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Novel Extracellular Electron Transfer Mechanisms and Interspecies Interactions in a Marine Sediment Microbial Consortium

JOSHUA SACKETT AND ANNETTE R ROWE

University of Cincinnati

Presenting Author: sacketja@ucmail.uc.edu

Extracellular electron transfer (EET) is the process by which some microorganisms transfer electrons across membrane(s) to/from solid-phase surfaces, such as minerals or electrodes. While significant advances in the understanding of mechanisms of EET-driven iron respiration have been made in organisms such as *Shewanella oneidensis* MR1 and *Geobacter* species, little is known about the mechanisms and ecology of mineral oxidation processes in marine sediments. To better elucidate the mechanisms and ecological implications of EET in oxidative processes, we are investigating the genetic basis of oxidative EET in pure cultures, and the nature of interspecies interactions during EET in co-cultures, of electrode-oxidizing *Thioclava electrotropha* ElOx9^{T} and *Idiomarina* sp. strain FeN1. These two organisms, isolated from the same marine sediment, are physiologically distinct and genetically tractable. Genomic and physiologic investigations into these organisms have shown that *Thioclava* is capable of heterotrophic and chemolithoautotrophic growth with elemental sulfur or hydrogen. Conversely, *Idiomarina* is an obligate aerobic heterotroph and is auxotrophic for eleven amino acids. Both organisms engage in cathode oxidation (-278 mV vs. SHE) – a proxy for mineral oxidation – yet their genomes lack homologs to canonical genes implicated in EET, such as the multi-heme outer membrane cytochromes responsible for iron respiration in *Shewanella* and *Geobacter* species.

To gain insight into the genetic basis of oxidative EET in these organisms, we conducted a suite of high-throughput whole-genome mutagenesis screens and transcriptome analyses. Whole-genome mutagenesis screens in *Thioclava* identified over 50 essential genes for cathode oxidation, including several hypothetical proteins and poorly characterized oxidoreductases that are predicted to localize to the cellular envelope. Transcriptome sequencing and comparative analysis of pure and cocultures is illuminating shifts in gene expression profiles and interspecies interactions under oxidative EET conditions. These experiments provide insight into novel mechanisms of extracellular electron uptake and illuminate potential mechanisms of electron transduction in polymicrobial marine sediment biofilms. In this presentation, I will discuss the results of these screens and report on our progress to biochemically characterize some of these gene candidates.