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ACUTE TOXICITY OF TWENTY INSECTICIDES TO STRIPED BASS, *MORONE SAXATILIS*[1]

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The acute toxicity of twenty insecticides to juvenile striped bass was determined in saline water. All bioassays were four-day tests using proportional diluters as described by Mount and Brungs (1967).

Endrin, Endosulfan, DDT, and Dursban were the most toxic with Median Lethal Concentration (TL_{50}) values of less than 1 µg/l. Carbaryl and Abate were the least toxic with TL_{50} values over 1,000 µg/l. DDD, Heptachlor, Methoxychlor, Toxaphene, Aldrin, Lindane, Chlordane, Malathion, Parathion, Dieldrin, E.P.N., Fenthion, Dibrom, and Methyl Parathion were also tested and are listed in order of decreasing toxicity. Some advantages of intermittent versus static bioassay testing are discussed.

INTRODUCTION

The San Francisco Bay and Delta region represents the most important striped bass habitat on the west coast. It is also an area which receives large amounts of pesticides from drainage systems, primarily the Sacramento-San Joaquin Rivers. Insecticides in this study were selected because measurable quantities of 14 out of the 20 have been reported in the waters of this region (Water Resources Control Board, 1971). Earnest and Benville (1971) found DDT levels in bay water in Tiburon, California to vary from 3 to 21 ng/l during 1969. The other insecticides were selected because mosquito control districts and others indicated these compounds were either now being used or had potential for use in the bay-delta area.

This study was an effort to provide intermittent flow bioassay data for insecticides on striped bass. Information of this type is useful to screen out the more toxic compounds from those in use or being considered for application. The determination of acute toxicity is the first of a logical sequence of evaluative steps leading to the determination of chronic sub-lethal effects of compounds potentially harmful to aquatic organisms.

METHODS

Striped bass (14–83 mm SL, 0.06–4.8 g) were obtained from the fish diversion facility operated by the Bureau of Reclamation at the Tracy pumping plant, Tracy, California. Fish were transported in fresh water to our facility where they were acclimated over a 3 day period to bay water. The fish were further acclimated to test water conditions in

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1,000 liter fiberglass tanks for at least 1 week before testing. Frozen brine shrimp were fed to the fish once daily to saturation.

The test water during the acclimation and test periods was filtered through a sand filter and salinity (Kahlsico salinity hydrometer), turbidity (Hach 2100 turbidimeter) and temperature were determined daily (Table 1).

TABLE 1—Toxicity of Insecticide to Striped Bass Listed in Descending Order.

Insecticide	Mean length (mm)	Mean weight (g)	Temp mean (C°)	Salinity mean (°/₀₀)	Turbidity mean (J.T.U.)	TL_{50} (95% C.I.) (ug/l)
Endrin	70	2.7	17±1*	28±2*	2	0.094 (0.045–0.19)
Endosulfan	33	0.3	16±1	30±1	1	0.1 (0.048–0.21)
DDT	70	2.7	17±1.5	28±1	2	0.53 (0.38–0.84)
Dursban	36	0.6	13±0.5	30±2	1	0.58 (0.35–0.97)
DDD	40	0.6	17±1	30±2	1	2.5 (1.6–4)
Heptachlor	33	0.5	13±1	28±1	1	3 (1–6)
Methoxychlor	70	2.9	15±0.5	28±	2	3.3 (2.1–5.1)
Toxaphene	60	2.3	17±1.5	30±2	1	4.4 (2–9)
Aldrin	70	4.3	13±1.5	28±2	2	7.2 (3.4–15.2)
Lindane	65	2.4	13±1	28±1	2	7.3 (4.5–11.9)
Chlordane	83	4.8	15±0.5	28±2	2	11.8 (5.7–24)
Malathion	34	0.4	13±1	30±1	1	14 (13–15)
Parathion	83	4.8	15±1	27±2	2	17.8 (4.8–65.7)
Dieldrin	78	4.3	14±0.5	28±2	3	19.7 (9.8–33.4)
E.P.N.	37	0.36	18±1.5	30±1	1	60 (25–150)
Fenthion	35	0.33	13±1	29±1	1	453 (216–955)
Dibrom	46	0.8	13±1	30±1	1	500 (100–2400)
Methyl Parathion	34	0.4	13±1	30±2	1	790 (170–1400)
Carbaryl	31	0.42	17±0.5	30±1	1	1000
Abate	14	0.6	13±1	30±1	1	1000

* Range

Water temperature was not controlled. Previous Winkler oxygen determinations with intermittent flow devices at this facility indicate that satisfactory oxygen levels are maintained with the biomass per tank used in these tests. We did not exceed 1g of fish per liter of water.

