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Dennis Murray,
Trent University, Canada

*CORRESPONDENCE
Claudia S. Maturana
claudiamaturana@ug.uchile.cl

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Editorial: Biodiversity of Antarctic and Subantarctic ecosystems

Claudia S. Maturana[1,2*], Hamish Spencer[3], Julieta Orlando[2,4], Peter Convey[1,2,5,6] and Tamara Contador[1,2,7]

[1]Cape Horn International Center (CHIC), Puerto Williams, Chile, [2]Millennium Institute Biodiversity of Antarctic and Subantarctic Ecosystems (BASE), Santiago, Chile, [3]Department of Zoology, University of Otago, Dunedin, New Zealand, [4]Department of Ecological Sciences, Faculty of Sciences, University of Chile, Santiago, Chile, [5]British Antarctic Survey (BAS), Natural Environment Research Council, Cambridge, United Kingdom, [6]Department of Zoology, University of Johannesburg, Johannesburg, South Africa, [7]Centro Universitario Cabo de Hornos, Universidad de Magallanes, Puerto Williams, Chile

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Editorial on the Research Topic
Biodiversity of Antarctic and Subantarctic ecosystems

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) adopted a work program (2019–2030) that included, under its first objective, the interlinkages between biodiversity and climate change (IPBES, 2019). Because most ecosystems worldwide face multiple anthropogenic pressures, however, it is difficult to disentangle the specific effects of climate change from those of others such as habitat degradation, pollution or overexploitation. Against this backdrop, the Antarctic and sub-Antarctic (ASA) regions —including some of the most pristine environments remaining on Earth— offer unparalleled opportunities to understand, evaluate and predict the impacts of climate change on biodiversity in the general absence of other confounding anthropogenic drivers. These regions serve as natural laboratories for two main reasons: first, ASA biodiversity has already endured repeated and drastic climatic oscillations over timescales ranging from decades to tens of millions of years, providing a unique archive of responses to past change; second, some ASA areas are now experiencing some of the fastest rates of warming on the planet. The South Shetland Islands, for example, have undergone profound transformations over the past four decades, including the emergence of new ice-free areas, streams and freshwater bodies (Lee et al., 2017; Petsch et al., 2022; Tóth et al., 2025). Studying these transitions provides essential insights into how climate change reshapes ecosystems when other anthropogenic drivers remain minimal.

Biodiversity under change

Evidence from terrestrial, freshwater and marine systems across the ASA highlights both the rapid pace and the complexity of ecological transformations. For instance, predictive models forecast shifts in the distribution of snow algae, predicting expansions at higher elevations but a loss of habitats on low-lying islands under warming scenarios (Gray et al.). Microbiome studies on Antarctic fairy shrimps show how host-associated microbial diversity contributes to adaptation and eco-evolutionary dynamics (Schwob et al.). In terrestrial ecosystems, nematodes (Jackson et al.) and insects (Maturana et al.) reveal how glacial history and dispersal capacity are imprinted within strong population structures. Freshwater communities, including microarthropods, respond not only to temperature but also to habitat type and vegetation structure (Bokhorst et al.). Research in the Southern Ocean reveals how dispersal, connectivity, and human activities collectively shape the resilience of benthic communities. Genetic analyses of *Siphonaria lateralis*, indicate that rafting provides only occasional dispersal opportunities, insufficient to prevent significant population differentiation but enough to prevent speciation, across Patagonia, the Falkland Islands/Islas Malvinas, South Georgia and Îles Kerguelen (Millán-Medina et al.). Complementary surveys in the Crozet archipelago uncover unexpectedly high shallow-water marine biodiversity, including new records and likely endemic species, while also revealing connections with other sub-Antarctic regions (Jossart et al.). Studies on the brittle star, *Amphiura belgicae*, reveal it to be a species complex with regionally isolated lineages, challenging the idea of a homogeneous Antarctic benthic fauna. Comparative phylogeography emerges as a valuable tool to identify shared historical processes shaping assemblages and to inform conservation efforts beyond simple species inventories (Sands et al.). Additionally, applied assessments, such as evaluating the impact of wharf construction at Rothera Research Station on Adelaide Island, demonstrate that, with effective mitigation, human activities can have minimal long-term effects on Antarctic macroepifaunal communities (Robinson et al.). Finally, phylogeographic studies of the gastropod *Laevilacunaria antarctica* reveal contrasting patterns of both high and low dispersal, suggesting that rafting may enable widespread connectivity despite the lack of pelagic larvae (González-Wevar et al.). Collectively, these studies depict a mosaic of unique and dynamic communities across Antarctica and the Southern Ocean, where evolutionary history, dispersal mechanisms, and human activities intersect to influence vulnerability and resilience in the face of accelerating climate change.

