Antarctic Environments Portal

Antarctic Marine Biodiversity

Information Summary

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Authors +

H. J. Griffiths (1), B. Danis (2), B. David (3), C. De Broyer (4), C. d'Udekem d'Acoz (4), S. Grant (1), J. Gutt (5), C. Held (5), G. Hosie (6), F. Huettmann (7), P. Koubbi (8), A. Post (9), B. Raymond (6), Y. Ropert-Coudert (10), A. P. Van de Putte (4)

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PEER-REVIEWED ✓

Synopsis -

The past two and a half centuries of marine biological work in the Southern Ocean have resulted in a vast catalogue of living organisms. During this time there have been several attempts to classify distinct regional biodiversity patterns in the seas around Antarctica. The recent publication of the *SCAR Biogeographic Atlas of the Southern Ocean* represents the most comprehensive international effort to date. The complete database represents 1.07 million occurrence records (from Antarctic and neighbouring waters) for 9,064 recognised species from ~434,000 distinct sampling stations. It highlights the hotspots of biodiversity and areas of high levels of sampling, as well as identifying areas, geographical and taxonomic, which require substantial future investigation. It also utilises habitat modelling methods to predict species and community distributions. This compilation serves as a vital benchmark of current biodiversity knowledge and as a significant tool for future scientific, conservation and resource management planning.

Summary -

Starting with James Cook's second voyage in 1772–1775 [1] a number of pioneering Antarctic exploratory expeditions progressively revealed the unique biodiversity of the Southern Ocean. Amongst the first to undertake systematic sampling of the seafloor [benthos] and plankton were the expeditions of *HMS Challenger, Belgica* and the *Discovery*. The resulting species descriptions provided the basis of modern taxonomy in the Southern Ocean.

The advent of the digital age has brought with it new tools for addressing biodiversity questions. Databases such as the Register of Antarctic Marine Species [RAMS] [2] and the SCAR Marine Biogeographic Information Network [SCAR-MarBIN], now part of The Antarctic Biodiversity Portal [3], have enabled researchers not only to access Antarctic biodiversity information online, but also to contribute to the most comprehensive catalogue so far of living organisms from the Southern Ocean. RAMS was compiled and published thanks to a collective effort of a board of 64 taxonomic editors. It built on earlier work by Clarke & Johnston [4], and currently provides a list of more than 8,300 valid species with an up-to-date systematic classification comprising more than 18,450 taxon names.

The SCAR Biogeographic Atlas of the Southern Ocean [5] gathered experts from all over the world in order to update our understanding of distributional patterns of biota in the Southern Ocean, which was previously based on publications such as the Antarctic Map Folio Series that included the zoogeographical classification of Hedgpeth [6,7] but also fitted in to a world-wide classification [14]. As one of the important legacies of the recent Census of Antarctic Marine Life [CAML], the Biogeographic Atlas made use of SCAR-MarBIN data, along with the compilation of results from CAML surveys and validated historical data. The Biogeographic Atlas represents the culmination of over a century of scientific endeavour, including major international collaborations such as the Ecology of the Antarctic Sea Ice Zone [EASIZ], CAML and the Commission for the Conservation of Antarctic Marine Living Resources [CCAMLR]. Knowledge of the gaps and peculiarities in the sampling is critical to the identification of diversity and richness patterns and will also help to identify both areas for future exploration, as well as hotspots of our knowledge that can be investigated in greater detail to answer more specific questions. The database used to produce the 2014 printed Biogeographic Atlas represents 1.07 million occurrence records [from Antarctic and neighbouring waters] for 9,064 valid species from ~434,000 distinct sampling stations [Figure 1].