All bioassays were 4-day tests (96-hour) using proportional diluters as described by Mount and Brungs (1967). Stock solutions were prepared by dissolving the insecticides in ethanol. Fish were sorted for size and placed 10 per concentration in 80 liter aquaria. The fish were not fed the day before bioassays started or during bioassays. Mortalities were recorded daily, but only the 96-hour results are reported. The TL_{50} (tolerance limits for 50% of the test animals) values were determined by converting the data to logs and probits and calculating a linear regression according to a modification of the Litchfield and Wilcoxin (1949) method. Technical information on insecticides used is listed in Table 2.

RESULTS

Endrin, Endosulfan, DDT, and Dursban proved to be the most toxic to striped bass with TL_{50} values of less than 1 µg/l. Carbaryl and Abate were at the other end of the scale proving to be relatively nontoxic with TL_{50} values over 1000 µg/l (Table 1).

TABLE 2—Technical Insecticides Used for Striped Bass Bioassays

Pesticide		Activity* %	Source
Endrin	1,2,3,4,10,10-Hexachloro-6,7-epoxy 1,4,4a,5,6,7,8,8a-octahydro-1,4-*endo-endo*-5,8-dimethanonaphthalene	99	City Chemical Co.
Endosulfan	6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide		
DDT	1,1,1-Trichloro-2,2-bis(p-chlorophenyl) ethane	77.2	City Chemical Co.
Dursban	0,0 Diethyl-0-3,5,6-Trichloro-2-pyridyl phosphorothioate	99+	Dow Chemical Co.
DDD	1,1-Dichloro-2,2,-bis(p-chlorophenyl) ethane	99	City Chemical Co.
Heptachlor	1,4,5,6,7,8,8- Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene	99+	City Chemical Co.
Methoxychlor	1,1,1-Trichloro-2,2-bis-(p-methoxyphenyl) ethane	89.5	City Chemical Co.
Toxaphene	Chlorinated camphene with 67–69% chlorine	100	City Chemical Co.
Aldrin	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-*endo exo*-5,8-dimethano-naphthalene	90	City Chemical Co.
Lindane	1,2,3,4,5,6-Hexachlorocyclohexane	100	City Chemical Co.
Chlordane	1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindan	60	City Chemical Co.
Malathion	5,(1,2-dicarbethoxyethyl)0,0-dimethyldi-thiophosphate ethyl phosphorodithioate	95	American Cyanamid Co.
Parathion	0,0-Diethyl-0-p-nitrophenyl phosphorothioate	--	American Cyanamid Co.
Dieldrin	1,2,3,4,10,10-Hexachlor-6,7-epoxy 1,4,4a,5,6,7,8,8a-octahydro-*endo-exo*-1,4:5,8-dimethanonapthalene	85	City Chemical Co.
E.P.N.	0-Ethyl-0-p-nitrophenyl phenylphosphono-thioic acid	87.7	Du Pont
Fenthion	0,0-Dimethyl-0-[4-(methylthio)-m-tolyl] phosphorothioate	--	Chemagro Corporation
Dibrom	1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate	90	Chevron Chemical Co.
Methyl Parathion	0.0-Diemthyl 0-p-nitrophenyl phosphorothioate	80	American Chemical Co.
Carbaryl	1-Naphtyl-N-methylcarbamate	98	Union Carbide
Abate	0,0,0′,0′-Tetramethyl 0,0′-thiodi-p-phenylene phosphorothioate	90	American Cyanide

* % of pure compound

DISCUSSION

It is realized that toxicity values may vary with fish size, temperature and salinity (Eisler 1970). Therefore, the order of descending toxicity presented in Table 1 may be altered with a more uniform size of fish and more controlled environmental conditions. The high variability in the results from certain tests was due to few data points being obtained. This would also affect the order of toxicity. Previous bioassay data in salt water to compare with this study is lacking. Wellborn (1971) reported 96-hour TL_{50} values for malathion and lindane on striped bass in fresh water under static conditions to be 0.24 and 0.40 mg/l, respectively. Our results were much lower, 0.015 and 0.007 mg/l, respectively. This can be explained in part due to the characteristics of static and intermittent bioassays.

All of our results were intermittent flow tests which are more meaningful than static tests. Under static conditions, oxygen and waste products can be stress-inducing factors (Lincer, Solon and Nair 1970). Also, pesticides may be absorbed by fish and glass resulting in

higher TL_{50} values (unpublished data, Fish Pesticide Research Laboratory, Columbia, Mo.). Earnest and Benville (1972) found static bioassays generated higher TL_{50} values than intermittent flow tests with two species of fish and four organochlorine insecticides. Since many of the TL_{50} values in the past have been based on static tests, we feel more studies comparing static and intermittent flow tests are warranted. The actual toxicity of other pesticides currently being used in the San Francisco Bay Area may in fact be much higher than expected since toxicities were determined under static conditions.

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