

# Avoidance of Aroclor® 1254 by Shrimp and Fishes<sup>1</sup>

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The polychlorinated biphenyl (PCB) Aroclor 1254 was found in Escambia River and Bay, which are parts of the estuary near our laboratory (DUKE et al. 1970). In laboratory experiments this chemical was toxic to certain mollusks (LOWE et al. 1972), arthropods (NIMMO et al. 1971) and fishes (HANSEN et al. 1971). Some invertebrates (HANSEN et al. 1973 and PORTMAN 1970) and fishes (HANSEN 1969; HANSEN et al. 1972; and SPRAGUE and DRURY 1969) possess the ability to avoid other toxic pollutants in water. Because it could be an advantage to mobile organisms in the river and bay if they could avoid toxic concentrations of Aroclor 1254, we conducted laboratory studies to determine if pink shrimp (*Penaeus duorarum*), grass shrimp (*Palaemonetes pugio*), pinfish (*Lagodon rhomboides*), sheepshead minnows (*Cyprinodon variegatus*) and mosquitofish (*Gambusia affinis*) could avoid water contaminated with 0.001, 0.01, 0.1, 1 or 10 mg/l of the PCB.

## Methods and Materials

Test animals were collected from local waters not contaminated by Aroclor 1254 and were acclimated to laboratory conditions for at least seven days before testing. If mortality exceeded 5% or abnormal behavior was observed in the 48 hours before a test the animals were not used. Pink shrimp were between 13 and 75 mm rostrum-telson length; grass shrimp 10-40 mm rostrum-telson length; mosquitofish and pinfish 20-50 mm standard length. Animals were not fed for 24-hours prior to testing.

The ability of these animals to avoid Aroclor 1254 was tested in a black plastic apparatus (HANSEN et al. 1972) in which animals could move from a holding area into either (1) a section that contained water with Aroclor 1254 or (2) a section that contained water without the PCB. Water maintained at 20° C, entered the upper end of each of the two sections at the rate of 400 ml/min and flowed to the drain in the holding area. Freshwater was used to test mosquitofish and 20 ‰ saltwater was used to test the other species. PCB dissolved in acetone was metered through stopcocks at 0.5 ml/min into the water entering one of the two sections. The same amount of solvent without PCB was metered into the other section.

Each species was tested at each concentration at least four times; twice with the PCB entering one section of the apparatus

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and twice with it entering the opposite section. For each of the four replications, 50 animals (except pink shrimp, when 25 animals were used for each replicate test) were placed in the holding area with a closed gate located at the junction of the holding area and the two sections. After 30 minutes the gate was opened, allowing access of animals to both sections. One hour later the gate was closed and the number of animals in each section was recorded. The apparatus was covered with black plastic during each test to shield the animals from external disturbances.

Concentrations of Aroclor 1254 selected were not lethal to any animal during the 1 1/2 hour avoidance study but 0.01 mg/l was toxic to pink shrimp, (NIMMO et al. 1971) grass shrimp, (NIMMO et al. In press) sheepshead minnows (SCHIMMEL In press) and pinfish (HANSEN et al. 1971) in chronic bioassays conducted for longer periods of time at this laboratory.

Some of the concentrations in the sheepshead minnow and grass shrimp tests were checked by chemical analysis. Methods of chemical analyses were identical to those used by NIMMO et al 1971.

The ability of these animals to avoid Aroclor 1254 was evaluated by the chi-square test on the assumption that if there was no avoidance response to the PCB, animals that left the holding area would enter each section with equal frequency. Avoidance was considered significant if the probability that observed distributions would occur by chance was 0.01 or less. Animals remaining in the circular holding area after a test was completed were not included in the statistical analyses.

### Results and Discussion

Grass shrimp, pinfish and mosquitofish avoided at least one concentration of Aroclor 1254 but pink shrimp and sheepshead minnows did not avoid any of the concentrations tested (Table 1). Grass shrimp and pinfish avoided 10 mg/l and mosquitofish 0.1, 1 and 10 mg/l of the PCB. In mosquitofish tests, PCB was added to fresh instead of salt water. Therefore, it is not known if the fish had a greater ability to avoid or if the response was affected by the test water.

This study demonstrates that some animals can avoid Aroclor 1254 in laboratory tests but we can only speculate on the possibility of avoidance of PCB's in the estuary. Concentrations of Aroclor avoided by mosquitofish in the laboratory have been found in the Escambia River near the source of a leak of this chemical (DUKE et al. 1970). Concentrations measured in water from other localities in the river and Escambia Bay never approached concentrations avoided by grass shrimp, pinfish or mosquitofish in the laboratory. If animals avoid because they sense the PCB in

TABLE 1

Capacity of aquatic animals to seek water free  
of the polychlorinated biphenyl, PCB, Aroclor 1254

Test Species	Aroclor 1254 Concentration (mg/l)	Number of Animals*		Percentage In PCB-Free Water
		In PCB-Free Water	In Water with PCB	
<u>Palaemonetes pugio</u>	0.001	60	64	48.4
	0.01	55	64	46.2
	0.1**	65	56	53.7
	1.0**	57	62	47.9
	10.0**	91	51	64.1***
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<u>Penaeus duorarum</u>	0.001	22	33	40.0
	0.01	34	34	50.0
	0.1	41	31	56.9
	1.0	33	36	47.8
	10.0	37	32	53.6
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<u>Cyprinodon variegatus</u>	0.001	51	44	53.7
	0.01**	42	40	51.2
	0.1**	48	48	50.0
	1.0	49	48	50.5
	10.0**	43	55	43.9
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<u>Lagodon rhomboides</u>	0.001	66	76	46.5
	0.01	55	48	53.4
	0.1	67	69	49.3
	1.0	121	119	50.4
	10.0	84	44	65.6***
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<u>Gambusia affinis</u>	0.01	38	34	52.8
	0.1	66	27	71.0***
	1.0	66	26	71.7***
	10.0	43	13	76.8***

\* Does not include animals in holding area at end of test.

\*\* Nominal Concentration = Average Measured Concentration:  
10.0 = 5.7, 1.0 = 0.48, 0.1 = 0.054, 0.01 = 0.033.

\*\*\* Statistically significant;  $\chi^2$ -test,  $\alpha = 0.01$ .

water, it seems unlikely that contamination by this chemical altered the movements of these animals except immediately adjacent to the site of the leak. Animals may avoid because they sense the toxic effect of a PCB and move to reduce this effect. If so, concentrations that can be avoided may possibly be much lower than shown in these tests where fish were in the PCB for a maximum of only 1 1/2 hours.

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