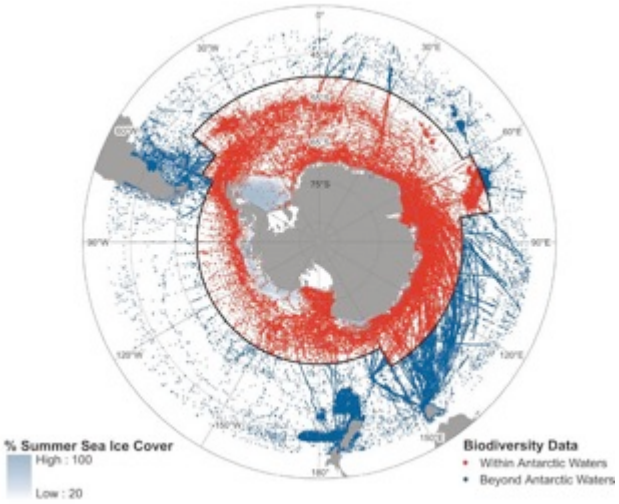

Figure 1. All biodiversity records used in the SCAR Biogeographic Atlas.

Data distribution maps clearly show the geographic areas in which publicly available information is lacking [Figures 2-4]. These are in regions with high summer sea ice concentrations and/or where scientific stations that are regularly supplied by ships are absent. For the latter, transects result from dedicated cruises only and are therefore less frequent. As an illustration of this, the portion of the Southern Ocean facing Marie Byrd Land [~100–150 °W] has no national stations or islands and consequently information is scarce for this sector. Similarly, benthic records are lacking for the Amundsen Sea, parts of the Bellingshausen Sea and most of the deep sea [8]. The lack of exploration of the deep sea is to be expected. Perhaps more surprising is that the Antarctic intertidal zone is also largely unexplored: until recently, it was considered a virtually lifeless desert [9]. The collapse of the Larsen ice shelves in 1995 and 2002 revealed how little is known of life under ice shelves [10]. Scientific knowledge is also largely limited to the spring and summer seasons. In this context, winter, characterized by heavy sea ice and extreme weather conditions, is definitely one of the remaining frontiers to be explored.

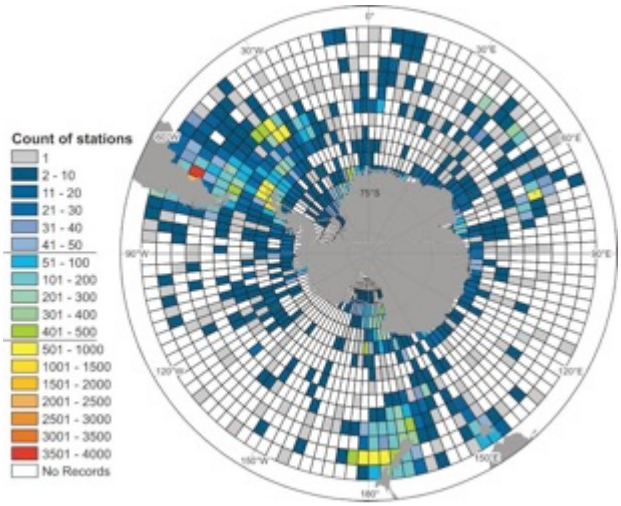

Figure 2. Count of all benthic sampling stations per 3° of latitude by 3° of longitude grid cell.

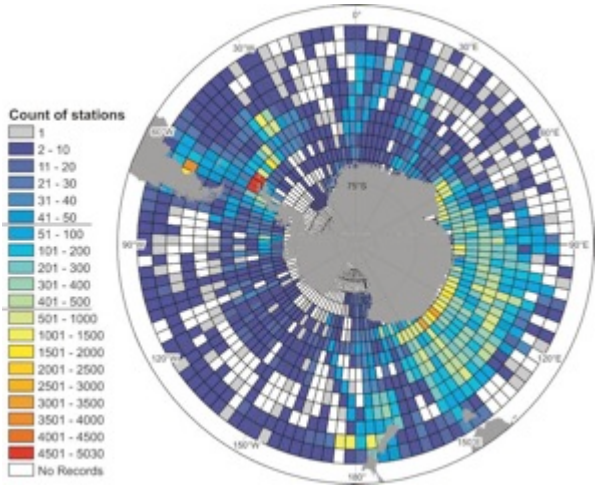

Figure 3. Count of all pelagic invertebrate sampling stations per 3° of latitude by 3° of longitude grid cell.

