



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

The rising concern for the future of marine ecosystems in the present scenario of global change, especially in the threatened Polar regions, has alerted the scientific world to the tremendous knowledge gaps that must be filled in order to better comprehend the nature and extent of future ecological and social problems. Among these gaps, the lack of a recent census of species due to lack of interest in taxonomic projects in the late 20th Century is one of the most serious. Therefore, in order to have a baseline to assess the nature of the expected structural and functional changes, international scientific committees and programmes such as the Antarctic Committee on Antarctic Research (SCAR) and the Marine Biodiversity Information Network (MarBIN) have included taxonomy as a priority scientific topic.

During the last International Polar Year (IPY 2007-2008), the simultaneous efforts of experts in multiple scientific disciplines have resulted in a bounty of scientific findings that have marked a significant step forward in our understanding of the structural and functional properties of Polar ecosystems. One of the programmes devoted to the study of the marine diversity in conjunction with the International Polar Year 2007-2008 was the Census of Antarctic Marine Life (CAML). It was a major multidisciplinary and multinational effort towards the knowledge of Antarctic marine life, and this *Biogeographic Atlas of the Southern Ocean* is one of its products.

This book is the result of the cooperative effort of more than 160 specialists, including biogeographers, taxonomists, molecular biologists and GIS experts, led by a team of 15 editors. Aside from the preface, foreword, list of contributors, acknowledgements, and a list of errata, the book is divided into twelve parts or chapters plus five appendices for selected taxonomic groups.

Part 1 (*Introduction*) gives a historical account of the first systematic efforts in Antarctic biogeography (the *Antarctic Map Folio Series*, 1967-1978). Part 2 (*Methods*) describes the data sources, data gap analysis and distribution models and patterns. The database, more than a million occurrence records of about 9000 species, is assigned to 3° grid cells. The resulting maps are stereographic projections centred on the South Pole and the 0° meridian, extended until 40°S. Part 3 (*Evolutionary setting*) describes the origins and relations

of Antarctic biota in light of plate tectonics and paleo-oceanographic characteristics, with the reconstruction of the surface isotherms in the Southern Ocean during the last glaciation. Part 4 (*Environmental setting*) presents the ice not only as the modeller of the Antarctic geomorphology, the habitat of a special community and the agent responsible for blooming phytoplankton events in spring, but also as a disturbing factor for shallow benthic communities as it scrapes (scours) the seabed. The Polar and sub-Polar hydrography, the water masses and the seasonal cycle of temperature, nutrient release and circulation are also discussed.

Part 5 (*Biogeographic patterns of the Benthos*) takes up more than a third of the volume (190 pages) and is dedicated to describing and mapping the distribution pattern of selected species of part of the benthic biota, 27 taxonomic groups from macroalgae to ascidians. In some cases bathymetric and latitudinal range and species richness, their relative frequency in the different Antarctic sub-sectors, and even palaeogeographic reconstructions for fossil species (Ostracoda) are given. This part also includes a classification of macrobenthos assemblages, with remarks about the effect of icebergs on the denudation and re-colonization of Antarctic shelves. The poorly known characteristics of the biodiversity in deep habitats (below 3000 m), and the distribution of active and fossil water vents, with the corresponding chemosynthetic communities, are also discussed, and this part ends with a brief account of biotic interactions in Antarctic benthos.

Part 6 (*Biogeographic patterns of pelagic and sea-ice biota*) attempts to estimate the seasonal phytoplankton diversity from satellite observations and the PHYSAT method, based on the analysis of sea surface irradiance anomalies in the visible zone of the spectrum, with different signals associated with the dominance of various phytoplankton groups. Here, five of them are represented: nanoeucaryotes, diatoms, *Phaeocystis*, *Prochlorococcus* and *Synechococcus*-like cyanobacteria. Regarding micro- and mesozooplankton, six groups are included in the analysis: ciliates (Tintinnidae), gelatinous zooplankton (Cnidaria), Molluscs (Pteropoda and Cephalopoda) and crustaceans (Copepoda, Ostracoda, Tanaidacea and Euphausiacea), plus miscellaneous groups thriving in the sea ice. For some characteristic groups such as euphausiids, the habitat suitability and its associated uncertainty is also mapped.

Part 7 (*Biogeographic patterns of fish*) adds to the distribution maps for coastal and deep-sea fish species their predicted distribution according to environmental variables (summer temperature, O₂, bathymetry, etc.) and for meso- and bathypelagic ones their daily changes in depth distribution (vertical migration). The distribution characteristics of the most emblematic

Antarctic animals—birds such as penguins, albatross and fulmars, and mammals (seals and whales)—are presented in Part 8 (*Biogeographic patterns of birds and mammals*).

