Simultaneous presence of bacteriochlorophyll and xanthorhodopsin genes in a freshwater bacterium.

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Photoheterotrophic bacteria represent an important part of aquatic microbial communities. There exist two fundamentally different light-harvesting systems: bacteriochlorophyll-containing reaction centers or rhodopsins. Here, we report a photoheterotrophic *Sphingomonas* strain isolated from an oligotrophic lake, which contains complete sets of genes for both rhodopsin-based and bacteriochlorophyll-based phototrophy. Interestingly, the identified genes were not expressed when cultured in liquid organic media. Using RT-qPCR, RNA sequencing and bacteriochlorophyll *a* quantification, we document that bacteriochlorophyll synthesis was repressed by high concentrations of glucose or galactose in the medium. Coactivation of photosynthesis genes together with genes for TonB-dependent transporters suggest the utilization of light energy for nutrient import. The photosynthetic units were formed by ring-shaped LH1-RC complexes with bacteriochlorophyll *a* and spirilloxanthin as the main light-harvesting pigments. The identified rhodopsin gene belonged to the xanthorhodopsin family, but lacks salinixanthin antenna. In contrast to bacteriochlorophyll, the expression of xanthorhodopsin remained minimal under all experimental conditions tested. Since the gene was found in the same operon as a histidine kinase, we propose that it might serve as a light sensor. Our results document that photoheterotrophic *Sphingomonas* use the energy of light under carbon-limited conditions, while under carbon-replete conditions they cover all their metabolic needs through oxidative phosphorylation.