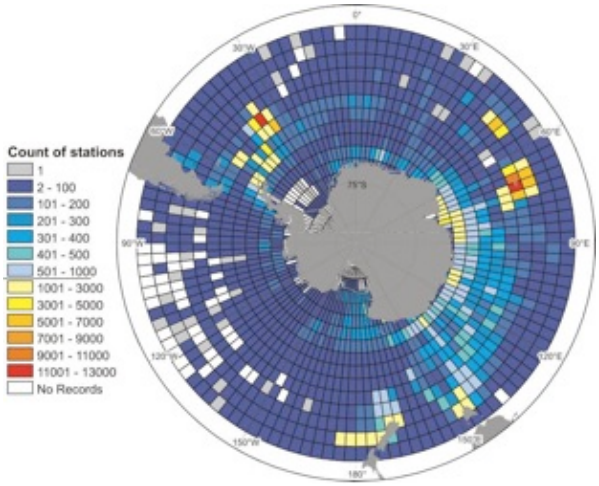

Figure 4. Count of all vertebrate sampling stations per 3° of latitude by 3° of longitude grid cell.

There is a great deal of variability in the sampling effort throughout the water column: benthic samples are mostly taken on the continental shelf [<700m], whereas pelagic samples are collected over both shallow and deep waters. Indeed, the vast majority of samples from all taxa come from the top 500 m [Figure 5]. Pelagic records have a more widespread distribution, mostly thanks to the Continuous Plankton Recorder [11] and Antarctic krill surveys, but the level of information decreases rapidly when moving into the deeper layers. At the surface, sightings of birds and mammals also have limitations but the use of animal-attached tracking devices alleviates these.

