Small Thiols Enhance Mercury Methylation Rates By Sulfate-Reducing Bacterium *Desulfovibrio desulfuricans* ND132 By Enhancing Hg Solubility

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Abstract:
Background: In order to help understand mercury uptake mechanisms in Hg-methylating bacteria, we examined the effect of a variety of sulfur-bearing Hg ligands and amino acids on methylmercury (MeHg) production by *Desulfovibrio desulfuricans* ND132. Dissimilatory sulfate-reducing bacteria (DSRB) are important mediators of this process in anoxic sediments and soils, and all of the identified Hg-methylators are *Deltaproteobacteria.* The metabolic pathways and genes involved in Hg uptake MeHg production by DSRB remain poorly understood. The facilitated uptake of Hg bound to amino acids has been proposed as an explanation for the ability to produce MeHg. However, the role of amino acids and small thiols in Hg methylation by DSRB has not been examined.
Methods: MeHg production experiments were conducted both in batch culture and with washed cells in minimal medium. Cells were grown up in pyruvate/fumarate medium reduced with TiNTA. In all cases, the Hg partitioning among species (inorganic Hg(II), MeHg and Hg^0) and between cells, culture medium, bottle walls was closely monitored. ND132 was used as a model strain because of its high methylation rate. Ligands included small amino acids with and without thiol moieties, and the thiols thioglycolate, DTE and mercaptoethanol. MeHg production serves as a surrogate for Hg uptake, as MeHg production is known to be intracellular.
Results: All of the thiol-bearing ligands tested significantly increased MeHg production by ND132 relative to unamended culture medium, while non-thiol amino acids (his and met) did not. Similarly, all of the thiols enhance Hg solubility, while his and met did not. MeHg production was linearly correlated with the amount of inorganic Hg in solution. In short-term (3h) washed cell assays, ND132 converted almost 100% of the filterable inorganic Hg into MeHg. Differences in MeHg production were not related to effects of the ligands on cell activity. Almost all of the MeHg produced by cells was rapidly excreted.
Conclusions: Small thiols appear to enhance Hg methylation by *D. desulfuricans* ND132 at least in part by holding inorganic Hg in solution. Since the thiols tested included compounds with a range of additional functional groups, charge and size, it is unlikely that they enhanced Hg uptake by stimulating specific amino acid transport mechanisms.