PCB METABOLITES SIMILAR TO PARENT PCBS IN TOXICITY TO SEA URCHIN EMBRYOS

In a preliminary assessment of the toxicity of PCB and DDT metabolites, Steven M. Bay, Darrin J. Greenstein and Karen D. Rosenthal measured effects of the metabolites in 96-hour tests using developing embryos of the purple sea urchin, *Strongylocentrotus purpuratus*. They found that three different metabolites of PCBs were toxic at low levels (0.1 to 0.4 mg/L), similar to the parent PCBs.

This is some of the first available evidence that the PCB metabolites tested — 3-Cl PCBol, 4-Cl PCBol and 5-Cl PCBol* — can be biologically active.

Previous research on the toxicity of polychlorinated biphenyl compounds (PCBs) has been concerned primarily with the parent compounds produced by industry. However, recent studies by SCCWRP researchers have shown that marine animals are exposed to metabolites of chlorinated hydrocarbons (both PCBs and DDT) in sediment and food at concentrations higher than those of the parent compounds (SCCWRP 1983-84 Biennial Report, 1984).

The researchers found that of the total PCB and DDT concentrations in marine sediments, 80 to 99 percent consisted of metabolites of these compounds. And in the tissues of marine organisms, oxygenated metabolites made up 35 to 99 percent of total PCBs and DDT. Despite the evident importance of these compounds in the marine environment, no assessment has been made of their toxicity relative to the parent compounds.

SCCWRP's sea urchin embryo bioassay has been used previously to test the toxicity of a variety of compounds (Oshida, Goochey and Mearns, 1981; Bay, Oshida and Jenkins, 1983). It is a sensitive, rapid and economical test.

Bay and his associates used the sea urchin embryo bioassay as a preliminary indicator of the toxicity of the metabolites relative to the parent compounds. The researchers exposed developing purple sea urchin embryos to a seawater solution of each compound for 96 hours. The resulting effects on sea urchin development were assessed by microscopic examination and by measuring echinochrome pigment production by the larvae.

Echinochrome is an orange pigment found in several tissues, particularly the soft tissues, of the embryo. Pigment production begins just prior to gastrulation. It is not present at fertilization. In past studies SCCWRP researchers found that accumulation of the pigment was highly correlated with normal development. As such, it is an indicator of normal development; its physiological function is not known.

In the bioassay, microscopic examination of the embryos revealed that each of the three PCB metabolites tested was capable of causing abnormal development (Figure 1). The echinochrome pigment measurements supported these observations. The estimated effective concentration (EC50) values for the compounds are shown in Figure 2. Two of the metabolites tested (3-Cl and 4-Cl PCBol) were similar in toxicity to the parent PCB mixture, Aroclor 1254, while the toxicity of 5-Cl PCBol was less than that of Aroclor 1254. Because of the static test method and low water solubility of the test compounds, the toxicant levels decreased during the exposure period. Consequently, these EC50 values are only approximate.

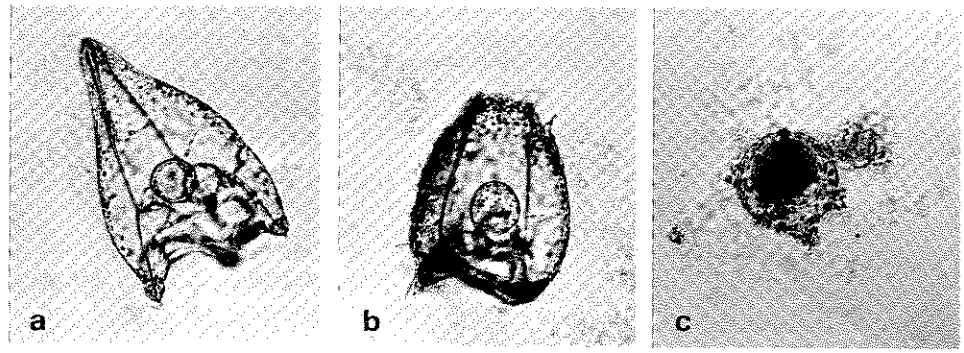

Figure 1. Developmental changes in sea urchin larvae following exposure to PCB compounds. a) Normal pluteus larvae. b) Pluteus from 0.04 mg/l PCB exposure, showing abnormal skeleton and arm formation. c) Unhatched pathologic embryo from 0.19 mg/l 4-Cl PCBol exposure.

Toxicity tests were also conducted on DDE and two of its metabolites, DDA, also known as 4-chloro-alpha-(4-chlorophenyl)-benzeneacetic acid, and DDOH, or 2,2-bis (4-chlorophenyl)-ethanol. The toxicity of DDE was similar to that of PCB. Echinochrome EC50 values for DDA and DDOH could not be calculated from the experimental data, but the results indicate that these metabolites had

less than half the toxicity of DDE.