Part 9 (*Changes and conservation in the Southern Ocean*) addresses the changes expected according to different scenarios of climate change, and the changes in relative occurrence and distribution of a number of birds and mammals (no invertebrates are considered), using predictions about future sea surface temperature, salinity, nitrate, chlorophyll and mixing depth. This part also includes suggestions for conservation and management in order to regulate sustainable resource harvesting (probably a blatant oxymoron) in the Southern Ocean.

Part 10 (*Patterns and processes of Southern Ocean biogeography*) contains the results on the regionalization of benthic and pelagic environments, plus considerations about the study of surface zooplankton using the Continuous Plankton Recorder (CPR) sampling method. The origins of bipolar distributions and the problems of cryptic species are also discussed, and two case studies of phylogeographic patterns using morphological and molecular genetics are presented.

Part 11 (*The dynamic biogeographic Atlas project*) examines the scope and requirements of the present printed version of the Atlas, as well as the characteristics and prospects for it becoming a dynamic online information system. It can be consulted at <http://atlas.biodiversity.aq>. Part 12 (*Conclusion: Present and future of Southern Ocean Biology*) is an overall summary. The volume closes with appendices for five taxonomic groups with phylogenetic species lists, data record sites and depth ranges.

At a time when the perception of the changes threatening the Southern Ocean is so vivid, the publication of this book is highly appropriate, and it can be considered an important contribution for stirring interest in taxonomy in international organizations and programmes. Another aim of the Atlas, to provide clear, easily accessible information on the distribution of Antarctic flora and fauna, has been accomplished in spite of the lack of a uniform format in the data presentation. However its fundamental goal, "...to fulfil the needs of biogeographic information for science, conservation, monitoring and sustainable management of the Southern Ocean.... in order to facilitate the transfer from pure scientific knowledge into policy-relevant information" appears to me to have been less fully achieved.

Any marine ecologist would be surprised at the absence of pelagic taxa that are basic for the functioning of marine ecosystems in general, but are particularly important in the Southern Ocean. Although the use of the term "species" could be inappropriate or at least very elusive in relation to bacteria and archaea, and

even more so in relation to viruses, some insights into the habitat and depth distribution of those groups using molecular techniques (OTUS?) would have been welcome. The treatment given to phytoplankton is even less understandable. Life in Antarctica depends not only on the timing and magnitude of global primary production, but also on the specific composition of primary producers. The rate and efficiency at which matter and energy are transferred to the upper consumer levels, from zooplankton to whales, and even the final fate of biogenic carbon, depend on the specific composition of the communities of phytoplankton. It would have been very helpful to compare the data corresponding to PHYSAT types with the real taxonomic data that are available.

Other important plankton groups have been strangely neglected. Tintinnids are of course interesting and beautiful, but in the economy of Antarctic pelagic systems their role is quite unimportant in comparison with the naked forms of ciliates. Other groups of protists, foraminifers and radiolarians, have also been forgotten, as have heterotrophic and mixotrophic dinoflagellates. Chaetognaths and pelagic tunicates are also absent, and cannot be considered minor characters. In particular, a couple of tunicate species (*Salpa thompsoni* and *Pegea confoederata*) are, with euphausiids (mainly *Euphausia superba*), the major players in the Antarctic ecological theatre. With the predicted shift from euphausiids to salps in the Southern Ocean, a biogeographic baseline must necessarily consider this missing group.

Some minor inconveniences are the concise, sometimes insufficient figure captions, with some errata (pages 261, 262, 263 and 419), and the lack of uniformity in the quantity of information provided, which differs from group to group. Only for some of them do the distribution maps of the different species show—marked as light grey dots—the sites where any species of the group have been recorded, allowing easy recognition at first sight of species coexistence and segregation. In some cases the information is more complete, giving the depth and latitudinal range, species clusters, similarity by sites, etc., while in others the information is reduced to the strict distribution maps. Above all, however, the format of the book makes it quite difficult to handle. Although by tradition Atlases are not exactly pocket books, this one is not only large but also printed on heavy paper and bound in paperback, making the 3-kg volume somewhat unwieldy. One expects that in the dynamic online version of the Atlas (<http://atlas.biodiversity.aq>) the gaps will be filled and the handling problems of the printed version will be avoided.

MIGUEL ALCARAZ
Institut de Ciències del Mar, CSIC.