OA3.8 - Photoacclimation in a newly isolated Eustigmatophyte alga capable of growth using far-red light

Benjamin M. Wolf[1,2], Meghan C. Barnhart-Dailey[3], Dariusz Niedzwiedzki[2], Jerilyn A. Timlin[3], Robert E. Blankenship[1,2,4]

[1]Department of Biology, Washington University in St. Louis, St. Louis, MO 63130
[2]Photosynthetic Antenna Research Center, Washington University in St. Louis, St. Louis, MO 63130
[3]Department of Bioenergy and Defense Technologies, Sandia National Labs, Albuquerque, NM 87185
[4]Department of Chemistry, Washington University in St. Louis, St. Louis, MO 63130

In most plants, algae, and cyanobacteria, photosynthesis is driven using light absorbed within the visible spectrum, 400-700 nm. However, sunlight additionally contains significant amounts of energy in the far-red region, 700-750 nm, and this light is typically transmitted through or reflected by oxygenic phototrophs. This creates a niche in the shade of other species where specialized oxygenic phototrophs can thrive using this wasted far-red light. By utilizing selective far-red light growth chambers, we have isolated a novel Eustigmatophyte alga, named FP5, from an aquatic environment in Forest Park (St. Louis, MO, USA) that can be grown using far-red light as its sole energy source. We have found that FP5 accomplishes this though light harvesting antenna protein complexes that shift the absorption of chlorophyll *a* into the far-red region.

Under its native growth conditions, FP5 would be exposed to not only dim, far-red light but also at times to much brighter unfiltered sunlight. To understand how a far-red adapted oxygenic phototroph responds to intense visible light, we grew this organism under both optimal far-red light as well as less-optimal blue light. To investigate the changes that occurred in the antenna system, we utilized hyperspectral confocal fluorescence microscopy (HCFM), steady-state and transient absorbance and fluorescence spectroscopy, and native gel electrophoresis. We found significant changes in the antenna architecture under blue light, which causes a general elimination of two far-red forms of the antenna while maintaining a basal red form. These observations indicate an ability of FP5 to radically alter its photosynthetic light harvesting system in response to varying light conditions.

As intense blue light leads to an elimination of the far-red forms of the FP5 antenna, we intend to further investigate the nature of the far-red system through comparative proteomic and transcriptomic studies. The response of FP5 to blue light has thus proven a valuable tool for investigating the specific changes required to endow the cells with this unusual far-red photosynthetic capacity. Understanding this capacity to utilize far-red light could have broad impacts on agriculture through genetic modification of crops and improvement of photosynthetic outputs, especially under shaded conditions.

(Supported by Photosynthetic Antenna Research Center (PARC), a Department of Energy (DOE) Energy Frontier Research Center (EFRC) under Grant #DE-SC 0001035. Data collected at Sandia National Labs was approved for public release (SAND2017-10711 PE).)