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Life on the edge: resistance mechanisms to desiccation and re-wetting of two Antarctic *Nostoc* sp. strains from freshwater and terrestrial habitats

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Abstract

Filamentous heterocystous cyanobacteria belonging to the genus *Nostoc* are ecosystem engineers in dry and oligotrophic environments worldwide. In Antarctica, the genus is often a dominant member in both terrestrial and lacustrine habitats, yet little is known about its specific adaptations to thrive in both extremely dry and wet conditions, and during its dispersal between habitats. Here we studied the response to short-term desiccation exposure and rehydration of two Antarctic terrestrial (ULC180) and freshwater (ULC008) *Nostoc* strains sharing 97.7% of ANI similarity. We compared the concentration of different pigments and osmolytes (i.e. trehalose and sucrose), the photosynthetic efficiency as well as the differential gene expression after RNA-seq (Illumina NovaSeq 2x150 bp) between the controls (T0) and the different treatments (D = after 3h of desiccation; RW1 = after 10 min of rehydration; RW2 = 24h of rehydration; RW3 = 72h of rehydration). Both strains reacted to dehydration by accumulating sucrose, whereas trehalose was present in lower concentrations. Only the freshwater strain showed a recovery in chlorophyll *a* content after 72h of rehydration. Transcriptomic profiles showed that both strains protected their cells during dehydration by inducing stress-related genes, such as those for the production of carotenoids, trehalose and nitrogen fixation, but these were significantly up-regulated only in the terrestrial strain. The latter one responded with a higher number of up-regulated genes compared to the freshwater strain, including those necessary to protect the photosystem II from degradation (e.g. *psb*A2 gene), enabling a stronger resistance to dehydration of ULC180 compared to ULC008.