Diatom distributions in space and time – a case study from the polar regions

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The composition, diversity and distribution of present-day biota are shaped by the geological, tectonic and climatic past, which resulted in the distinct biogeographical realms we observe in the terrestrial biosphere. Here I summarize our recent studies on the biogeography of polar freshwater diatoms. Antarctic lake-dwelling diatom communities are impoverished and imbalanced in comparison with Arctic communities, and characterized by high levels of endemism. Moreover, molecular data on ubiquitous morphospieces that are widespread in the Antarctic region are starting to reveal substantial hidden diversity, with distinct Antarctic and sub-Antarctic lineages. This suggests that estimates based on the morphospecies concept are conservative and may strongly underestimate the observed levels of endemism. The Antarctic communities are further characterized by the absence of key functional groups such as planktonic taxa, a general paucity of globally successful genera, and an overrepresentation of terrestrial lineages. Comparison of contemporary Antarctic floras with fossil Miocene assemblages points to high rates of local extinction during glacial maxima, in combination with radiations and the selective survival of aerophilic taxa in glacial refugia. We also observed strong bioregionalisation patterns within the Antarctic Realm, which are highly concordant with the three main biogeographical regions traditionally recognized in plants and animals, namely Sub-Antarctica, Maritime Antarctica and Continental Antarctica. Paleolimnological evidence suggests that diatom communities are relatively stable and remain within their respective biogeographical region throughout the Holocene. Within Continental Antarctica, the observed biogeographic provincialism is likely related to differences in the glacial history of the ice-free regions. Sediment records spanning the Late Quaternary period indicate that lake districts which escaped complete glacial overriding during the Last Glacial Maximum (LGM) hold a relict diatom flora, composed of Antarctic endemics and ubiquitous taxa that inhabit cold environments elsewhere. By contrast, in regions that were completely overridden by the East Antarctic Ice Sheet, the diatom communities are composed of aerophilic Antarctic endemics and ubiquitous taxa. These taxa were probably derived from a local diatom pool that was able to survive in local terrestrial nunataks. This is confirmed by a time-constrained molecular phylogeny of the aerophilic diatom *Pinnularia borealis* which suggests that the Antarctic lineage diverged 7.8 (2-15) Ma ago, and hence before the onset of Pleistocene glacial-interglacial cycles. In addition, there is evidence for large-scale extinctions during the LGM of species currently thriving in Sub-Antarctic habitats but which were present in Continental Antarctica during the warmer Eemian interglacial.