Cold-loving bacterium from a mountain lake harvests light energy using both bacteriochlorophyll-containing photosyntems as well as proton-pumping rhodopsins

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Bacterium *Sphingomonas glacialis* AAP5 isolated from the alpine lake Gossenköllesee contains genes for anoxygenic phototrophy as well as proton-pumping xanthorhodopsin. However, these genes are not expressed in standard laboratory conditions. In order to find under which conditions the organisms expresses its light harvesting apparatus we conducted a larger investigation employing RNA sequencing, RTqPCR, metabolic assays and biochemical and biophysical investigation of its photosynthetic complexes. We found out that our strain readily express xanthorhodopsin when illuminated at temperatures below 14°C. In contrast bacteriochlorophyll-containing reaction centers are expressed between 4 and 23°C in the dark. Thus, cells grown at low temperature under natural light-dark cycle produced both photosystems. The photosynthetic complexes contain circular light harvesting complex 1 surrounding the type-2 bacterial reaction center. The light harvesting complex is composed from 16 homodimeric subunits. Each subunit binds one bacteriochlorophyll-a pair and one spirilloxanthin molecule. The purified xanthorhodopsin contains carotenoid nostoxanthin serving as an auxiliary antenna and performs the standard photocycle. The xanthorhodopsin-producing cells reduced upon illumination their respiration by 70%. This documents that the harvested light energy was utilized in the metabolism, which can represent a large benefit under carbon-limiting conditions. The presence of two different photosystems may represent a metabolic advantage in alpine lakes where photoheterotrophic organisms face large changes in irradiance, limited organic substrates and low temperature.

References:
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