Hydrogen is an energy source for endosymbiotic bacteria of hydrothermal vent mussels

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To date only two electron donors have been clearly identified as energy sources for chemosynthetic symbionts of invertebrates from hydrothermal vents and cold seeps: sulfide and methane. The energy yield from aerobic hydrogen oxidation is higher than from sulfide and methane, but no hydrogen-oxidizing vent or seep symbionts are currently known. In this study we show that vent mussel symbionts use hydrogen as an energy source. The mussel *Bathymodiolus puteoserpentis* dominates the biological community at the Logatchev vent field on the Mid-Atlantic Ridge where hydrogen concentrations are unusually high due to serpentinization. The Logatchev mussels harbor both sulfur- and methane-oxidizing symbionts in their gills. *B. puteoserpentis* gill tissues consumed H_2 at significantly higher rates than symbiont-free mussel tissue indicating that the symbiotic bacteria are responsible for the observed activity. Incubation experiments with radioactively labeled bicarbonate showed carbon fixation in symbiotic gill tissue with H_2 as the only electron source. Using primers specific to the *hynL* gene coding for the large subunit of the membrane-bound uptake hydrogenase we were able to amplify and sequence this gene from the symbiont-containing gill tissues of *B. puteoserpentis*. We also found this gene in other vent mussels including *B.* aff. *thermophilus* that harbors only thiotrophic symbionts. This indicates that it is the thiotrophic and not the methanotrophic symbiont that is able to use hydrogen as an energy source. Intriguingly, we were not able to amplify the *hynL* gene in mussels with thiotrophic symbionts from seeps, where H_2 concentrations are typically very low. Given the high concentrations of hydrogen at some vent sites, this electron donor could contribute significantly to primary production by chemoauotrophic symbionts.

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