Census of Antarctic Marine Life
SCAR-Marine Biodiversity Information Network

BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

CHAPTER 6.3. SOUTHERN OCEAN GELATINOUS ZOOPLANKTON.

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THE BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

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6.3. Southern Ocean Gelatinous Zooplankton

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1. Introduction

The final years of the 19th century and the first few decades of the 20th century were perhaps the golden age for studies of Southern Ocean gelatinous zooplankton (Moser 1909, Browne 1910, Vanhöffen 1912, etc.) with only sporadic reports thereafter (Kramp 1948, 1949, 1957) until samples taken by the USNS *Eltanin* were analysed and reported after the mid-1980s (Larson 1986, Alvariño *et al.* 1990, Navas-Pereira & Vannucci 1990). The vast majority of the occurrence data for gelatinous Antarctic zooplankton comes from the USNS *Eltanin* cruises and, as such, is concentrated mainly in waters south of the 35th parallel, between 20°W and 130°W. Other data harvested from the Ocean Biogeographic Information System (OBIS) included a small taxonomic subset of easily recognizable species recorded in the *Discovery* data from the Southampton Oceanography Centre (erroneous depth records not included) and Rectangular Midwater Trawl (RMT) data from the Australian Antarctic Data Centre, as well as a more taxonomically comprehensive dataset compiled from the literature, centering on high quality vertical distribution data produced by Francesc Pagès and others (Lindsay 2012), that are nevertheless unfortunately quite limited in their geographic range. Most Antarctic planktonic species are considered circumpolar in their distribution, so although the maps in the present Atlas seem to show limited geographical distributions this is most likely an artefact of the sampling rather than a reflection of the true distributions. Furthermore, the southern hemisphere in general is vastly understudied and, as a result, although many of the occurrence patterns in the present Atlas seem to infer that distributions are confined to the Antarctic or sub-Antarctic, this may not actually be the case.

2. Biogeography and depth distribution

2.1. Generalities

Including undescribed species, approximately 12 species of ctenophores, 18 species of scyphomedusae, >30 species of siphonophores and >71 species of hydromedusae are known to inhabit the Antarctic and sub-Antarctic waters of the Southern Ocean. Their latitudinal ranges can be divided into several categories – from coastal Antarctic endemics primarily concentrated close to the ice or confined to the continental shelf, to cosmopolitan species, the range of which extends into Antarctic waters. In contrast to more mobile animals such as squids or fishes, gelatinous zooplankton, being planktonic, are more liable to be transported out of their "home" ranges and either into or out of Antarctic waters through horizontal advection. This is particularly true of the holoplanktonic groups such as siphonophores, trachymedusae, narcomedusae, ctenophores and the coronate scyphomedusae *Periphylla periphylla* (Péron & Lesueur, 1810) and *Atolla* spp., and less true for those meroplanktonic species for which the origin of their medusa stage is from benthic polyps. The distributions of the planktonic stages are closely tied to the water masses that they inhabit and the depths of these water masses can change with latitude or indeed longitude. Unfortunately, much of the published data consists of records from nets that traversed multiple water masses but only depth of capture data was available for graphically presenting this data in map form.

The taxonomy of gelatinous zooplankton is still relatively undeveloped compared to many other groups of organisms, especially those with shells or other hard body parts. Indeed, one of the commoner polar siphonophores, *Muggiaea bargmannae* Totton, 1954, was only described in 1954 and is therefore missing from the data from the early *Discovery* or *Gauss* expeditions, even though it certainly occurred — probably being misidentified as *Dimophyes arctica* (Chun, 1897) with which it shares many morphological features. Information on the various developmental stages of species is either non-existent or scattered through the literature in a variety of languages. Usually only the easily-recognizable polygastric stage of siphonophore species is reported and, therefore, where the life history stage is not explicitly stated in the original reference, these records are plotted on the same map as the polygastric stages, albeit with a different symbol. Failure to recognize younger stages can lead to apparent distributions that are quite different to the real distributions of a species. An example of this can be seen in the physonect siphonophore *Pyrostephos vanhoeffeni* Moser, 1925, where its younger stages have apparently been misidentified as *Bargmannia elongata* Totton, 1954, giving an erroneous, apparent distribution for *B. elongata* including many points south of the Antarctic Polar Front but with very few records of *P. vanhoeffeni* in this area, where the younger stages of *P. vanhoeffeni* actually apparently predominate. An up-to-date taxonomic treatment of Southern Ocean gelatinous zooplankton is sorely needed to enable further biogeographic work to proceed with the correct species assignations.

2.2. Neritic Antarctic endemics

This group contains neritic animals presumably bound to the shallow coast due to the habitat of their benthic polyp stage. It includes species such as the ulmarid scyphomedusae *Desmonema glaciale* Larson, 1986 (Fig 1, Map 1) and *Diplulmaris antarctica* Maas, 1908. The anthomedusa *Leuckartiara brownei* Larson & Harbison, 1990 would also seem to be in this group although the adult medusa stage has a lower epipelagic/upper mesopelagic distribution. Some holopelagic organisms, such as the beroid ctenophore *Beroe compacta* Moser, 1909 also appear to be confined to coastal waters close to the continent (Lindsay pers. obs.).

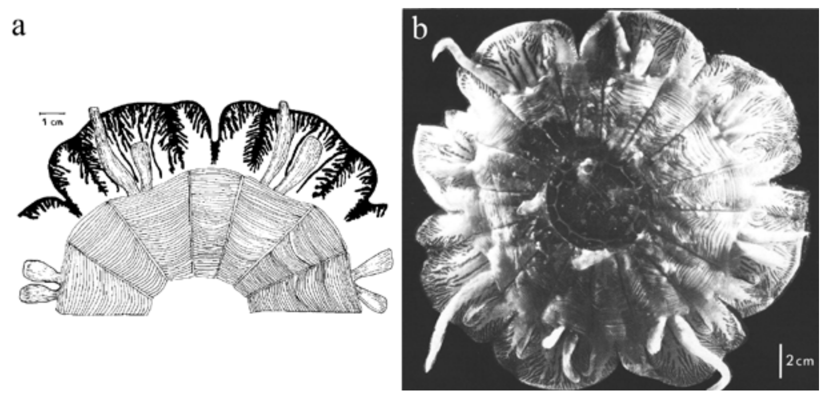
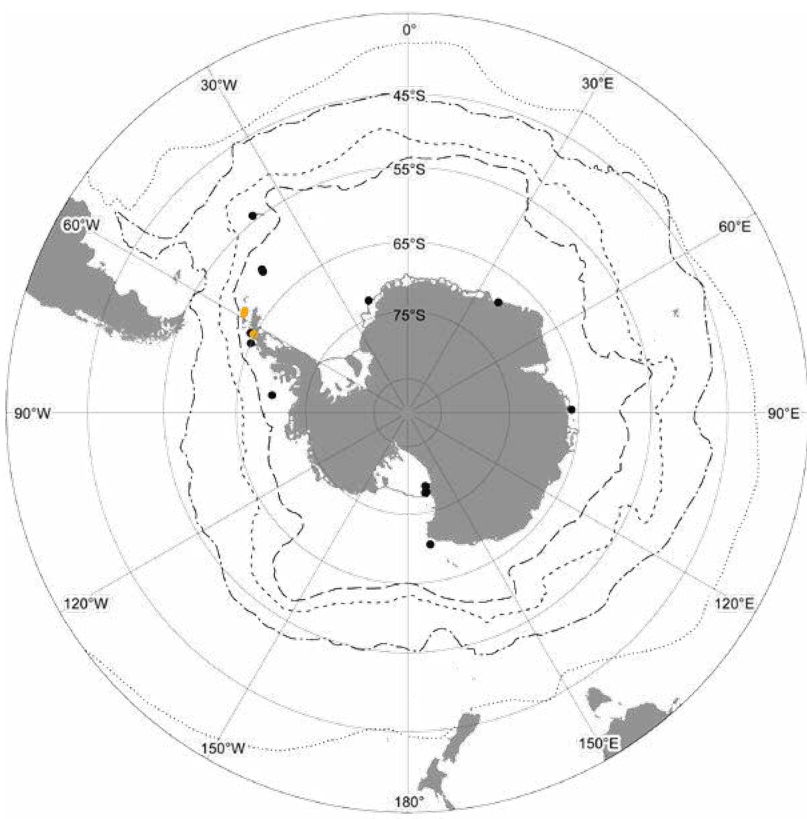


Figure 1 *Desmonema glaciale* Larson, 1986 line drawing (left) and photograph (right) extracted from the original description.



Map 1 *Desmonema glaciale*
● Epipelagic (0-200 m)
● Indeterminate depth

Gelatinous Plankton Map 1 Distribution of *Desmonema glaciale* based on available data.

2.3. Antarctic species concentrated primarily close to the coast

The species in this group have distributions centered around landmasses south of the Polar Front but can also be found near land in the Sub-Antarctic Zone. These include species with polyps probably living in deeper waters such as the anthomedusa *Zanclonia weldoni* Browne, 1910 (Fig. 2, Map 2), as well as those with polyps probably occurring in shallower waters such as the anthomedusa *Heterotentacula mirabilis* (Kramp, 1957), and the leptomedusa *Cosmetirella davisi* (Browne, 1902). The distributions of the medusae, mostly off the continental shelf in the former species and over the shelf in the latter two species, probably mirror those of their benthic polyp stage. Younger stages of some species can be quite difficult to correctly identify, although records of *C. davisi* off south-west Africa and southern Patagonia seem to be valid. Some holopelagic organisms, such as the physonect siphonophore *Pyrostephos vanhoeffeni*, also seem to be associated with the coast/ice, not only around the Antarctic continent, and can be transported oceanwards of the coast as they mature (Fig. 3, Map 3).

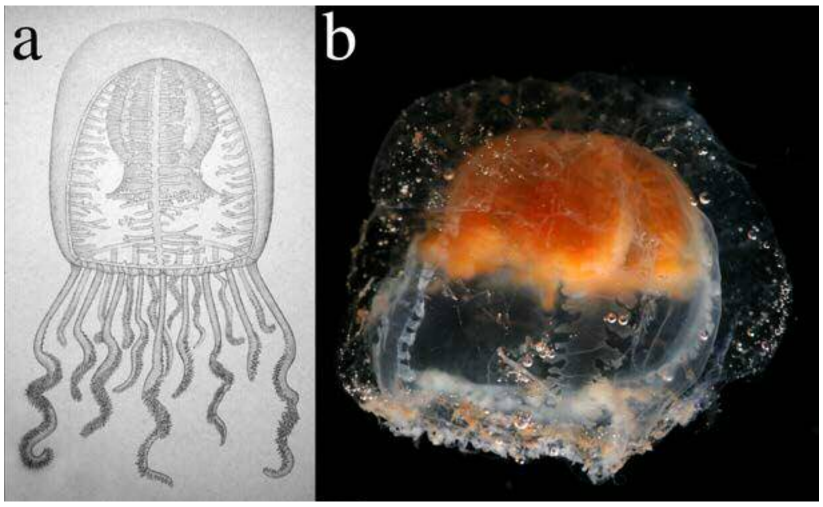


Figure 2 Original line drawing of *Zanclonia weldoni* (Browne, 1910) (a), and photograph of an RMT net-caught specimen by DJL (b).

