POTENTIAL ROLE OF LATERAL GENE TRANSFER IN THE EVOLUTION OF BIOFILM COMMUNITIES AT THE LOST CITY HYDROTHERMAL FIELD AND IN THE EARLIEST STAGES OF CELLULAR EVOLUTION. William J. Brazelton[1], Mausmi P. Mehta[1], and J.A Baross[1], [1]Center for Astrobiology and Early Evolution and School of Oceanography, University of Washington, Seattle, WA 98195. braz@uw.edu.

Densely populated microbial biofilms at the Lost City Hydrothermal Field are thriving in carbonate chimneys where fluids can reach 90ºC and pH 10-11, conditions previously unknown to support life [1]. Environmental sequencing studies of 16S rRNA genes have shown that biofilms inhabiting the hottest, highest pH zones are dominated by a single archaeal species [2]. We report further work that has revealed metabolic, morphological, and genetic diversity in these biofilms that could not have been predicted from 16S rRNA sequences. Both methanogenesis and anaerobic oxidation of methane (AOM) at 80ºC and pH 10 were detected at similar rates. Transmission electron microscopy revealed multiple cell morphologies within the biofilm, and some cells contained intracellular membranes that may facilitate methane oxidation. Furthermore, environmental sequencing of the intergenic transcribed spacer (ITS) region [3] and a nitrogen fixation gene (*nif*H) yielded much greater diversity than evident in 16S rRNA. The wide phylogenetic range of *nif*H sequences suggests the influence of lateral gene transfer (LGT). Indeed, 8% of all metagenomic sequences from a Lost City carbonate chimney encode transposases, the enzymes required for insertion of DNA during LGT. All previously reported metagenomic datasets contain at least an order of magnitude fewer transposases [4]. These results suggest that rampant LGT among members of the Lost City biofilm may serve as a generator of phenotypic diversity in a community with very low organismal diversity.

The emerging view of the Lost City biofilms as consortia of multiple subpopulations that are metabolically linked and frequently sharing genes is reminiscent of the pre-Darwinian proto-cells imagined by some authors as the transition between chemical evolution and modern cellular evolution [5-7]. Proto-cells would have existed in something like a biofilm where they were metabolically linked with other proto-cells and with whom they engaged in promiscuous lateral gene transfer. Frequent genetic exchange would have promoted a unity of biochemistry in the early stages of evolution while also increasing the phenotypic diversity of the community, allowing divergence of distinct lineages. These hypothetical processes thought to be important to the early evolution of life can be directly investigated today by examining the biofilms of Lost City carbonate chimneys.

References:

[1] Kelley D. S. et al. (2005) *Science*, *307*, 1428-1434.

[2] Schrenk M. O. et al. (2004) *Environ. Microbiol*, *6*, 1086-1095.

[3] Brazelton W. J. et al. (2009) *Environ. Microbiol. Reports*, DOI: 10.1111/j.1758-2229.2009.00097.x

[4] Brazelton W. J. and Baross J. A. (2009) *ISME J.*, *3*, 1420-1424.

[5] Baross J. A. and Hoffman (1985) *Origins Life Evol. Biosphere*, *15*, 327-345.

[6] Kandler O. (1994) Nobel Symposium No. 84, Early Life on Earth, 152-160.

[7] Woese C. R. (1998) *PNAS*, *95*, 6854-6859.