Investigation on the Distribution of DDT and Aroclor 1254 in Laboratory-Grown Marine Phytoplankton

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The widespread application of organochlorine compounds as pesticides and the use of industrial synthetic materials in the last three decades has significantly increased their concentration in the environment. As a result certain toxicological, mutagenic and even carcinogenic problems related to some organochlorine compounds have been detected (EPSTEIN and LEGATOR 1971, BUTLER 1971). These factors emphasize the urgency for the further investigation of DDT and PCB's (as the most widespread organic pollutants) distribution in the global environment, their primary sources of release and their effects on basic food systems of which marine phytoplankton play an important part. Recently several papers were published in which investigation of accumulation, metabolism and various effects of organochlorine compounds on marine diatoms were described (KEIL et al. 1971, MOSSER et al. 1974). The aim of this work is to stress some experimental problems in such investigations due to the very low solubility of DDT and PCB's in water and their high adsorption affinity toward solid phase (PICER et al. 1977, PICER et al. 1977, PIERCE et al. 1974).

MATERIALS AND METHODS

Fifteen 300-ml Erlenmeyer flasks, each containing 100 ml of filtered seawater (1.2 μ Millipore filter) salinity 30‰ and nutrients for maintenance of marine algae were used. These culture media were inoculated with the monoculture phytoplanktonic species Dunaliella tertiolecta. Five flasks served as controls. In another ten flasks the solution of chlorinated compounds was added (3 μl of ethanol solution at concentration 10^{-7} g/ml). Added organochlorine compounds solutions with inoculted media were gently swirled. Flasks were capped with aluminium foil and phytoplankton was cultured at 13°C by a method previously described (PAFFENHOFER 1970). Distribution of organochlorine compounds was investigated after 2, 24, 48, 216 and 360 hr of phytoplankton growth. At previously defined times, the flask contents were filtered through a 1.2 μ Millipore filter. The content of organochlorine com-

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pounds was determined in filtrate, Millipore filter adsorbed on walls of Erlenmeyer flask, on vacuum flasks used for the filtration and on aluminium which capped the Erlenmeyer flasks.

Extraction of organochlorine compounds from the filtrate was performed by means of n-hexane. Desorption of investigated pollutants from the surface of glass and aluminium foil was performed by means of methanol-n-hexane mixture (1:1). Millipore filter contents were extracted by means of n-hexane in an ultrasonic bath.

A Hewlett-Packard Model 7620 gas chromatograph with an electron capture detector (^{63}Ni) was used for the quantitative determination of DDT and Aroclor 1254. A 4% SE-30 + 6% OV-210 column was operated at 210°C with the detector at 250°C and at the argon-methane (20:1) carrier gas flow rate of 30 ml min^{-1}. Measurements were made by comparing peak heights of sample and standards.

RESULTS AND DISCUSSION

For the determination of adsorbed organochlorine compounds on Millipore filters and phytoplankton organisms a desorption step was carried out in an ultrasonic bath by means of n-hexane. It is possible that during this extraction step EC sensitive substances were also extracted from Millipore filters. For illustrations chromatograms of these extracts are presented on Figure 1. After the purification of extracts on alumina column (Picer et al. 1977) (Figure 1, chromatogram a) there are some troublesome peaks but following silica gel separations (chromatograms b and c) no significant EC peaks remained which could create difficulties in the determination process of investigated pollutants by means of EC chromatography (PICER and AHEL 1977). Chromatograms d), e) and f) are obtained when a Millipore filter was used for the filtration of phytoplankton suspended in seawater without addition of organochlorine compounds. Extraction, clean up on alumina column and the separation of extracts on silica gel column are performed in the same way as previously described.

In Figure 2 curve 1 presents a total yield of DDT from the investigated system expressed in percents of pollutant added into a system. Distributions of DDT for filtrate (curve2), Millipore filter (curve 3), walls of Erlenmeyer flask (curve 4), walls of vacuum flask (curve 5) and aluminium cap (curve 6) are also presented in Figure 2. Some distributions and yields for Aroclor 1254 are presented in Figure 3.

It must be stressed that the presented distributions and yields are arithmetic mean values of duplicate samples. Frequently, duplicate values varied markedly in parallel samples. As an illustration of such differences Figure 4 presents the chromatograms of parallel samples.

