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BIODEGRADABILITY OF HYDROCARBONS BY CYANOBACTERIA[1]

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Five cyanobacterial species (*Phormidium* sp., *Nostoc* sp., *Anabaena* sp. *Aphanothece conferta*, and *Synechocystis aquatilis*) isolated from the Suez Canal coast at the city of Ismailia (Egypt) were tested for biodegradation of four hydrocarbon (HC) compounds: two aliphatic compounds (*n*-octadecane and pristine) and two aromatic compounds (phenanthrene and dibenzothiophene). High degradation efficiencies for the two aliphatic compounds were measured for *A. conferta* (64% for *n*-octadecane and 78% for pristine) and *S. aquatilis* (85% for *n*-octadecane and 90% for pristane). However, the other biodegradation percentages ranged between weak and moderate percentages.

Key index words: Aphanothece conferta; **biodegradation of hydrocarbons; cyanobacteria; marine aquatic pollution; Suez Canal coast**

***Abbreviations:* BTMA, benzyl-trimethylammonium-chloride; DCM, dichloromethane; HC, hydrocarbon; OCC, organo-clay complexes**

Pollution of marine environments with HCs has become a worldwide problem on the tide of industrialization. The sources of marine HC pollution are mainly runoff from land and municipal/industrial wastes, routine ship maintenance like bilge cleaning, air pollution from cars and industry, natural seeps, tanker accidents, and offshore oil production (NRC 1985, U.S. Coast Guard 1990). It has long been known that poly-nuclear aromatic HCs exhibit serious toxic and carcinogenic effects (Miller and Miller 1974, McCann et al. 1975). Therefore, the study of the biotransformation and biodegradability of these aromatic compounds in the environment is of basic and particular value.

The main process acting in the cleanup of HC-contaminated ecosystems is microbial biodegradation, which has been extensively studied and reviewed (Atlas 1984, Leahy and Colwell 1990, Chaillan et al. 2006). Numerous microorganisms, including bacteria, fungi, and yeasts, are known for their ability to degrade HCs (Oudot et al. 1993, Chaillan et al. 2004). In tropical crude oil production sites, cyanobacterial mats often develop on petroleum-polluted zones including surface soils and water environments. After the release of oil during the Gulf War in Kuwait, a bloom of cyanobacteria intimately associated with oil was also observed (Sorkhoh et al. 1992).

There is increasing evidence that photosynthetic microorganisms, particularly cyanobacteria, may contribute to the oxidation and degradation of HCs. However, it is important to emphasize that only in some cases were the tested cyanobacterial cultures axenic and that many studies have been carried out on nonaxenic cultures.

Among the earliest studies on the potential of photosynthetic microorganisms, including cyanobacteria, for aromatic HC oxidation is the study of Ellis (1977). This author investigated the phenol and catechol degradation potential of some microalgae and cyanobacteria. Most of the work on aliphatic HCs has focused on the potential of these phototrophs for the complete utilization of these compounds.

Previous reports have shown the ability of cyanobacteria to oxidize oil components. Al-Hasan et al. (1998) reported that nonaxenic cultures of *Microcoleus chthonoplastes* and *Phormidium corium*, isolated from oil-rich sediments of the Arabian Gulf, were able to degrade *n*-alkanes. Studies on *Oscillatoria* sp. and *Agmenellum quadruplicatum* demonstrated their ability to oxidize naphthalene to 1-naphthol (Cerniglia et al. 1980a). Other studies showed that *Oscillatoria* sp. can oxidize biphenyl to *n*-hydroxybiphenyl (Cerniglia et al. 1980b) and that *A. quadruplicatum* metabolizes phenanthrene into *trans*-9,10-dihydroxy-9,10-dihydrophenanthrene and 1-methoxy-phenenthrene (Narro 1985). Several other strains were reported to degrade crude oil and other complex organic compounds (Lee et al. 1974, Cerniglia et al. 1984, Yan et al. 1998, Radwan and Al-Hasan 2000, Raghukumar et al. 2001, Mansy and El-Bestway 2002). However, in most biodegradation studies with cyanobacteria, it was not clear whether the strains used were definitively axenic (Abed and Köster 2005). It is known to be very difficult to cultivate cyanobacteria in axenic culture and to clean them from naturally associated aerobic heterotrophic bacteria. Thus, the contribution of aerobic heterotrophic bacteria associated with cyanobacteria to the biodegradation process needs to be carefully evaluated. In this study, I have addressed this

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