

Compositional and functional transition in epibiotic symbionts of *Shinkaia crosnieri*: Morphology, structure, energy and carbon metabolisms during rearing

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Galatheid crab, *Shinkaia crosnieri* (Decapoda: Galatheididae) forms dense colonies in deep-sea hydrothermal vent fields in the Okinawa Trough. The individuals *S. crosnieri*, which collected from the Hatoma Knoll and Iheya North fields in the Okinawa Trough, had numerous morphologically novel ventral setae covered with filamentous epibiotic microorganisms. Phylogenetic analyses using 16S rRNA gene cloning and fluorescence *in situ* hybridization revealed that filamentous microbial communities were heterogeneous and consisted of previously uncultivated phylotypes within the *Epsilonproteobacteria* (the Sulfurovum group) and the *Gammaproteobacteria* (thioautotrophic and methanotrophic symbiont groups) in both populations from the different fields. The tracer uptake experiments using the stable carbon isotope labeled substrates clearly demonstrated that both $\text{H}^{13}\text{CO}_3^-$ and $^{13}\text{CH}_4$ were assimilated into the setae associating the epibiotic microbial communities, and epibiont-independent tissues of living *S. crosnieri*. The incorporation of $\text{H}^{13}\text{CO}_3^-$ into the microbial cells and the animal tissues was strongly promoted only by the presence of the reduced sulfur compounds but not by the presence of H_2 . This clearly implies that strictly sulfur-oxidizing chemolithoautotrophic and methanotrophic production of the epibionts supports the trophic basement of *S. crosnieri*. The populations of *S. crosnieri* collected from both fields were successfully reared in sulfidic and aerobic environment in an aquarium for more than 5 months. Transition in the epibiotic community structure and metabolic activity was monitored. During the rearing, only potentially thioautotrophic gamma-proteobacterial epibionts among the initially predominant components was sustained while methanotrophic gamma-proteobacterial and thioautotrophic epsilon-proteobacterial components were replaced by other newly emerging bacterial components

Challenges to mineral-water interface models: Nanoparticles, molecularity, and ordered water

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In electrical double layer (EDL) models like Stern-Grahame, electrical charge and potential are assumed to be uniform in any specific plane above an oxide surface. In models like diffuse double layer, constant capacitance and triple layer, mass laws are written to describe reactions of averaged surface hydroxyls, while mass laws for surface species formation are corrected with electrostatic terms based on model-dependent charge and potential calculated for planes within the Stern layer. More recently, the concept of multiple site models were introduced that kept the concept of uniform planes of electrical charge and potential. Despite the use of such 'plane' models for the EDL, it is known that surface electrical potentials should be much larger near surface sites. This discreteness in charge has a significant effect on predictions of electrical potential in the diffuse layer, but in the absence of theory including molecularity, models all adopt the planar uniform-potential picture. A question is how such models might be applied with nanoparticles, especially in the 1-10 nm length scale where large deviations from normal behavior are both expected and observed? How much of the 'unusual' behavior is due to interfacial charge distributions affected by high curvature effects, e.g. differences in pKa of low-coordination surface sites?

Adding to the complication is the nature of interfacial water, whose molecularity is always left out of EDL formulations. To first order the dielectric constant near the surface ought to be smaller than in the bulk, with gradual decay back to bulk with distance. But higher order hydrogen bonding arrangements are also important, and ordered local layering of water may have a large effect on interface structure, outer sphere complexation and nanoparticle-nanoparticle interactions.

Our immediate interests reside in improving the description of interfacial water, from both the simulation and experimental standpoint. Crystal truncation rod (CTR) studies yield information on the ordered part of the interfacial water, while use of crystal-chemical constraints allows assignment of dipolar orientations. Interferometric sum-frequency vibrational spectroscopy (SFVS), allows assessment of all surface water species with non-cancelling dipole moments. These methods are thus complementary, but applying them in combination remains daunting. The issues raised here will be discussed using initial results from goethite, diasporite, alumina and hematite interfacial characterization.