



Seasonal and ontogenetic changes of mycosporine-like amino acids in planktonic organisms from an alpine lake

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ABSTRACT: We studied the quantitative and qualitative mycosporine-like amino acid (MAA) composition in phytoplankton and the copepod *Cyclops abyssorum taticus* from an alpine lake over a 15-month period. Up to eight MAAs were identified in the samples, with shinorine being predominant. The MAAs occurred year round and showed a strong seasonal pattern. Compared with ice-cover periods, concentrations during the summer were on average 3.6 and 3.0 times higher in phytoplankton and *C. abyssorum taticus*, respectively. During the summer, the contents of MAAs in phytoplankton decreased with depth, suggesting their photoprotective role. Chlorophyll a-specific concentrations of MAAs in phytoplankton correlated significantly with the incident solar radiation and ultraviolet (UV) water transparency ($r^2 \leq 0.36$), however, the strongest relationship was found with water temperature ($r^2 = 0.67$). In zooplankton, highest contents of MAAs were found in eggs, nauplii, and young copepodids, presumably providing a high level of photoprotection for progeny. Proportions of the dominant MAAs in the copepod showed seasonal and ontogenetic variations, which were consistent with relative changes in the predominant MAA, but not other abundant MAAs, in phytoplankton. Considering a time lag of approximately 1 month between the synthesis and subsequent accumulation of these compounds, MAA concentrations in late copepodid to adult life stages were significantly correlated to those in phytoplankton. Annual patterns in MAAs with high concentrations during periods of elevated environmental stress are consistent with the idea that these compounds play an important role in protecting aquatic organisms against UV damage.

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