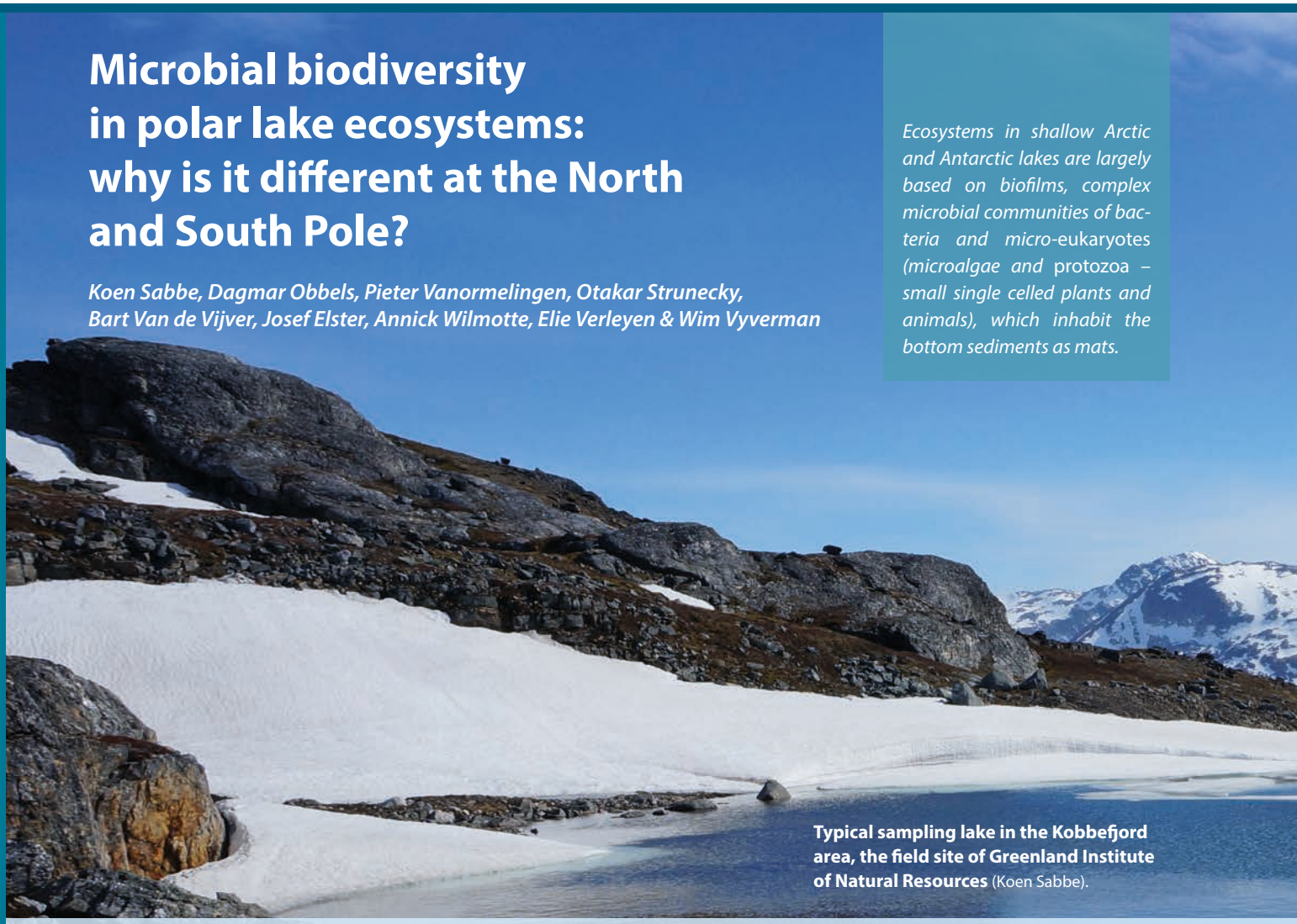
Microbial biodiversity in polar lake ecosystems: why is it different at the North and South Pole?

Koen Sabbe, Dagmar Obbels, Pieter Vanormelingen, Otakar Strunecky, Bart Van de Vijver, Josef Elster, Annick Wilmotte, Elie Verleyen & Wim Vyverman

*Ecosystems in shallow Arctic and Antarctic lakes are largely based on biofilms, complex microbial communities of bacteria and micro-*eukaryotes *(microalgae and* protozoa *– small single celled plants and animals), which inhabit the bottom sediments as mats.*



Typical sampling lake in the Kobbefjord area, the field site of Greenland Institute of Natural Resources (Koen Sabbe).

AIMS OF THE PROJECT

We wanted to understand what mechanisms shape the biodiversity of biofilms, by making a comparison between Arctic and Antarctic lakes.

WHAT DID WE DO?

During summer 2013, we sampled microbial biofilms in about 80 lakes in Greenland. Bottom sediment samples were taken using a sediment corer from deeper parts of the lakes, but we also sampled the shallower parts and other wetland habitats (seepage areas, bogs, etc.). In addition, we took samples to characterize the environment (nutrients, pH, conductivity, etc.).

WHERE DID WE WORK?

We selected two sampling regions each with an INTERACT station, one in the low Arctic zone (near the Greenland Institute of Natural Resources (•67) in Nuuk and Kapisillit, West Greenland) and one in the high Arctic (Zackenberg Research Station (•70), Northeast Greenland), in order to cover the different Arctic climatic conditions.

