










Review

Chlamydomonas reinhardtii, an Algal Model in the Nitrogen Cycle

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Abstract: Nitrogen (N) is an essential constituent of all living organisms and the main limiting macronutrient. Even when dinitrogen gas is the most abundant form of N, it can only be used by fixing bacteria but is inaccessible to most organisms, algae among them. Algae preferentially use ammonium (NH₄⁺) and nitrate (NO₃⁻) for growth, and the reactions for their conversion into amino acids (N assimilation) constitute an important part of the nitrogen cycle by primary producers. Recently, it was claimed that algae are also involved in denitrification, because of the production of nitric oxide (NO), a signal molecule, which is also a substrate of NO reductases to produce nitrous oxide (N₂O), a potent greenhouse gas. This review is focused on the microalga *Chlamydomonas reinhardtii* as an algal model and its participation in different reactions of the N cycle. Emphasis will be paid to new actors, such as putative genes involved in NO and N₂O production and their occurrence in other algae genomes. Furthermore, algae/bacteria mutualism will be considered in terms of expanding the N cycle to ammonification and N fixation, which are based on the exchange of carbon and nitrogen between the two organisms.

Keywords: algae; *Chlamydomonas*; nitrogen cycle; nitric oxide; nitrous oxide

1. Introduction

Nitrogen (N) is an essential macronutrient that supports life in all living beings. This nutrient is an elemental constituent of biomolecules, such as nucleic acids, proteins, chlorophylls, cofactors, and signal molecules, among others.

In nature, living organisms can use different N reservoirs, and the biotic and abiotic conversions among different N forms constitute the biogeochemical N cycling. These N reservoirs and N flux in terrestrial and marine ecosystems have been recently reviewed [1]. Ammonium (NH₄⁺) bound into rocks and sediments is the largest N reservoir (1.8 × 10¹⁰ Tg nitrogen). However, this NH₄⁺ has a minimal impact on the annual N cycling because it is accessible only upon erosion [1]. The largest available N reservoir for organisms is dinitrogen gas (N₂) with 3.9 × 10⁹ Tg, which represents 79% of the atmospheric air. However, due to the reduced reactivity of the triple bonded N₂, only a small group of organisms having the dinitrogenase enzyme complex can use it as N source [1–3]. The global and usable N-reservoirs are organic nitrogen (9 × 10⁵ Tg), nitrate (NO₃⁻) (6 × 10⁵ Tg), and nitrous