Foraminifera

5.2. Benthic Foraminifera

Andrew J. Gooday¹, Nina Rothe¹, Samuel S. Bowser² & Jan Pawlowski³

¹National Oceanography Centre, University of Southampton Waterfront Campus, Southampton, UK
²Wadsworth Center, New York State Department of Health, Albany, New York, USA
³Department of Zoology and Animal Biology, University of Geneva, Sciences III, Geneva, Switzerland

1. Introduction

Foraminifera (heterotrophic protists) occur in almost all marine environments from intertidal mudflats to the deepest ocean trenches. Molecular genetic analyses place them within the supergroup Rhizaria, together with radiolarians, pseudopods (Pawlowski & Burki 2009). Most described foraminiferal species have a test (‘shell’) composed of calcium carbonate secreted by the cell or agglutinated from foreign particles stuck together with organic or calcareous cement. The tests are often multichambered with the chambers arranged in patterns (e.g. linear, biserial, triserial, spiral) that are characteristic at the family or generic level. In addition, recent studies have revealed a wealth of ‘primitive’, largely undescribed species with single-chambered (‘monothalamous’) tests composed of agglutinated or organic material (e.g. Habura et al. 2008).

Because they are abundant in all parts of the Southern Ocean (SO) and of interest to both geologists and biologists, a substantial literature exists on benthic foraminifera from Antarctic waters. The Atlas includes a selection of commonly reported species and those that appear to be endemic to these regions. Several important caveats should be mentioned. First, we have not attempted to cover the entire body of literature on Antarctic foraminifera. Second, many of the records that we have included are not supported by illustrations, making it impossible to check identifications. Third, we included dead and ‘total’ (live + dead) records, as well as those based on ‘live’ (Rose-Bengal stained) tests. Because dead tests can be transported over distances of 10s or 100s of kilometres (Murray 2006) some biogeographic studies (e.g. Murray 2013) have considered only ‘live’ records. Transport of tests by currents and mass wasting events, ice-rafting, and the exposure of non-Recent sediments are potentially important problems around Antarctic coast (Uchio 1960). However, disregarding records based on unstained (dead or ‘total’) assemblages would have eliminated important distributional data from areas around Antarctica where ‘live’ data are scarce or absent. Also, while these processes can modify geographic and bathymetric distributions in particular areas, they are less likely to substantially alter biogeographic patterns on the continental scale considered in this Atlas.


2. Methods, including limitations of coverage

Foraminifera have been collected in Antarctic waters since the first half of the 19th century. Sampling sites are concentrated around the Antarctic Peninsula in the Drake Passage, the Weddell and Scotia Seas and the Ross Sea, particularly the McMurdo Sound area (Cornellus & Gooday 2004). The Adelie-George V shelf and slope and Prydz Bay are also fairly well sampled. Soviet expeditions (1956–1990) collected material at numerous points around East Antarctica between Oates Land and Enderby Land (Mikhalevich 2004). Apart from the Peninsula, coverage is sparse around West Antarctica. Various devices have been used to obtain this material. Many early studies, which were linked to major national expeditions, employed a combination of small sounding samples and large dredge or trawl samples (Pearsley 1914, Chapman 1916, Heron-Allen & Earland 1922, 1932, Wiesner 1931, Earland 1933, 1934, 1936, Chapman & Parr 1937, Parr 1950). Petersen grab, trawl, dredge and small gravity cores were often used in studies from the 1960s and 1970s (e.g. Uchio 1960, McKnight 1962, Pflum 1963, Kennett 1968). While earlier investigations were largely descriptive, many studies published during the 1960s and 1970s incorporated some quantitative data (e.g. McKnight 1962, Pflum 1963, Kennett 1968). Another important development in Antarctic foraminiferal research during this period was the application of Rose Bengal staining (first used in Antarctica in the early 1950s) to distinguish dead tests from those that were assumed to be alive when collected (Uchio 1960, Echols 1971, Herb 1971, Basov 1974). Recent research on SO benthic foraminifera has seen the introduction of box cores (Mackensen & Douglas 1989, Mackensen et al. 1990, 1993, Ascoli 1995, Schmidli & Mackensen 1997, Murray & Pudsey 2004) and hydraulically-dampered multiple corers (Harloff & Mackensen 1997, Cornellus & Gooday 2004). The multiple corer is particularly effective because it retains the light, fluctuate surface sediment in which many living foraminifera reside.

