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Review

The diatom molecular toolkit to handle nitrogen uptake

Alessandra Rogato [a,*], Alberto Amato [b], Daniele Iudicone [b], Maurizio Chiurazzi [a], Maria Immacolata Ferrante [b,**], Maurizio Ribera d'Alcalà [b]

[a] Institute of Biosciences and BioResources, CNR, Via P. Castellino 111, 80131 Naples, Italy
[b] Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology, Villa Comunale 1, 80121 Naples, Italy

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ABSTRACT

Nutrient concentrations in the oceans display significant temporal and spatial variability, which strongly affects growth, distribution and survival of phytoplankton. Nitrogen (N) in particular is often considered a limiting resource for prominent marine microalgae, such as diatoms. Diatoms possess a suite of N-related transporters and enzymes and utilize a variety of inorganic (e.g., nitrate, NO_3^-; ammonium, NH_4^+) and organic (e.g., urea; amino acids) N sources for growth. However, the molecular mechanisms allowing diatoms to cope efficiently with N oscillations by controlling uptake capacities and signaling pathways involved in the perception of external and internal clues remain largely unknown. Data reported in the literature suggest that the regulation and the characteristic of the genes, and their products, involved in N metabolism are often diatom-specific, which correlates with the peculiar physiology of these organisms for what N utilization concerns. Our study reveals that diatoms host a larger suite of N transporters than one would expected for a unicellular organism, which may warrant flexible responses to variable conditions, possibly also correlated to the phases of life cycle of the cells. All this makes N transporters a crucial key to reveal the balance between proximate and ultimate factors in diatom life.

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1. Introduction

The oceans cover approximately 70% of the Earth's surface. They contribute to roughly half of global primary production (Falkowski and Raven, 1997) and to an equal proportion of the Earth oxygen, being in fact the *blue lung* of the planet. The most important players in this game are phytoplankton, a highly phylogenetically diverse ensemble of photosynthetic microscopic organisms, prevalently unicellular, often aggregated in chains or colonies, which thrive in the upper illuminated layer of the oceans, the so called photic zone. Besides producing oxygen and fixing carbon, these organisms participate in most of the major biogeochemical processes on Earth. For at least 3 billion years, they have actively influenced the composition of the

* Corresponding author. Tel.: +39 081 6132 410; fax: +39 081 6132 706.
** Corresponding author. Tel.: +39 081 5833 268.
E-mail addresses: alessandra.rogato@ibbr.cnr.it (A. Rogato), mariella.ferrante@szn.it (M.I. Ferrante).

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