

Growth of *Synechocystis aquatilis* f. *salina* (blue-green algae) on different nitrogen : phosphorus ratios: An ecophysiological approach

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Abstract

During an integrated study of Lagoa da Barra, a lagoonal complex of Maricá - RJ, Brazil, from October 1990 to August 1993, nutrient concentrations (C, N, P), phytoplankton and zooplankton communities and the lagoon's metabolism were investigated weekly. Cyanophyta dominated the phytoplankton community throughout the period of study. *Synechocystis aquatilis* f. *salina* was the dominant species, representing 90 % of the total biomass and density of the phytoplankton community in January 1991 (DOMINGOS et al. 1995). A marked depletion in nitrogen concentration, followed by a massive fish mortality (*Brevoortia tyrannus aurea*, a filter feeder), at the end of the exponential growth phase of *S. aquatilis* f. *salina* characterised this period. At the time of the mortality, the N:P ratio was 2:1, and the average N:P throughout the period of study was 8:1. Laboratory experiments using a strain of this species isolated from the study site were carried out to provide a better understanding of the factors determining the success of this alga in this community. Unialgal cultures were grown in ASM-1 medium, with an initial pH 8, at $25 \pm 2^\circ\text{C}$, in a 12 h L/D cycle at $40 \mu\text{mol m}^{-2} \text{s}^{-1}$ photon flux. Cultures were continuously bubbled with filtered air. Experiments were undertaken to determine the effect of nitrogen limitation on: 1, growth rate (cellular daily counts); 2, photosynthetic and respiratory activities (oxygen variation (WINKLER) after two hours incubation in light and dark bottles, on the exponential and stationary growth phase); 3, intra- and extra-cellular carbohydrate (DUBOIS et al. 1956); 4, cellular protein (BRADFORD 1976); and 5, cellular chlorophyll (MACKINNEY 1941) during the growth of this species. In these experiments, ASM-1 medium was 10-fold diluted (ASM-1/10) and N:P ratios were 3:1, 10:1 and 30:1. NO_3^- was used as the only nitrogen source. All experiments were performed with three replicates at each growth condition, here presented as average values. A markedly diminished growth was observed

with the lower N:P ratio. Growth rate, chlorophyll concentration, photosynthetic and respiratory rate ($\mu\text{mol O}_2 \text{ h}^{-1}$) increased proportionately with the increase in nitrogen content of the medium. Protein and carbohydrate cellular results suggest that under nitrogen starvation the flow of fixed carbon in photosynthesis is switched from the path of protein synthesis to that leading to carbohydrate. As a consequence, carbohydrate excretion was also high at the beginning of growth. Photosynthetic efficiency, measured as oxygen evolution on a chlorophyll basis ($\mu\text{mol O}_2 \text{ mg chl a}^{-1} \text{ h}^{-1}$), was severally affected by nutrient limitation, low values being observed even during the exponential growth phase. Respiratory rate was higher in the 30:1 medium during the exponential and stationary growth phase. There was no measurable photosynthetic activity during the stationary growth phase. It seems that the cells must have used their reserves to survive, and a process of cellular imbalance took place. These data show that *S. aquatilis* f. *salina* was not able to grow well in the experimental condition with the lower N:P ratio, although the dominance of this species in the lagoon was related to periods of low N:P values. The species growth during these periods may be sustained by an undetectable nitrogen supply. Reasons are the analytical constraints and/or the fast assimilation and turnover rate of the nutrient, which could not be measured. There is also a possibility that the severe environmental conditions observed in the lagoon would be more intense to other phytoplanktonic species. It must be remembered that there are significant ecological differences between cultures and natural systems and we should be careful with comparisons and extrapolations from one to the other. The physiological response of these cells will also be analysed in other medium conditions. Furthermore, the toxin production of the cells grown in all culture conditions are being analysed. Preliminary toxicity tests showed that this species produces microcystins (heptapeptide hepatotoxins), which could be related to the fish mortality observed in Lagoa da Barra in February 1991.

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