Several different methods have been used to process Antarctic foraminiferal samples. Wet-sieving is normal but the sieve size used has varied widely: 63 µm (Mylim & Anderson 1981, Ascoli 1995, Violanti 1995, Murray & Gooday 2004), 74–75 µm (Kennett 1968, Anderson 1975, Jones & Pudsey 2004), 100 µm (Lindenberg & Auras 1984), 125 µm (Quilty 1985, Mackensen 1990, 1993, Harloff & Mackensen 1997, Majewski 2005), 150 µm (Mead & Kennett 1987). This has an important influence on the species recovered (Fierro & Rodríguez 1987), Foraminifera have been picked from dried residues (Kennet 1968, Mead & Kennett 1987, Mackensen et al. 1990, Violanti 1995), or residues that were dried and then re-wetted (Murray & Pudsey 2004) or concentrated from dried residues using a heavy liquid (Echols 1971, Bernhard 1987 et al. 1997) Gooday & Bowser 1991, Bowser & Gooday 1994, Gooday & Pawlowski 2004, Sabbathati et al. 2004, Cedhagen et al. 2009, Pawlowski & Majewski 2011) and polythalamous (Pawlowski et al. 2007b, Majewski & Pawlowski 2010, Schweitzler et al. in press) species. Live specimens have also formed the basis for cytological studies (e.g. Travis & Bowser 1991, Bowser et al. 1995, Habura et al. 2004) and Pawlowski et al. (2011) explored foraminiferal diversity by extracting total DNA from sediment samples collected in Explorers Cove (McMurdo Sound) and the deep Weddell Sea, respectively.

3. General composition of the Southern Ocean fauna

Antarctic foraminiferal faunas include calcareous, agglutinated and organic-walled species, although, as discussed below, assemblages dominated by either agglutinated or calcareous species occur in some settings. Large species of agglutinated genera such as Cyclammina, Hormosina, Hyperammina, Pilulina, Psammosphaera, Rhabdammina and Saccammina, as well as milolids (e.g. Corneospira, and Cornuspiridae, Pyrgo, Pyrgoellus) and some other calcareous taxa (e.g. Hoeglundina, Dentalina), often abound in trawl samples (Wisner 1931, Herb 1971, Schmidli & Mackensen 1993). Among smaller calcareous foraminifera, species of Globocassidulina, Cibicides, Trifarina, Epistominella and Pullenia are common (e.g. Mackensen et al. 1993, Majewski 2010). Although frequently ignored, monothalamous taxa are abundant and diverse where an effort has been made to look for them, as in Explorers Cove (Gooday et al. 1996, Pawlowski et al. 2002), Admiralty Bay, King George Island (Majewski et al. 2007, Sinniger et al. 2008) and the deep Weddell Sea (Cornellus & Gooday 2004). Komokiaceans and other enigmatic forms are abundant in the Weddell Sea (Gooday et al. 2007), and probably other abyssal areas.

Attached foraminifera often settle on glacially transported dropstones and other hard substrates. Sessile species belonging to the agglutinated genera Dendrophyra, Dendronina, Sorosphaera and Tholosina are common on the continental slope around South Georgia, the Antarctic Peninsula and in the Scotia Sea (Earland 1933, 1934). A majority (69%) of the 852 stained foraminifera in a box core (>300 µm fraction, 0–5 cm layer) from the upper slope in the NW Weddell Sea (RV Polarstern Cruise 61, Station 133, 1100 m water depth) were found on dropstones. Elsewhere, cibicides and other calcareous species live on biogenic substrates such as scallop shells (Alexander & Delacasa 1987).