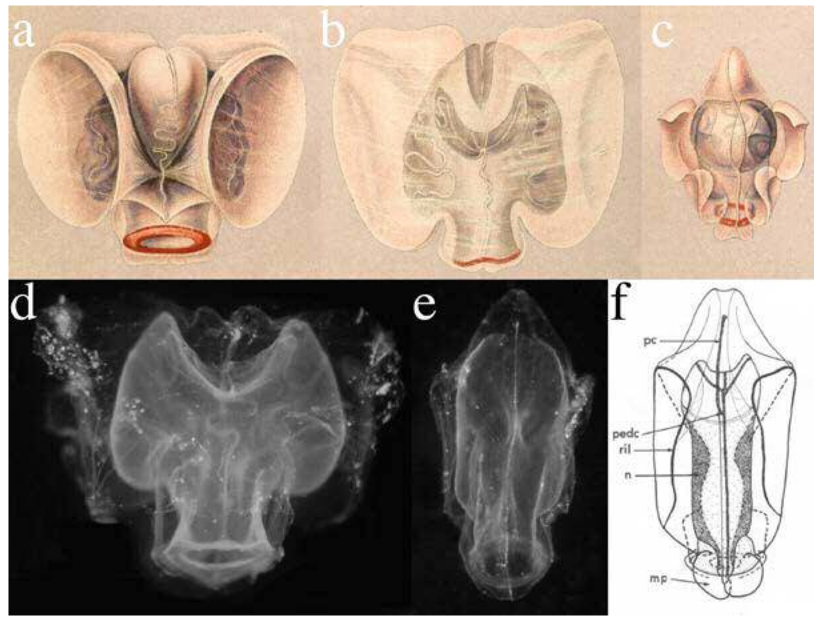
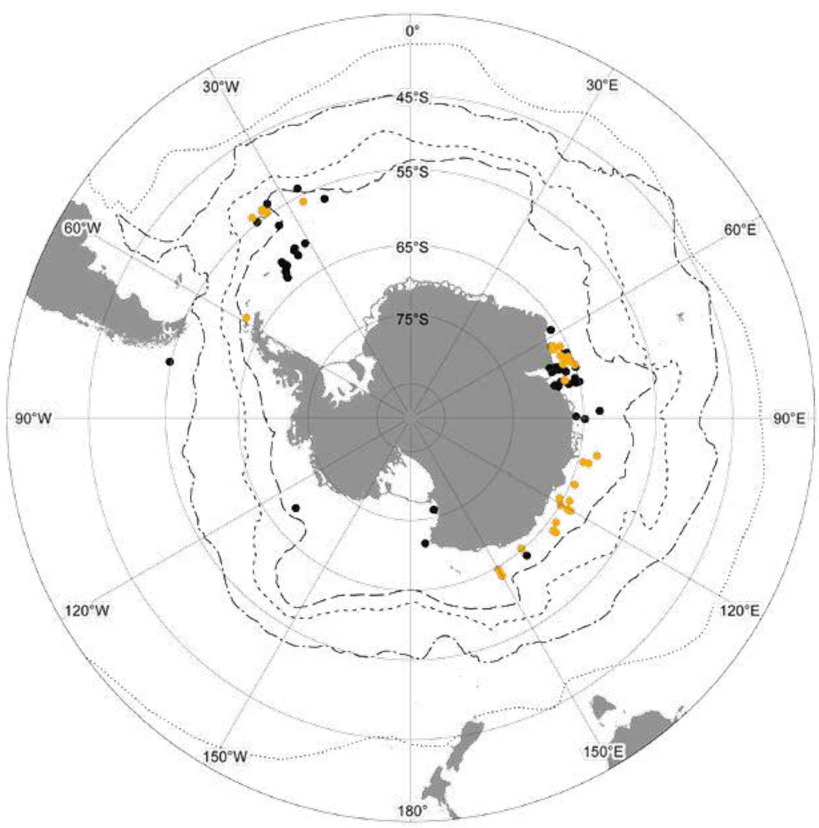
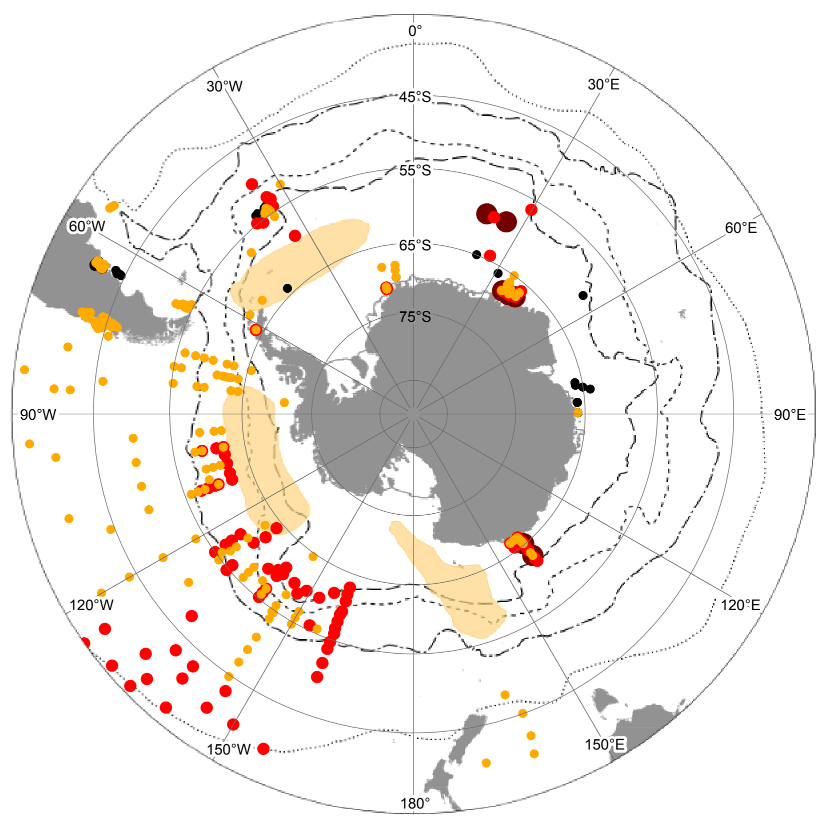


Figure 3 Original line drawing of *Pyrostephos vanhoeffeni* Moser, 1925 (mature nectophore in upper view (a) and lower view (b), immature nectophore (c), photograph of a mature (d) and immature (e) nectophore from an entire colony by EG, line drawing of a mature nectophore of *Bargmannia elongata* Totton, 1954 (f) from Pugh (1999).



Map 2 *Zanclonia weldoni*
- Epipelagic (0-200 m)
- Indeterminate depth

Gelatinous Plankton Map 2 Distribution of *Zanclonia weldoni* based on available data, showing its coastal distribution over deeper water mostly within the Polar Front.



Map 3 *Pyrostephos vanhoeffeni*
- Epipelagic (0-200 m)
- Mesopelagic (200-1000 m)
- Bathypelagic (>1000 m)
- Indeterminate depth

Gelatinous Plankton Map 3 Distribution of *Pyrostephos vanhoeffeni* based on available data. At least a subset of the records of *Bargmannia elongata* by Alvariño (1990), such as those found within the Ross Sea, are assumed to actually be misidentified younger nectophores of *P. vanhoeffeni*. The paucity of records within the Polar Front suggests that this is where the majority of young colonies occur, maturing as they are advected northwards.

2.4. Sub-surface Antarctic endemics also found in the surface layer at or north of the Polar Front through upwelling

Species in this group tend to be associated with the Winter Water or are in any case usually confined to depths below the surface thermocline. Upwelling brings them into the surface layer at the Polar Front or in other upwelling regions. Examples of these species include the anthomedusa *Calycopsis borchgrevinki* (Browne, 1910) (Fig. 4, Map 4) and the polygastric stage of *Diphyes antarctica* Moser, 1925 (Fig. 5, Map 5a). The polyps of *C. borchgrevinki* presumably occur in the deeper waters of the continental slope and the medusa stage is unable to tolerate conditions in the surface layer, though it can often be found between the surface thermocline and 200 m depth — hence the "epipelagic" distribution in Map 4. *Diphyes antarctica* can tolerate conditions in the surface layer and remains there as it is advected northwards towards the Sub-Tropical Front. Its apparent absence in the epipelagic layer between 60˚ and 120˚E appears to be an artefact due to a lack of taxonomic expertise rather than a real absence as many "siphonophore nectophores" were reported in the samples (AADC, 2013). The sexual (eudoxid) stage of *D. antarctica* appears to remain at lower epipelagic or mesopelagic depths as it is advected northwards (Map 5b).

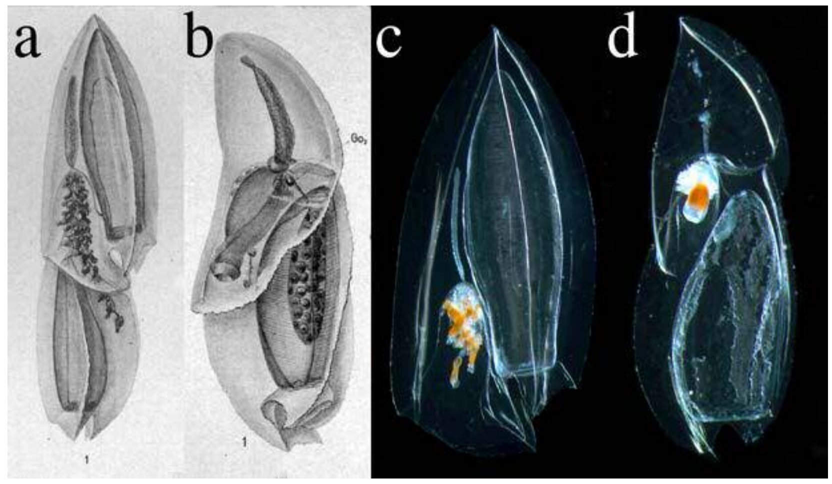


Figure 5 Original illustration of *Diphyes antarctica* Moser, 1925 (left), and photographs by Dr. Russell Hopcroft (right) of polygastric (a, c) and eudoxid (b, d) stages [not to scale].

