

Can you see the light? How microbes and polar light environments orchestrate plant adaptations and global biodiversity

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Efforts to mitigate biodiversity loss driven by climate change are hindered by an incomplete understanding of the geo-evolutionary processes that shape species' adaptive capacity. Key factors include polar light regimes characterised by seasonal periods of continuous daylight and darkness ("polar night"), climate change-driven species' range shifts, microbial interactions, and hybridisation. In a recent *One Earth* Perspective, our team highlighted the role of light-sensitive microbes in plant adaptation and proposed that polar light environments promote circumpolar hybrid zones by synchronising reproductive phenology, potentially maintaining genetic diversity over geological timescales. To investigate this, Antarctic hair grass (*Deschampsia antarctica*), one of only two native vascular plant species in Antarctica, was used as a model system. Plants from maritime Antarctica and Chilean Patagonia were (1) examined for the occurrence of plant-associated aerobic anoxygenic phototrophic bacteria (AAPB) with bacteriochlorophyll-based near-infrared fluorescence, and (2) transplanted to two climatically distinct sites in Finland: Turku (60°26'N) and Utsjoki (69°45'N). AAPBs are photoheterotrophs that rely on environmental organic carbon but capture solar energy via anoxygenic photosynthesis.

Overall, AAPBs were detected in 68% of Antarctic

plants and 59% of Patagonian plants. The highest proportions were found in the leaf phyllosphere and endosphere. In the phyllosphere, AAPB presence was similar between regions: 85% of Antarctic plants and 84% of Patagonian plants. However, a notable difference was observed in the leaf endosphere, where AAPBs were found in 80% of Antarctic plants, compared to 69% of Patagonian plants. This trend was further highlighted in the root endosphere, where AAPBs were less frequently detected: 37% of Antarctic plants versus only 18% of Patagonian plants. These findings suggest a higher prevalence of AAPBs in the endosphere of Antarctic plants, particularly in the leaf tissues. Despite the shift in hemisphere, the transplanted plants adjusted to the new annual rhythm. After two growing seasons, survival and flowering patterns reflected their latitudinal origin: Patagonian plants performed better in Turku, while Antarctic plants exhibited greater success in Utsjoki. Overall, plant performance was higher in Utsjoki, likely due to more stable winter temperatures and protective snow cover. These findings highlight the role of microbes and geographic adaptation history in shaping phenological responses to extreme light and temperature conditions and suggest that *D. antarctica* may be capable of adjusting to the increasingly extreme photoperiods at high latitudes under climate change.