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Biodegradation and Bioremediation of Chlorinated Aliphatics by Methane-utilizing Bacteria

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Trichloroethylene (TCE), one of the typical chlorinated aliphatics, an organic chemical that has been used primarily as an industrial solvent for the last decades. The deliberate discharge of TCE into the environment has resulted in a persistent contamination problem in subsurface soils, sediments, and groundwater. The contamination of the chlorinated compounds has been of heightened concern due to its toxicity and potential carcinogenicity. TCE and other chlorinated compounds are generally more efficiently degraded and mineralized under aerobic conditions than anaerobic. Cultures of methane-utilizing bacteria (methanotrophs) and the cultures coexisting with heterotrophs can degrade or mineralize those chemicals more rapidly than other autotrophs (i.e., ammonia oxidizers) and heterotrophs. The methanotrophs are divided into two major groups based on 16S rRNA sequence information: Group I and Group II. Only a few species of each group have been reported to produce soluble methane monooxygenase (sMMO) which is actively involved in the non-specific and cometabolic degradation of the recalcitrant organics including TCE. Quite extensive researches have been performed on the sMMO because of its relative easiness in preparation and its importance in industrial and environmental application, particularly, the remediation of recalcitrant chemicals in the enviroment. The sMMO is a complex enzyme system which is composed of three protein components: A, B and C. The three gene clusters coding sMMO have been reported in the strains, *Methylococcus capsulatus* Bath, *Methylosinus trichosporium* OB3b and *Methylocystis* sp. M. The gene clusters possess a partial DNA sequence homology for each other and the genetic information appears to be diversified without a clear orientation. In contrast, particulate methane monooxygenase (pMMO) has been much more refractory to biochemical study and hence genetic study. However, a pMMO system from the strain Bath has been purified and its gene cluster has been recently elucidated. The gene cluster carries two open reading frames, *pmoA* and *pmoB* which turns out to be evolutionary related to the gene cluster coding ammonia monooxygenase from an ammonia utilizer (*amoA* and *amoB*). Recently the important roles of methanotrophic cultures in biodegradation and bioremediation (especially, *in situ*) of various halogenated aliphatics have been broadly recognized. Moreover, their remediation technologies utilizing methanotrophs have been extensively studied in laboratory and pilot scale levels and, more recently, rapidly moves on field scales for commercial application.