Chronic Exposure of Blue Crabs, Callinectes Sapidus, To Sublethal Concentrations of DDT
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and a reduction in the number of predators and competing species. This simplification of the food web, together with the low diversity index, results in marked population fluctuations. In contrast to the large numbers of Collembola per sample in Frenchman's Cave, Christiansen, Willson and Tecklin (1961) reported an average of 11 Collembola per 1,500 cc sampling unit from Hunter's Cave, Iowa, where the organic content of samples at no time exceeded 5%.

Finally, several species of invertebrates found in Frenchman's Cave are of particular interest since they are most often associated with caves. How such troglophiles (facultative cave inhabitants) as the beetle *Quedius (Microsaurus)* sp., the antlike beetle *Brathinus nitidus,* and the cave orb weaver spider *Meta menardi* reached the gypsum caves of Hants County, Nova Scotia, emphasizes our ignorance of the means of dispersal utilized by organisms. Dispersal into Nova Scotia is complicated since the province is a peninsula connected to the continent by an extensive low-lying area presently covered by salt marshes and coniferous bogs. Bleakney (1958) noted that the special environments of this isthmus have limited the dispersal of many invertebrates and vertebrates, including flying forms of both. Obviously troglophiles must have means of dispersal that transport them through unfavorable environments to the habitat to which they are physiologically adapted.

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CHRONIC EXPOSURE OF BLUE CRABS, *CALLINECTES SAPIDUS,* TO SUBLETHAL CONCENTRATIONS OF DDT

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Abstract. Juvenile blue crabs, *Callinectes sapidus,* were reared in flowing seawater containing sublethal concentrations of DDT. Crabs fed, molted, and grew for 9 months in seawater containing 0.25 ppb (micrograms/liter) DDT but could survive only a few days in water containing DDT in excess of 0.5 ppb.

Commercially important marine crustaceans are extremely sensitive to many of the commonly used insecticides (United States Department of the Interior 1963, 1964), but preliminary studies show that blue crabs, *Callinectes sapidus,* will tolerate low concentrations of DDT for long periods.

This note describes the results of an experiment in which a small number of blue crabs was exposed continuously for 9 months to a sublethal concentration of DDT in flowing seawater. Such chronic exposures are of interest because blue crabs, especially the juveniles, spend much of their lives in shallow estuarine waters which may occasionally be polluted with insecticides.

This experiment was conducted at the Bureau of Com-

mercial Fisheries Biological Laboratory, Gulf Breeze, Florida, between April and December 1964. Facilities are available for conducting bioassays in flowing seawater which is pumped directly from Santa Rosa Sound.

Six juvenile blue crabs averaging 27 mm in carapace width were placed in each of three plastic aquaria with a capacity of approximately 20 liters. Each aquarium was divided into six compartments, 150 × 150 mm, to prevent cannibalism and facilitate the keeping of records on individual crabs. Seawater flowed through each aquarium at a constant rate of 154 liters/hr. Acetone stock solutions of DDT were mixed in aspirator bottles and metered into two of the aquaria at a rate of 0.5 ml per minute to obtain the desired concentration. This constant-flow apparatus was illustrated in detail by Lowe (1964). The crabs in the third aquarium were maintained as controls with only seawater flowing through the aquarium. In preliminary bioassays blue crabs tolerated a significantly higher concentration of acetone in the test solution than was used in this experiment.

The crabs were fed frozen fish throughout the experiment. Pieces of fish flesh of approximately the same size were placed daily in each crab's compartment after the removal of any uneaten food. Additional food in the form of plankton was possibly obtained from the unfiltered seawater.

During preliminary screening tests juvenile blue crabs survived only a few days in flowing seawater containing DDT in excess of 0.5 ppb. Therefore, concentrations of 0.5 and 0.25 ppb were chosen as test solutions for the chronic exposures.

Although only 4 of 18 crabs (22%) survived the entire 9 months of captive life, most appeared to feed, molt, and grow normally. Records of molting and final size of individual crabs are itemized in Table I because of the paucity of this type of information in the literature. There was no difference in behavior between the control crabs and those in the 0.25-ppb DDT solution, but frequent observations of the crabs in the 0.5-ppb solution showed this concentration to be near the threshold of tolerance. Two of the crabs in the 0.5-ppb solution became paralyzed and died after 2 weeks of exposure. These and other crabs dying in the 0.5-ppb solution exhibited typical symptoms of insecticide poisoning (extreme irritability, increased sensitivity to external stimuli, and eventual paralysis) before death.

All crabs surviving the DDT exposure molted as frequently as the controls. One crab that survived the 0.5-ppb exposure and two from the 0.25-ppb concentration molted at least six times, the maximum number of molts for any of the control crabs. The average number of molts during the first 8 weeks of the experiment was 2.5 for the crabs in both the control and 0.25 ppb DDT; no deaths occurred during this period. The crabs surviving the entire 36 weeks of captive life occupied approximately 75% of their individual compartments and had barely enough room to move around. The size variation among individuals was as expected. Data on crabs from Chesapeake Bay show that linear measurements of an instar may vary by as much as 50% of the mean dimension (Tyler and Cargo 1963). Two of the crabs surviving 36 weeks of exposure to DDT were females; half-moon-shaped abdomens indicated the ultimate instar.

TABLE I. Survival and growth records of individual blue crabs held in captivity

Test solution	Initial carapace width (mm)	Weeks of survival	Total number of molts	Carapace width at death (mm)
Control	25	36	6	121[a]
	25	22	5	87
	25	20	4	64
	25	16	3	61
	28	12	3	50
	25	11	3	49
0.25 ppb DDT	27	36	7	136[a]
	27	36	6	135[a]
	30	29	5	90
	23	26	6	114
	28	17	4	71
	25	12	3	51
0.50 ppb DDT	29	36[b]	6	114[a]
	24	20	4	53
	25	8	2	48
	30	7	2	47
	25	2	1	—
	30	2	0	—

[a] Crabs alive at end of experiment.
[b] 23 weeks in 0.5 ppb followed by 13 weeks in 0.25 ppb DDT.

Any conclusions drawn from this experiment must be made with caution because of the small number of animals used. The data suggest that a natural crab population could exist in estuarine waters chronically polluted with low levels of DDT, but that a sudden slight increase in concentration could be disastrous.

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