused to date on reproductive biology and larval development (Gorny *et al.* 1992; Gorny & George 1997; Thatje *et al.* 2005b; Lardies & Wehrtmann 2011), biochemical or metabolic characteristics (Dittrich 1990; Bluhm *et al.* 2002), digestive systems (Storch *et al.* 2001) and their infestation by ectoparasites (Raupach & Thatje 2006). There is no information on their trophic ecology and how they might contribute to ecosystem function, for example by re-cycling nutrients from deposited organic matter in sediments. In the recent International Polar Year (2007–2008), numerous shrimp specimens and observations were recorded from different regions around Antarctica. Results from studies of these datasets will improve understanding of the decapod shrimps' overall role in the Antarctic ecosystem.

Acknowledgements

We would like to thank K. Schnabel and S. Mills of NIWA Invertebrate Collection, Wellington, S. Keable of Australian Museum Sydney Marine Invertebrate Collection, K. Reed of Smithsonian Institution, Washington D.C., and L. Corbari and P. Martin-Lefèvre of Muséum National d'Histoire Naturelle, Paris, for access to the shrimp specimens and information about the respective collections. We also thank D. Bowden, C. d'Udekem d'Acoz, S. Thatje, C. De Broyer, and two anonymous referees for their valuable suggestions that improved the manuscript. This study was funded by the New Zealand Government under the New Zealand International Polar Year-Census of Antarctic Marine Life Project (IPY2007-01) and University of Auckland Doctoral Scholarship. We gratefully acknowledge project governance during IPY by the Ministry of Fisheries Science Team and the Ocean Survey 20/20 CAML Advisory Group (Land Information New Zealand, Ministry of Fisheries, Antarctica New Zealand, Ministry of Foreign Affairs and Trade, and National Institute of Water and Atmosphere Ltd). This is CAML contribution # 120.