The virtual absence of certain higher taxa, such as brachyuran crabs and sharks, is a notable general feature of the Antarctic marine fauna (Clarke & Johnston 2003). The Elphididaeae represent a comparable example among foraminifera. The first modern Antarctic species of this family, which is particularly common in the Arctic, was only recently described from King George Island (Majewski & Tatur 2009).
Foraminifera Maps 1–6

Map 1
- *Ammoflintina argentea* Echols
- All records of benthic Foraminifera

Map 2
- All records of benthic Foraminifera

Map 3
- *Rosalina globularis* d'Orbigny
- All records of benthic Foraminifera

Map 4
- *Schackoinella antarctica*
- All records of benthic Foraminifera

Map 5
- *Cornuspiroides rotundus* Schmiedl & Mackensen, 1993
- All records of benthic Foraminifera

Map 6
- *Delosina sutilis* Earland, 1934
- All records of benthic Foraminifera

(See also section ‘Notes on mapped species’)

Foraminifera Maps 1-6
1. *Ammoflintina argentea* Echols, 1971
3. *Rosalina globularis* d'Orbigny, 1926
5. *Cornuspiroides rotundus* Schmiedl & Mackensen, 1993
6. *Delosina sutilis* Earland, 1934

(See also section ‘Notes on mapped species’)

Biogeographic Atlas of the Southern Ocean
4. Bathymetric distribution

Foraminifera are present at all depths around Antarctica. In shallow-water settings, for example coastal forads, assemblages are related to their proximity to glaciers, sedimentary regime and distance from the open ocean, as well as to bathymetry (Chang & Yoon 1995, Majewski 2005). On rocky substrates around the Peninsula, Lips & DeLaca (1980) identified a sequence of zones, characterised by differences in foraminiferal densities and species composition, that extend to depths of 33–45 m and reflect the combined influences of ice abrasion and benthic algal production. In deeper water, depth-related assemblages have been recognised in Lutzw-Holm Bay (Uchih 1960), the Ross Sea (McKnight 1962), the Drake Passage (Herb 1971) and the Scotia Sea area (Echols 1971). Based on the data of McKnight, Bandy & Echols (1964) delineated eight groups of species, each of which only occurred below a certain depth (164, 384, 475, 612, 800, 1281, 1670, 2620 m). Kenneth (1968) compiled depth ranges for species in the Ross Sea and recognised ‘abrupt changes in the fauna’ at 270, 450–520, 1390 and 2200 m. However, many species had ranges different from those observed elsewhere in the Antarctic, making it impossible to define a foraminiferal depth zonation which will apply to the Antarctic as a whole’ (Kenneth 1968). It should also be noted that the bathymetric distribution may create spurious depth distributions (Uchih 1960).

Calcarea genera (e.g. *Epistominella* and *Globocassidulina*) are often represented by only 2–3 species in Antarctic waters, with one species occurring in deep water and another in coastal settings. Some species, however, have bathymetric ranges extending from the shelf to the abyss (Bandy & Echols 1964, Kenneth 1968, Murray 1991), raising the possibility that they comprise two or more cryptic species. Alternatively, in the absence of a downslope transport, broad depth ranges may reflect the dispersal of foraminiferal propagules combined with a more or less isothermal water column. These factors could explain the genetic coherence of *Bathyallogromia weddelensis* between 1100 and 6300 m depth (Goody et al. 2004).

