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AMMONIUM AND UV RADIATION STIMULATE THE ACCUMULATION OF MYCOSPORINE-LIKE AMINO ACIDS IN *PORPHYRA COLUMBINA* (RHODOPHYTA) FROM PATAGONIA, ARGENTINA[1]

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The combined effects of ammonium concentration and UV radiation on the red alga *Porphyra columbina* (Montagne) from the Patagonian coast (Chubut, Argentina) was determined using short-term (less than a week) experimentation. Discs of *P. columbina* were incubated with three ammonium concentrations (0, 50, and 300 µM NH_4Cl) in an illuminated chamber (PAR = 300 µmol photons · $m^{-2} \cdot s^{-1}$, UVA = 15 $W \cdot m^{-2}$, UVB = 0.7 $W \cdot m^{-2}$) at 15° C. Algae incubated at 300 µM ammonium showed a significant increase ($P < 0.05$) in the concentration of mycosporine-like amino acids (MAAs) compared with the initial value or with the other ammonium treatments. The increase of MAAs was, however, a function of the quality of irradiance received, with a higher increase in samples exposed to UVA compared with UVB (29% and 5% increase, respectively). However, UVB radiation was more effective in inducing MAA synthesis per unit energy received by the algae. Samples exposed to PAR only had an intermediate increase in MAA concentration of 16%. Chl *a* concentration decreased through the incubation with the greatest decrease at high ammonium concentration. Phycobiliprotein (BP) decreased through time with the smallest decrease occurring at high ammonium concentration. Photoinhibition (as a decrease of optimal quantum yield) was significantly greater under nitrogen-deprived conditions than that under replete ammonium levels. Maximal gross photosynthesis (GP_{max}), as oxygen evolution, and maximal electron transport rate (ETR_{max}), as chl fluorescence, increased with the ammonium concentration. Positive relationships between maximal GP or ETR and pigment ratios (BP/chl *a* and MAAs/chl *a*) and negative relationships with chl *a* concentration were found.

Key index words: **ammonium; biliproteins; chl fluorescence; mycosporine-like amino acids; photosynthetic activity; *Porphyra*; quantum yield; UV radiation**

Abbreviations: **a, area; A, absorbance; α, photosynthetic efficiency; BP, phycobiliprotein; DIN, dissolved inorganic nitrogen DW, dry weight; ETR, electron transport rate; F_o, initial fluorescence in the dark-adapted state (all reaction centers are open, oxidized); F_m, maximal fluorescence in the dark-adapted state (all reaction centers are closed, reduced); F_m', the same for the light-adapted state; F_v/F_m, optimal or maximal quantum yield; FW, fresh weight; GP, gross photosynthetic rate; GP_{max}, gross photosynthetic rate at light saturation; P, PAR; PA, PAR + UVA; PAB, PAR + UVA + UVB; PAM, pulse amplitude modulated fluorescence; PC, phycocyanin; PE, phycoerythrin; Φ_{PSII}, effective quantum yield as chl fluorescence; Φ_{O2}, photosynthetic quantum yield as oxygen evolution; R_d, dark-respiration rate; UVA, ultraviolet A (λ = 315–400 nm); UVB, ultraviolet B (λ = 280–315 nm); UVR, ultraviolet radiation (λ = 280–400 nm)**

Normal levels of solar UV radiation (UVR) and the increased flux due to the depletion of the stratospheric ozone layer harm many biological processes. Multiple detrimental effects of UVR on proteins, DNA, and other biologically relevant molecules of autotrophic organisms as well as chronic depression of physiological processes (photosynthesis, growth) and influences on community structures have been reported (Buma et al. 1995, 1997, Franklin and Forster 1997, Häder and Figueroa 1997, Aguilera et al. 1999b, Helbling et al. 2001, Villafañe et al. 2002). Of prime interest is the identification of repair and/or protective mechanisms that allow phototrophic organisms living in high-light habitats to survive and reproduce.

One mechanism that acts against UV damage is the biosynthesis and accumulation of UV-absorbing compounds, mainly mycosporine-like amino acids (MAAs) (Dunlap and Shick 1998). The MAAs are water-soluble low-molecular-weight molecules with high molar

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