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The Fractionation of Nitrogen Isotopes in Macroalgae during the Assimilation of Nitrate and Ammonium as a Function of Concentration

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In order to determine the amount of fractionation of ^{15}N and ^{18}O during the assimilation of NO_3^- in marine macrobenthic algae, two species *(Ulva* sp. and *Agardhiella* sp.) were grown in a wide range of concentrations of NO_3^- (2-500 μM). Two types of experiments were performed, one in which the concentration of NO_3^- was allowed to decrease as it was assimilated by the algae over a 24 hours period and the water and nutrients then restored to the original concentrations and a second set in which the concentration was maintained at a low steady state value by means of a syringe pump. The effective fractionation factor during assimilation was determined by measuring the δ^{15}N of the (i) new algal growth produced, and (ii) measuring the δ^{15}N and δ^{18}O of the NO_3^- in the free drift experiments which were left for 0, 12, 24, and 48 hours. The fractionation of ^{15}N and ^{18}O was modeled using a Rayleigh distillation model. The results indicate that the fractionation factor during assimilation for NO_3^- is dependent upon the concentration of NO_3^- in both species of algae and approaches unity at concentrations of less than 10 μM. The change in the fractionation factor with respect to concentration is the greatest at lower concentrations (1-10 μM). There is also evidence that the fractionation factor falls below unity at very low concentrations. Determinations of the assimilation factor made using the δ^{15}N of the NO_3^- and the solid algal material provided statistically the same result.

At normal marine concentrations of NO_3^-, fractionation during assimilation can be considered to be negligible. However, at higher concentrations, fractionation during assimilation will lead to isotopic enrichment of the δ^{15}N of the NO_3^- pool regardless of the δ^{15}N of the source. In addition, to changing the relationship in fractionation relative to concentration, the relationship between the δ^{15}N and δ^{18}O also varies, with values close to unity at higher concentrations and decreasing at lower concentrations. These results suggest different fractionation mechanisms at high and low NO_3^- concentrations.