Studies on the Assimilation of 1,1,1-Trichloro-2,2-bis (p-chlorophenyl) ethane (DDT) by *Crassostrea virginica* Gmelin

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INTRODUCTION

Although the effects of DDT and other chlorinated hydrocarbons on the American oyster, Crassostrea virginica Gmelin, have been intensively studied (1,2,3,4,5,6), the entry site of DDT into the oyster has not been identified. The molluscan mantle, however, has been shown to be a site of active uptake for a variety of materials (7,8,9).

In this work, uptake of DDT by the oyster was studied in an attempt to isolate the entry site and an uptake mechanism. Demonstration of a site and mechanism would provide a tool, via competition and screening studies, for the determination of the normal metabolites with which DDT may compete.

MATERIALS AND METHODS

Crassostrea virginica were taken periodically from Mississippi Sound at Pass Christian, Mississippi. Individuals were selected by measurement of shell length; only those oysters measuring between 50 mm and 150 mm were used.

Groups of 7 oysters were incubated in aquaria containing sea water suspensions of powdered milk (10) and various levels of pesticides. All exposures were for six hr. Rates of change of turbidity with time were monitored by optical density readings using a Dlett-Summerson Model 900-3 colorimeter with a 5 cm light path. Statistical analyses

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confirmed that no significant effects on pumping rates of oysters were caused by a DDT concentration of less than 0.4 mg/l, an Aldrin concentration of 0.4 mg/l, or both. (See Figures 1A and 1B).

Attempts to demonstrate a mantle uptake mechanism and site using C^{14} -labeled DDT and Aldrin were unsuccessful. No mantle uptake could be shown.

Other experiments were run using non-labeled DDT. Sixty oysters were thoroughly cleaned on the outer shell surface by wire brushing and were then exposed to a flowing sea water solution of DDT (0.4 mg/l) for a period of 8 hr. Following exposure, the oysters were rinsed with clean sea water for an additional 8 hr. Random samples of six oysters were withdrain from the incubation tank after 0.5 hr, 1.0 hr, 1.5 hr, 2.0 hr, and 4.0 hr exposure.

The remaining oysters (after 8 hr exposure) were randomly divided into groups of six and are identified as follows:

Group 1. Fresh, whole DDT-treated oysters
Group 2. Fixed, whole DDT-treated oysters (fixed by injection of 5 ml of 40% formaldehyde)
Group 3. Gut washings (guts of fixed, treated oysters were washed with 6 ml of 20 ppt sea water; these "washed" individuals were then dissected and the various parts divided into groups)
Group 4. Gut tissue
Group 5. Mantle tissue
Group 6. Gills and muscle
Group 7. Mantle liquor
Group 8. Mantle washings (the mantles were washed with petroleum ether immediately after excision in order to remove any superficial DDT)

Note: The remaining 12 oysters were discarded.