5. Zoogeography

Many common Antarctic foraminiferal species are known from other parts of the World Ocean. Bathyal and abyssal regions, in particular, are inhabited by typical deep-sea forms. Murray (1991) recognised a series of SO deep-water associations dominated by cosmopolitan species such as *Cyclammina pumilla*, *Epistominella exigua*, *Nuttilidites umboniferus* and *Globocassidulina subglobosa*. Cornelius & Goody (2004) estimate that ~2/3 of the calcareous species in deep Weddell Sea samples also occurred at the Porcupine Abyssal Plain. To the south of the Antarctic convergence Goody et al. (2007) recognised ~40 species of *Cromekiaea* and similar forms, 61% of which are reported by typical deep-sea forms. The more restricted distributions of continental shelf species compared to those in deeper water is illustrated by an analysis of Saidova’s data (Table 2). Of the 1791 species listed in her monograph on Pacific Ocean foraminifera, 221 occur in Antarctic waters. Most (~70%) of those confined to the Antarctic (i.e. not occurring in the temperate or tropical Pacific in Saidova’s material) are restricted to the shelf (~1000 m); 9% of the 13 species occurring in Antarctic and adjacent southern temperate regions have a similar depth distribution. In contrast, most (~79%) species with wide ranges extending from the Antarctic to parts of the Pacific beyond the southern temperate zone are confined to depths >1000 m.

DNA analyses suggest that benthic foraminifera living on the Antarctic shelf are genetically homogenous. Ribosomal DNA sequences are almost identical in populations of *Epistominella vitrea* from the Ross Sea (<30 m water depth) and the Weddell Sea (~1000 m) (Pawlowski et al. 2007a). Despite considerable morphological variability, all examined specimens of *G. biora* from Admiralty Bay had identical ITS rDNA sequences (Majewski & Pawlowski 2011). Twelve morphospecies from the Antarctic Peninsula (Admiralty Bay) and McMurdo Sound (New Harbor) exhibit the same lack of genetic differentiation, suggesting pan-Antarctic gene flow among shelf foraminifera (unpublished data). Earland (1934) already pointed to the circumpolar-Antarctic distribution of some species and Majewski (2004) concluded that most species living on the Antarctic shelf display this pattern. However, there are some apparent exceptions, notably the genus *Notodendrodes*, which is apparently endemic to the Ross Sea. The type species, *N. antarcticus*, was described from Explorers

---

Table 1  Possibly endemic Antarctic species described in Russian literature but often assigned to well-known cosmopolitan species; based on data in Mikhailichev (2004)

<table>
<thead>
<tr>
<th>Commonly used name(s) in non-Russian literature</th>
<th>Non-Russian records</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Foraminifera</em></td>
<td>Commonly used name(s) in non-Russian literature</td>
</tr>
<tr>
<td><em>Paurophragmoides antarctica</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Saccammina basiloculata</em></td>
<td>Mikhailichev, Pronina, &amp; Nestell, 2000</td>
</tr>
<tr>
<td><em>Normocinclus distans</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Pauululocollata antarctica</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Cibicides antarcticus</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Cyclammina orbicularis asellata</em></td>
<td>R. abyssorum</td>
</tr>
<tr>
<td><em>Cyclammina pusilla</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Planispira antarctica</em></td>
<td>Saidova, 1975</td>
</tr>
<tr>
<td><em>Cibicides</em></td>
<td>Saidova, 1975</td>
</tr>
</tbody>
</table>


Table 2  Bathymetric distribution of foraminiferal species in Antarctic waters. Species are divided into those that occur 1) only around Antarctica; 2) around Antarctica and in the adjacent south temperate zone; 3) around Antarctica and in the tropical and/or north temperate zones. Based on data in Saidova (1975, Tables 1-11)
Foraminifera Maps 7–12


Cove on the west side of McMurdo Sound (DeLaca et al. 1980), and has been located outside the Sea ice, in a wide bathymetric range reported (Habuba et al. 2005). This species, as well as other species, *N. hyalinosphaira*, occurs in Explorers Cove and elsewhere in McMurdo Sound (DeLaca et al. 2002) and in much deeper water under the Ross Ice Shelf (Pawlowski et al. 2005).

