# Antarctic lichen *Dermatocarpon polyphyllizum* affected by desiccation and low temperature

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## INTRODUCTION

Photosynthetic processes in lichen photobionts have been studied in many biophysical and physiological studies for decades. Lichens are poikilohydric organisms well adapted to the desiccation/rehydration cycles. They are photosynthetically inactive when desiccated, however, upon rehydration, they can perform primary photosynthetic processes within seconds. Antarctic lichens are also able to tolerate *e.g.* long periods of low and freezing temperature, high UV irradiance and other environmental stress factors. Antarctic lichen *Dermatocarpon polyphyllizum* (*Verrucariaceae*) is a foliose lichen with green alga as a photobiont. It usually grows on rock surfaces in polar regions or in higher altitudes. In our study, we used chlorophyll fluorescence to evaluate desiccation-induced limitation of primary photosynthetic processes of the species.

## MATERIAL AND METHODS

In our study, we investigated the effect of gradual desiccation and low temperature on chlorophyll fluorescence and spectral reflectance parameters. We used samples of *D. polyphyllizum* collected in February 2018 and 2019 in the James Ross Island, Antarctica. After the transfer to a laboratory, lichen thalli were allowed to rehydrate for at least 24 h. The samples of *D. polyphyllizum* were exposed to gradual desiccation at the temperature of 18, 10 or 4°C. Relative water content (RWC) of lichen thalli was measured gravimetrically during the desiccation, together with repeated measurements of photosynthetic parameters related to fast chlorophyll fluorescence induction.

The fast chlorophyll fluorescence induction (OJIP) was used to evaluate photosynthetic processes in photosystem II. The OJIP kinetics is measured within the first 2 s after saturation pulse on pre-darkened sample. Several OJIP-derived parameters are calculated from OJIP kinetic, describing functioning of photosynthetic apparatus.

## RESULTS AND DISCUSSION

Dehydration-response curves showed a statistically significant change in many parameters, *e.g.* maximum quantum yield of PSII photochemistry ($F_V/F_M$), quantum yield of energy dissipation (Phi_$D_0$) or flux of dissipated excitation energy ($DI_0/RC$). Temperature-induced changes were observed as well. At the temperature of 18°C, substantial change of measured parameters started at about 25% RWC, whereas this critical RWC was higher at the lower temperature (35% for 10°C and 45% for 4°C).

The measured chlorophyll fluorescence decreased during gradual desiccation The OJIP kinetics were flattened because of decreased maximal fluorescence ($F_P$) indicating increased number of inactive reaction centres that dissipated excitation energy rather through thermal dissipation than chlorophyll fluorescence emission. This correlates with previously mentioned higher Phi_$D_0$ and $DI_0$/RC measured in samples with low RWC. A decrease of minimal fluorescence ($F_0$) was also found and attributed to quenching of energy in LHCs and structural arrangements of LHCs during desiccation.

Analysis of the OJIP kinetics revealed the K-band (0.3 ms), its height more pronounced with decreasing RWC. The K-band usually found at highly stressed organisms. It is related to damage to the PSII donor side, *i.e.* it reflects desiccation-induced inhibition of oxygen evolving complex.

The samples of *Dermatocarpon polyphyllizum* responded sensitively to both desiccation and low temperature stress. The fast chlorophyll fluorescence induction is very efficient method for evaluating photosynthetic response to the above-specified stress factors.

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