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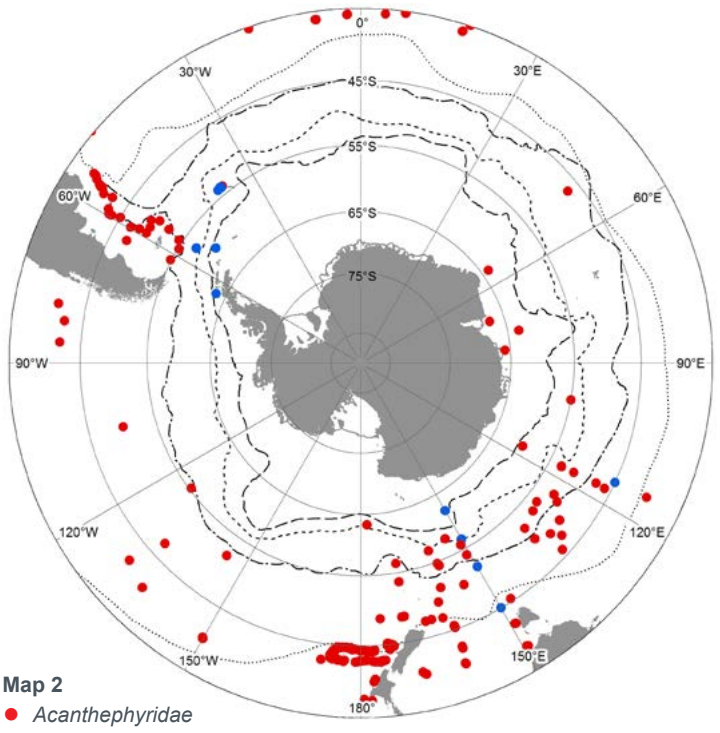
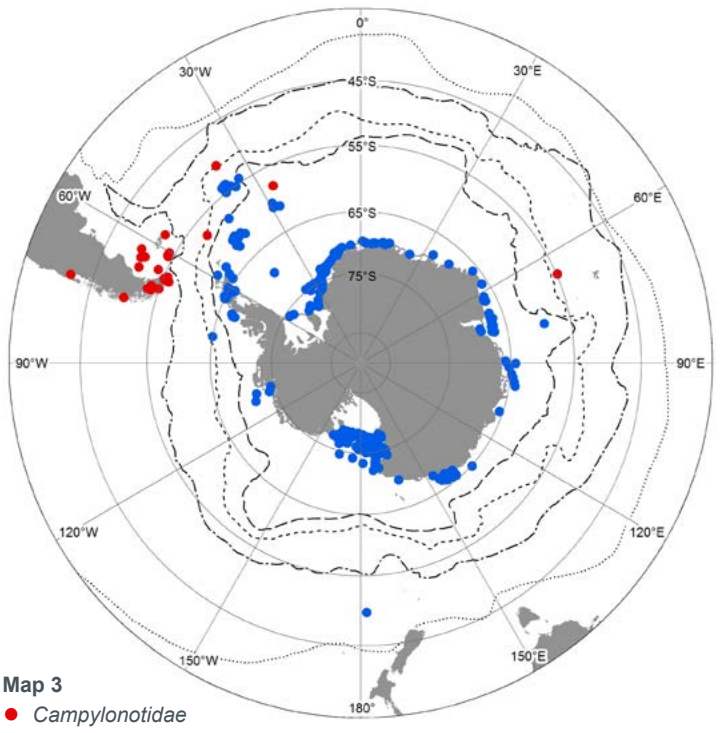
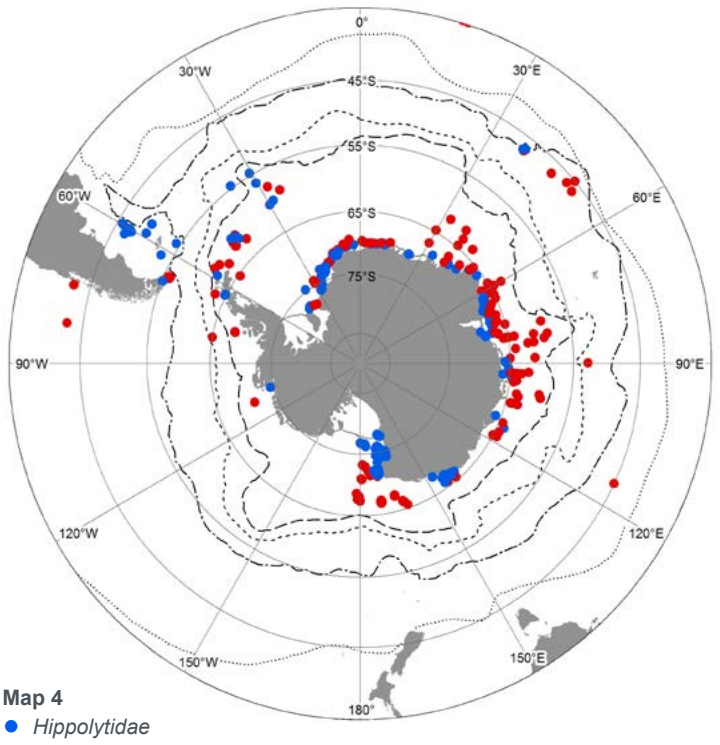


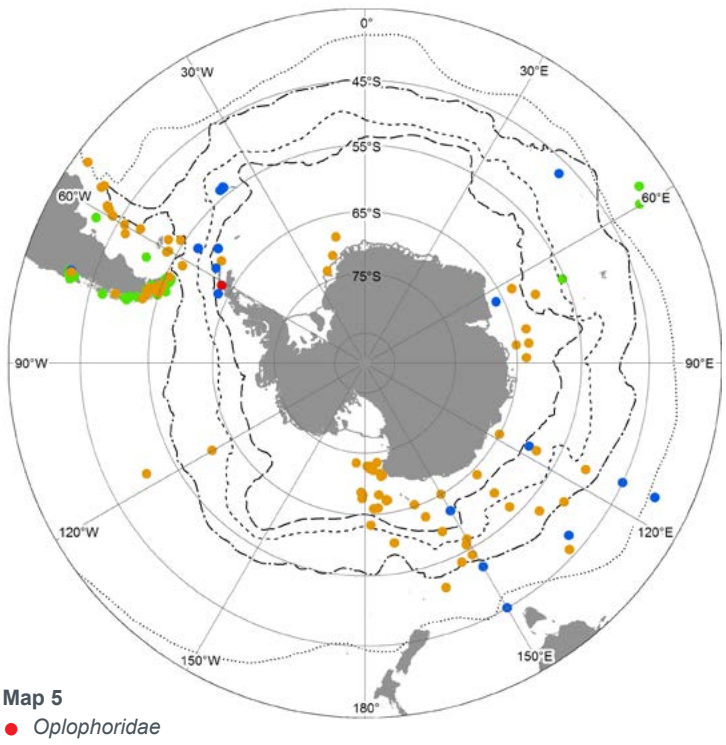
Map 2
- *Acanthephyridae*
- *Benthesicymidae*