6. Factors and processes influencing geographic distribution

The complex pattern of bathymetry, sediment types, water mass characteristics, sea-ice cover and surface productivity around Antarctica make it difficult to untangle the factors underlying the geographical distribution of foraminiferal species. Geographical patterns probably reflect multiple inter-related factors. As in other oceanic areas (Gooday et al. 2012), the organic matter flux to the seafloor seems to strongly influence the abundance and distribution of foraminiferal species, particularly in deep water (e.g. Ascoli 1995, Mackensen et al. 1995). However, the fact that Antarctic shelf faunas are often either predominantly calcareous or predominately agglutinated, suggests that carbonate dissolution at fairly shallow depths is an often overriding factor (Saidova 1998, Mikhailichev 2004). This separation has been recognised in the Ross Sea (Kendett 1968, Ward et al. 1987), Lützow-Holm Bay (Igarashi et al. 2001), the Weddell Sea (Anderson 1975, Mackensen et al. 1990), and eastern Scotia Ridge (Echols 1971) and the George V – Adélie shelf (Millam & Anderson 1981). In the Ross Sea, a shallow CCD, linked to ice cover, very low temperatures and very high salinities, is considered responsible for confining calcareous assemblages to depths <400 m, with mixed calcareous/agglutinated assemblages at 400-650 m and agglutinated assemblages below 650 m (Kendett 1968). A similar depth-related separation exists between calcareous and agglutinated assemblages in McMurdo Sound (Ward et al. 1987). Dissection boundaries appear to be related to upwelling masses and ice front in the Ross and Weddell Seas (Anderson 1975, Osterman & Kellogg 1979, Millam & Anderson 1981). For example, shallow calcareous assemblages are associated with Fresh Shelf Water in the eastern Weddell Sea (Anderson 1975). However, some of the same dissolution-resistant species are associated with Saline Shelf Water on the George V – Adélie margin, indicating that calcareous species are not entirely controlled by watermass properties (Millam & Anderson 1981). On the Bellingshausen margin of the Antarctic Peninsula, Isua (1990) recognised two species groups, one dominantly agglutinated and the other predominantly calcareous, that are associated with Circumpolar Deep Water and Weddell Sea Transitional Water, respectively, and are not closely related to the CCD or to the organic carbon content of the sediments. Similarly, the faunal relationship between sediment types and foraminiferal assemblages around Antarctica is somewhat ambiguous. In the Ross Sea, Kendett (1968) found no link between faunal trends and sediment types, or in most cases with bottom-water characteristics (salinity and temperature). On the Adélie-George V continental shelf and slope, however, Millam & Anderson (1981) report a close association between faunal distributions and sediment types, calcareous species dominating in areas of sand or muddy sand on topographic highs with agglutinated species dominating in areas of sand or muddy sediments on low topographic depressions. These sediment types reflect different hydrodynamic regimes, the sandy sediments being linked to moderate intense currents and the muddy sediments to sluggish currents. An assemblage dominated by *Trifarina antarctica* is found with strong bottom currents and sandy sediments around the shelf break in the eastern Weddell Sea (Mackensen et al. 1990). A comparable assemblage is present in the western Ross Sea (Ascoli 1995). In the deep (>2000 m water depth) Scotia Sea, some foraminiferal species are largely restricted to diatomaceous sediments while others are found only in sediments without diatoms (Echols 1971).

Salinity and suspended sediment load may influence foraminiferal assemblages in coastal settings (particularly fjords) impacted by glacial meltwater (Majewski 2005, Rodrigues et al. 2010). The elphidid *Cribroelphidium webbii* is confined to the inner parts of fjords in close proximity to retreating tidewater glaciers (Majewski & Tatur 2009). Like its Arctic counterparts, this species appears to flourish in these muddy, brackish-water settings with high sedimentation rates. Another factor in near-shore and intertidal settings is the presence of larger, single-chambered foraminifera. On the one hand, these environments are also very heterogeneous, with rocks and algae providing habitats for many different foraminiferal species (Lips & DeLaca 1980). In deeper water, dropstones provide an important substrate for sessile species.