Since the results suggest that the metabolites are biologically active, further research will be conducted using organisms which could be exposed to such compounds through sediment contact or food. These are more probable avenues of exposure than is contaminated seawater.

* 3-Cl PCBol is 2,2',5'-trichloro-4-biphenylol. 4-Cl PCBol is 2',3',4',5'-tetrachloro-4-biphenylol. 5-Cl PCBol is 2',3,3',4',5' pentachloro-2-biphenylol. There are literally hundreds of different compounds among oxygenated PCB metabolites. These three compounds were available commercially and have been found both in the tissues of marine organisms and in sediments of the Southern California Bight.

References

Bay, S. M., P. S. Oshida and K. D. Jenkins. 1983. A simple new bioassay based on echinochrome synthesis by larval sea urchins. Mar. Environ. Research 8:29-39.

Gossett, R. W., D. A. Brown, S. R. McHugh, and A. M. Westcott. 1984. Measuring the oxygenated metabolites of chlorinated hydrocarbons. pp. 155-169 In: SCCWRP Biennial Report, 1983-1984, W. Bascom (ed.). Long Beach, Calif.

Oshida, P. S., T. K. Goochey and A. J. Mearns. 1981. Effects of municipal wastewater on fertilization, survival and development of the sea urchin, *Strongylocentrotus purpuratus*. In: Biological Monitoring of Marine Pollutants, F. J. Vernberg, A. Calabrese, F. P. Thurberg, and W. B. Vernberg (eds.). Academic Press, N.Y.

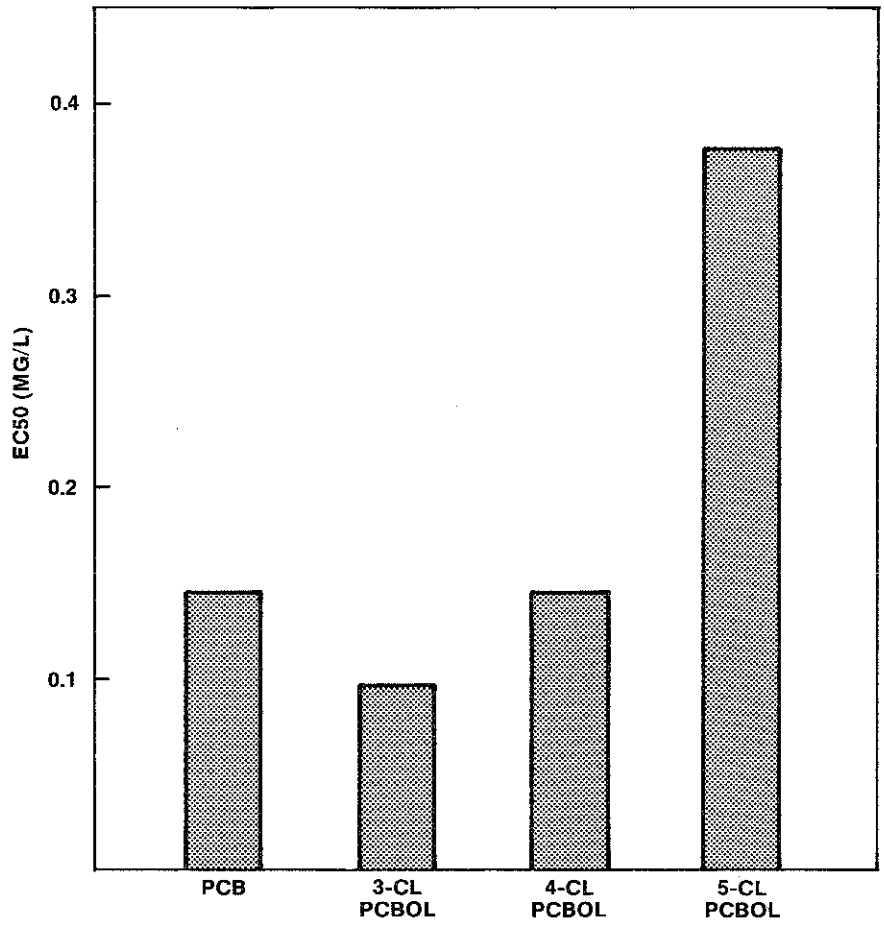

Figure 2. Relative toxicity of Aroclor 1254 (PCB) and selected PCB oxygenated metabolites (PCBols). Exposure levels producing 50% reductions in echinochrome pigment production (EC50) were calculated using toxicant concentrations at the start of each experiment.