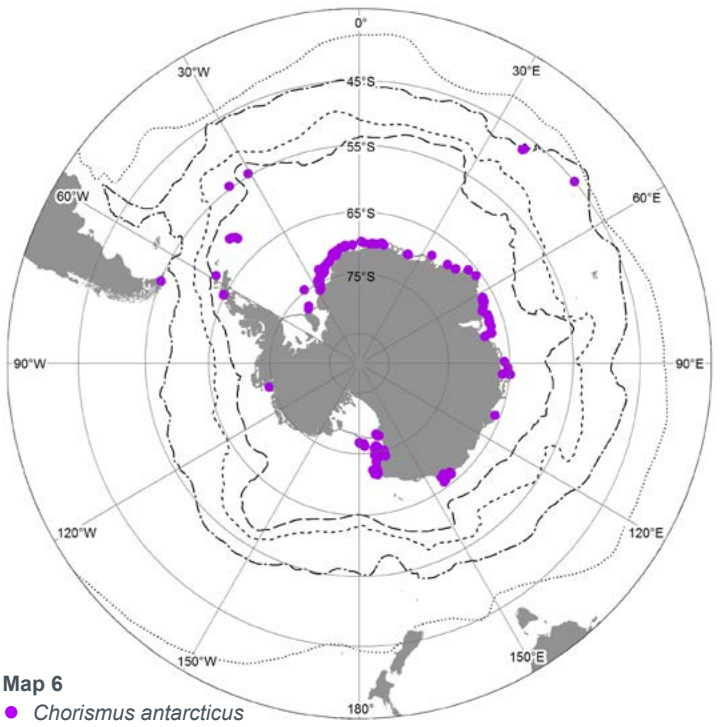
Map 3
- *Campylonotidae*
- *Crangonidae*



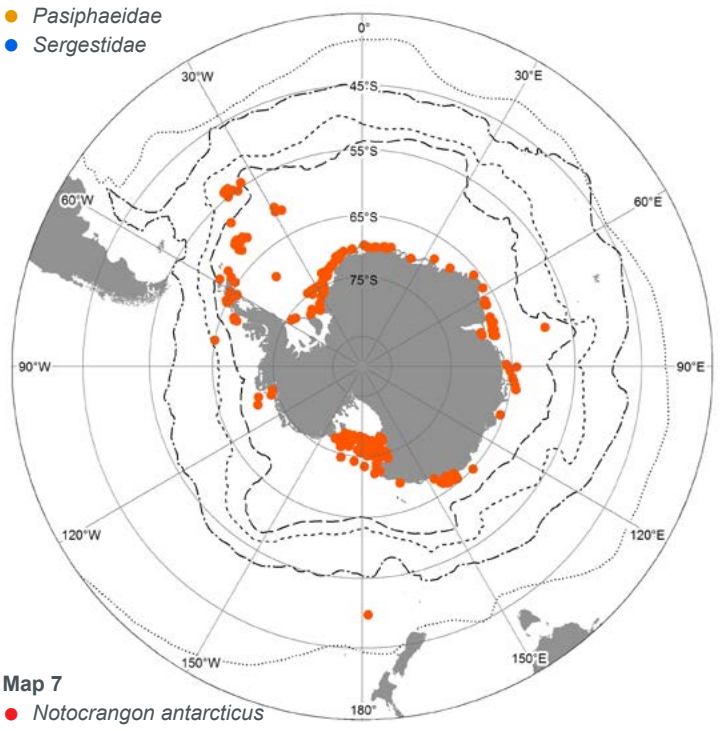
Map 4
- *Hippolytidae*
- *Nematocarcinidae*



