A Metabolically Versatile Cyanobacterium and the Low-Oxygen Proterozoic World

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The delay in the rise of oxygen to present day levels at the end of the Proterozoic represents an important gap in our understanding of ancient biogeochemical cycling. Little Salt Spring, a karst sinkhole in Sarasota County, FL, USA, water has low sulfate concentrations (<5 millimolar) and micromolar concentrations of both oxygen and sulfide in the photic zone, similar to ocean surface conditions expected during long stretches of the Proterozoic. Red microbial pinnacle mats which are rich in 2-methyl bacteriohopanepolyols, an important microbial biomarker, occupy the sediment-water interface in the sunlit upper basin of the sinkhole. We isolated a dominant member of the pinnacle mat, a red cyanobacterium, which is capable of primary productivity by anoxygenic photosynthesis and also produces 2Me-BHPs. in situ analyses indicate the isolate is capable of performing anoxygenic photosynthesis in the pinnacle mats. Physiological characterization suggests the isolate is poised to rapidly switch between oxygenic and anoxygenic photosynthetic activity. Genomic sequencing provides insight into the genetic machinery underlying this physiology which is not well-characterized in cyanobacteria, as well as the synthesis of 2Me-BHPs. We discuss the role of this metabolic versatility in situ and as a mechanism that could have stabilized the low-oxygen Proterozoic world in the presence of oxygenic phototrophs. photosynthetic activity of the isolate (B). DCMU, 3-(3,4-dichlorophenyl)-1,1-dimethylurea.

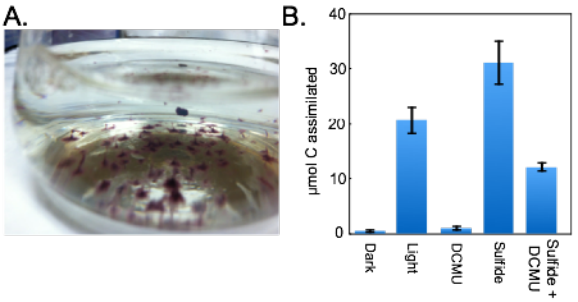

Figure 1. Little Salt Spring cyanobacterium in axenic culture (A), and anoxygenic photosynthetic activity of the isolate (B). DCMU, 3-(3,4-dichlorophenyl)-1,1-dimethylurea.