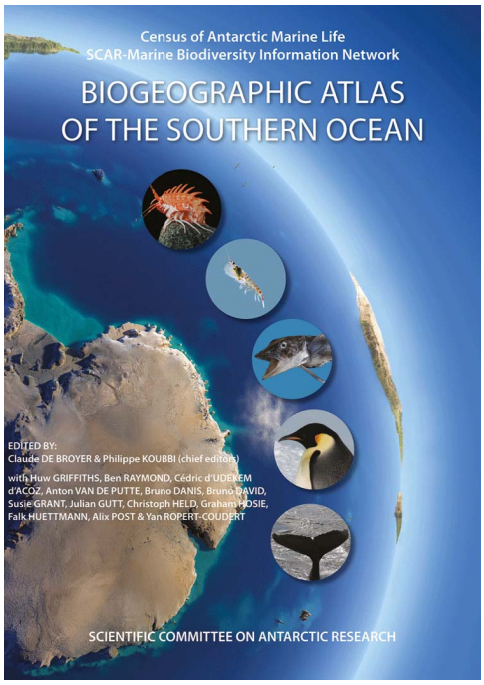
Book review

Biogeographic Atlas of the Southern Ocean

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



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

Over the past few decades the field of biogeography has expanded with rapid technological and methodological developments. This, in conjunction with increasing data availability, is enhancing our understanding of how species and ecosystems are distributed in geographic space and geological time on a global scale. The Southern Ocean is still a vast frontier of discovery, with many parts of it largely unexplored, but the recently published *Biogeographic Atlas of the Southern Ocean* (De Broyer et al., 2014) has drawn on the richest source of biodiversity data collected to-date to increase our understanding on the distribution of a large number of species and assemblages in this region. The occurrence data that were compiled for the atlas came from literature since the beginning of Antarctic exploration to the present, museum collections, the Census of Antarctic Marine Life (CAML 2005–2010) and other recent Antarctic surveys. These data were used in generating more than 800 distribution maps and multiple syntheses describing the distribution patterns and processes of a significant number of organisms in this region.

The atlas begins with a comprehensive history of biogeography and bioregionalisation in the Southern Ocean that is followed by a description of the data and various modelling methods and analyses used. The evolutionary setting of the Southern Ocean is then explained in terms of species richness relative to the Arctic and lower latitudes, which leads into discussion on the 'Out of the Tropics' and 'Thermohaline expressway' evolutionary models for which there is mostly ongoing support. Key events in the evolution of Southern Ocean marine fauna are documented dating back to ~390 Ma (in the Early-Middle Devonian) with the importance of refugia and polynyas being highlighted in terms of species persistence during periods of pronounced changes and regional extinctions. The reconstruction of tectonic plates through geological time is detailed with reference to the Tasman or Australian–Antarctic Passage that connected Tasmania and Australia to the Antarctic, and the Drake Passage connecting the Antarctic Peninsula to South America. The subsequent chapter synthesises information on environmental factors, including depth and slope of the seafloor, geomorphic features, bottom sediment, temperature, sea-ice and others in relation to their broad relevance to patterns of Southern Ocean biodiversity. Several chapters are dedicated to detailed descriptions of the current biogeography of a large number and diversity of taxa, inhabiting benthic and/or pelagic environments, such as macroalgae, crustaceans and copepods, sponges, hydroids, jellyfish, Antarctic hexacorals, sea worms, gastropods, bivalves, octopuses, sea spiders, fish, birds and mammals to name a few. The biogeography of macrobenthic assemblages and deep-sea biota are also provided, but predominantly on the basis of expert opinion due to the relative paucity of data.

The latter part of the atlas moves on to discuss future change and conservation. Potential changes in the relative occurrence indices of a number of pelagic species and biogeographical provinces are projected in response to future climate change. Projected changes in species' relative occurrence indices were indicative of declining habitat quality and decreasing range size with poleward shifts projected for biogeographic provinces. The importance of understanding the current and potential future biogeography of the Southern Ocean for conservation is stressed and our ability to assess and detect climate-induced change throughout this region is also discussed along with the challenges and future approaches that could be taken. The role of CCAMLR's Scientific Committee in providing scientific advice on the implications of future change on the current management of living marine resources is highlighted along with the necessity for international collaboration among various institutions in both a research and management capacity. Patterns and processes of Southern Ocean biogeography are further described through benthic and pelagic regional classification and analyses of zooplankton communities, phylogeography and population genetics. Plans for a future dynamic biogeographic atlas are revealed with a conclusion that focuses on what is required to improve our understanding of present and future Southern Ocean biogeography.

As with all data collected in the marine environment, and especially in regions that are as difficult to access at the Southern Ocean, strong geographic and taxonomic biases were evident in the occurrence data used in the biogeographic mapping and analyses. This is acknowledged in many chapters of the atlas with some discussion of the implications for describing current distributions and model predictions and projections. There is, however, limited discussion on how this issue of biased sampling effort can be dealt with, which is a little surprising given the strong influence it can have on our understanding of biogeography. Notable gaps in benthic sampling include the majority of the deep sea, the perennial ice-covered western Weddell Sea and the geographically remote Amundsen Sea. Pelagic sampling effort is generally confined to the upper 200 m of the water column, over both shallow and deep water, and reflects the location of national research bases and the logistical routes use to reach them. While widening the distribution of sampling effort to encompass these gap areas is one solution, which cannot be achieved without considerable effort and expense, perhaps there should be more focus on testing existing, and developing new, methods to correct sampling bias in the data that is already available. Despite sampling effort limitations, the representation of individual phyla has improved since the last SCAR-MarBIN assessment with six additional phyla being added (including Bryozoa, Chaetognantha, Echiura, Formaninifera, Porifera and Sipuncula) and a number of benthic seaweeds. Additionally, all of the biogeographic data, compiled and validated by the SCAR Marine Biodiversity Information Network for the atlas, is now publicly available (www.biodiversity.aq) providing a valuable resource for the Antarctic science community. In conclusion, the *Biogeographic Atlas of the Southern Ocean* is an excellent reference for all parties with an interest in the Southern Ocean.

Dr K. Reid
Editor, *CCAMLR Science and* Science Manager, CCAMLR