MACROALGAL RESPONSES TO NITROGEN SOURCE AND AVAILABILITY: AMINO ACID METABOLIC PROFILING AS A BIOINDICATOR USING *GRACILARIA EDULIS* (RHODOPHYTA)[†]

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ABSTRACT

The use of macroalgae as biological indicators of dissolved nutrient source and availability in the water column was investigated. Total tissue nitrogen (N) content, pigments, and amino acids of the red alga *Gracilaria edulis* (Gmelin) Silva were compared to N source and availability in laboratory and field incubations to identify responses that would serve as bioindicators of N. Field-collected algae were preincubated (6–8 wk) in low-nutrient seawater to deplete their luxury reserves ofN. Incubations were then conducted for periods of 3 d in

laboratory aquaria (N-spiked seawater) and in the field using macroalgal incubation chambers. After incubation in different N sources (NH_4^+, NO_3^-, and urea) in laboratory aquaria, photosynthetic pigments (phycoerythrin and chlorophyll *a)* and total tissue N increased, in response to increasing [NH_4^+] but not to [NO_3^-] or [urea]. Incubation in two ranges of [NH_4^+], one from 0 to 80 μM and the other from 0 to 800 μM, in laboratory aquaria increased the total amino acid pool. Citrulline concentrations were the most responsive to [NH_4^+] *(r^2*= 0. 84). NH_4^+ source treatments produced increases in citrulline, phenylalanine, serine, and free NH_4^+ and decreases in alanine; NO_3^-treatments produced increases in glutamic acid, citrulline, and alanine; and urea treatments produced increases in free NH_4^+ and decreases in phenylalanine and serine. The observed variations in amino acid content facilitated the development of an index for each N source based on relative concentrations of various amino acids (i. e. metabolic profiling). *Gracilaria edulis* was incubated along a field N gradient in the Brisbane River (three sites) and Moreton Bay (four sites), Queensland, Australia. Both phycoerythrin and tissue N appeared to respond equally to NH_4^+ and NO_3^- availability in the field. N source indices, based on amino acid concentration, were effective predictors of both [NH_4^+] and [NO_3^-] over a wide range of concentrations along the field gradient. Macroalgal physiological responses, particularly amino acid content, to changes in source and availability of N appear to be useful as sensitive bioindicators of N.