From the presented results it is evident that in the system of laboratory-grown phytoplankton, a distribution curve of low solubility organochlorine compounds is very complex and unpredictible. As a consequence in further investigations on the toxicities of these substances on phytoplankton under similar experimental conditions great care must be taken to determine where the pollutant is added into the system.

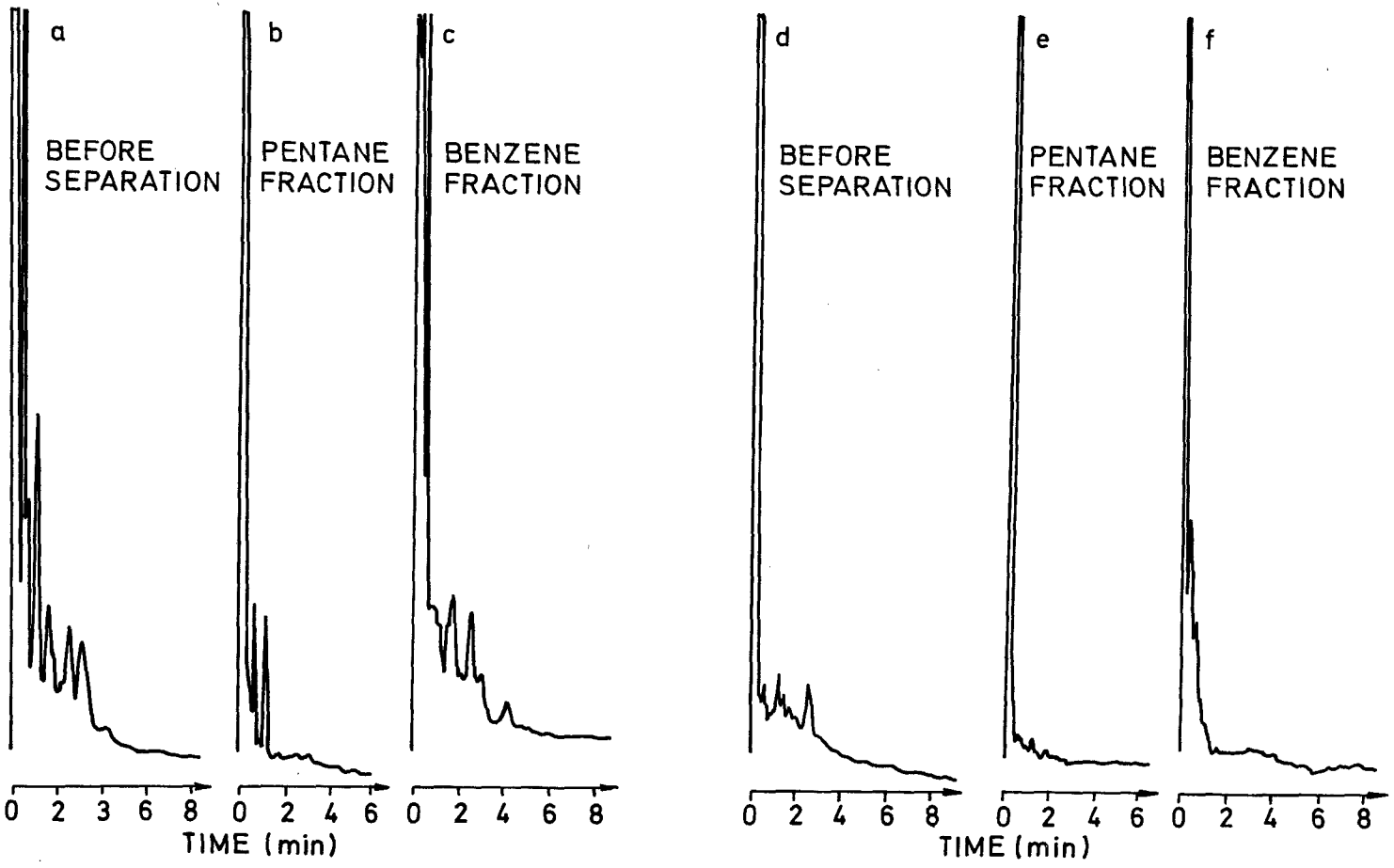

Figure 1. Chromatograms of Millipore filter extract before and after silica gel separation. Millipore filter extracts - chomatograms a), b) and c). Millipore filter plus phytoplankton extracts - chromatograms d), e) and f).