Map 5
- *Oplophoridae*
- *Pandalidae*
- *Pasiphaeidae*
- *Sergestidae*

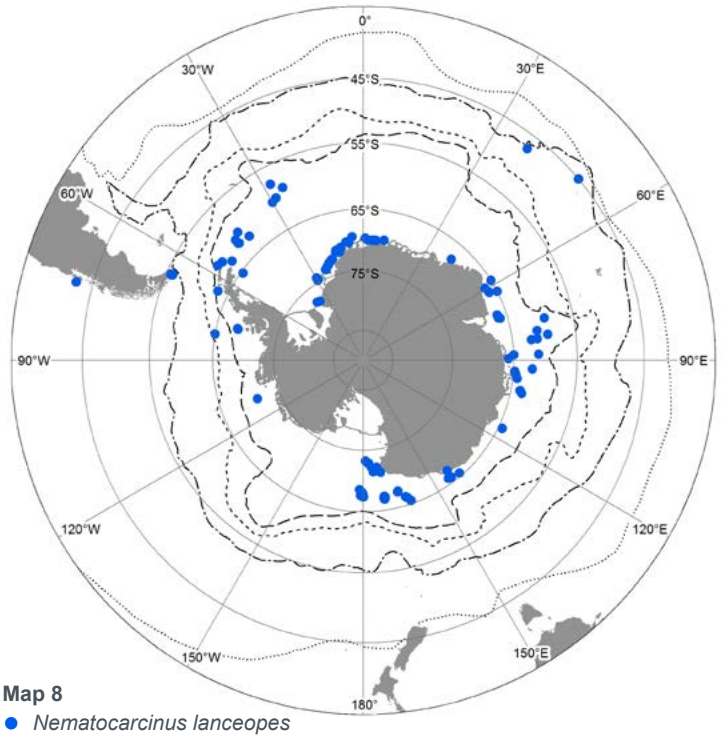


Map 6
- *Chorismus antarcticus*

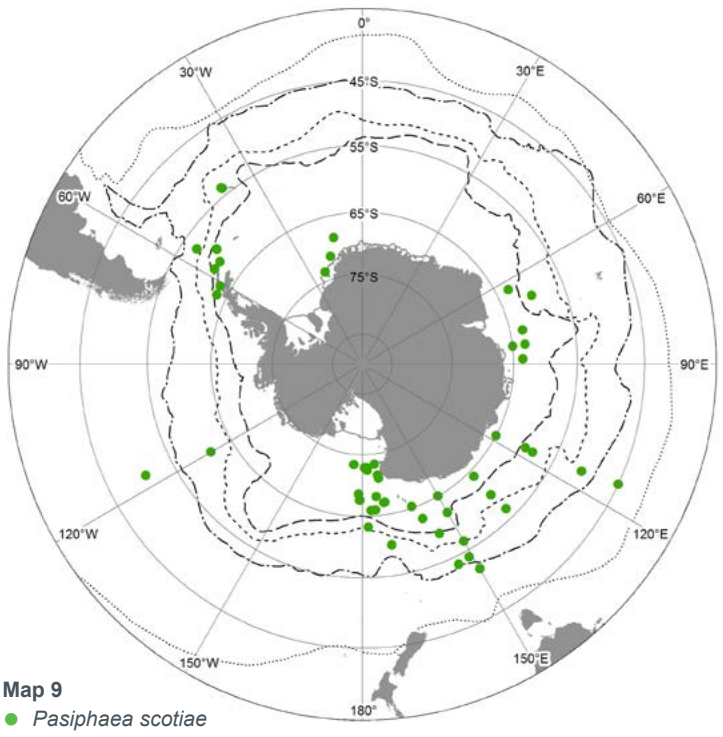


Map 7
- *Notocrangon antarcticus*

Shrimps Maps 2-7 Map 2 Distribution of Acanthephyridae (red) and Benthesicymidae (blue). Map 3 Distribution of Campylonotidae (red) and Crangonidae (blue). Map 4 Distribution of Hippolytidae (blue) and Nematocarcinidae (red). Map 5 Distribution of Oplophoridae (red), Pandalidae (green), Pasiphaeidae (orange) and Sergestidae (blue). Map 6 Distribution of *Chorismus antarcticus* (Pfeffer, 1887). Map 7. Distribution of *Notocrangon antarcticus* (Pfeffer, 1887).



Map 8
● *Nematocarcinus lanceopes*



Map 9
● *Pasiphaea scotiae*

Shrimps Maps 8-9 Map 8 Distribution of *Nematocarcinus lanceopes* (Bate, 1888). Map 9 Distribution of *Pasiphaea scotiae* (Stebbing, 1914).

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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

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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.