

Reproduction of Guppies (*Lebistes Reticulatus*) After a Single Exposure to Dieldrin— A 12 Months' Study

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Little work has as yet been done to define the amount of damage which pesticides might cause to the reproduction of fish.

Holden⁽¹⁾ expressed fears of possible dangers to reproduction by presence of DDT in fish ovaries and testes.

The U.S. Fish-Pesticide Research Laboratory in a 2 year research programme⁽²⁾ concluded that "though engorgement of DDT poisoned insects might occur shortly after an application, it is doubtful that it could recur often enough to damage a fish population". Even after deliberate addition of DDT to a stream or pond, its rate of disappearance was rapid, whilst it was considered doubtful whether normal use of DDT could damage fisheries chronically, provided repeated flagrant misuse of the pesticide could be ruled out. Studies on lake trout fry from areas of high DDT use around New York showed a relatively close relationship between the concentration of DDT in eggs and fry-mortality⁽³⁾.

As no reference to a possible relationship between dieldrin contamination and fish reproduction was found in the literature, Lebistes reticulatus (guppies), which are viviparous, were exposed to dieldrin, and the effects on reproduction studied.

MATERIALS AND METHODS

Dieldrin: Recrystallised dieldrin, HEOD content 99.5% was used.

Aquarium water: The water used in aquaria and exposure water were made up according to the formula described by the U.K. Ministry of Agriculture, Food and Fisheries: i.e., deionised water with the following salts added:- CaCl_2 , 0.320 g., NaCl , 0.029 g., NaNO_3 , 0.009 g., $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 0.151 g., Na_2SO_4 , 0.109 g., NaHCO_3 , 0.275 g., in 10 litres. The water was aerated for 24 hours before use and the final pH was 7.4.

Fish Tanks: The tanks used for breeding and rearing the fry were all-glass, measuring 12" x 12" x 18" and contained 30 litres of water. All tanks were maintained at a temperature of $21.5^\circ\text{C} \pm 1.5^\circ\text{C}$, aerated and exposed to twelve hours light per day. The light was supplied by one 60 Watt fluorescent tube per two tanks and controlled by a time switch.

Fish: The fish were bred in Tunstall Laboratory and as far as could be observed had not been mated. Before the experiment began they were approximately six months old and were within a weight range of $70 \text{ mg} \pm 10 \text{ mg}$. They were fed daily with a mixture of bran, liver meal and dried daphnia, with a weekly supplement of live mosquito larvae and fresh mouse liver.

Experimental Design

Exposure: 25 fish of each sex were placed in separate tanks containing 10 litres of prepared water to which was added 0.5 ml of a 1 mg/ml solution of recrystallised dieldrin in dimethyl sulphoxide, giving a final concentration of 0.05 ppm dieldrin. Previous tests had shown that addition of 50 ppm dimethyl sulphoxide did not influence the toxicity of dieldrin to fish⁽⁴⁾. After two hours exposure surviving fish were transferred to dieldrin-free water. Samples of the exposure water were taken before and after the exposure

period and their HEOD content determined by gas-liquid chromatography.

Reproduction: Twenty-four hours after exposure the survivors were transferred to the appropriate breeding tank. The distribution of fish in the tanks is shown in Table 1. Only seven control females were used in order to give the same number of females in each tank.

Table 1 - The numbers of *Lebistes reticulatus* used to study the effect on reproduction following exposure for 2 hours to 0.05 ppm dieldrin

Aquarium Tank No.	Number of fish used			
	Treated		Control	
	Male	Female	Male	Female
1		7	10	
2	9			7
3	7	7		
4			10	7

Litters: The litters were removed from the breeding tanks within 12 hours of birth and placed in separate tanks without adults. Records were kept of the number of fish born.

RESULTS

HEOD content of exposure water: The HEOD content of the water in which the fish were exposed is given in Table 2. The reduction in HEOD content represents an uptake by the fish of approximately 12 mg/kg body weight.

Table 2 - The HEOD content of water before and after exposure for two hours of 25 male and 25 female *Lebistes reticulatus*

HEOD content of water (ppm)			
Male		Female	
Before	After	Before	After
0.046	0.041	0.042	0.035

Mortality of parent fish: During the 12 months trial period some fish died. Therefore the total reproductive capacity of the females in each tank has been expressed in "fish-months", i.e. number of female fish multiplied by the number of months during which they were fecund. Three control females died during the year. No exposed female fish died. Four male control and one exposed male fish died during the 12 month period. "Fish-months" amounted to 84 in each tank except tank No. 2 which gave 50 "fish-months".

Reproduction: The numbers of fry produced in each tank are given in Table 3. These numbers divided by "fish-months" give the mean reproductive capacity per female per month.

Table 3 - Reproduction

Tank	1	2	3	4
Parental Exposure	Female	Male	Male + Female	Neither
"Fish-months"	84	50	84	84
Total number of fry	210	109	265	241
Number of fry per female per month	2.50	2.18	3.15	2.87

Survival of fry: Numbers of fry alive after 12 months and percentage survival is given in Table 4.

Table 4 - Survival of fry

Tank	1	2	3	4
Parental Exposure	Female	Male	Male + Female	Neither
Number of survivors	99	59	115	61
% survival	47.1	54.1	43.4	25.3

Sex ratio of fry: By the end of the 12 month period 20% of total surviving fry had reached sexual differentiation, and in all tanks the female to male ratio was 1 : 1.

Abnormalities of fry: No behavioural or anatomical abnormalities were observed in any of the fry.

DISCUSSION AND CONCLUSIONS

The median lethal concentration for a 2 hour exposure to dieldrin for Guppies (Lebistes reticulatus) is approximately 0.05 ppm, whilst for Harlequin fish (Rasbora heteromorpha) and trout (Salmo species) the median lethal concentration is approximately 0.01 ppm. However, in the laboratory the effect of dieldrin on the reproduction of these two latter species is difficult to determine because they are oviparous. A reproduction trial with guppies which are viviparous obviates many technical difficulties.

The effect of dieldrin on male reproductive activity is inconclusive, as it can be measured only by their ability to produce young in control females. The mating behaviour in the guppy is such that often the mating of one male and one female is unsuccessful and more than one male normally has to court a female guppy to result in fertilisation. As far as the female population is concerned, it appears that none of the surviving females had suffered from the exposure.

Paradoxically the exposed fish showed a better reproductive record than the unexposed fish. This can be explained by the fact that initial exposure eliminated the weaker fish and left the more robust fish. Three factors support this hypothesis: (a) the lower mortality over the year in the exposed parent fish, (b) the larger number of young produced per exposed female and (c) the superior survival rate in the offspring of exposed fish compared with the unexposed group.

The dieldrin exposure to which the parent fish were subjected was of the kind that can occur in flowing waters, and the findings regarding its effects are not in disagreement with those published by the U.S. Fish Pesti-

cide Research Laboratory in relation to D.D.T.

It may therefore be concluded that a short exposure to dieldrin up to a median lethal concentration has no harmful effect on the reproduction of surviving guppies.

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