7. Taxonomic issues

The abundance of foraminifera in marine environments and their importance in geological studies has generated a vast taxonomic literature, referring mainly to the 'hard-shelled' taxa. Publications on Antarctic foraminifera typically include lists of identified species. Some are well illustrated but others lack illustrations raising the possibility of misidentification. The names of some agglutinated species (e.g. in the genera *Reophax* and *Psammosphaera*) typically include lists of identified species complexes rather than single species. The very wide bathymetric ranges reported for others also make identifications questionable. For example, records for *Epistominella exigua* span a depth range from <30 m to >5600 m in Antarctic waters. At least some of the shallower records probably refer to a related species, *E. leuciva* (Pawlowski et al. 2007). Globocassidulina subglobosa is another example of a calcareous species for which a range that includes both calcareous and agglutinated species. Molecular analyses are beginning to resolve some of these problems, but further studies of this kind are necessary.

8. Summary

Numerous papers describe the distribution and diversity of benthic foraminifera around Antarctica. While our understanding of the biogeography of this group is often hampered by taxonomic issues. However, in general terms, deep-water assemblages (>1000 m water depth) include many species with wide distributions in other oceans, while coastal and shelf (<1000 m) assemblages are more restricted in their distributions. High species diversity (up to 6 species per quadrat) is also found in typically restricted taxa. The occurrence of calcareous and agglutinated assemblages suggests that carbonate dissolution, linked to a multicarbonate compensation depth, is an often overriding factor.

Notes on mapped species

Map 5. *Coronuporites rotundus* Schmiedl & Mackensen, 1993 According to Schmiedl and Mackensen (1993) *Coronuporites laocoon* (Brady) of Wiesner (1931) belongs to *C. rotundus* as a species appearing on the same slide as the type specimen (1931), we also include here C. striolatus (Brady, 1882) of Heron-Allen and Earland (1922) from McMurdo Sound and C. striolatus from the continental shelf adjacent to Prydz Bay (Wiesner 1931). — Map 7. *T. earlandi* de Wisselink & Earland, 1936 Wide depth range from which this essentially abyssal species is reported suggests that some records are misidentifications. — Map 13. *Astrammina rara* Wiesner, 1931 DeLaca (1986) and Tappan (1987) considered *Astrammina pyriformis* Heron-Allen & Earland, 1923a and *Peleophaora comuta* Heron-Allen & Earland, 1932a to be synonyms. The type specimens of *P. comuta* from South Georgia, in the Natural History Museum, London (NHML) close examination reveals that 1) there are no molecular data from South Georgia to confirm the synonymy, 2) deposited DNA sequences from McMurdo Sound suggest the existence of two species, 3) Wiesner (1931) illustrations of two tests show that one test has a single large grain whereas the other species appears to flourish in these muddy, brackish-water settings with high species diversity (up to 6 species per quadrat). These considerations suggest that our present concept of *A. rara* may encompass more than one species. We are not convinced that species illustrated by Majewski (2005) and Igarashi et al. (2001) belong to *Astrammina rara*. Records from non-Antarctic settings display apparent inconsistencies with records from other species. The relationship between sediment types and faunal distributions and sediment types, calcareous species dominating in organic-rich siliceous muds and oozes in shelf basins and foraminifera around Antarctica, but our understanding of their zoogeography is often hampered by taxonomic issues.
Map 13
- *Astrammina rara*
- All records of benthic Foraminifera

Map 14
- *Astrammina triangularis*
- All records of benthic Foraminifera

Map 15
- *Bowseria arctowskii*
- All records of benthic Foraminifera

Map 16
- *Hippocrepinella hirudinea*
- All records of benthic Foraminifera

Map 17
- *Notodendrodes antarctikos*
- All records of benthic Foraminifera

Map 18
- *Notodendrodes hyalinosphaira*
- All records of benthic Foraminifera

**Foraminifera Maps 13–18**


Biogeographic Atlas of the Southern Ocean
Foraminifera

Map 19
- *Ammomarginulina ensis*
- All records of benthic Foraminifera

Map 20
- *Portatrochammina antarctica antarctica*
- All records of benthic Foraminifera

Map 21
- *Portatrochammina antarctica wiesneri*
- All records of benthic Foraminifera