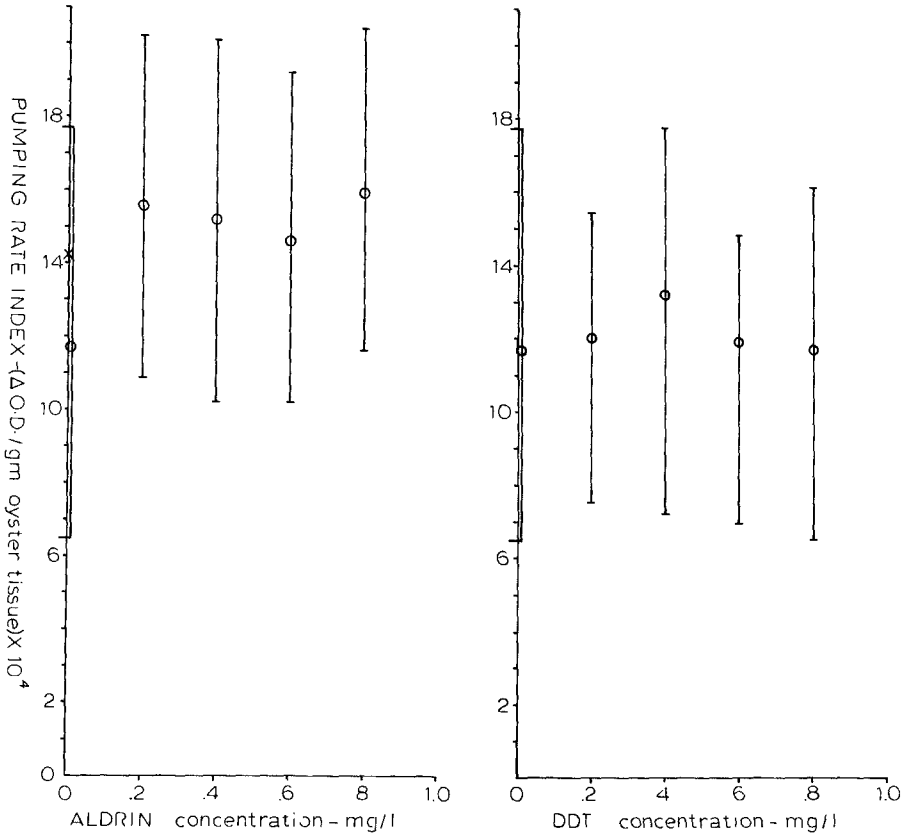

FIGURE 1A PUMPING RATE INDICES SINGLE PESTICIDE CONCENTRATION

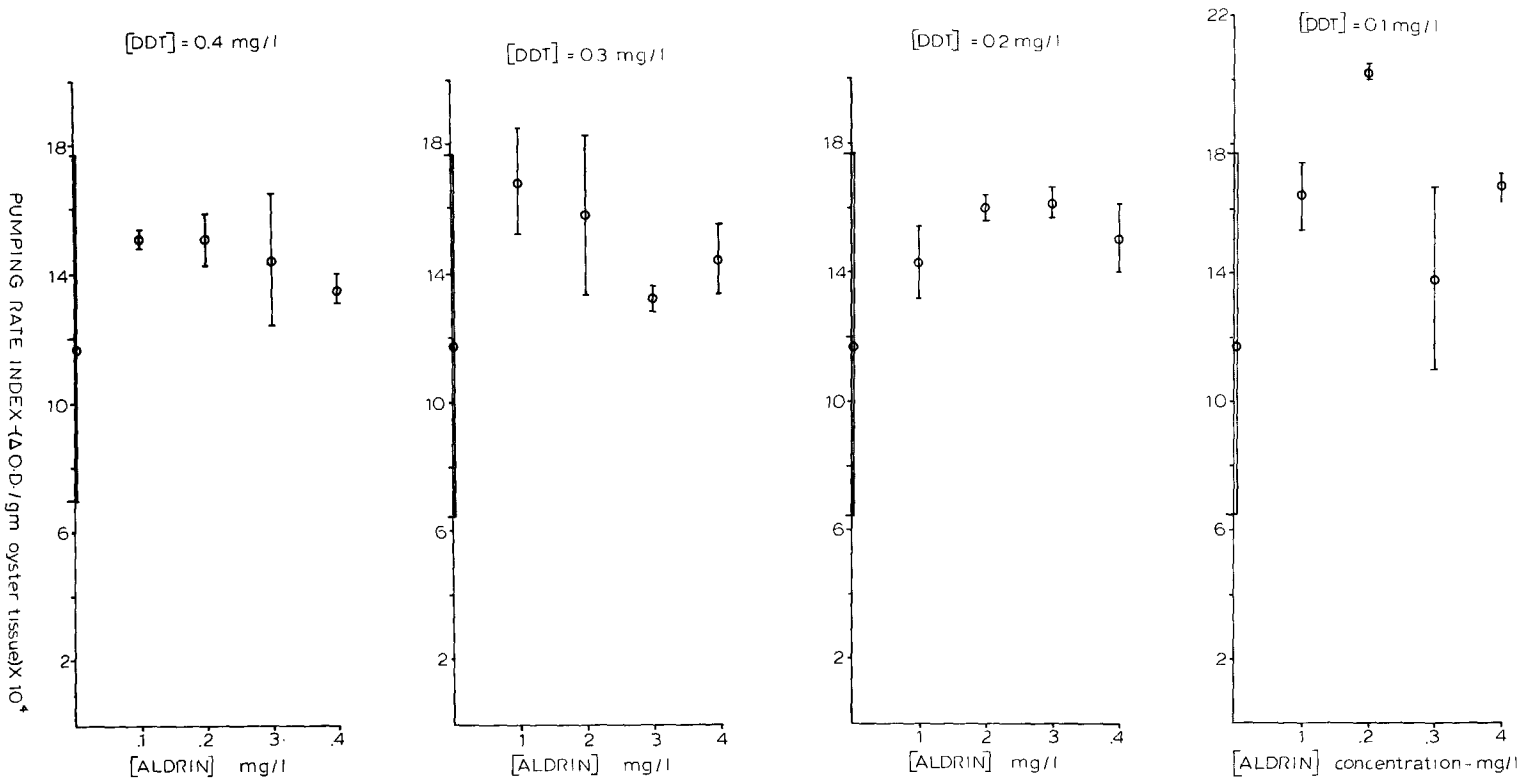

FIGURE 18 PUMPING RATE INDICES MIXED PESTICIDE CONCENTRATIONS

All samples were quantitatively analyzed by gas-liquid chromatography using a Varian-Aerograph Model 1800 gas chromatograph equipped with an Electron Capture (H^3) detector.

RESULTS AND DISCUSSION

The periodically sampled mantle tissue showed a rapid increase in DDT levels (including p,p' -DDD, 1-chloro-2,2- bis(p-chlorophenyl) ethylene and p,p' DDE, 1,1-dichloro-2,2- bis(p-chlorophenyl) ethylene) over the course of 4 hr. However, (Figure 2) the data seem to indicate uptake by diffusion rather than by active transport.

Initiation of incubation involved the insertion of the water inlet host into the oyster tank. This may have caused some of the oysters to close their shells. The apparent latent period seen in the first 0.5 hr of incubation is probably due to this initial disturbance of the oysters.

The scattered plots occurring at the 2 hr stage probably represent a sampling error. These plots were ignored when the uptake curves were drawn. There is no reason to believe that some of the metabolities, DDD and DDE, were lost only at this stage of incubation, especially since the level of DDT continued to increase regularly.

In the second portion of this experiment, (Groups 1-8), a material balance was performed on dissected, fixed oysters. Data are reported in Table 1. Rapid depletion of gut pesicide content is indicated by the neglible residues found in the gut washings. The high levels in the gill areas are of great interest. Comparison of mantle DDT levels after 4 hr exposure and no depuration period, to those following 8 hr exposure and 8 hr depuration, showed a surprisingly rapid rate of pesticide elimination.