Conservation and governance challenges

Translating scientific advances into effective conservation policy for ASA biodiversity remains an urgent challenge (Coetzee et al., 2017; Lee et al., 2022). While many sub-Antarctic islands and their surrounding waters receive various forms of protection under the national systems of their sovereign authorities, the Southern Ocean and all land and ice south of the sixty-degree latitude parallel form the area of governance of the international Antarctic Treaty System (ATS), which was negotiated in 1959 and has been in force since 1961. The ATS provides the mechanism and means to designate and manage areas of protection (Antarctic Specially Protected Areas and Antarctic Specially Managed Areas; APSAs and ASMAs) within the regions under its jurisdiction. This process is currently achieved through the Protocol on Environmental Protection to the Antarctic Treaty, which has been in force since 1998. Despite its achievements, however, the ATS relies on consensus-based decision-making, which has hindered progress on critical issues such as climate-change recognition, ASPA and ASMA establishment, and the designation of Marine Protected Areas through the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (Coetzee et al., 2017). Recent years have highlighted the risk of stalemate in this governance system, raising concerns about its capacity to adapt under mounting geopolitical pressures. In terrestrial and freshwater environments, additional linked policy challenges include management of non-native species, biosecurity and the conservation of rapidly emerging habitats, such as new lakes and streams revealed by glacier retreat. Effective safeguarding of ASA biodiversity requires integration of evolutionary history, ecological processes and the unique vulnerabilities of both marine and terrestrial systems.

Contribution from this Research Topic

This Research Topic addresses this challenge and emphasizes the importance of ASA biodiversity, as well as the integration of its evolutionary history across terrestrial and marine systems. The twelve contributions, including notable work from early-career researchers, cover a broad spectrum from microorganisms to top predators, illustrating how environmental factors and climate change influence ecological and evolutionary processes. Studies show how past climate history has shaped terrestrial species, while microbial and freshwater research highlight the role of diversity in adaptation. Marine-focused contributions reveal both limited dispersal patterns and unexpected endemism in benthic invertebrates, challenging assumptions of widespread connectivity across sub-Antarctic islands and the Southern Ocean. Comparative phylogeography proves to be a powerful tool for identifying shared historical processes across groups, providing a stronger foundation for conservation planning. Overall, these studies depict dynamic and diverse communities where historical legacies, dispersal mechanisms and human activities intersect, affecting vulnerability and resilience.

Looking forward

Taken together, the contributions to the Research Topic highlight the intricate interactions between historical, biological, and environmental factors that shape current ASA biodiversity. They portray a landscape of change, where climate-driven ecological reorganization manifests in shifts in microbiome diversity, species distribution and community restructuring. These findings emphasize the pressing need for long-term monitoring, adaptive conservation strategies and governance frameworks that can bridge the gap between science and policy. By integrating insights across ecosystems and taxa, this article collection provides a vital scientific foundation for confronting the challenges that climate change poses to some of the planet's most fragile and unique ecosystems.

Author contributions

CM: Supervision, Writing – original draft, Conceptualization, Writing – review & editing, Validation, Data curation. HS: Methodology, Supervision, Validation, Writing – review & editing. JO: Validation, Data curation, Supervision, Writing – review & editing. PC: Supervision, Writing – review & editing, Investigation, Validation, Data curation. TC: Supervision, Writing – review & editing, Validation, Data curation.

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References

Coetzee, B. W. T., Convey, P., and Chown, S. L. (2017). Expanding the protected area network in Antarctica is urgent and readily achievable. *Conserv. Lett.* 10, 670–680. doi: 10.1111/conl.12342

IPBES (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany: IPBES secretariat.

Lee, J. R., Terauds, A., Carwardine, J., Shaw, J. D., Fuller, R. A., Possingham, H. P., et al. (2022). Threat management priorities for conserving Antarctic biodiversity. *PLoS Biol.* 20, e3001921. doi: 10.1371/journal.pbio.3001921

Petsch, C., Da Rosa, K. K., De Oliveira, M. A. G., Velho, L. F., Silva, S. L. C., Sotille, M. E., et al. (2022). An inventory of glacial lakes in the South Shetland Islands (Antarctica): temporal variation and environmental patterns. *Ann. Braz. Acad. Sci.* 94, e20210683. doi: 10.1590/0001-3765202220210683

Tóth, A. B., Terauds, A., Chown, S. L., Hughes, K. A., Convey, P., Hodgson, D. A., et al. (2025). A dataset of Antarctic ecosystems in ice-free lands: classification, descriptions, and maps. *Sci. Data* 12, 133. doi: 10.1038/s41597-025-04424-y