Genus *Polaromonas* contains species with both rhodopsin and bacteriochlorophyll-based phototrophy

Mohit Kumar Saini
Laboratory of Anoxygenic Phototrophs, Institute of Microbiology CAS, Třeboň 37901, Czechia

Polaromonas is a psychrotolerant and aerobic bacteria commonly found in cold environments such as glacial ice, permafrost, alpine lakes, and polar regions. Members of this genus, which belongs to the class *Betaproteobacteria*, are notable for their metabolic versatility with ability to adapt low temperatures and nutrient-poor conditions. To date, 10 species of *Polaromonas* have been described, none of which are known to be phototrophic.

In this study, we isolated four strains of *Polaromonas* (MK2, MK5, MK7, and MK13) from freshwater samples collected from the Římov Reservoir in South Bohemia, Czech Republic. All strains were rod-shaped, Gram-negative, motile, and grew optimally under aerobic conditions with a 12 h light/12 h dark cycle at 15–20 °C (growth range: 4–25 °C) and at pH 7.2. Bacteriochlorophyll *a* and spheroidenone were identified as the major pigment. Spectral analysis revealed an unusual absorption peak at 828 nm in strains MK5, MK7, and MK13, while MK2 exhibited a standard peak at 860-870 nm—suggesting the presence of a potentially novel light-harvesting complex.

The 16S rRNA gene sequences of the isolated strains showed 98.22–98.62% similarity to known type strains (*Polaromonas eurypsychrophila* and *Polaromonas aquatic*). Phylogenetic analysis suggests the presence of three novel species: one represented by MK2, one by MK7 and another grouping MK5 and MK13. Whole-genome analysis revealed that all strains possess intact photosynthetic gene clusters (PGCs), with strain MK7 uniquely harbouring both PGC and xanthorhodopsin genes, indicating dual phototrophy. Additionally, one strains (MK2) contained genes associated with carbon fixation (RuBisco).

These findings suggest that the isolated strains represent novel species within the genus *Polaromonas*, exhibiting unique metabolic capabilities, including anoxygenic phototrophy, rhodopsin - based phototrophy and carbon fixation.