Evidence for Mixotrophy and Metabolic Switching in Chemotrophic Hot Spring Microbial Communities

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Microbial communities inhabiting high temperature (>73°C) and non-photosynthetic geothermal springs are commonly assumed to be supported primarily by chemolithoautotrophic metabolisms. However, recent isotopic evidence suggests that chemosynthetic microbial populations in some geothermal environments in Yellowstone National Park (YNP), Wyoming utilize both organic and inorganic carbon sources, and may be capable of metabolic switching between autotrophy and heterotrophy depending on organic substrate availability. To test this hypothesis, we used a radiotracer approach to quantify and compare rates of dissolved inorganic carbon (DIC), formate ($HCOO^-$), and acetate ($C_2H_3O^{2-}$) assimilation and/or mineralization in 13 YNP chemosynthetic communities that span a range of geochemical conditions (pH, temperature, DIC/DOC levels, etc). These data were combined with taxonomic profiling of and geochemical measurements to identify populations and geochemical regimes that may dictate substrate preferences and transformation rates in these communities. Our results indicate that, while DIC assimilation is greater than that of formate and acetate in most YNP chemotrophic communities, formate and/or acetate assimilation and/or mineralization (heterotrophy) also occur in these systems at rates that are often comparable, and in some cases exceed, those of DIC assimilation. Moreover, substrate suppression experiments indicate that populations preferentially utilize formate over DIC as a carbon and/or energy source, suggesting the capability of metabolic switching between these carbon sources in response to changing substrate concentrations. Native DIC, $HCOO^-$, and $C_2H_3O_2^-$ concentrations were inversely correlated with rates of their utilization, indicating a role for biological activity in maintaining low *in situ* substrate concentrations.