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Effect of a PCB (Aroclor 1254) on the Striped Hermit Crab, *Clibanarius vittatus* (Anomura: Diogenidae) in Static Bioassays

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Polychlorinated biphenyls (PCBs) produced under various trade names, are compounds that have been detected in the water, sediment, and biota of marine habitats worldwide (KOEMAN et al. 1969, DUKE et al. 1970). Highly refractory, these compounds resist biodegradation (CAREY & HARVEY 1978; FURUKAWA et al. 1978) and may yet pose an environmental hazard through mechanical resuspension of, or leaching from, contaminated sediments (GRESSHOFF et al. 1977, WILSON & FORESTER 1978).

Numerous studies have been conducted concerning the toxicity of PCBs to marine decapod crustaceans. NIMMO et al. (1971,1975) in flow through bioassays recorded toxicities of Aroclor 1254 to pink shrimp (Penaeus duorarum), brown shrimp (Penaeus aztecus), and grass shrimp (Palaemonetes pugio) of 0.1 - 12.5 µg/L (parts per billion) in tests lasting one to two weeks. ROESIJADI et al. (1976) using Aroclor 1254 in static bioassays reported a 96 h LC_{50} range of 41-86 µg/L for adult P. pugio. In flow through bioassays using Aroclor 1016, HANSEN et al. (1974) gave 96 h LC_{50s} of 10.5 and 12.5 µg/L for P. aztecus and P. pugio, respectively.

Data remain scarce on the toxicity of PCBs (Aroclors) to other decapod crustaceans, in particular, anomuran crabs. With this in mind, studies were undertaken to evaluate the acute toxicity of a commercial PCB mixture, Aroclor 1254 (Monsanto Chemical Company, Lot KI02-602), to the striped hermit crab, Clibanarius vittatus.

MATERIALS AND METHODS

Hermit crabs were collected on 15 September 1977, from a marsh fringe along West Bay, Galveston, Texas, placed into 20-L plastic containers, and transported with aeration to the laboratory. Crabs were introduced as two groups into two 265-L wood and fiberglass aquaria and acclimated five days before testing. Aquaria water was changed totally every other day. Aquaria conditions were; temperature 28± 1°C, salinity 23± 2 ppt., and pH, 7.8. Food consisted of small daily portions of fish which was discontinued within 24 h of testing. Mortality in each group was less than 1% during acclimation.

Tests were conducted without aeration in 3.8-L glass jars which had been washed with acid (HCl), acetone, and distilled water. Filtered seawater from the beachfront of central Galveston Island

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was provided by the National Marine Fisheries Service, and was filtered (Whatman #2, 8 µm pore) a second time before use. To each jar was added 1 L of seawater and with stirring, one of seven concentrations of Aroclor 1254 (3,5,10,15,20,25,and 30 µg/L) dissolved in pesticide grade acetone. Acetone as a carrier does not appear to be synergistic with Aroclor 1254 (ROESIJADI et al. 1976).

Controls consisted of two concentrations of pesticide grade acetone in seawater (3 and 30 µg/L) and one of seawater only. One hour after addition of the Aroclor 1254, hermit crabs were introduced either two per jar (6 per concentration) or one per jar (3 per concentration). This was done to evaluate whether two crabs per jar was too stressful. Tests were conducted in triplicate (9 organisms per concentration, 90 organisms total) and concentrations were not renewed during the tests. Monitoring for death or moribund condition occurred at 12,24,48,72, and 96 h. Conditions in the jars were; temperature 22± 1° C, salinity 23± 1 ppt., pH 7.8, and an average dissolved oxygen concentration of 5 ppm. Animals were not fed during the tests.

RESULTS

Within the concentrations tested (7), and with the 90 hermit crabs tested, no mortalities were observed. To test this experimental design, a concurrent static bioassay with adult P. pugio (30 per concentration, 300 organisms total), showed Aroclor 1254 toxic in a range of 10-30 µg/L within 96 h. This range compares favorably with the results presented by ROESIJADI et al. (1976).

While no mortalities were observed, the crabs within the higher concentrations (20,25, and 30 µg/L) were less active than those present in the lower concentrations. Interestingly, many of the crabs in the higher concentrations as well as the lower (5,10, and 15 µg/L) did not retreat into their shells, an action which could have lowered the amount of exposed surface area. Since no mortalities were observed in any concentration after 96 h, six of the crabs already subjected to 30 µg/L were placed (2 per jar) into three other 3.8-L glass jars. These jars contained seawater and a concentration of Aroclor 1254 of 300 µg/L. Observations for 96 h indicated that no organism had yet died. This is significant considering the concentration used.

DISCUSSION

It appears from these data that C. vittatus is relatively insensitive to Aroclor 1254. Concentrations up to 30 µg/L are nonlethal. Furthermore, an experiment involving only 6 organisms previously exposed to Aroclor 1254, did not produced mortalities within 96 h at a concentration of 300 µg/L. While this small experiment is by no means conclusive, it does serve to illustrate the high tolerance of C. vittatus to Aroclor 1254.

With the polychlorinated pesticide, mirex, TAGATZ et al. (1977), in flow through bioassays, obtained mortalities of C. vittatus in 10 to 70 days using an average mirex concentration of 0.038 µg/L. In static bioassays with Pagurus longicarpus, EISLER (1969), obtained 96 h LC_{50s} of 6, 18, and 55 µg/L using p,p'-DDT, dieldrin, and heptaclor, respectively. Considering these organochlorine pesticides, Aroclor 1254 seems to be less toxic. NIMMO et al. (1971) have illustrated this in tests comparing the toxicity of p,p'-DDT and Aroclor 1254 to the pink shrimp, P. duorarum. NIMMO et al. reported that this organism was 10 times more sensitive to p,p'-DDT than to Aroclor 1254.

Physiological mechanisms allowing the intertidal scavenger, C. vittatus, to tolerate extremes of temperature, salinity, and dissolved oxygen along the Gulf Coast, may be partially responsible for its tolerance to Aroclor 1254. HALL et al. (1978) have stated that the larger surface to volume ratio of invertebrates, allowing greater absorption of a toxicant, could account for part of the greater sensitivity of some invertebrates compared to vertebrates (fish). A reduction in exposed surface area due to the shell enclosure, may have added, in some degree, to the tolerance of C. vittatus to Aroclor 1254.

NIMMO et al. (1975) have indicated that the true toxicity of Aroclor 1254 is not revealed in short term static tests. NIMMO et al. have observed that Aroclor 1254 is 10 to 100 times more toxic in flow through tests lasting several weeks. While long term flow through tests may be more significant considering present day situations, short term static tests can be useful in providing information on the response of an organism to an acute, single dosage. Further bioassay testing is required, in view of NIMMO et al.'s findings, to fully evaluate the effects of Aroclor 1254 to C. vittatus. Additional tests determining whether a detoxifying physiological mechanism or a structural characteristic (shell enclosure) are solely responsible for the tolerance of C. vittatus to Aroclor 1254 as compared to other decapod crustaceans, are needed.

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