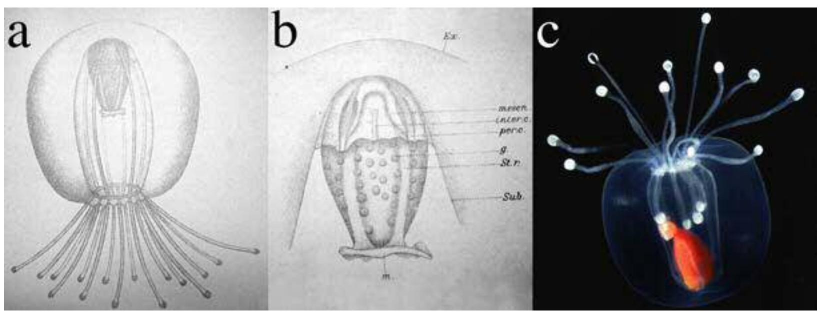
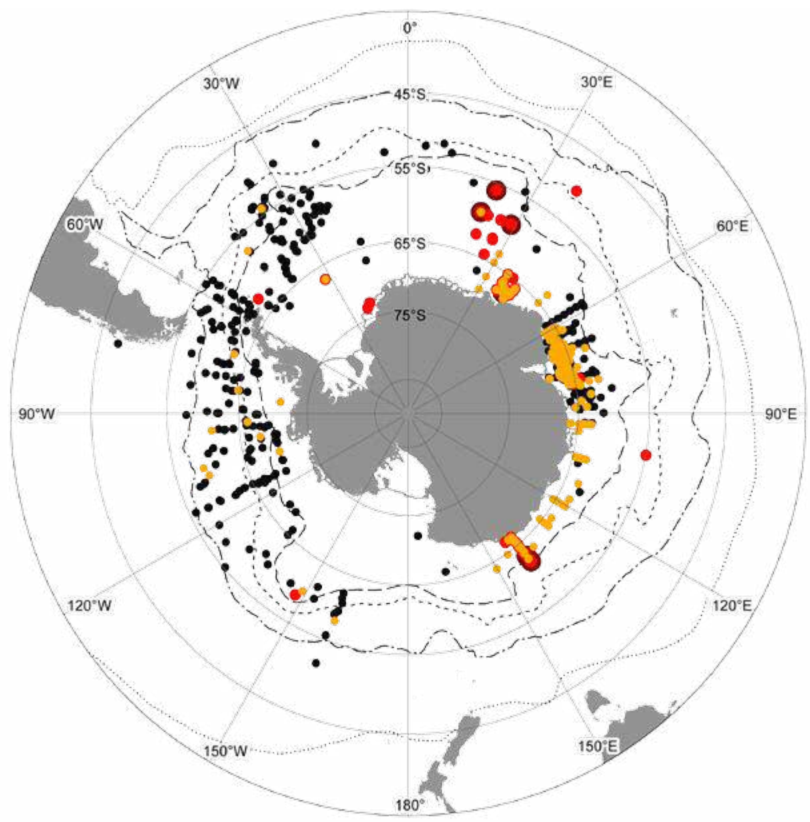
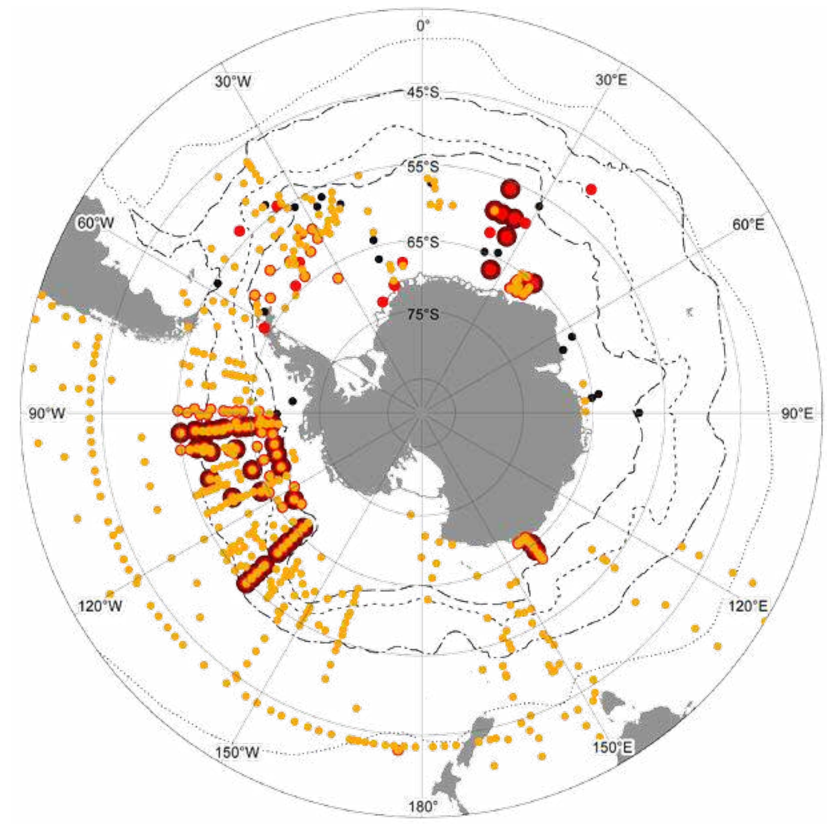
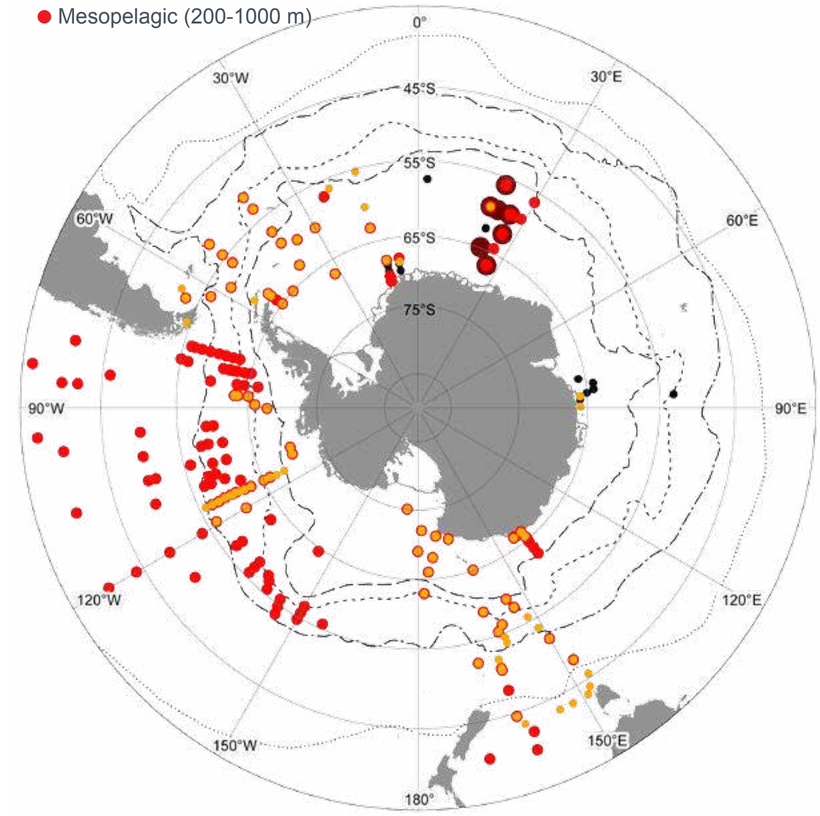


Figure 4 Original line drawing of *Calycopsis borchgrevinki* (Browne, 1910) (entire medusa (a), stomach and gonad morphology (b), and a photograph by Ingo Arndt of a living specimen in its natural orientation (c).





Map 5a *Diphyes antarctica* polygastric stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth



Map 4 *Calycopsis borchgrevinki*
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 4 Distribution of *Calycopsis borchgrevinki* based on available data, showing its epipelagic coastal distribution and subduction to meso- and bathypelagic depths as it is advected northwards.

Map 5b *Diphyes antarctica* eudoxid stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Maps 5 Map 5a. Distribution of polygastric stages of *Diphyes antarctica* based on available data. — Map 5b. Distribution of eudoxid stages of *Diphyes antarctica* based on available data.

2.5. Sub-Antarctic inhabitants of the epipelagic zone

Some species such as the calycophoran siphonophore *Eudoxoides spiralis* (Bigelow, 1911) occur predominantly to the north of the Antarctic Convergence, only rarely occurring closer to the continent and presumably having been transported there in some eddy or the like (Fig. 6, Map 6b) where they undoubtedly perish. This group also includes the calycophoran siphonophores *Eudoxoides mitra* (Huxley, 1859), *Sphaeronectes koellikeri* Huxley, 1859, the physonect siphonophore *Agalma elegans* (Sars, 1846), and the rhopalonematid trachymedusa *Rhopalonema velatum* Gegenbaur, 1857. Most of these species probably inhabit the entire southern hemisphere temperate zone but appear not to occur there due to the dearth of surveys to the north of the Sub-Antarctic Front.

2.6. Bipolar species concentrated within the Polar Front

The calycophoran siphonophore *Muggiaea bargmannae* Totton, 1954 (Fig. 7, Map 7a–b) and the cydippid ctenophore *Dryodora glandiformis* (Mertens, 1833) belong to this group. They are basically epipelagic or upper mesopelagic and although they can be subducted and advected outside of the Polar Front they cannot survive there. The bathypelagic records for *M. bargmannae* have a good possibility of being due to contamination from shallower layers (e.g. Pugh *et al.* 1997).