Map 22
- *Pseudobolivina antarctica*
- All records of benthic Foraminifera

Map 23
- *Textularia earlandi*
- All records of benthic Foraminifera

Map 24
- *Textularia wiesneri*
- All records of benthic Foraminifera


80
Foraminifera Maps 25–30

Map 25
- *Astrononion antarcticus*
- All records of benthic Foraminifera

Map 26
- *Cibicides antarcticus*
- All records of benthic Foraminifera

Map 27
- *Globocassidulina biora*
- All records of benthic Foraminifera

Map 28
- *Glandulina antarctica*
- All records of benthic Foraminifera

Map 29
- *Ehrenbergina glabra*
- All records of benthic Foraminifera

Map 30
- *Epistominella vitrea*
- All records of benthic Foraminifera

(See also section 'Notes on mapped species')
in shallow-water Antarctic settings, 2) it is widely distributed around the continent and genetically distinct from C. subglobosa, which is much smaller and occurs in deep water, and 3) G. crassula is probably restricted to regions north of the Polar Front. Here, we include only records for C. biora. — Map 30. Epistominella vitrea Parker, 1953 This is essentially a slope species. Abyssal records may refer to C. biora. — Map 30. Epistominella vitrea Parker, 1953
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) 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 benthos and pelagic taxa and of the key communities, in the light of both 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.ai) 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.

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 interconnectable databases, forming the scientific base of the Ocean Biodiversity 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 ecosystemic 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.

Cédric d’UDEKEM d’ACOZ is a research scientist at the Royal Belgian Institute of Natural Sciences, Brussels. His main research interests lie in the 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 Polarcirkel and to several sampling campaigns in Norway and Svalbard.

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

Falk HUETTMANN is a marine biologist at the Royal Belgian Institute of Natural Sciences in Brussels. He is the senior author of the book “Mammals and birds of the Weddell Sea” and manages the Southern Ocean Mammal Database (SOMBASE). He has published papers in various fields, including ecotoxicology, physiology, biodiversity informatics, polar biodiversity or information science.

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 Scientific Officer for the Antarctic Biodiversity 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 BIOEUGOSCIENCES, University of Montpellier. His main interests include clonal community composition and more specifically on sea urchins. He authored a book and edited an extensive database on Antarctic echinoderms. He presently heads the scientific council of the Muséum National d’Histoire Naturelle (Paris), and Deputy Director at the CNRS Institute for Ecology and Environment.

Alexandra POST is a marine geoscientist, with expertise in benthic habitat mapping, sedimentology and geophysical characterization of the seafloor. She has worked at Geoscience Australia since 2002, with a primary focus on understanding seabed 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 shelf following the successful CANA, voyage there.

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 ecosystemic 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.

Cédric d’UDEKEM d’ACOZ is a research scientist at the Royal Belgian Institute of Natural Sciences, Brussels. His main research interests lie in the 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 Polarcirkel and to several sampling campaigns in Norway and Svalbard.

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

Falk HUETTMANN is a marine biologist at the Royal Belgian Institute of Natural Sciences in Brussels. He is the senior author of the book “Mammals and birds of the Weddell Sea” and manages the Southern Ocean Mammal Database (SOMBASE). He has published papers in various fields, including ecotoxicology, physiology, biodiversity informatics, polar biodiversity or information science.

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 Scientific Officer for the Antarctic Biodiversity 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 BIOEUGOSCIENCES, University of Montpellier. His main interests include clonal community composition and more specifically on sea urchins. He authored a book and edited an extensive database on Antarctic echinoderms. He presently heads the scientific council of the Muséum National d’Histoire Naturelle (Paris), and Deputy Director at the CNRS Institute for Ecology and Environment.

Alexandra POST is a marine geoscientist, with expertise in benthic habitat mapping, sedimentology and geophysical characterization of the seafloor. She has worked at Geoscience Australia since 2002, with a primary focus on understanding seabed 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 shelf following the successful CANA, voyage there.