Bypassing the redox ladder: cable bacteria as electron sinks for other microbes

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Many coastal marine sediments display activity of long filamentous bacteria, so-called cable bacteria, that couple sulfide oxidation at depth to oxygen consumption at the surface. By performing long-distance electron transport these novel microbes bypass the conventional ‘redox ladder’ in sediments. Conjointly, cable bacteria drastically change the geochemistry of the sediment at a centimeter-scale, which thus could also affect the microbial community functioning. This study provides the first evidence for a tight metabolic link between cable bacteria and chemoautotrophic bacteria in marine sediments. Using stable isotope labeling combined with biomarker analysis, it was possible to show that in the presence of cable bacteria, high rates of chemoautotrophy were observed in centimeter-deep anoxic sediments. This deep chemoautotrophy could not be attributed to cable bacteria, as Nano-SIMS ^{13}C-labeling revealed that the incorporated carbon was organic (propionate) rather than inorganic (bicarbonate). Experiments in which electrogenic sulfur oxidation was inhibited (induced anoxia and cutting of sediment), showed a decrease in ^{13}C-incorporation into biomarkers for both organic and inorganic carbon, indicating a metabolic interdependence of the two microbial communities. Our results suggest chemoautotrophic bacteria (most likely sulfur oxidizing Gammaproteobacteria and Campylobacterales) may use the cable bacteria as an electron sink in centimeter-deep sediments where electron acceptors (O_2, NO_3^-) are not available. The exact interspecies electron transfer mechanisms however remains unresolved. Long-distance electron transport by cable bacteria hence gives a new twist to the sedimentary ‘redox ladder’, by providing a bio-available electron sink in deeper sediments.