Identification and Potential Biological Effects of the Major Components in the Seawater Extract of a Bunker Fuel

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INTRODUCTION

In January, 1971, approximately 840,000 gal of bunker fuel (Standard Oil Co. of California) was accidently discharged into San Francisco Bay. About 60% of the oil was recovered by methods capable of recovering only floating or beached insoluble residues (CHAN, 1973). Inevitably, escaping portions of the oil fouled littoral marine communities and water birds, often with fatal results (WHITE, 1972). Unknown amounts of the volatile fractions of oil escaped to the atmosphere, and some dissolved in the water column. We presently report the composition of the seawater extract of a bunker fuel similar to that spilled in 1971, and comment on previous methodology for obtaining the seawater-soluble fraction of bunker fuels (BOYLAN and TRIPP, 1971) as well as the possible significance of the dissolved oil to a local crab species.

"Bunker fuel" is a term applied to various mixtures of petroleum-derived compounds, which are often waste products of refineries. Although no two bunker fuels are identical, those produced by a single refinery are generally similar. We chose the present bunker fuel (identified as Chevron Tank 1899) because of its availability and similarity to that involved in a spill of major proportions, although this fuel is not necessarily representative of a uniformly formulated class of materials.

Few data have been published concerning the composition of water-soluble material released from crude or fuel oils, and meaningful conclusions regarding the biological effects of aqueous extracts of fuels are lacking (KITTREDGE, 1973; LICHOTOVICH et al., 1971). Seawater extracts of a bunker fuel have been shown to contain naphthalene as well as methyl and dimethyl naphthalenes (BOYLAN and TRIPP, 1971). The known toxicities of such compounds for fish (PICKERING and HENDERSON, 1966; HOLLAND et al., 1960) indirectly suggest that
large scale release of water solubles constitutes a threatening, though less visible hazard than the more obvious fouling effects of floating oil.

METHODS

Seawater extracts of a test bunker fuel (Chevron Tank 1899) were prepared by mixing 1000 ml aged seawater and 50 g bunker fuel in a Waring, 4 liter blender at low speed for 1 minute. The dark brown aqueous phase was separated and filtered through Whatman #1 paper. The resultant solution was filtered through diatomaceous earth and then through a 0.45μ membrane filter. The final solution was clear and colorless with no visible emulsion and had a strong cresol-like odor. Other extracts were prepared by repeating the procedure with distilled water and by eluting the water-soluble components from sand impregnated with bunker fuel. Dissolved organic compounds were recovered by extraction, either with reagent chloroform or with reagent pentane. The resultant solution was concentrated on a rotary evaporator and analyzed by gas chromatography (GLC) on a column of 20% FFAP on 70/80 AW DMCS Chromasorb W (Varian Aerograph Co.) using an Aerograph Model A550 oven with A600 electrometer. Major components were purified by preparative gas chromatography on columns of Carbowax 20M and SE-30 as required. Individual components were identified by mass spectrometry and, as necessary, by infrared spectroscopy and thin-layer chromatography.

RESULTS and DISCUSSION

Gas chromatograms of seawater extracts of bunker fuel are shown in Fig. 1. When chloroform was used for recovery, the major component of the seawater extract (Fig. 1a) comprising 36% of the dissolved oil, was identified as acetophenone, based on its mass spectrum (parent ion m/e = 120 with major fragments at m/e = 105, 77 and 51 and infrared spectrum, νC=O 1965 cm⁻¹). The component responsible for the peak of retention time 6.7 min was identified as 2-phenyl-2-propanol by its mass spectrum (parent ion m/e = 136; major fragments at m/e 43 and 121), infrared spectrum and its thin-layer Rf-value on silica gel. Other components which were identified by their mass spectra and GLC retention times included naphthalene, phenol, and o- and p-cresol. In addition, the methylnaphthalenes were identified by coinjection with authentic samples. The presence of xylenols was indicated by minor peaks with retention