Gas exchanges measurements of carboxysome mutants reveal conditional phenotypes and insights into cyanobacteria carbon concentrating mechanism.

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Gas exchange measurements in plants have improved the depth and resolution of photosynthesis and plant CO2 assimilation rates, yet this technique is not widely adapted for cyanobacteria. Cyanobacteria are faster growing than plants, single-celled, and have a well-characterized carbon concentrating mechanism (CCM), but how individual components affect carbon utilization remains poorly understood. The central part of the CCM in cyanobacteria is a proteaceous bacterial microcompartment (BMC) called the carboxysome. Carboxysomes are unique among BMCs because they house rubisco, the critical metabolic enzyme in carbon-fixing autotrophs. This demand creates selective pressure on the carboxysome and associated proteins to evolve rapid responses to environmental stressors. Our knowledge of central carboxysome components is limited to their role in assembly and structure. More poorly understood is the function of accessory shell components widely found throughout carboxysome-containing bacteria phyla. Also, the field's current hypothesis of the carboxysome shell as a selectively impermeable barrier lacks direct evidence. We utilize novel gas exchange techniques adapted for liquid cultures to characterize the general photosynthetic performance within the cyanobacteria *Synechoccocus elongatus* PCC7942 and elucidate accessory shell components' role in carbon fixation and carboxysome function. This research aids in our understanding of BMCs and improves future designs of synthetic BMCs.