2.7. Discontinuously-distributed boreal deep-water inhabitants

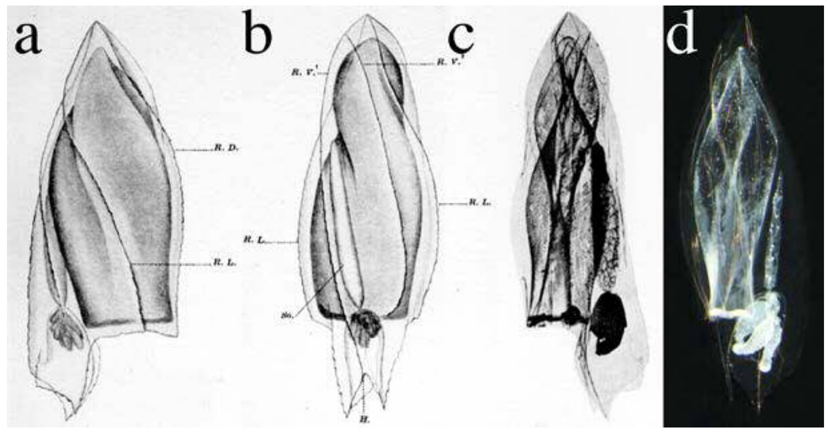
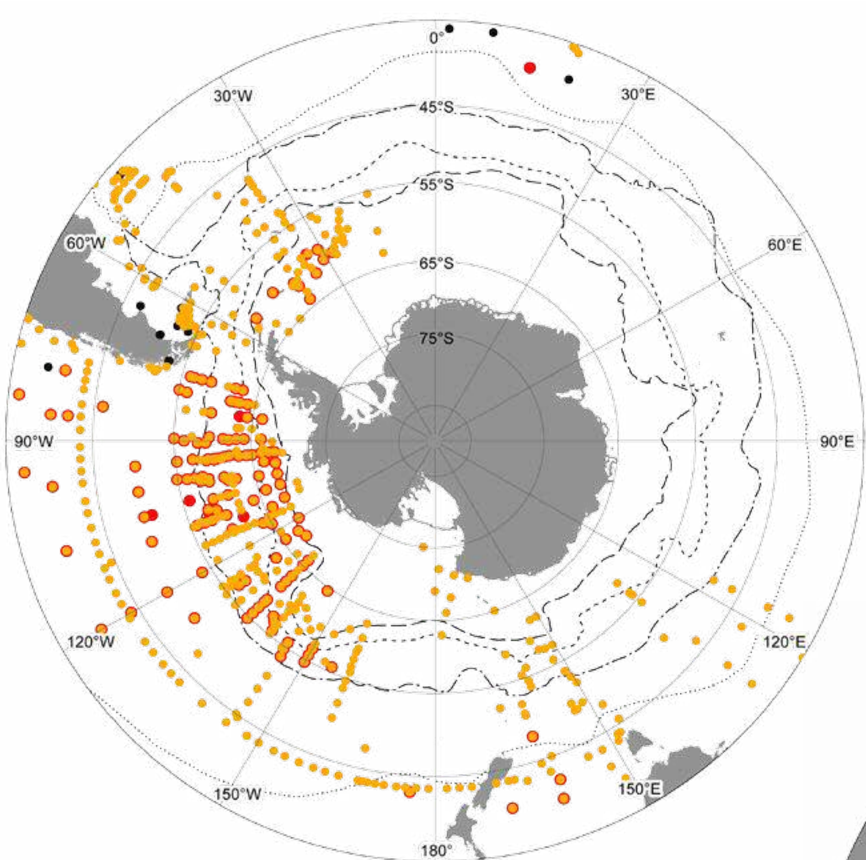
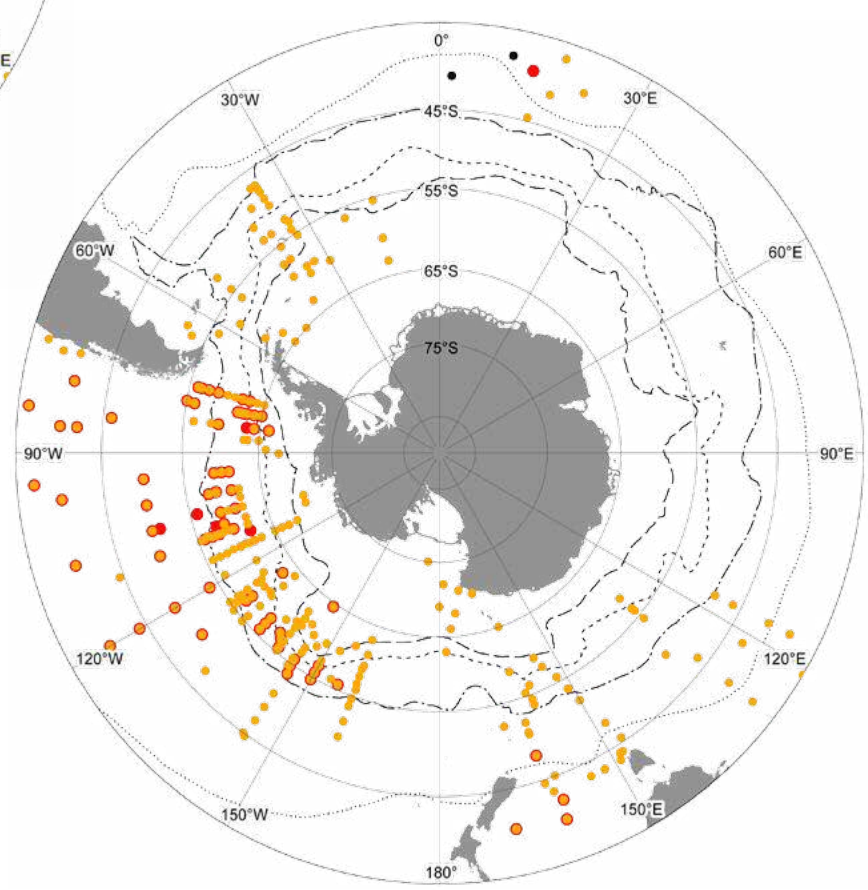


Figure 6 Original illustration of anterior nectophore of *Eudoxoides spiralis* (Bigelow, 1911) in lateral (a) and lower (b) views, a photograph in lateral view from the original description (c), and a photograph in upper-lateral view of a formalin-preserved individual from the Kurose Hole, Ogasawara Islands, Japan, by MMG (d).



Map 6a *Eudoxoides spiralis* polygastric stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Indeterminate (>1000 m)



Map 6b *Eudoxoides spiralis* eudoxid stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● IIndeterminate (>1000 m)

Gelatinous Plankton Map 6 Map 6a. Distribution of polygastric stages of *Eudoxoides spiralis* based on available data, showing its predominantly epipelagic distribution in subantarctic waters with occasional entrainment in warm eddies transporting it close to the Antarctic continent. — Map 6b. Distribution of eudoxid stages of *Eudoxoides spiralis* based on available data, showing its predominantly epipelagic distribution in subantarctic waters with occasional entrainment in warm eddies transporting it close to the Antarctic continent.

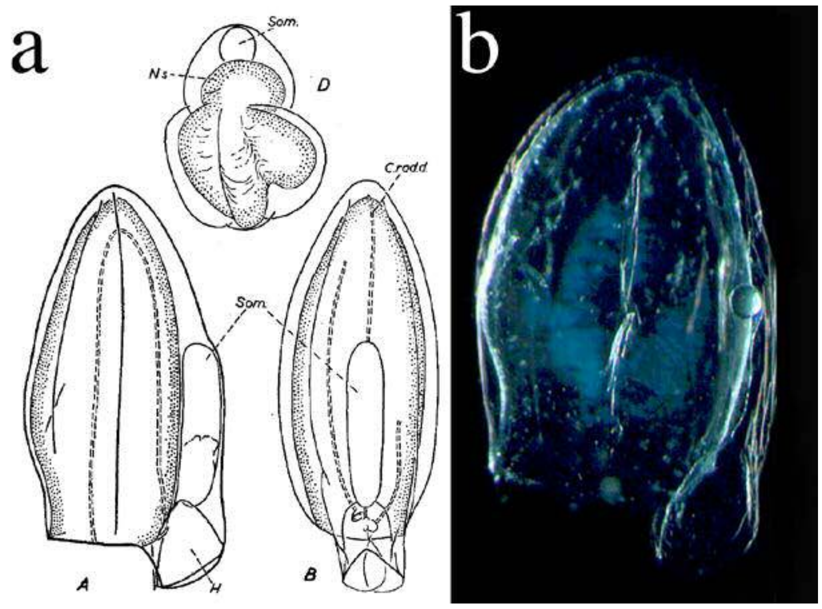
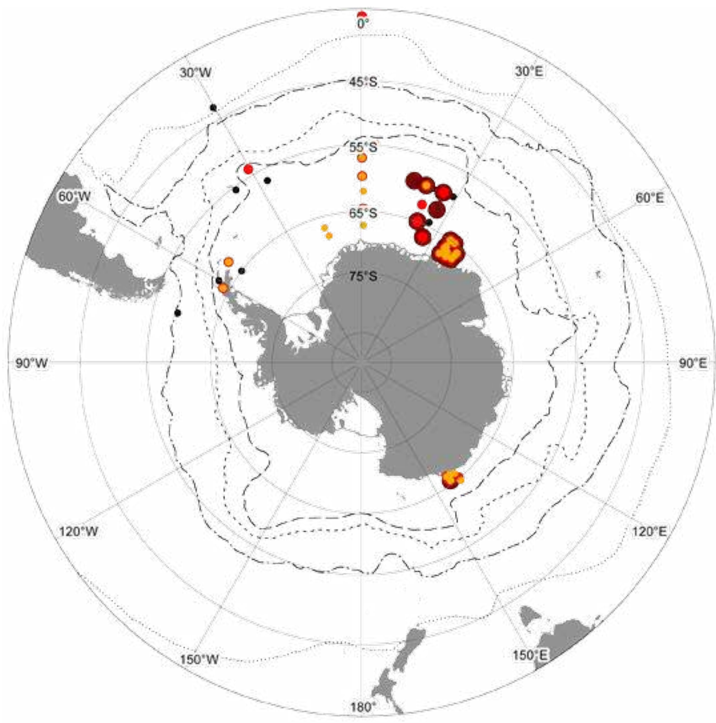
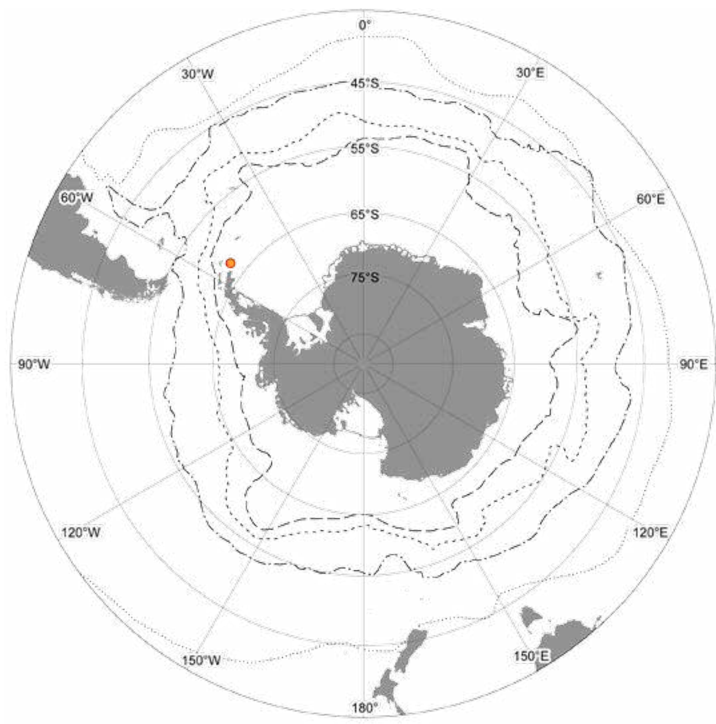


Figure 7 Original line drawing of *Muggiaea bargmannae* Totton, 1954 (a), and photograph by Dr. Russell Hopcroft (b) [not to scale].



