Desiccation induced nitrate and ammonium uptake in the red alga *Catenella repens* (Rhodophyta, Gigartinales)

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Nitrate and ammonium uptake rates were measured under laboratory conditions for the intertidal mangrove alga *C. repens* when the thalli were desiccated to 0-60% and resubmerged. An enhancement in the nitrate and ammonium uptake was seen in plants desiccated up to 20-40%. These enhanced rates were 1.76 (for nitrate) and 1.42 (for ammonium) times higher than the uptake rates of fully hydrated plants (control). After desiccation, the enhancement in the nitrate uptake rates on resubmergence lasted much longer than the increase in ammonium uptake. The degree and duration of this enhancement in nitrate uptake due to desiccation must be aiding the alga in the procurement of nitrogen.

Intertidal organisms frequently encounter a varying habitat in terms of exposure to the air and seawater. During low tides intertidal algae exposed to the air may face nutrient stress. Effect of the exposure/desiccation on the nitrogen nutrition of these algae becomes important as coastal waters are known to be nitrogen limited during the summer months and the repeated emergence increases the possibility of further nitrogen stress. The capability of an alga to take-up nitrogen during the stress period partially determines its survival success in a community.

Red alga *Catenella repens* (Lightfoot) Batters (Rhodophyta, Gigartinales) a potential source of iota-carrageenan grows in a peculiar habitat attached to the pneumatophores in the mangrove swamps. The plants remain exposed to the external atmosphere for quite sometime in a day, due to the tidal cycle. In the present paper, we report the effect of desiccation on the nitrate and ammonium uptake rates in *C. repens* under laboratory conditions.

*Catenella repens* plants collected from the intertidal mangrove forests of Sundarbans, West Bengal, India (lat 21°39"N, long 88°03"E) at 2.2 m above chart datum were brought to the laboratory, cleaned and acclimatized to the culture room conditions (temp 26±2°C; 14:10, L:D; 2800 lux). Desiccation rate of the plants was determined in the laboratory following Quadir *et al*. After about 60-65% desiccation was obtained, the thalli were removed and dried at 70°C for 48 h to obtain the dry weight. Using the curve obtained by plotting time (h) vs. desiccation (%), plants were desiccated to required percentages for further experiments. Plants at 0% desiccation (hydrated) served as control.

A time course study was performed initially to determine the period required for reaching the constant in uptake rate of nitrate/ammonium. The multiple container methods was then followed to determine the effect of desiccation on nitrate and ammonium uptake rates upon resubmergence in seawater. The experimental medium consisted of nutrient depleted, aged, sterile ambient seawater with a known concentration of nitrate (30 μM) or ammonium (15 μM) added to it. The time course experiment was performed using one litre of medium while the multiple-flask experiments were done using 500 ml of medium in each flask. The plant biomass and medium volume ratio was maintained at 1 g wet wt/l. All the sets were exposed to the same set of experimental conditions to which thalli were acclimatized. The time course study was done by determining the depletion rates of nitrate/ammonium from the medium by sampling every 10 min initially for 90 min and then every 60 min for about 6 h as per Strickland & Parsons. One control (hydrated) thallus and one desiccated (up to 30%) thallus were tested for the time course study. The nitrate and ammonium experiments were run separately in triplicate. The time course study helped us to decide the incubation time for further batch experiments (the initial 20 min for ammonium and 30 min for nitrate). Uptake rates were expressed on dry wt basis. Plotting uptake rates against the percent desiccation of the thallus, prior to
reimmersion in the uptake medium, we obtained the percent desiccation producing maximum uptake rates (optimal desiccation). This then helped us to find out the range of desiccation resulting in the enhancement of uptake upon resubmergence. The optimally desiccated plant was finally placed in filtered natural seawater, and the increase in the wet wt was continuously measured to find out the time taken for total rehydration of the thallus. The relative rehydration at any time (t) was calculated as per Thomas et al. The desiccation rate calculated under laboratory conditions indicated that 60-65% of desiccation occurs in less than 4 h and that the low water content was retained after this time (Fig. 1). Similar desiccation rates have been reported for Ulva, Fucus and Iridaea under simulated field conditions.

Catenella repens desiccated up to 20-40% had an enhanced nitrate and ammonium uptake upon resubmergence (Fig. 2). These enhanced rates were 1.76 (for nitrate) and 1.32 (for ammonium) times higher than the uptake rates of the fully hydrated plants (controls). Catenella repens occurs at a height of 2.2 m above chart datum. Desiccation induced uptake of nitrate and ammonium in the supralittoral and midlittoral algae has also been reported in Enteromorpha intestinalis, Fucus distichus, Pelevetiopsis limitata and Gigartina papillata.

The time course studies (Fig. 3) have made clear that (i) plants of C. repens initially take up

![Fig. 1](image1.png)  
**Fig. 1**—Rate of desiccation (%) of C. repens under laboratory conditions

![Fig. 2](image2.png)  
**Fig. 2**—Effect of desiccation on nitrate and ammonium uptake in C. repens

![Fig. 3](image3.png)  
**Fig. 3**—Time course of disappearance of nitrate and ammonium from the medium

![Fig. 4](image4.png)  
**Fig. 4**—The relative rehydration of the optimally desiccated thalli of C. repens
ammonium very rapidly as compared to nitrate, (ii) the uptake rates for ammonium in both hydrated and desiccated plants were constant only for 15-20 min of submersion and then decreased, (iii) the enhancement of ammonium uptake due to desiccation also lasted for the initial 20 to 30 min, (iv) the hydrated plants showed increase in nitrate uptake with time and (v) the enhancement in nitrate uptake due to desiccation was almost constant for more than an hour.

The optimally desiccated plant (30%) when kept for rehydration showed that relative rehydration rate was very rapid for the initial 10 min (Fig. 4) and thereafter it stopped absorption of water after about 65 min of rehydration.

Accumulation of inorganic nitrogen by macro algae has been the focus for many studies. Such short-term uptake studies are important to understand the ability of an alga to withstand stress and respond to brief upsurge of higher nutrient levels in the ambient conditions. The duration and degree of increase in nitrate uptake after desiccation must be aiding in the procurement of nitrogen required for growth. The biochemical and certain physiological changes involved in this process following desiccation, however, are being studied.

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References