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Accumulation and Retention of Mirex by Brook Trout Fed a Contaminated Diet

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The detection of high levels of mirex in Lake Ontario fish has raised many questions regarding the utilization of this fishery for the present and future. Continuous monitoring programs, including trend analysis, are presently being conducted, but whether salmonids such as lake trout, Salvelinus namaycush, can effectively eliminate mirex is not known. IVIE et al. (1974) found that mosquito fish (Gambusia affinis) fed a diet containing 50 ppm mirex for 15 days contained 24 ppm mirex after that period. After being placed on clean feed for 130 days, the residues had dropped to 13 ppm, and the researchers reported that the half-life was, therefore, 130 days. LOWE et al. (1971) reported that the body burden of mirex in pinfish (Lagodon rhomboides) dropped from 30-40 ppm to 18 ppm after an elimination time of 56 days.

The objective of this study was to determine if salmonids could effectively eliminate mirex after accumulating it through their diet. Brook trout (Salvelinus fontinalis) was selected as the test organism, since it is generically close to lake trout and could be procured and handled more easily, under laboratory conditions, in the numbers of fish needed for this study.

METHODS

A total of 200 brook trout (S. fontinalis) were fed a mirex-contaminated diet for 104 days. This diet was made by dissolving mirex in acetone and then combining it with a dry trout food using a mortar and pestle. Additional dry food was added at intervals over a one-week period while mixing in a large electric mixer. Fish were fed 0.7 mg mirex/kg of body weight three times a week from June 1 through September 12, 1977. Overall feeding rate was 2.0% of the total fish weight per feeding, and the feed contained 29 µg/g mirex. At feeding times a small amount of water was added to a predetermined amount of contaminated feed and a wet paste formed which was then formed into small pellets and fed. After 17, 32, 56, 86 and 104 days of feeding, ten fish were selected at random for analysis.

After the 104-day feeding period, all fish were placed on a mirex-free diet. At 16, 32, 56, 86, 150 and 385 day intervals, ten fish were sacrificed and analyzed for mirex to determine elimination rate. All of the fish removed for analysis during the mirex feeding period, as well as the elimination period,

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were analyzed on a whole fish basis. Each fish was ground and blended in a Hobart food chopper until a homogenous mixture was obtained. The ground sample was then frozen and subsequently lyophilized. When dry, the sample was extracted overnight with hexane on a Soxhlet apparatus. A 1.0 g aliquot of the resulting lipid material was then put through a standard Florisil column (20 mm ID, 25 cm in length). Activated 60-100 mesh PR grade Florisil was used. The 6% diethyl ether in petroleum ether fraction (200 mL) was collected in a 300-mL Erlenmeyer flask and subsequently concentrated on a steam bath with a gentle stream of air. The residue was analyzed on a gas chromatograph equipped with a ^{63}Ni detector. The column was operated at 185°C with a nitrogen flow rate of 60 mL/min. A 2mm ID x 3 m glass column packed with 7.5% Viscasil 30,000 on 80-100 mesh Gas-Chrom Q was used. The detector output was analyzed on a computing integrator.

RESULTS

The results are presented in Figures 1 and 2 and summarized in Tables 1 and 2. The points and vertical line in the figures represent the mean $\pm$ the standard error for ten fish for each sampling date. There was considerable variability among different fish which indicated individual variation in the rates of mirex uptake and retention. There was no difference found, however, between males and females, and both were equally variable. Certain fish may have been more aggressive feeders and thus consumed more contaminated food.

After 104 days of mirex feeding, the average concentration in the fish was 6.3 µg/g. The rate of accumulation was rapid and never reached a plateau level. After the 385-day period of being fed mirex-free feed, the mirex concentration had dropped to an average of 2.1 µg/g. During this elimination phase, however, the brook trout increased in weight from an average of 175 g to 571 g. Therefore, the decline in the mirex concentration which was found during the elimination phase was due to growth dilution.

Figure 2 shows the total number of µg of mirex present per individual fish at each of the sampling dates. As with Figure 1, the rate of accumulation was rapid and never reached a plateau level. In contrast to Figure 1, however, there does not appear to be any decline in amount of mirex per fish during the elimination phase of the project. The average body burden at the end of mirex feeding was 1,100 µg mirex per fish, and after 385 days of uncontaminated feed, the levels averaged 1,200 µg mirex per fish. There was no significant reduction found in the levels after 385 days when compared to fish at the start of the elimination phase. The other sampling times likewise were not significantly different from the fish at the start of the elimination phase. Very little elimination of