Map 7a *Muggiaea bargmannae* polygastric stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth



Map 7b *Muggiaea bargmannae* eudoxid stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)

Gelatinous Plankton Map 7 Distribution of polygastric stages of *Muggiaea bargmannae* based on available data, suggesting that it is subducted into the mesopelagic layer as it is advected northwards.

extending south to the edge of the continental shelf

Some species are distributed in boreal waters of both the northern and southern hemispheres and penetrate into the deep water up to the Antarctic continental shelf. The anthomedusa *Pandea rubra* Bigelow, 1913 (Fig. 8, Map 8) has an asexual polyp stage that grows only on the shells of a certain species of pelagic snail, thought to be an epipelagic, cold-water species of the genus *Clio* (Lindsay *et al.* 2008)

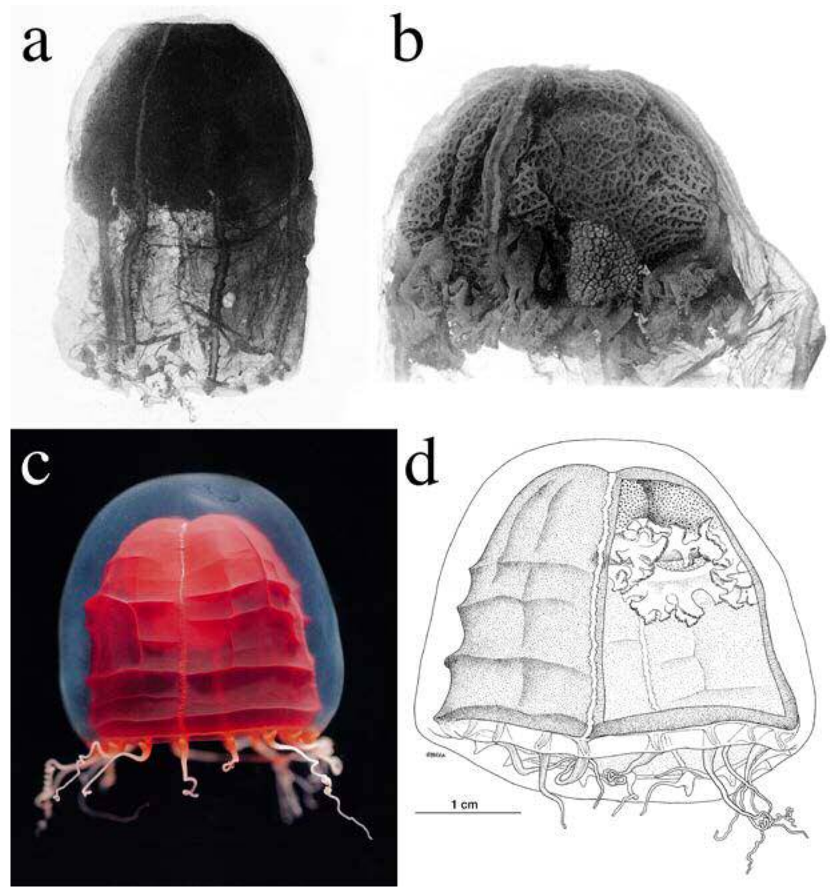
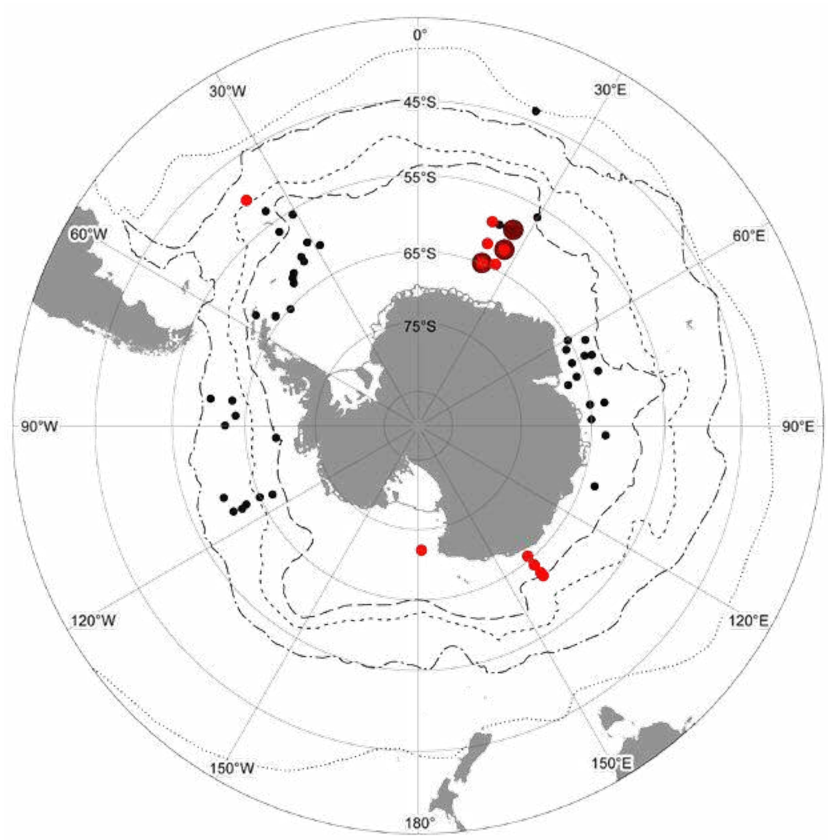


Figure 8 Original photographs of *Pandea rubra* Bigelow, 1913 (entire medusa (a), stomach and gonad morphology (b)), a photograph of a living specimen from off Japan by DJL (c) and a line drawing of the same (d).



Map 8 *Pandea rubra*
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 8 Distribution of *Pandea rubra* based on available data, showing its meso-bathypelagic distribution.

2.8. Deep-water inhabitants extending south to the edge of the continental shelf

Species that occur in deep waters worldwide can be entrained in southward-flowing deep water and can penetrate to the Antarctic continental shelf break. Some species such as the rhopalonematid trachymedusa *Pantachogon haeckeli* Maas, 1893 (Fig. 9, Map 9) and the calycophoran siphonophore *Vogtia serrata* (Moser, 1925) are confined to upper mesopelagic layers at their shallowest extent, while others such as the calycophoran siphonophore *Rosacea plicata* Bigelow, 1911 (Fig. 10, Map 10) and the coronate scyphomedusa *Periphylla periphylla* (Péron & Lesueur, 1810) can penetrate the epipelagic (Fig. 11, Map 11), although only when surface temperatures are cold in the case of the latter. Other species inhabit the lower mesopelagic with their distributions becoming deeper as they approach the Antarctic continent. They include species such as the calycophoran siphonophores *Gilia reticulata* (Totton, 1954) (Fig. 12, Map 12a) and *Clausophyes moserae* Margulis, 1988, and the halicreatid trachymedusa *Botrynema brucei* Browne, 1908. The sexual eudoxid stages of *G. reticulata* have yet to be reported from epipelagic waters (Map 12b).

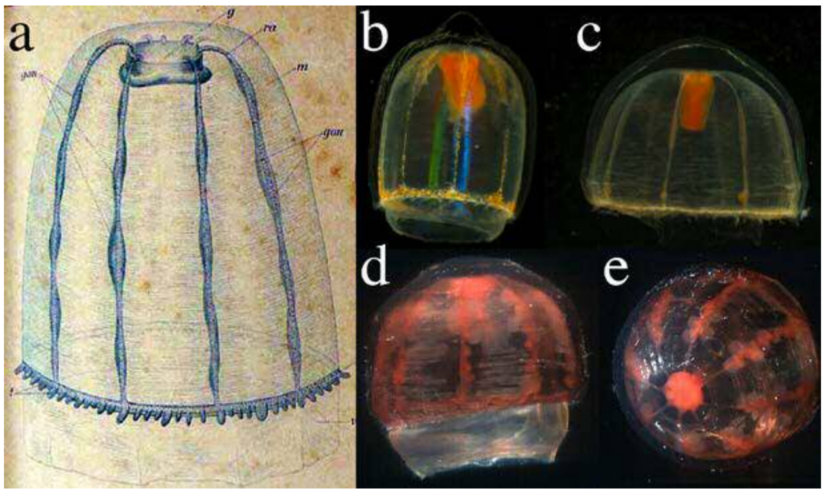


Figure 9 Original illustration of *Pantachogon haeckeli* Maas, 1893 (a), and photographs by DJL of individuals in various stages of development (immature: b, c; mature: d, e) [not to scale].

