Title

Cross-compartment metabolic coupling enables flexible photoprotective mechanisms in *P. tricornutum*

Authors

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Project Goal

An in depth understanding of light energy utilization in photosynthesis under dynamic light environments has important implications for renewable food and fuel related industrial applications. In this study we simulated and investigated the intracellular metabolic flux in *P. tricornutum,* a unique organism that has amazing light tolerance capacity, under a wide range of acclimation light levels using state-of-the-art system biology tools. Our goal is to find out what physiological mechanisms enable this microalgal species to mediate excessive photon energy effectively.

Abstract

Photoacclimation consists of short and long-term strategies used by photosynthetic organisms to adapt to dynamic light environments. Observable photophysiology changes resulting from these strategies have been used in coarse-grained models to predict light-dependent growth and photosynthetic rates. However, the contribution of the broader metabolic network, relevant to species-specific strategies and fitness, is not accounted for in these simple models. Here we incorporate photophysiology experimental data with genome-scale modeling to characterize organism-level, light-dependent metabolic changes in the model diatom *P.tricornutum*. Oxygen evolution and photon absorption rates were combined with condition specific biomass compositions to characterize metabolic pathway usage of cells acclimated to four different light intensities. We identify photorespiration, an ornithine-glutamine shunt, and branched chain amino acid metabolism as the primary alternate electron pathways for consuming excess light energy. Additionally, simulations suggest carbon shunted through photorespiration is recycled back to the chloroplast as pyruvate, a mechanism distinct from known strategies in other phototrophs. Overall, our results suggest a flexible metabolic network in *P. tricornutum* that tunes inter-compartment metabolism to optimize energy transport between the organelles, consuming excess energy as needed. Characterization of these alternate electron flows broadens our understanding of energy partitioning strategies in this clade of ecologically important primary producers.

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