HabitAnt

Past and future habitability in Antarctic lakes: succession, colonization, extinction, and survival in glacial refugia

DURATION
15/01/2021 - 15/04/2025

BUDGET
871 394 €

PROJECT DESCRIPTION

Coupled climate and earth-system models predict increased temperature and altered precipitation patterns in vast regions of Maritime and coastal Continental Antarctica, which will likely result in more extensive glacial melt and the expansion of ice-free areas, increasing connectivity between regions, and changes in their hydrology. The effects of these environmental changes on terrestrial and aquatic biodiversity are likely to cause biotic homogenization between regions, the extinction of certain taxa, and the spread of invasive species. Importantly, terrestrial and lacustrine biota in the Antarctic are more distinct and biogeographically structured than previously believed. These observations come from evidence of high levels of endemism and narrow distributional ranges due to the long-term survival and diversification of taxa in isolated glacial refugia. Identifying the location of these refugia is largely based on biodiversity data and molecular phylogenies of contemporary biota. However, in some cases, the available biological data disagree with reconstructions of the deglaciation history of the regions based on geological constraints. It is evident that the observed disparity between geological and biological data regarding the exact location of glacial refugia needs to be tackled by interdisciplinary research combining approaches from biological and earth sciences.

HabitAnt aims at studying past, present and future habitability of lakes and their catchments in coastal East Antarctica. This will be based on the elucidation of key processes that contributed to their present-day community structure, including long-term persistence of biota in glacial refugia, and extinction, colonization, diversification and biological succession in response to environmental changes during the past 130,000 years. Specifically, we aim to (1) identify the presence of local glacial refugia including those situated below present-day sea level, (2) infer the recent evolutionary history of selected key lacustrine and terrestrial Antarctic biota in different functional and taxonomic groups, (3) assess species assembly and biological succession in newly formed lakes after deglaciation and their response to climate warming, and (4) use this paleoecological information, in combination with existing inventories of recent distribution data, to predict the response of these communities to future climate changes.

Our studies will be based on well-dated lake sediment cores from three regions in Continental Antarctica with a contrasting deglaciation history. We will analyse ancient DNA (aDNA), microfossils and a suite of sedimentological and biogeochemical proxies, including a quantitative paleotemperature proxy and fossil photosynthetic pigments. We will focus our paleoecological analyses on three-time windows, namely the Eemian interglacial, the last glacial period, and the Holocene. The aDNA and microfossil data will be dovetailed with extensive, recently developed datasets of present-day lacustrine communities in the Antarctic. This will allow us to study the potential colonisation of taxa currently thriving in the sub-Antarctic and Maritime Antarctica into the Continental Antarctic ice-free oases during past warm periods. Extinctions and survival of taxa during the last glacial period will be studied in sediments spanning the Eemian to Holocene interglacials. In combination with studying submarine basins containing Late Pleistocene and Early Holocene terrestrial and paleolake sediments, this will enable us to identify the presence of local (hidden) glacial refugia. Phylogenetic molecular clock analyses of selected cyanobacteria, protists and invertebrates will be used to infer their evolutionary dynamics and histories. Combined, these datasets will allow us to model the optimum and tolerance of key taxa for temperature and other relevant environmental conditions in Antarctic lakes.

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The proposed work will resolve long-standing conundrums regarding life in terrestrial and lacustrine environments in the Antarctic. The inclusion of submarine paleolakes will potentially allow us to identify regions that acted as glacial refugia, which might require a revision of the current set of proposed refugia on the continent. These data will be useful to design conservation strategies for Antarctic biodiversity and support decisions taken by the Antarctic Treaty Consultative Meetings. The findings will directly contribute to different initiatives organised within current and future SCAR Scientific Programs. The cyanobacterial strains used for developing the molecular phylogenies will be deposited in the public BCCM/ULC Cyanobacteria culture collection, and all molecular data will be published in open access data repositories. This will ensure the appropriate conservation of this unique biological material and the derived data for future generations.

The results will be published in international peer-reviewed journals and presented at international scientific meetings and during special sessions organized by the partners. The long-standing commitment of the partners for developing outreach activities and giving courses at universities will ensure that our findings will be communicated to the general public and students. Our biodiversity data will be available through the Antarctic Master Directory and can be used in future modelling experiments to predict the response of Antarctic lake communities under future climate change scenarios.

CONTACT INFORMATION

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