TOXICITY OF SIX ORGANOPHOSPHORUS INSECTICIDES TO FISH

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WITH the increasing use of agrochemicals for crop protection, the possible hazard to fish in ponds and reservoirs also increases. The run-off water is also likely to contaminate rivers. During aerial spraying for the control of hairy caterpillar with endrin, mortality of fishes in wells has been reported. It was therefore felt necessary to determine the relative toxicity of insecticides to fish. A study[1] was already made of the toxicity of endrin to fish. In this note, the results of studies on the effect of organophosphorus insecticides to fish and frog tadpoles are reported.

Static, constant volume bioassays as described by Doudoroff *et al.*[2] were performed. The experimental fish used were of size 2·5 to 6·0 cm. generally except that *C. mrigala* and *L. fimbriatus* were of size 1·0–2·0 cm. (early fry). The test animals were conditioned for 48 hours prior to use. 20 l. glass aquaria jars with 10 l. water were used in the bioassays. Two early fry or one advanced fry per litre of water were used. The medium had the range of composition indicated in Table I. The final dissolved oxygen was not allowed to drop below 5·0 mg./l. The median tolerance limit (TLm) as well as the lethal concentration killing 100% of fish (LC_{100}) were noted for the duration of 48 hours. The results are presented in Table III. The concentrations of the chemicals used are furnished in Table II.

TABLE I

Quality of the water in the bioassay of pesticides

Parameters	Experiments with metasystox, parathion, malathion	Experiments with phosphamidon and nuvan	Experiment with folidol
Temperature ° C.	25·7–29·9	28·5–28·8	30·5
Dissolved oxygen mg./l:			
Initial	13·8–14·2	13·4–14·4	11·4
Final	5·4– 8·2	6·8– 9·2	6·8
Free CO_2 mg./l.	1·1– 2·10	1·5	1·2
Total alkalinity ($CaCO_3$ mg./l.)	43·5–91·0	47·2–66·8	68·1
pH	7·0– 7·5	7·1	7·0
Hardness mg./l. ($CaCO_3$)	64–96	..	..

TABLE II

Active ingredients in the commercial preparations used

Name of the insecticides as used in the tests	Manufacturers	Active ingredient
Paramar-50	Hexamar	50% parathion
Malamar-50	,,	50% malathion
Folidol E.605	Bayer	5% ethyl parathion
Metasystex	,,	25% matasystox
Dimecron	Ciba	100% phosphamidon
Nuvan 100 EC	,,	100% DDVP

TABLE III

Toxicity of six-organophosphorus insecticides to certain species of fish

Species tested	Paramar-50		Malamar-50		DDVP		Metasystox		Folidol		Dimecron	
	TLm	LC_{100}	TLm	LC_{100}	TLm	LC_{100}	TLm	LC_{100}	TLm	LC_{100}	TLmL	C_{100}
Cyprinus carpio (Bangkok strain)	6·5	9·0	10·0	13·5	15·0	22·5	9·0	18·5	..	..	51·5	76·0
C. carpio (German)	..	..	8·5	16·0	5·5	9·5	20·0–25·0	30·0	..	..	..	..
Tilapia massambica	4·0–5·0	6·0–7·0	8·3	10·0	3·0	6·8	12·0–12·5	20·0	0·6	0·8	..	..
Cirrhina mrigala	5·0	8·5	7·0	15·0	25·0–30·0	35·0–40·0	17·0	31·5	..	..	..	..
Labeo fimbriatus	7·5	10·0	8·5	12·0	18·0	37·5	16·0	28·5	..	..	..	..
Danio sp.	..	..	13·5	14·0	..	..	..	..	..	..	..	..
Labeo rohita	..	..	8·0	10·0	..	..	..	..	..	..	..	..
Barbus machecola	2·0	2·5	..	..	..	..	..	..	..	..	..	..
Frog tadpoles	..	..	..	..	10·0	18·0	..	..	..	>50·0	..	..
Gambusia affinis	..	..	..	..	..	..	..	..	0·1	0·2	..	..