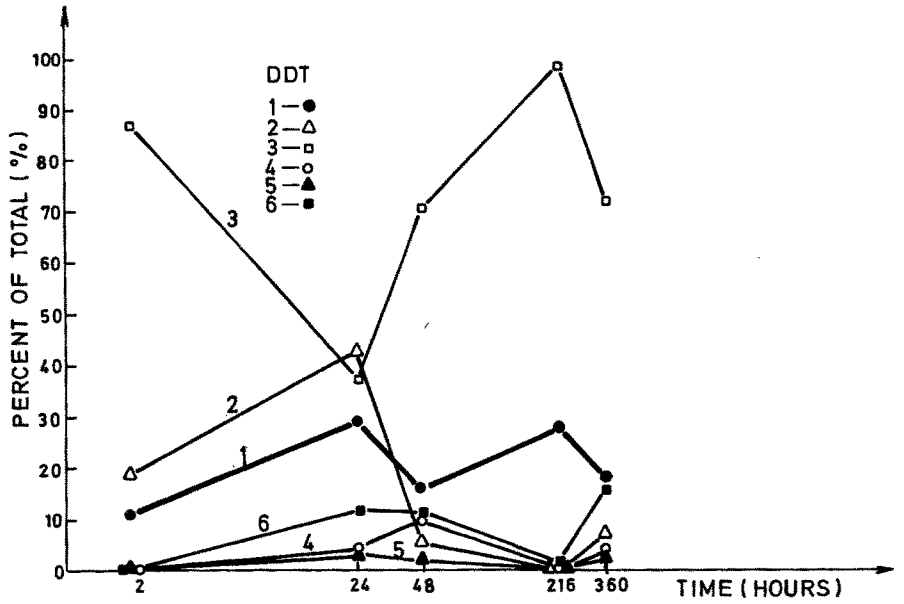

Figure 2. Total yields (curve 1) and distribution of DDT between filtrate (curve 2), Millipore filter (curve 3), walls of Erlenmeyer flask (curve 4), walls of vacuum flask (curve 5) and aluminium cap (curve 6).

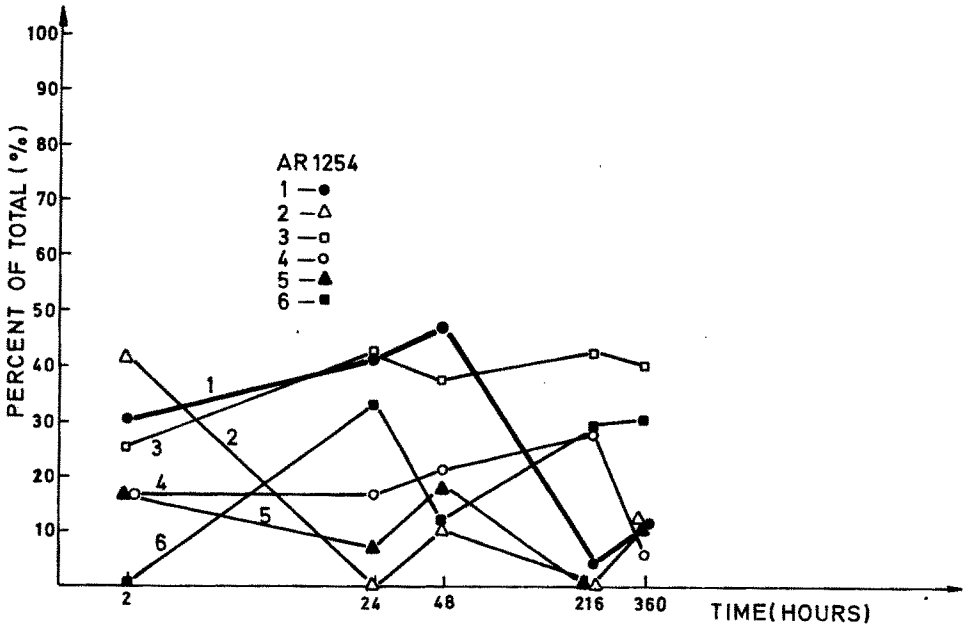

Figure 3. Total yields (curve 1) and distribution of Aroclor 1254 between filtrate (curve 2), Millipore filter (curve 3), walls of Erlenmeyer flask (curve 4), walls of vacuum flask (curve 5) and aluminium cap (curve 6).

