An Omics-based View on the Physiology of Electrically-conductive Cable Bacteria

ANDREAS SCHRAMM

Section for Microbiology & Center for Electromicrobiology, Department of Bioscience, Aarhus University, DK-8000 Aarhus, Denmark. andreas.schramm@bios.au.dk

Cable bacteria of the family Desulfobulbaceae form centimeter-long filaments comprising thousands of cells. They occur worldwide in the surface of aquatic sediments, where they connect sulfide oxidation with oxygen or nitrate reduction via long-distance electron transport, and can have a massive impact on the biogeochemical cycling of sulfur, iron, nitrogen, and phosphorous. We have used a combination of genomics, transcriptomics, proteomics, and microscopic imaging of selected traits to shed light on the metabolism and ecophysiology of these as yet uncultured bacteria. Our combined data suggest that cable bacteria oxidize sulfide by inversing the canonical sulfate reduction pathway and have limited organotrophic potential but may assimilate smaller organic acids and alcohols. Cable bacteria fix CO_2 using the Wood-Ljungdahl pathway, and synthesize polyphosphates and polyglucose as storage compounds. We propose a model for electron flow from sulfide to oxygen that involves periplasmic cytochromes, type IV pili as integral components of conductive periplasmic fibers, and periplasmic oxygen reduction. This model suggests that the multicellular cable bacteria gain energy in their anodic, sulfide-oxidizing cells, while their cathodic cells in the oxic zone live of their storage compounds and flare off electrons through intense oxygen reduction without energy conservation.