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Differential Response of Marine Diatoms to Solvents

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Unicellular algae in aquatic ecosystems are subjected to a variety of pollutants from sources such as runoff from agricultural lands and industrial outfalls. Organic solvants are natural components of oil deposits and commonly find their way into surface waters as a result of discharges from refineries, waste oil, disposal, and accidental spills. Organic solvents can make their way into the environment as industrial wastes. Because of their carcinogenic potential (Ward et. al. 1986), contamination of soil and water by solvents is cause for serious concern. Relatively few reports have been published on the comparative toxicity of solvents towards test organisms, and these dealt primarily with fish and aquatic invertebrates (Bringmann and Kuhn 1980; LeBlanc and Suprenant 1983). However, only few data of toxicity effects of solvents on algae have been published (Pearson and McConnell 1985 Lay et. al., 1984; Ward et. al. 1986; Stratton 1987; Tadros et. al.1994).

Phytoplankton species vary in their tolerance to trace metals (Stratton 1987; Tadros at al., 1990). Diatoms in particular are able to detoxify trace metals by the excretion of organic compounds (Butler et. al.1980). In a previous study, (Tadros and Johansen 1988) reported that diatoms collected from different sites in the Gulf of Mexico varied in their physiological characteristics.

Algae have been considered to be good indicators of bioactivity of industrial wastes (Walsh and Merril 1984) Unicellular algae vary in their response to a variety of toxicants (Tadros et. al.

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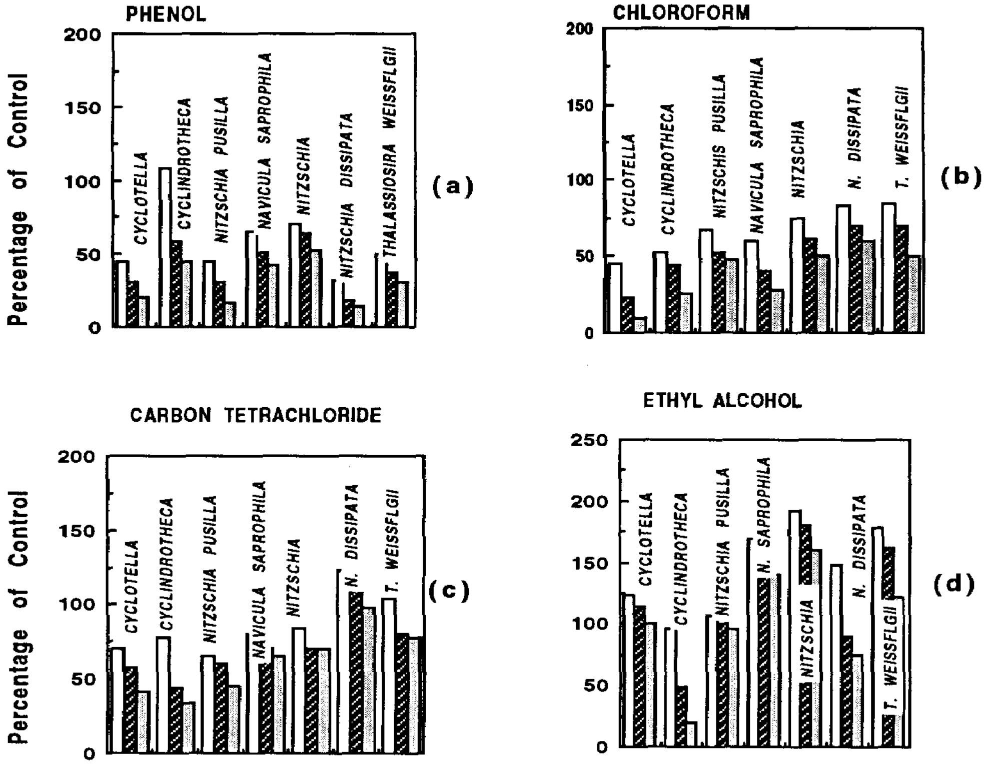
1980). Little is known, however, about toxicity of solvents to marine diatoms.

The work reported here was done to examine the effect of selected solvents on seven diatom species to determine whether they differed in their responses to these chemicals.