WHAT DID WE FIND?

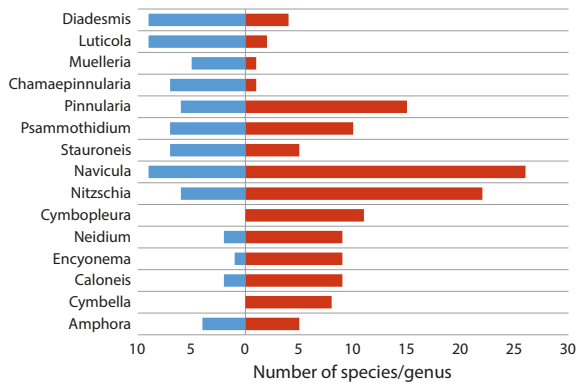
We collected both live biofilm materials, from which cyanobacteria and microalgae were isolated and brought into culture, and frozen biofilm samples, both of which are being used for an in-depth characterization based on DNA molecules using so-called next generation sequencing methods (i.e. methods which "read" the composition of the DNA molecules). While to-date the analyses are still in full progress, preliminary results have uncovered a high microbial diversity in the Greenland lakes, in particular in some groups of silica-shelled microalgae or diatoms. Interestingly, the observed species are different from those in similar habitats in Antarctica, suggesting different evolutionary pathways for biofilm community development in each Polar Region.

WHY ARE THE RESULTS IMPORTANT?

Despite the huge importance of microbial organisms in aquatic ecosystems, both freshwater and marine, their biodiversity remains understudied and hence little understood in comparison with larger animals and plants. It has often been assumed that microbial species, unlike animals and plants, have unlimited dispersal and will therefore be found wherever the environment is suitable for growth. As a result, formation of new species in isolation *(allopatric speciation)* should be negligible and global biodiversity low. The Arctic and Antarctic offer a unique opportunity to test hypotheses regarding

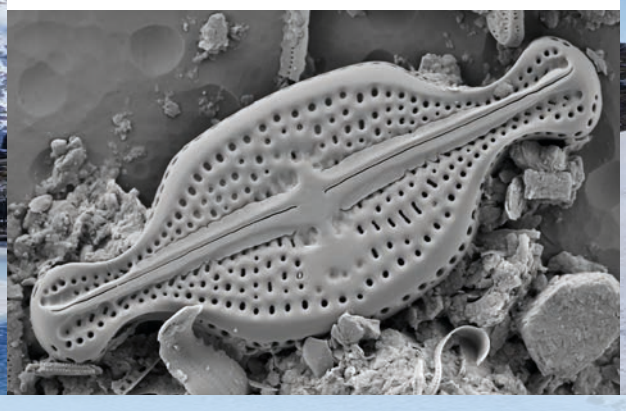
Microbial biofilm (the brownish layer at the top of the sediment core) recovered from the bottom sediment of a lake in the Kobbefjord area (Koen Sabbe).

Bringing a core (taken using a so-called UWITEC corer) from the bottom sediment of a lake in the Kapisillit area to shore (Dagmar Obbels).



Species richness (= the number of species) of diatom genera is not the same in Antarctic (blue) and Arctic (red) lakes. This suggests that the diatom communities in both regions have evolved in isolation of one another.

Diatoms are microalgae which are very common in polar biofilms (here the species *Luticola katkae* is shown in a *scanning electron micrograph*).



the biodiversity and evolution of microbial organisms. While being highly similar from an environmental point of view, the two Polar Regions are separated from one another by the temperate and tropical belts. In addition, the Arctic Region is connected to the Northern Hemisphere land masses, while the Antarctic is isolated by the Southern Ocean. Our project will test the existing hypothesis that because of unlimited dispersal and similar environments, most polar micro-organisms will be present in both Polar Regions. This view needs to be tested as there is growing evidence of dispersal limitation and *endemism* in microbial organisms (endemic species only occur in a specific geographic area). If the latter is true, our data should show that given the higher connectivity of Arctic areas, microbial communities there will be relatively diverse, while the more isolated Antarctic communities will be species-poor and dominated by endemic species.

THE ADVENTURE

Our sampling campaigns took us to two beautiful yet contrasting regions of Greenland: from the sunny late spring tundra full of flowers, birds and, inevitably, mosquitoes in Southwest Greenland to the cold and harsh late summer conditions of Zackenberg. The empty space and silence of the Greenland landscape was overwhelming, especially if you come from a busy country in mainland Europe. Sightings of whales, reindeer and muskoxen made the experience complete.

Further information

Koen Sabbe[1], Dagmar Obbels[1], Pieter Vanormelingen[1], Otakar Strunecky[2], Bart Van de Vijver[3], Josef Elster[2], Annick Wilmotte[4], Elie Verleyen[1] & Wim Vyverman[1]

[1] Laboratory of Protistology and Aquatic Ecology, Department of Biology, Ghent University, Ghent, Belgium
[2] Centre for Polar Ecology, Department of Ecosystem Biology, University of South Bohemia, Ceske Budejovice, Czech Republic
[3] National Botanic Garden of Belgium, Domein van Bouchout, Meise, Belgium
[4] Centre for Protein Engineering, University of Liège, Liège, Belgium

Contact: koen.sabbe@ugent.be