Switch-hitting carbon; An investigation of metabolic flexibility in hydrothermal vent tubeworm symbiosis.

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The well-studied symbioses of the Siboglinidae tubeworms have helped our understanding of life in chemosynthetic environments. However, the full extent of their metabolic breadth or flexibility remains elusive. The tubeworms (having no mouth, gut or anus) rely on intracellular gammaproteobacteria for nutrition. Early work verified that high primary productivity rates for this association were supported by a sulfur oxidizing symbiont that uses the Calvin-Benson-Bassham cycle to fix carbon. However, the isotopic values for the tubeworms are not consistent with this cycle. Recently, metagenomics and proteomic studies have shown that the symbionts have and express the genes for key enzymes in the reductive tricarboxylic acid cycle, suggesting this symbiont could be utilizing two different carbon fixation pathways. Here we present data from a series of experiments with Riftia pachyptila and Ridgeia piscesae to determine A) whether both modes of carbon fixation are active B) what role the environment has in determining which pathway is utilized and C) whether morphologic and isotopic differences among host worms is a reflection of the carbon fixation pathway favored. Accordingly, we did a series of high-pressure shipboard experiments on Riftia, incubating them under varying conditions. In addition, we collected and compared Ridgeia from vent sites that have differing geochemical regimes and morphotypes. Employing transcriptomics, proteomics and isotopic analyses, our data are consistent with a model by which the symbiont favors one pathway over the other as a response to geochemical conditions. The switch-hitting of carbon fixation modes is, to our knowledge, unprecedented among vent symbioses and may represent an adaptive strategy for the stochastic vent environment.