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Ecological and biogeochemical aspects of microbial degradation of phenolic materials in the California coastal marine environment

A dissertation submitted in partial satisfaction of the requirements for the Doctor of Philosophy in Marine Biology

by

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ABSTRACT OF THE DISSERTATION

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Phenolic materials are found in numerous environments. They are particularly well represented in coastal environments due to anthropogenic pollution, *in situ* production by marine organisms, and as a component of riverine humic materials flowing into estuaries. They were thus chosen as model compounds for the study of microbially mediated organic carbon dynamics in coastal systems. To determine the rates and utilization dynamics of phenolic materials by coastal marine bacteria, a sequential approach was used in which marine bacteria were first assayed to determine their ability to utilize phenolics, various sites in the California coastal zone were then analyzed qualitatively and quantitatively for phenolic materials, a method was developed to determine microbial utilization rates of phenolic materials using a high specific activity radiolabeled tracer and finally, utilization rates of *p*-cresol were determined at ambient concentrations.

Phenol, cresol isomers (*o*-, *m*-, and *p*-), catechols, and methoxyphenols were the predominant phenolic materials identified in several representative coastal environments off California. Concentrations ranged from about 2.5 to 370 $ng \cdot l^{-1}$. Biodegradation rates of *p*-cresol were measured in five coastal areas using high specific activity ^{3}H-labeled *p*-cresol added at no more than 10% of the ambient *p*-cresol concentration. Rates of microbial utilization were high, up to 35.5 $ng \cdot l^{-1} \cdot hr^{-1}$ in San Francisco Bay. Turnover times were calculated using the measured ambient concentration of *p*-cresol and ranged from 1.72 hours (San Francisco Bay) to 37 hours (at Spanish Landing in San Diego Bay). Utilization kinetics indicated microbial degradation of more complex, humic type material containing phenolic moieties.

From this work, it is concluded that biodegradation of phenolic compounds plays a major role in the biogeochemistry of organic materials in coastal marine environments. Rates determined for the breakdown of the phenolic component of humic materials in estuarine environments indicate that microbially mediated turnover times are considerably faster than for other means suggested, such as photodegradation or sedimentation.

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