DIEL PERIODICITY OF CARBON AND NITROGEN ASSIMILATION IN FIVE SPECIES OF MARINE PHYTOPLANKTON

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BY
Giacomo Ruggiero DiTullio

Thesis Committee:
Edward A. Laws, Chairman
Satoru Taguchi
David M. Karl

ABSTRACT

The diel patterns of carbon and nitrogen assimilation were investigated in five taxonomically diverse species of unicellular algae grown in NH_4^+ limited cyclostats (12:12 LD). The 24 h incorporation rate of C-14 into protein provided an indirect estimate of nitrogen assimilation. The N/C assimilation ratios were compared with actual N/C composition ratios at 6 h intervals throughout the diel cycle. Calculated rates of N-assimilation were overestimated during the photoperiod and underestimated at night. The average overestimation found during the photoperiod (71%), as well as the 24 h average (24%) were especially striking at the lower growth rates. Accumulation of intracellular nitrogen pools during the dark period may have been responsible for the greater discrepancy at lower growth rates. The most accurate estimate of N-assimilation was obtained from the 24 h average. The 24 h average estimates at the fast growth rates were only 4% higher than the actual uptake rates.

The N/C assimilation ratio underestimated the N/C composition ratio during the photoperiod. But after 24 h, the N/C assimilation ratio averaged 104% of the N/C composition ratio. The diel phasing of carbon assimilation, in conjunction with dark nitrogen uptake, was responsible for the diel oscillation in N/C composition. The N/C assimilation ratio underestimated the N/C composition ratio

during the photoperiod because the specific activity of the protein carbon was less than the specific activity of the total carbon. Protein synthesis at night fueled by the carbon end-products of carbohydrate respiration resulted in isotopic equilibrium between the protein carbon pool specific activity with that of the total cell carbon. The net result was an accurate prediction of the N/C composition ratio after 24 h.

During the photoperiod, the C-14 method overestimated net carbon production by an average of 24%. The decrease in particulate C-14 activity at night due to respiration was 105% greater than the predicted decrease estimated from the loss in particulate carbon concentration. As a result the particulate carbon specific activity decreased during the night. Dark respiration of carbon with an average specific activity greater than the whole cell mean value could not entirely account for this phenomenon. Excretion of carbon with an average specific activity less than the whole cell mean value during the photoperiod into a large pool of unlabelled DOC may partially explain the overestimation of net particulate carbon production during the photoperiod. Similarly uptake of low specific activity DOC must have accounted in part for the decline in the specific activity of particulate carbon during the dark period. The average estimated DOC excretion rates (14%) were well within most reported values and imply respiration rates of ~ 10% of photosynthetic production. Estimated excretion rates during the photoperiod are consistent with other studies which have also found cyclic release of DOC.