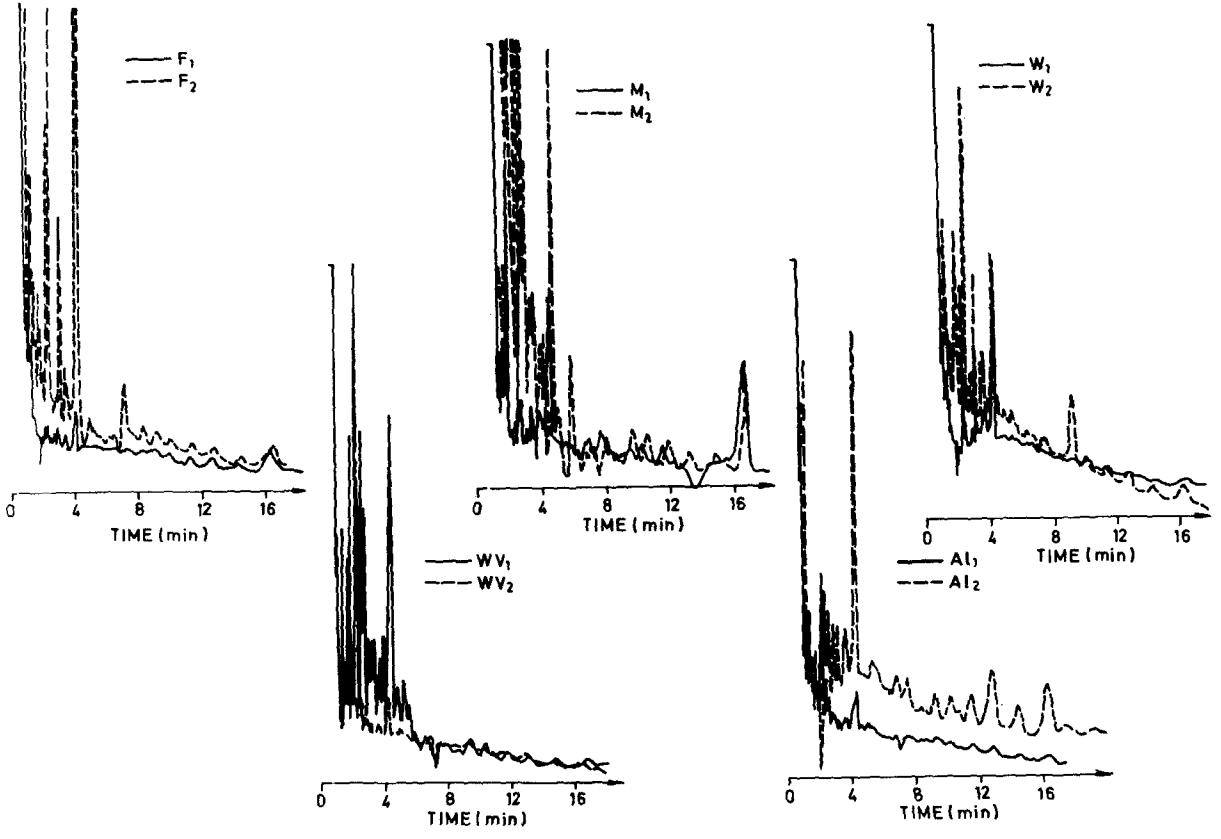

Figure 4. Chromatograms of parallel samples after alumina cleaning: F - Filtrate; M - Millipore filter extracts; W - Wall of Erlenmeyer flask; WV - Wall of vacuum flask; Al - Aluminium foil used as a cap.

Regarding the low yields of pollutants added to the system (only 4.3 percent of Aroclor 1254) difficulties encountered are primaily due to the volatility and the adsorption of investigated pollutants.

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