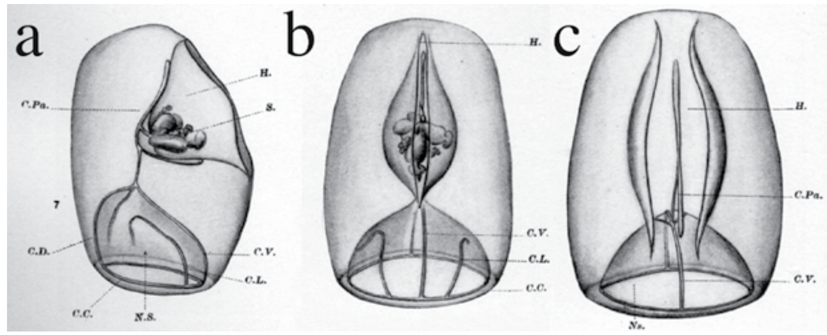
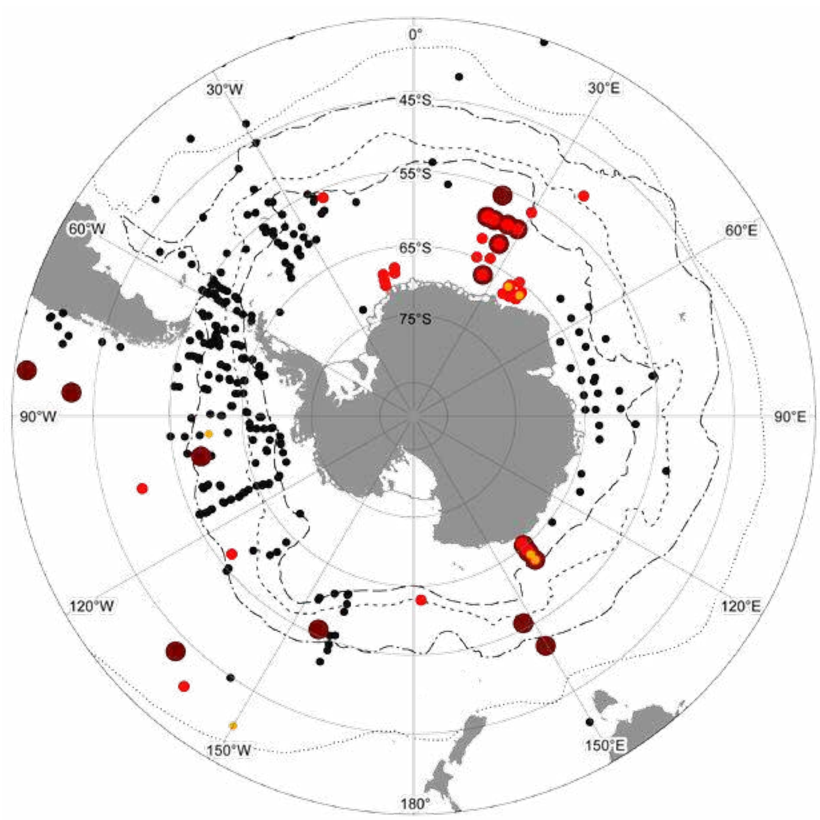
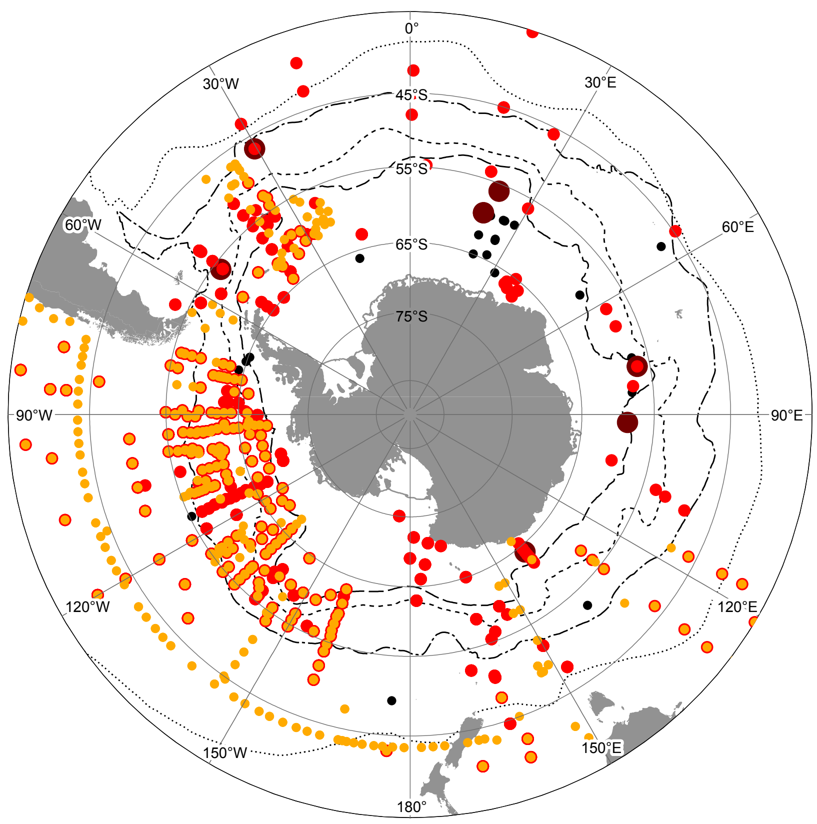


Figure 10 Original line drawing of *Rosacea plicata* Bigelow, 1911 with N2 nectophore in lateral view (a), and lower view (b), N3 nectophore in lower view (c).



Map 9 *Pantachogon haeckeli*
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 9 Distribution of *Pantachogon haeckeli* based on available data, showing its meso-bathypelagic distribution encroaching on the Antarctic continent.



Map 10 *Rosacea plicata*
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 10 Distribution of *Rosacea plicata* Bigelow, 1911 based on available data, showing its mesopelagic distribution around the Antarctic continent and its epipelagic distribution north of the Polar Front where it is upwelled and is advected northwards with surface water up to the Sub-Tropical Front.

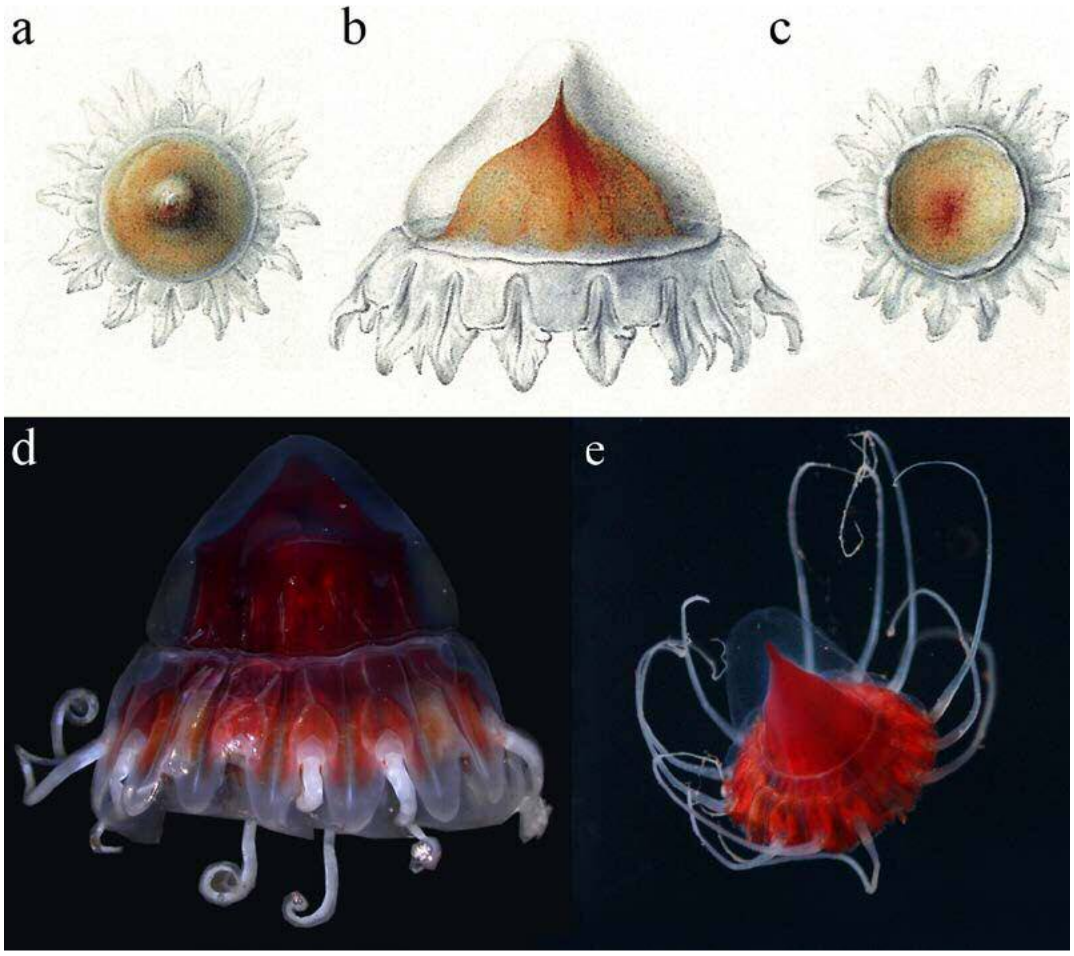
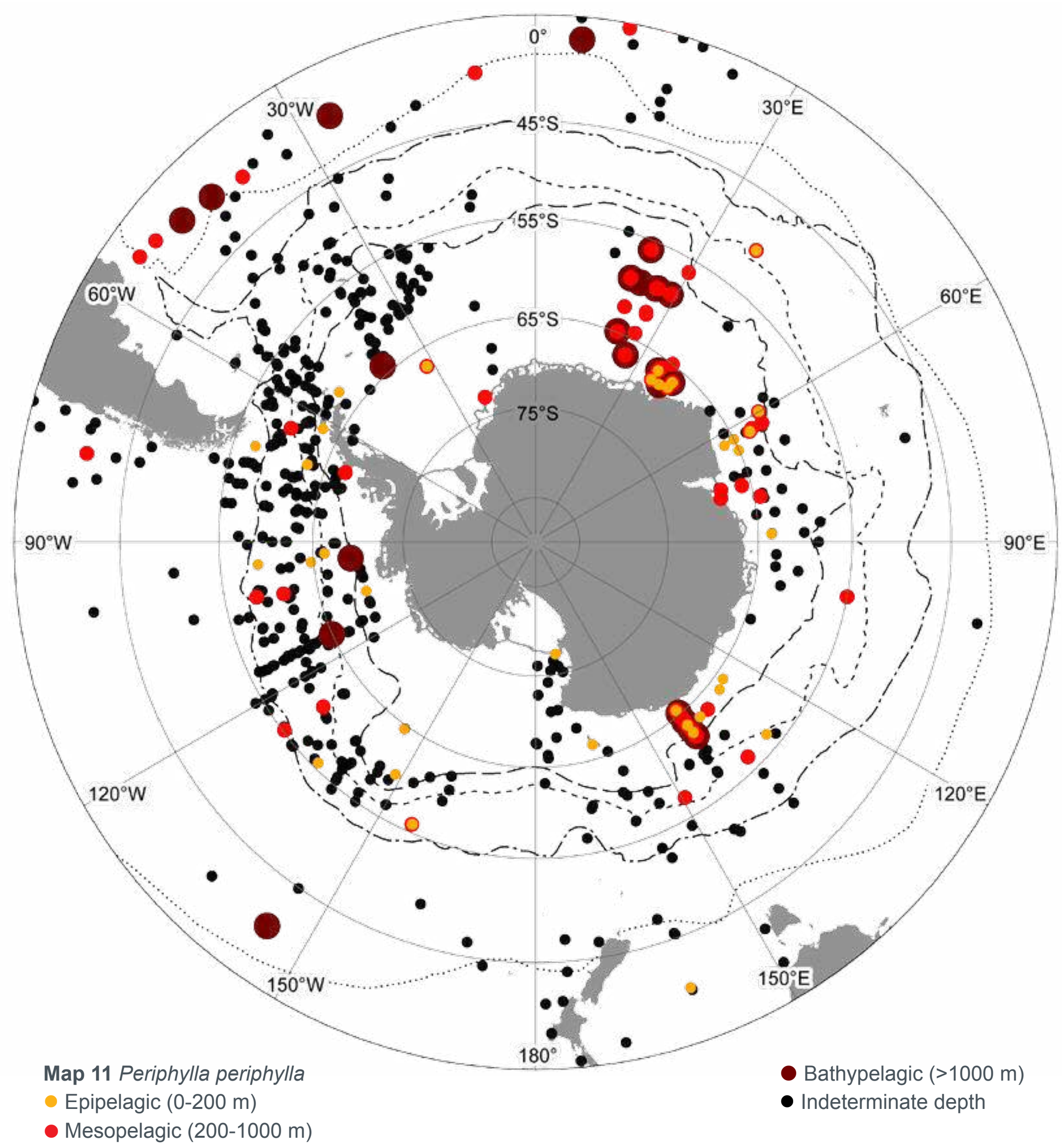


Figure 11 Original watercolour of *Periphylla periphylla* (Péron & Lesueur, 1809) in dorsal (a), side (b) and ventral (c) views, and photographs from the Lazarev Sea by Ricardo Giesecke (d) and from off Japan by DJL (e).



