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Original Article

Use of non-limiting substrates to increase size; a generic strategy to simultaneously optimize uptake and minimize predation in pelagic osmotrophs?

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Abstract

Coexistence of two organisms competing for the same nutrient is possible if one is an 'uptake', and the other a 'predation defence' specialist. In pelagic food webs this principle has been linked to cell size. Small osmotroph cells, with their high surface : volume ratio, have been argued to be uptake specialists, while larger osmotrophs avoiding the intense grazing pressure from small protozoan predators might represent 'predation defence' specialists. This may seem like an obligatory trade-off situation that necessitates a choice of either being small or being large, and thus being potentially dominant in oligotrophic or in eutrophic environments, respectively. However, in a more precise form, the theory for nutrient diffusion states that it is the 'surface : cell requirement of limiting element' ratio, rather than the 'surface : volume' ratio, that is important. The distinction is crucial, since it opens up the possibility of there being life strategies that use a non-limiting element to increase size. Hypothesized to maximize uptake and predator defence simultaneously, such strategies should be particularly successful. We suggest that this strategy is exploited by osmotrophs with different size and physiology, such as heterotrophic bacteria, unicellular cyanobacteria and diatoms. Since the strategy implies a shift in organism stoichiometry, the biogeochemical implications are strong, illustrating the tight relationships between physical micro-scale processes, organism life strategies, biodiversity, food web structure, and biogeochemistry.