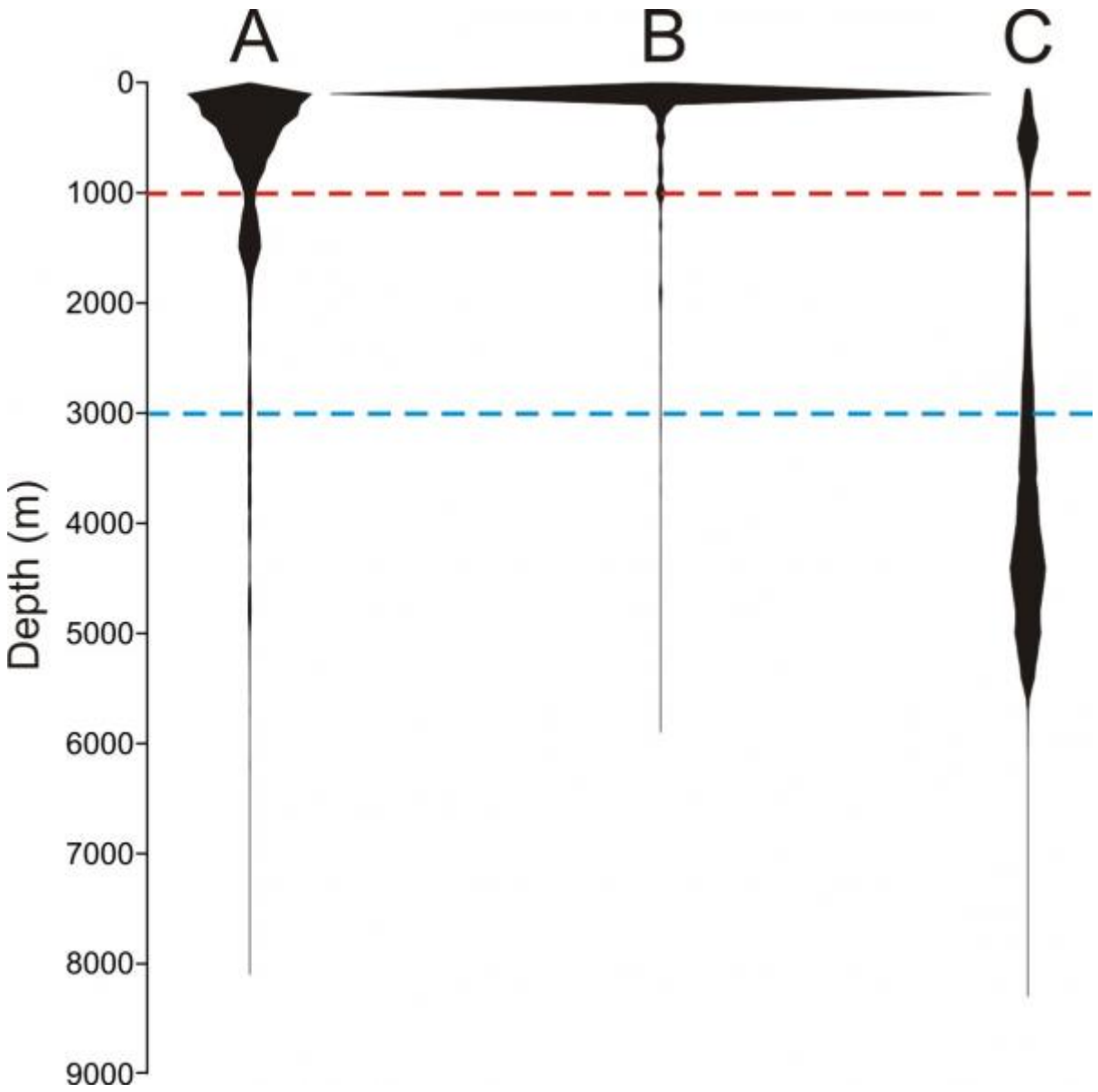

Figure 5. The relative distribution of Southern Ocean (A) benthic sampling intensity (average = 800 m), (B) pelagic sampling intensity (average = 120 m) and (C) seafloor area with depth (average = 3460 m). Red line indicates the 1000 m depth (shelf break), blue line indicates the 3000 m depth (abyssal plain).

While the Biogeographic Atlas [5] mostly dealt with species occurrence data, advances in molecular techniques are changing our understanding of circumpolar and cosmopolitan species, indicating the need for further, more detailed, taxonomic work on potentially cryptic species that cannot be distinguished morphologically [12]. Although future sampling, molecular data and taxonomic publications may reveal higher biodiversity levels, it seems likely that the overall pattern of a rich and distinct Antarctic fauna will remain correct.

The 2014 Biogeographic Atlas [5] highlights the need to consider groups of organisms on a case-by-case basis, depending on factors such as their habitat needs and spatial distributions. Compilations of biogeographic data, as in the Atlas and in information networks like the Antarctic Biodiversity Portal, provide tools to help identify key species that can serve as indicators of changes in their environment. However, it is crucial to take into account species-specific

characteristics, such as reproductive strategy, life history, physiological limits and evolutionary history, as well as interactions between species, in order to understand how environmental changes will impact the future survival and distribution of species and ecosystems [13]. For many groups we have yet to acquire the high-resolution, georeferenced knowledge needed to draw meaningful conclusions regarding biogeographic patterns. Supplementing occurrence data with abundance or biomass, along with quantification of survey effort and standardised sampling methods, will allow future analyses of biogeography and diversity to be more detailed and more ecologically meaningful. Emerging species and community modelling approaches offer the possibilities for adding to knowledge generated by traditional methods. In this context, the online dynamic Biogeographic Atlas, started in 2015, will be a living resource that will increase in functionality and data over time. It is poised to become a vital tool for scientists, policy makers and resource managers. It will also serve as a window for the general public to discover the wonders of these remote, inaccessible regions of the globe.

Key Events +

RELATED INFORMATION SUMMARIES

RELATED EMERGING ISSUES

KEYWORDS

Atlas Biogeography Conservation Hotspots Southern Ocean

RESOURCES

Register of Antarctic Marine Species

Antarctic Biodiversity Information Facility

Antarctic macrobenthic communities compilation

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