Gelatinous Plankton Map 11 Distribution of *Periphylla periphylla* based on available data, showing its bathypelagic distribution and encroachment on the Antarctic continent.

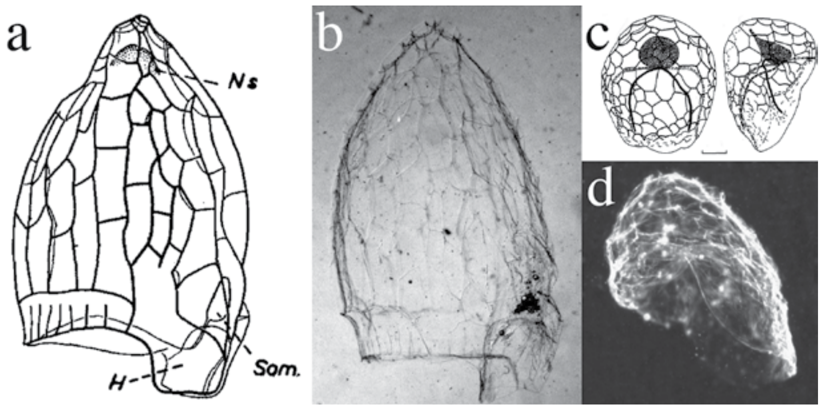
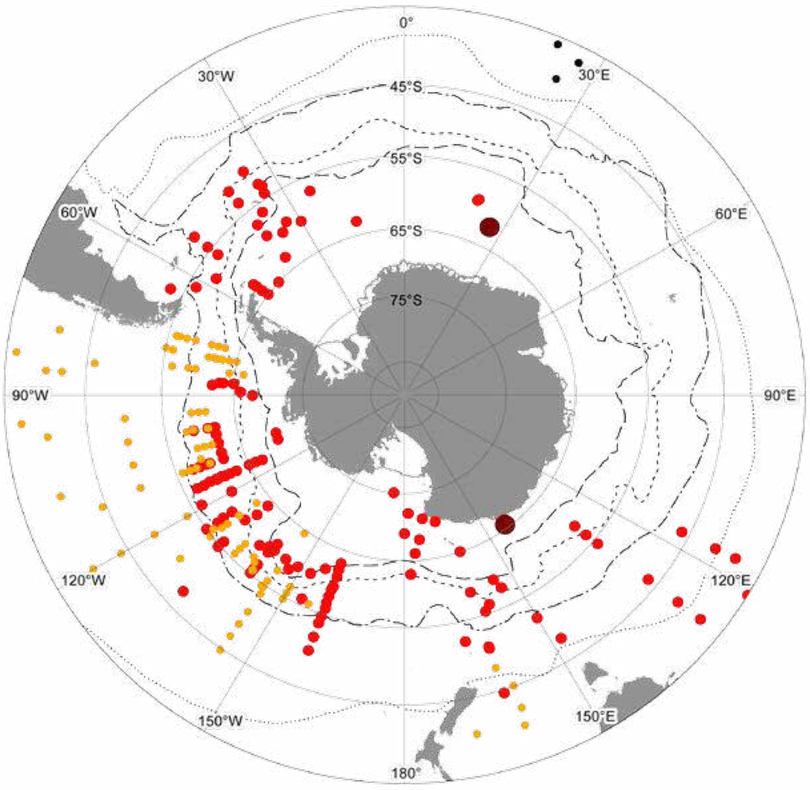
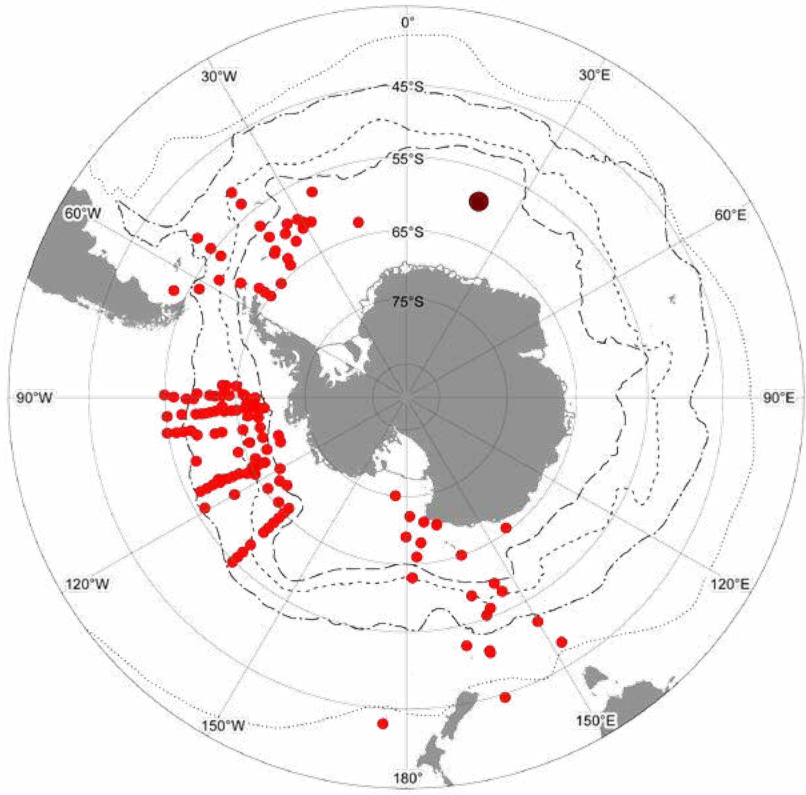


Figure 12 Original line drawing of anterior nectophore of *Gilia reticulata* (Totton, 1954) in lateral view (a), photograph of a fresh specimen from Pagès et al. 2006 (b), line drawings of upper [left] and lateral [right] views of a eudoxid bract from Pugh & Pagès 1995 [scale bar 0.5 mm] (c), and a photograph of a eudoxid bract in lateral view by MMG (d).



Map 12a *Gilia reticulata* polygastric stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth



Map 12b *Gilia reticulata* eudoxid stage
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)

Gelatinous Plankton Map 12a Distribution of polygastric stages of *Gilia reticulata* based on available data, showing its mesopelagic distribution in the offshore waters of the Antarctic continent and its epipelagic distribution north of the Polar Front where it is upwelled and is advected northwards with surface water up to the Sub-Tropical Front. — Map 12b. Distribution of eudoxid stages of *Gilia reticulata* based on available data, showing its mesopelagic distribution.

2.9. Southern Hemisphere extending south of the Polar Front

Some species such as the rhopalonematid trachymedusa *Crossota brunnea* Vanhöffen, 1902 (Fig. 13, Map 13) and the cydippid ctenophore *Bathyctena chuni* (Moser, 1909) seem to originate/flourish in the Deep Water of the Southern Ocean and penetrate northwards to replenish their populations in the Southern Hemisphere. *Crossota brunnea* is not synonymous with *C. rufobrunnea*, its northern hemisphere counterpart, contrary to the assertion of Navas-Pereira & Vannucci (1990).

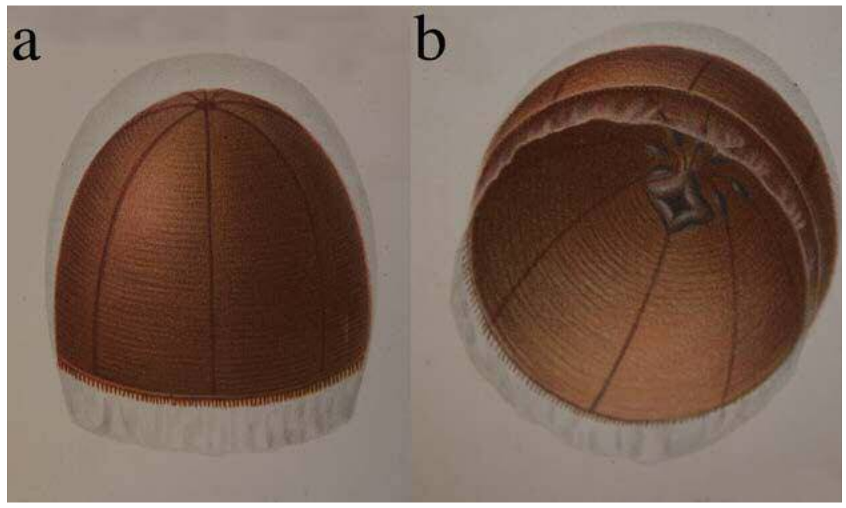
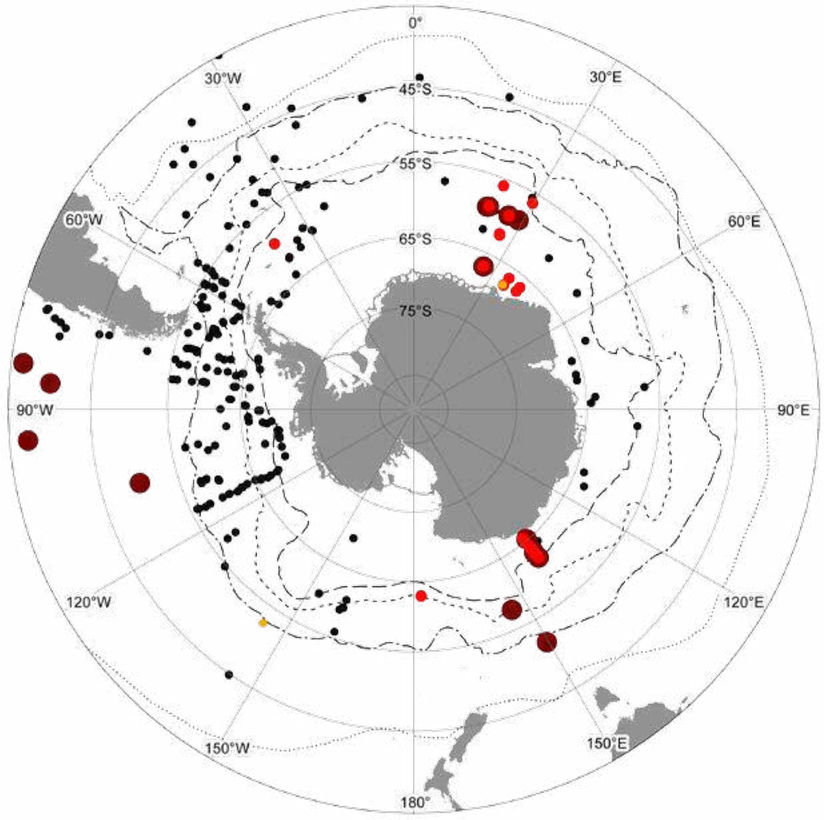


Figure 13 Original line drawings of *Crossota brunnea* Vanhöffen, 1902 (lateral view (a), ventro-lateral view (b).