MATERIALS AND METHODS

The seven species of diatoms were collected and isolated from the intertidal region of the Gulf of Mexico (Tadros and Johansen 1988). The strains were: Cyclotella sp., Cyclindrotheca sp., Nitzschia pusilla sp., Navicula saprophila sp., Nitzschia sp., Nitzschia dissipata sp., and Thalassiosira weissflgii sp., All the species were maintained and tested in Guillard's f/2 medium (Tadros 1990) enriched with artificial sea-salt mix (Instant Ocean, Aquarium System, Inc.., East Lake, OH) and with trace elements. Salinity of the medium was 20 parts per thousand and the pH ranged between 8.0 and 8.2. All diatom species were axenic. The following chemicals were tested:ethanol, chloroform, carbon tetrachloride, trichloroe thylene and phenol. The chemicals were obtained from J.T. Baker Chemicals Co (Phillipsburg, New Jersey, USA). All test organisms were assayed in water-soluble fraction concentrations of 0.2, 0.25, 0.3 mL added to 100 mL medium. Several higher concentrations were tested, but they caused bleaching of all tested organisms and therefore they were not considered in the assay. The 1 % solution was prepared by adding 1 mL of chemical to 100 mL water (volume to volume) and stirring in covered glass bottles with Teflon-coating-lined screw caps for 2 hr. After allowing the solution to settle for 1 hr the water-soluble fraction was siphoned into another container for distribution to the test containers. The assay was carried out in tubes containing 25 mL medium. All assays were conducted in triplicate test tubes. Each test tube was inoculated from exponential growing cells at an initial density of approximately 4 x 10^3 cells/mL. All cultures were incubated on a shaker for 96 hr at a temperature of 30^0C under cool-white light producing 100 uEm^{-2} s^1 irradiation in continuous cycle. The growth was measured after 96 hr spectrophotometrically at 525 nm on a Fisher electrophotometer (Pittsburgh, Pennsylvania USA). All expe



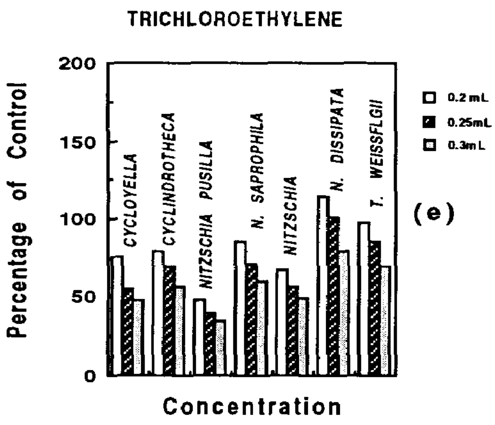


Figure 1. Effect of solvents on growth of marine diatoms, expressed as a percentage of the control. Standard deviation did not exceed 2%, of the mean for three replicates.

ri-ments were performed in a environmental chamber in the laboratory. Data in figures are the means and standard deviations from three independent experiments with triplicate cultures and triplicate samples within each individual experiment. The statistical significance of the data was estimated by means of a student's t test for $p<0.05$.

RESULTS AND DISCUSSION

Results of the assays are presented in Figure 1,. All data are expressed as percentage of the control levels. Diatoms treated with phenol (Figure 1a). The data showes that most of the diatoms were sensitive to the phenol treatment even in low concentration of 0.2%, with the exception, Cyclindrotheca sp., was stimulated at low concentration of 0.2%, but because sensitive to increasing the concentration to 0.25% or 0.3%. Algae treated with chloroform at three different concentrations, the data show that Nitzchia, Nitzschia dissipata and Thalssiosira wessflogii and Nitzschia dissip ata tolerated some what higher concentrations (0.3%) of chloroform (Figure 1b). All other species tolerated lower concentration (0.2%). Increasing the concentration of the chemical in the treatment caused inhibition in the growth. Cyclotella sp., was very sensitive to higher concentrations (0.25%, 0.3%)

However, Nitzschia dissipata sp., and Thalassiosira wessflogii sp., were stimulated in media treated with carbon tetrachloride at all concentrations (figure 1c). The other species tolerated the chemical in lower concentrations (0.2%, 0.25%). Medium was treated with ethyl alcohol in three different concentrations. The data (Figure 1d) shows that most of the species were stimulated. Ethyl Alchol was not toxic. Similar results were obtained with Skeletonema costatum sp., (Cowgill et al. 1989). However treating the algae with trichloroethylene in three concentrations, the data (Figure 1e) showed that Nitzschia dissipata sp., and Thalassiosira weissflogii sp., were stimulated at the lowest concentration (0.2%). The other species tolerated the chemical; except Nitzchia pussilla sp., was sinsitive to all concentrations.

In this work wide variations occurred in response to the chemicals among individual species of the diatoms. Nitzschia dissipata sp., and Thalassiosira Weisflogii sp., proved to be the most tolerant species. This observation is in agreement with that of Jay and Balakrishnan (1990) and Tadros et. al (1990). Investigations using differint algal species as test organisms have shown that alga vary greatly in their response to chemicals (Walsh and Merril,1984 Tadros et al. 1990; Tadros et al. 1994). Differential sensitivity of the diatom species to the chemicals could induce species shifts within communities (Cairns 1985).

It has been suggested that increased toxicity of more octanol-soluble compounds to unicellular green algae may be related either to the greater ability of these compounds to penetrate and damage the lipoprotein cell membrane or to overall lipid content of the algae (Ahlgren et al.1990)

The data presented suggest that when bioassays are conducted to determine the effect of solvents on algal species, one should consider several species to obtain realistic data (Walsh and Merril 1984).

Applying different organisms would provide a broader basis for assessing the damaging action of water pollutants. Ecotoxicological testing of potential water pollutants to evaluate their toxicity involving only one organism would give an incomplete and biased picture of the effects of pollutants.

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