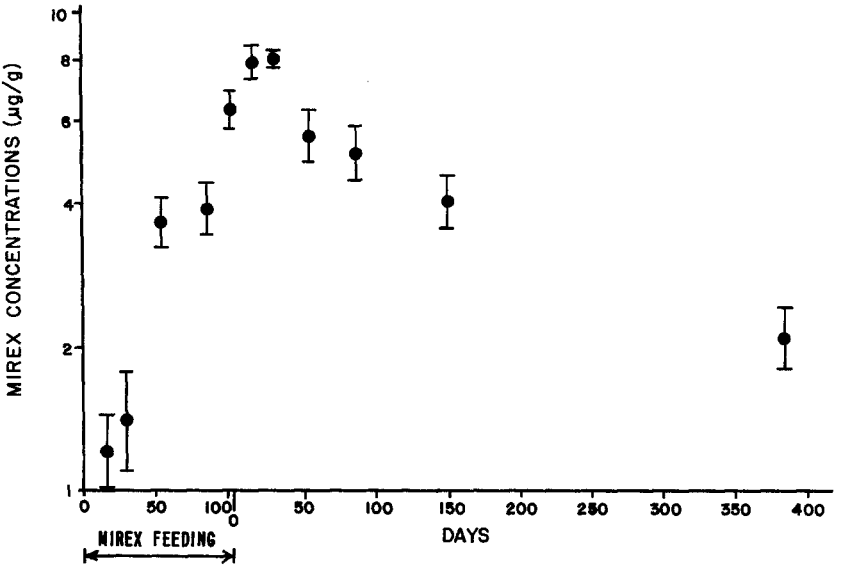

Figure 1. Mean mirex concentration (µg/g) in brook trout during and after mirex feeding.

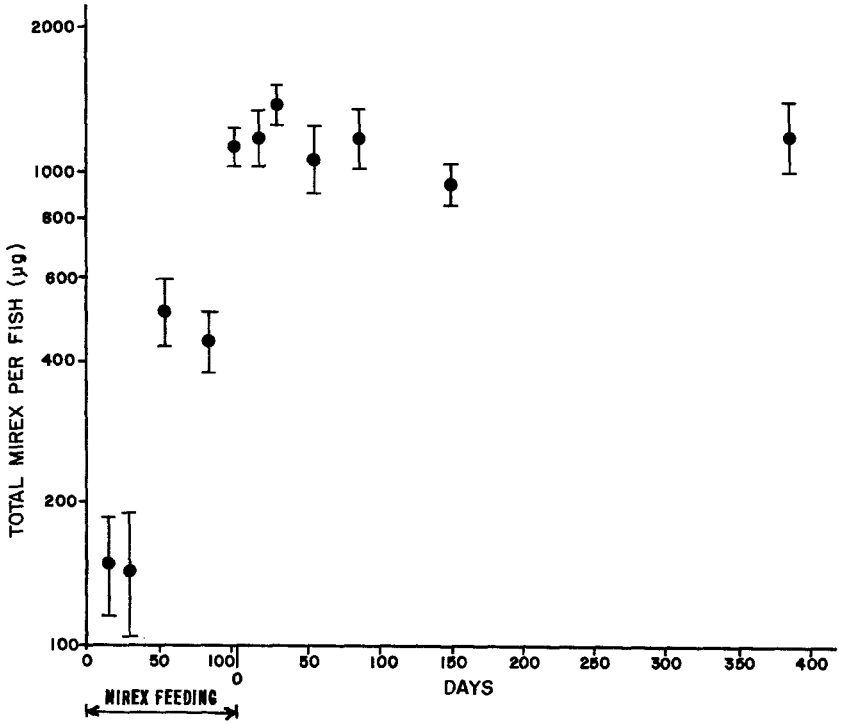

Figure 2. Total amount of mirex (µg) per fish during and after mirex feeding.

Table 1. Mirex concentrations in brook trout fed mirex-contaminated feed (0.7 mg/kg body wt.) up to 104 days.

Days from start of feeding mirex	Average length (cm)	Average weight (g)	Average conc. mirex (ug/g)*	Average total mirex per fish (ug)
17	21.7	114.5	1.2	150
32	21.2	92.3	1.4	150
56	23.2	133.7	3.7	510
86	22.7	111.5	3.9	440
104	24.4	175.0	6.3	1100

*Wet weight

Table 2. Mirex concentrations in brook trout after removing them from the mirex diet and placing them on a mirex-free diet for 365 days.

Days from cessation of feeding mirex	Average length (cm)	Average weight (g)	Average conc. mirex (ug/g)*	Average total mirex per fish (ug)
16	--	145.4	7.9	1200
32	26.3	171.3	8.0	1400
56	25.2	187.5	5.6	1100
86	26.3	231.0	5.2	1200
150	26.1	246.7	4.1	940
385	34.4	570.6	2.1	1200

*Wet weight

mirex from these fish occurred during the year they were fed uncontaminated feed. Analysis of this feed showed no measurable amounts of mirex.

Often, researchers have found similar results, but have come to different conclusions. IVIE et al. (1974) determined that the half-life of mirex was 130 days since the residue levels dropped 50% during that period. This was based on a parts per million concentration, however, and does not take into account the increase in weight of the fish during that time. LOWE et al. (1971), however, states that mirex is not easily metabolized by pinfish.

Fish mortalities during the study period were less than 5% and no higher than normal hatchery mortality. In addition, no abnormalities or reduction in growth were noted. Brook trout appear to be able to carry high levels of mirex without apparent adverse effects, as has been reported in lower forms such as crustaceans (LOWE et al. 1971). They accumulate mirex rapidly and retain it with little or no elimination for long periods. It would thus appear that a long-lived species such as lake

trout would continue to accumulate mirex in Lake Ontario as long as it is exposed to it. More importantly, it may continue to contain residues for the major portion of its life, even after the source is eliminated.

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