Map 13 *Crossota brunnea*
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 13 Distribution of *Crossota brunnea* based on available data, showing its predominantly bathypelagic distribution in the offshore waters of the Antarctic continent and occurrence north of the Sub-Tropical Front

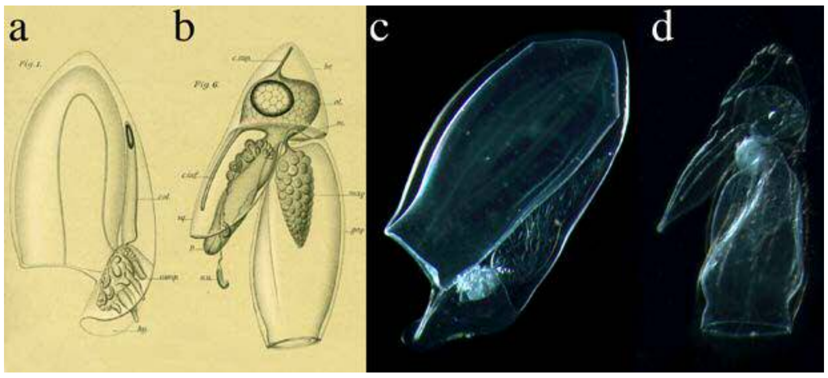
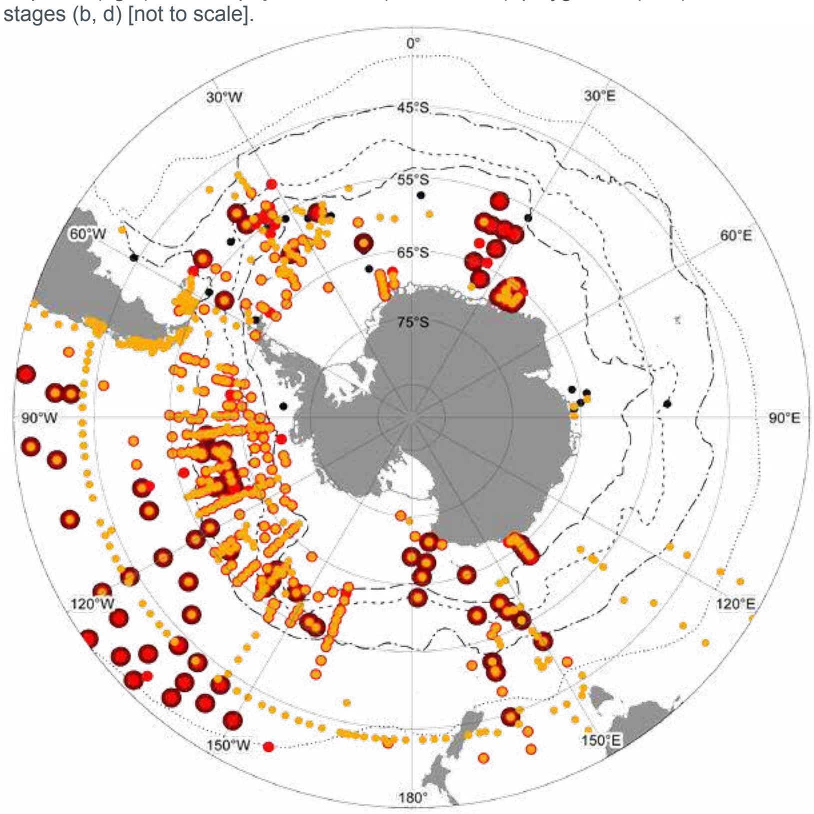
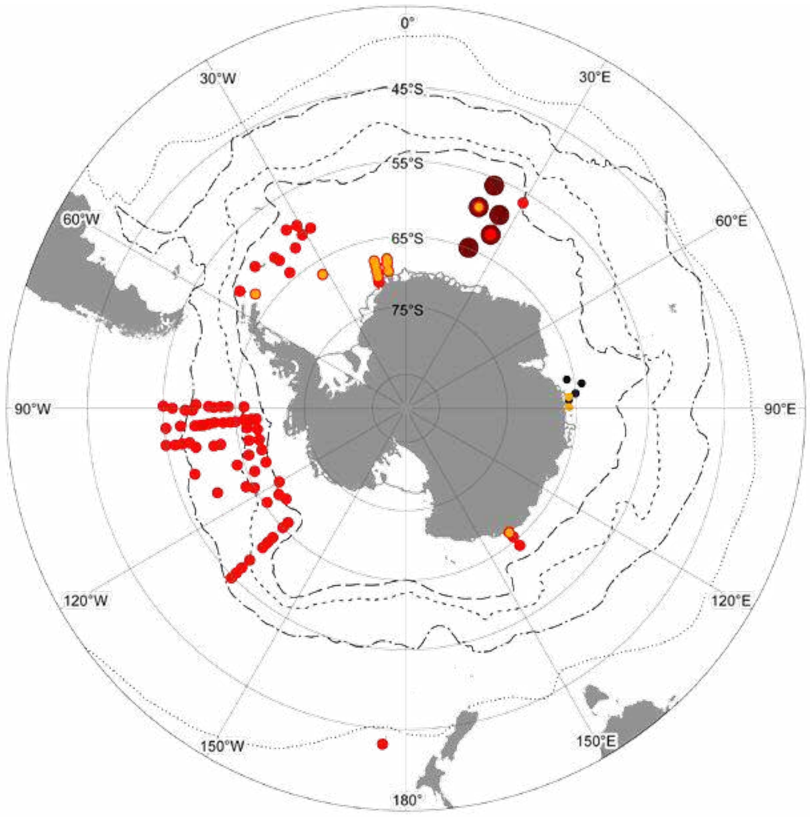


Figure 14 Original illustration by Chun 1897 (left), and photographs by Dr. Russell Hopcroft (right) of *Dimophyes arctica* (Chun, 1897) polygastric (a, c) and eudoxid stages (b, d) [not to scale].



Map 14a *Dimophyes arctica* polygastric stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth



Map 14b *Dimophyes arctica* eudoxid stage
● Epipelagic (0-200 m)
● Mesopelagic (200-1000 m)
● Bathypelagic (>1000 m)
● Indeterminate depth

Gelatinous Plankton Map 14a Distribution of polygastric stages of *Dimophyes arctica* based on available data, showing the wide range of its distribution. — Map 14b. Distribution of eudoxid stages of *Dimophyes arctica* based on available data, showing its predominantly mesopelagic distribution.

2.10. Cosmopolitan extending to south of the Polar Front

The calycophoran siphonophore *Dimophyes arctica* (Chun, 1897) is probably the only member of this group (Fig. 14, Map 14a). It occurs at both poles, mostly in epipelagic and upper mesopelagic waters, and in mesopelagic to bathypelagic waters worldwide. The sexual eudoxid stage seems to be distributed deeper than the polygastric stage when mapped (Map 14b) and some layered net samples have also reported that although habitat depth ranges largely overlap, population peaks for the eudoxids are deeper than the polygastric stages (e.g. Grossmann 2010).

3. Conclusions

In the majority of cases the distribution type of various gelatinous zooplankton species is unclear, due to a combination of limited taxonomic expertise and sampling artefacts. The sizes or life history stages are also seldom recorded though both depth distributions and environmental niche preferences could well vary according to these factors. Small calycophoran siphonophores slip through the mesh of large aperture nets such as the Rectangular Midwater Trawls (RMT) commonly used for plankton studies in the Southern Ocean and soft-bodied forms such as ctenophores are often destroyed to the point where species identification is impossible, if indeed any tissue remains at all. Although the ctenophores *Callianira antarctica* Chun, 1897 and large pink or brown *Beroe* species are conspicuous inhabitants of the Southern Ocean, their distributional type is not yet determined. Studies on gelatinous zooplankton in the Southern Hemisphere outside of the Southern Ocean are even fewer than within it, and as a result the true endemicity of many species has yet to be conclusively proven. In fact, the "endemic" species *Leuckartiara brownei* and *Heterotentacula mirabilis* have also been reported in recent years from the Mediterranean Sea (Pagès *et al*. 1999, Bouillon *et al.* 2000)! New species continue to be described from the Southern Ocean and its surrounding waters (e.g. Grossmann *et al.* 2012). The study of the gelatinous zooplankton fauna of the Southern Ocean would benefit greatly from the collection, photographic recording, and preservation for taxonomic study of pristine specimens of many of the species, preferably with some tissue preserved for DNA analyses and the voucher specimen fixed and preserved in buffered 4% formalin-seawater solution. The use of imaging technologies such as remotely-operated vehicles (ROVs) and in-situ photographic devices such as the Visual Plankton Recorder (VPR) or Underwater Video Profiler (UVP) would greatly augment the more traditional approach of SCUBA diving with a camera — still an invaluable tool for increasing our knowledge on this fragile but important component of the planktonic fauna of Antarctic seas.

4. Data Source

Data have been extracted from the following sources: Alvariño et al. (1990), Araujo (2012), Australian Antarctic Data Centre (accessed 2013), British Antarctic Survey (GBIF accessed 2013), Daniel (1985), Fuentes (2006), Fuentes *et al.* (2008), Grossmann (2010), Guerrero *et al.* (2013), Hardy & Gunther (1935), Hopkins (1985), Kramp (1948, 1949, 1957), Larson (1986), Larson & Harbison (1990), Leloup (1932, 1934), Lindsay & Fuentes (unpublished), Mackintosh (1934), Margulis (1992), Moser (1925), Museum Victoria (OBIS accessed 2013), Navas-Pereira (1992), Navas-Pereira & Vannucci (1990), National Museum of Natural History [U.S.] (accessed 2013), Ocean Genome Resource (accessed 2013), O'Sullivan (1982), Pagès & Gili (1989), Pagès & Kurbjeweit (1994), Pagès & Orejas (1999), Pagès & Schnack-Schiel (1996), Pagès *et al.* (1992, 1994, 1996), Palma (1985, 1994), Palma & Aravena (2001), Palma & Rosales (1997), Palma *et al.* (1999), Panasiuk-Chodnicka & Żmijewska (2010), Pugh *et al.* (1997), SCAR-MarBIN (De Broyer & Danis 2013), Southampton Oceanography Center Discovery Collections Midwater Database (accessed 2013), Toda *et al.* (2010), Totton (1954), Vanden Berghe (2007), Vanhöffen (1908, 1912). These publications are indicated with an asterisk in the references.

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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

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.

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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.