Exploring plastid function in free-living nonphotosynthetic algae

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Abstract:

Photosynthesis is an ancient (emerged 3.2-3.5 BYA) autotrophic pathway (Blankenship, 2010) - which likely evolved first in bacteria - capable of harnessing energy from sunlight and converting it into chemical energy (Arnon, 1971). The diverse versions of photosynthesis are the main source of food on planet Earth (Blankenship, 2010). Particularly, oxygen-producing (i.e., oxygenic) photosynthesis evolved circa 2.5 BYA in the ancestors of modern cyanobacteria (Blankenship, 2010). The rise of photosynthesis dramatically altered conditions on Earth by oxygenating the atmosphere during the “Great Oxygenation Event”, which occurred about 2.4 BYA (Cardona *et al.*, 2015). However, despite the ecological relevance of photosynthesis, lineages from every domain of the Eukaryote group, including a diverse variety of land plants and algae, have lost the ability to photosynthesize numerous times independently (Wicke *et al.*, 2013). Nonphotosynthetic algae typically retain colourless plastids with highly reduced genomes. Most studies about the loss of photosynthesis have focused parasitic lineages that were once photoautotrophic (Figueroa-Martinez *et al.*, 2015). However, not all lineages that have lost photosynthesis are parasites or pathogens (Figueroa-Martinez *et al.*, 2015). Diverse free-living colourless algae presumably evolved from mixotrophic ancestors to nonphotosynthetic habits without parasitic/pathogenic stages (Troost *et al.*, 2005; de Castro *et al.*, 2009). My work aims to gain a better understanding of the physiological roles of the colourless plastids in free-living chlamydomonadalean algae. Using transcriptomic approaches, I investigated the metabolic functions of the nonphotosynthetic plastid of *Polytoma uvella*. Similarity and intracellular targeting analyses of the *P. uvella* transcriptomic data provided a detailed catalog of the functions retained in the colourless plastid after the adoption of a nonphotosynthetic lifestyle. Reconstruction of complete metabolic pathways indicate that the *P. uvella* plastid hosts multiple key metabolic functions, such as the metabolism and biosynthesis of a number of amino acids, purine and pyrimidine metabolism, terpenoid biosynthesis, fatty acid biosynthesis, starch and sucrose metabolism, fatty acid biosynthesis, glycerolipid metabolism, carbon fixation, biosynthesis of porphyrin and chlorophyll, carotenoid biosynthesis, and mismatch repair. The TOC-TIC complex for plastid protein import also seems to be fully functional. Overall, my results provide important insights into the metabolic roles of the plastids in free-living nonphotosynthetic algae.

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