From the results, it is clear that folidol is the most toxic among the organophosphorus chemicals, the TLm 48 hours for *Tilapia* being 0·6 ppm. 'Dimocron' (Phosphomidon) was the least toxic, while DDVP and metasystox were only less toxic than the phosphorothionates (parathion and malathion). Schouwenburg and Jackson[3] found that the TLm of Phosphamidon to Coho salmon was about 7·4 ppm which value is very much lower than ours. Muncy and Oliver[4] found a low TLm value of 6·0 ppm for phosphamidon for red Crawfish, while our values are high. They also found that malathion upto 20 ppm was not toxic, whereas for our fishes this dosage was quite lethal. The values obtained by Henderson and Pickering[5] for fathed minnows are nearly comparable with our values for parathion and malathion. Lahav *et al.*[6] in Israel obtained rather high values for the toxicity of malathion and DDVP to carp. They found that upto 30 ppm of 50% DDVP was not toxic to carp for 96 hours and that the LC_{100} for carp of malathion was 35 ppm. The TLm 48 hours values for DDVP and metasystox obtained by Kimura and Matida[7] for common carp, goldfish and trout were less than the values reported here by us. In fact DDVP was found to be highly toxic by these Japanese workers, whereas for their fish ethyl parathion was not so toxic as recorded by us. Pickering *et al.*[8] however found as low as 0·01 ppm malathion to kill 40% of blue gills. Carlson[9] also recorded similar low values—48 hr. TLm for blue gill sunfish being 0·14 ppm. Robeck *et al.*[10] determined the TLm 96 hr. of parathion to bluegill to be 0·7 ppm.

There appears to be differential toxicity based on species. With regard to parathion and malathion, the difference was not much. DDVP was 10 times more toxic to *Tilapia* than to *mrigal* (48 hr. TLm being 3·0 ppm and 30·0 ppm respectively). It was also more toxic to the German strain of carp than to the Bangkok strain. Frog tadpoles, which resisted 55·0 ppm of phosphamidon succumbed to 18·0 ppm of DDVP. Since the toxicity of DDVP to more economic species such as *L. fimbriatus, C. mrigala* and *C. carpio* is lower, there is scope for the use of DDVP as a selective fish toxicant. This is confirmed by other workers[15] also. It can also be used to eliminate frog tadpoles from fish nurseries.

Meyer[11] and Henderson *et al.*[12] thought that malathion could be used as selective fish toxicant. Our data indicate that malathion is not suitable for this role but that DDVP would be a useful selective fish toxicant. The toxicity of metasystox was high to the Bangkok strain of common carp but less for other species. 300 ppm of $CaCl_2$ (hardness of the medium 238 ppm) did not reduce the toxicity of metasystox or of parathion to fish. A slight increase in mortality was noted. 300 ppm of $MgSO_4$ (hardness 190 ppm) also did not reduce the toxicity of parathion. pH value upto 9·0 also did not influence the toxicity. Handerson and Pickering[14] also noted that hard water did not reduce the toxicity of parathion or malathion to fish.

In view of the fact that these organophosphorous insecticides are easily and rapidly decomposed in water[10-14] (Holden, 1963), they could be used for the eradication of unwanted fish from ponds and lakes.

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1. Sreenivasan, A. and Natarajan, M. V., *Frog Fish Culturist*, 1962, **24**, 198.
2. Doudoroff, P. *et al.*, *Sewage & Industr. Wastes*, 1951, **23**, 1380.
3. Schouwenburg, W. J. and Jackson, J. K., *Canad. Fish. Culturist*, 1966, **37**, 35.
4. Muncy, H. J. and Oliver, A. D. Jr., *Trans. Amer. Fish. Soc.*, 1964, **92** (4), 428.
5. Henderson, G. and Pickering, Q. M., *Ibid.*, 1958, **87**, 39.
6. Lahav, M., Sarig, S. and Shilo, M., *Bamidgoh*, 1964, **16** (3), 87.
7. Kimura, S. and Matida, Y., *Bull. Freshwater, Res. Sta. Tokyo*, 1958, **7** (2), 51.
8. Pickering, Q. M., Henderson, C. and Lemke, A. E., *Trans. Amer. Fish. Soc.*, 196:, **91** (2), 175.
9. Carlson, G. A., *Ibid.*, 1966, 95 (1) 1
10. Robeck, C. G., Dostal, K. A., Cohens, J. M. and Kriesal, J. F., *Jour. Amer. Water Works*, 1965, Assoc. **57** (2), 18.
11. Meyer, Fred P., *Trans. Amer. Fish. Soc.*, 1965, **94** (3), 203.
12. Henderson, G., Pickering, Q. M. and Tarawell, C. M., "Biological problems in water pollution," *Trans. 1959 Seminar, U.S., P.H.S.*, 1960, p. 76.
13. Holden, A. V., *Effluent and Water Treatment Journal*, Dec. 1965, 1967, p. 3.
14. Henderson, G. and Pickering, Q. M., *Trans. Amer. Fish. Soc.*, 1958, **87**, 59.
15. Srivastava, O. S. and Konar, S. K., *Progr. Fish Cult.*, 1966, **28**, 235.