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Physiological Comparison of Four Cryogenic Arctic Snow Algae Strains

Snow algae belong to the photoautotroph freshwater microorganisms successfully thriving on semi-permanent to permanent snow and ice fields around the world. They are well known for their large, colorful blooms in cryospheric environments exposed to extreme conditions such as low temperatures and high irradiance in the summer month. Apart from green chlorophyll, other pigments such as xanthophyll or secondary carotenoids are known to be produced under high-light stress which turn the snow red or yellow. Their pigments darken snowfields worldwide, reducing albedo and thereby accelerating melt of snowpacks. Although knowledge of distinct phylogeny within snow algae is increasing, we do not know how these species respond to varying levels of light intensities.

We investigated four snow algae strains - *Microglena sp., Chloromonas remiasii, Sphaerocystis sp., and Raphidonema sempervirens* - focusing on their physiology under high light conditions (500–700 µmol m^{-2} s^{-1}). We employed pulse amplitude modulated (PAM) fluorometry combined with algal growth rate measurements, and quantified intracellular reactive oxygen species (ROS) in cultures exposed to high light conditions and controls. Our results show that among all four species, *Microglena sp.* was the only strain to efficiently grow under these conditions. Its response to high light included a progressive reduction in electron transport rate, indicating decreased photosystem efficiency under prolonged exposure, while ROS production remained stable, which further suggests increased resilience to light stress. This work increases our understanding of physiological responses of snow algae to environmental stressors relevant in future scenarios where melt seasons will extent and shifts in their habitats will occur faster.

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