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Viral Take-over of Host Photosynthetic Electron Transport: Investigating the role of Cyanophage-encoded Plastocyanin

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Marine picocyanobacteria are the most abundant primary producers in the world's oceans. They are infected by specific viruses, cyanophages. So-called auxiliary metabolic genes (AMGs) encoded in the genome of cyanophages are believed to facilitate the takeover of the cyanobacterial cell by maintaining host metabolism during infection.[1] A commonly occurring AMG is the plastocyanin-like gene *petE*.[2] Plastocyanin (PetE) is found in most photosynthetic organisms and it ferries electrons from the cytochrome *b6f* complex to photosystem I (PSI).[3] We hypothesize that phage PetE is one of many tools cyanophages use to hijack cyanobacterial cells for viral replication and we investigated its role during infection.

We demonstrated that phage *petE* encodes for a functional plastocyanin. This viral gene is advantageous during infection as its deletion causes a clear delay in host cell lysis. Phylogenetic analysis showed that phage PetE has conserved amino acid alterations and clusters separately from its cyanobacterial counterparts. Furthermore, *in silico* prediction suggested that phage PetE has different properties compared to host PetE, and biochemical studies employing recombinant protein confirmed that phage and host PetE differ in midpoint redox potential and isoelectric point. In addition, the rate of *in vitro* PSI reduction by phage PetE was significantly slower than host PetE.

Our results suggest that the main interaction partner of phage PetE may not be PSI. Instead, we postulate that phage plastocyanin redirects electrons towards the respiratory cytochrome terminal oxidase. Thus, it contributes to the proton motive force, and helps meeting the high ATP demand required by phage genome replication.

Reference #1

D. Lindell, J.D. et al. Nature, 2005, 438(7064), 86-89.

Reference #2

Puxty, R. J., et al (2015. Photosynthesis Research, 126(1), 71-97.

Reference #3

E.L. Gross. Photosynthesis Research, 1993, 37(2), 103-116.

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