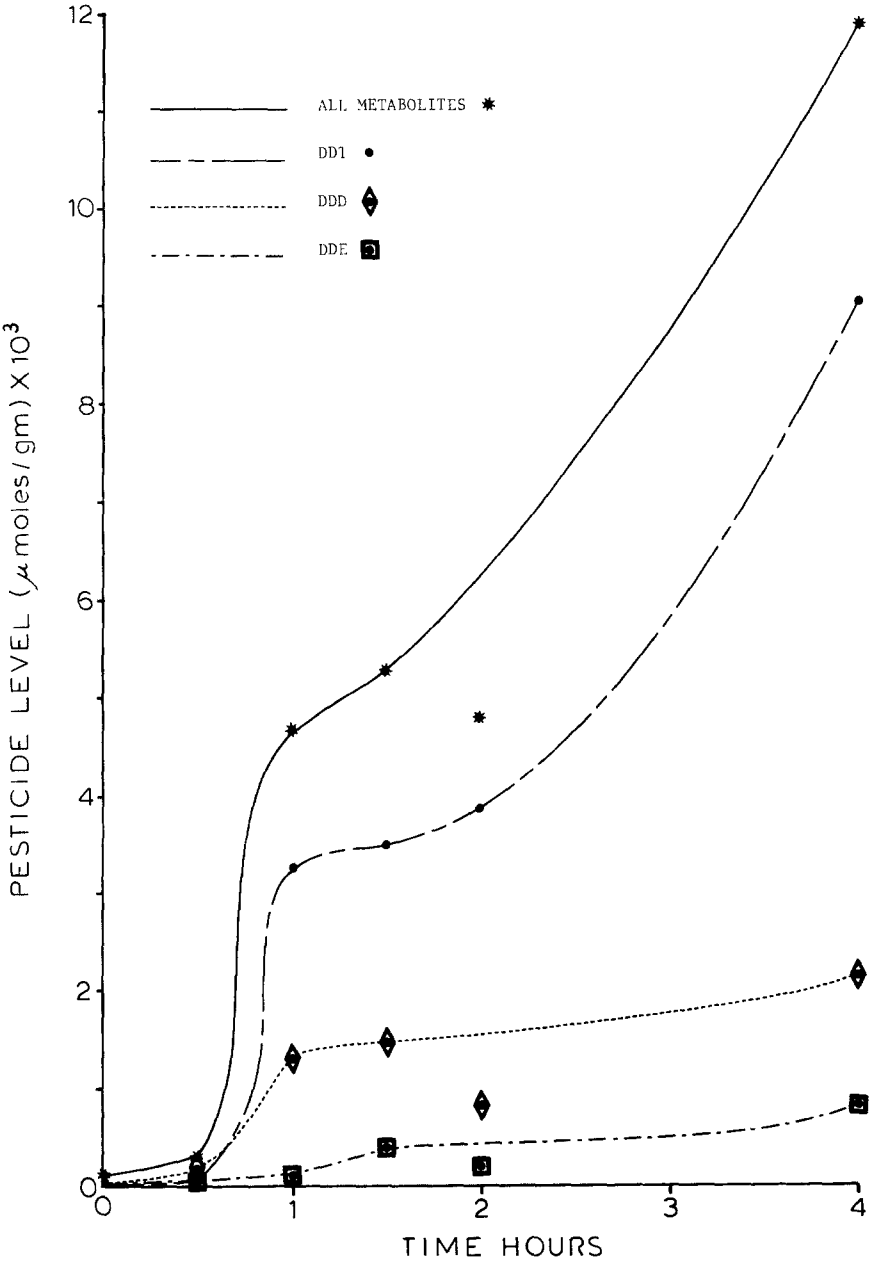

FIGURE 2. MANTLE TISSUE CONTENT OF DDT DURING TIME COURSE EXPERIMENTS

TABLE 1. DDT Material Balance - Fixed Oysters. Data are (micromoles/gm) $X10^3$, fixed whole tissue basis.

	Total Metabolites	Per Cent of Total
Gut Washings	0.01	0.04
Gut Tissue	10.19	33.4
Mantle Tissue	3.98	13.0
Gills and Muscles	16.32	53.5
Drainings	0.003	0.01
Mantle Washings	0.001	0.003
	30.50	99.953
Whole, fresh oysters	32.26	
Whole, fixed oysters	29.80	

CONCLUSIONS

The gills of the oyster are probably the primary entry site of DDT. The gut may be a DDT entry site also, but is of secondary importance. Further, mantle uptake of DDT has not been demonstrated. Hence, DDT found in the mantle is probably deposited there by the circulatory system after uptake across the gills. On the basis of the rapid rate of pesticide elimination from oyster tissue, the value of the oyster as an environmental integrator is questionable.

Reported solubility values for DDT range from 0.1 ug/l to 45 ug/l (11,12,13). Although these values are contradictory, the fact remains that DDT has an extremely low solubility in water. This low solubility, as well as a tendency for sorption on particulate matter and/or equipment employed in sample handling, may make kinetic studies with DDT and similar compounds impossible.

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