TOXICITY OF CERTAIN ORGANOPHOSPHORUS AND CARBAMATE INSECTICIDES TO RAINBOW TROUT

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The chemical control of snow mosquiues may introduce problems on the direct nd indirect toxic effects associated with sh and wildlife if done indiscriminately. n order to obtain an indication of the relive toxicity of a number of insecticides a fish species commonly associated with ountainous recreational areas, laboratory sts were conducted on rainbow trout, *almo gairdnerii* Richardson (Mt. Shasta rain) from the San Joaquin Hatchery at riant, California. The effects of eight incticides, considered as candidate mateals for mountain *Aedes* control, were udied. Dosages approximating concenations that would be encountered in the eld were applied; these concentrations ere derived from data on other species f mosquitoes in non-mountainous habits (Lewallen 1958, Lewallen 1959, Lewlen and Gjullin 1960, Mulla *et al.*, 1961). o study the effects of these materials under severe conditions, a second series of sts was run at ten times the anticipated eld dosage.

It is unlikely that concentrations approxnating the dosages used in these laboory tests would ever be encountered by out. Snow mosquitoes breed to a great xtent in isolated meadow and forest pools, nd if a treated pool drained into a stream ontaining trout, the toxicant would be pidly diluted by the running water.

Treatment of marshy lake margins for osquitoes might affect fish in adjacent eas if highly toxic compounds are aplied; however, the large volume of lake ater in comparison to the marsh water, robably would provide a large dilution ctor in such instances.

Organophosphorus or carbamate insecides were considered desirable for use mountainous areas of California, since ese compounds have limited residual roperties. Organochlorine compounds ve been used against aedine species in mountain habitats in other states (Roth *et al.*, 1947; Rees and Nielsen, 1952).

Certain organochlorine compounds may not directly affect fish or other forms of wildlife at the concentrations used, but the persistent nature of this class of compounds may lead to introduction of these materials into the food chains of the mountain environment. It is advisable insofar as possible to avoid the development of a situation that may be comparable to TDE residues found in fish and grebes at Clear Lake as a result of control measures taken against the Clear Lake gnat, *Chaoborous astictopus* D & S. (Hunt and Bischoff, 1960).

METHODS AND MATERIALS. Fry about one week old with the yolk sac attached were used in one series of tests. Another series of tests involved actively feeding fry about one month old; they were offered mosquito larvae treated at the same dosage as the water containing the fry. This method subjected feeding fry to both internal and external poisoning effects. Twenty 4th instar moribund larvae of *Culex pipiens quinquefasciatus* Say were added to each carton of fry; feeding by fry was variable; in some cases all the larvae were consumed, in other cases none were eaten.

Fish used in these studies were taken from steel troughs at the hatchery in which a continuous flow of river water was maintained at 48° F. A small net was used to transfer fry from the troughs into half-gallon paper cartons containing 500 ml. of hatchery water. Ten fish were placed in each container and transported to the laboratory (30 minute interval). No aeration of the water in transport was required.

At the laboratory, the cartons were kept under refrigeration at 46.4° F. A small aquarium pump supplied aeration during the 24-hour test period.

Toxicants were introduced into the 500

ml. of water containing fry by pipetting one ml. of acetone wt./vol. solutions which were calculated to give the desired concentrations in parts per million. The following field doses were used: 0.1 lb./acre = 0.2 ppm.; 0.25 lb./acre = 0.5 ppm.; 0.5 lb./acre = 1.0 ppm.; and ten times field doses of 1 lb./acre = 2.0 ppm.; 2.5 lb./acre = 5.0 ppm; 5 lb./acre = 10.0 ppm.

Each dosage was replicated three times to obtain the average figures shown in Tables 1 through 4.

Controls were run with each series of tests. No mortality was observed in any of the controls run simultaneously with treated fish. Early attempts with sac fry demonstrated that excessive aeration had a deleterious effect, so this was avoided. After 24 hours of exposure to the toxicants, the fish were transferred to fresh, untreated water and returned to the hatchery where they were observed for an additional 48 hours.

DISCUSSION OF RESULTS. Baytex®, Dylox®, and Hercules AC5727 did not produce any mortality in rainbow trout fry at all dosages tested. Fish treated with 2 ppm. AC5727 exhibited some signs of poisoning after 24 hours, but they recovered by 72 hours. Fish treated with Baytex® and Dylox® did not show signs of toxication at these high dosages.

Parathion at the field dosage level (0. ppm.) produced no apparent adverse e fects on either sac fry or feeding fry however, at ten times the field dosag considerable mortality was produced i feeding fry, but not in sac fry.

DDVP was not lethal to either sac o feeding fry at field dosages, but produce 100 percent mortality in 24 hours to bot stages at ten times the anticipated fiel dosage.

Dibrom® was toxic to sac fry at fiel dosages, but not to feeding fry. At te times the field dosage 100 percent mo tality of both stages was obtained in 2 hours.

Trithion® was only slightly toxic to th feeding stage at field dosages and pr duced no mortality to sac fry. At te times the field dosage no apparent harmfu effects were observed on sac fry, but fee ing fry exhibited considerable mortality.

Malathion was toxic to both stages a all dosages used.

On the basis of these tests, it appea that Baytex®, Dylox®, Hercules AC572 DDVP, Trithion®, and parathion coul be used as chemical control agents again mountain *Aedes* without harm to expose trout populations. This supports the vie that chemical control of mosquitoes an fish preservation are compatible whe proper materials and dosages are chose

TABLE 1.—Effect of insecticides on one week old sack fry rainbow trout.[1]

Insecticide	Dosage (ppm.)	Percent mortality 24 hrs.	48 hrs.	72 hrs.	Remarks
Parathion	0.2	0	0	0	No apparent harmful effect
Baytex®	0.2	0	0	0	No apparent harmful effect
Dibrom®	1.0	0	23	23	Survivors appeared norm at 72 hrs.
Malathion	1.0	17	17	26	Survivors appeared norm at 72 hrs.
Dylox®	1.0	0	0	0	No apparent harmful effec
DDVP	1.0	0	0	0	No apparent harmful effec
AC5727	0.5	0	0	0	Fish affected at 24 h Recovered at 72 hrs.
Trithion®	0.5	0	0	0	No apparent harmful effec

[1] Concentrations approximate field dosages for mosquito control. Field application of insecticid for mosquito control is based on the amount of toxicant per unit area of surface (pounds per acre To calculate the ppm. dosages used here an average water depth of three inches was assumed.

Dibrom® or malathion should be used for mosquito control only in situations where there is no possibility of contaminating water containing trout.

SUMMARY. Toxicity tests were conducted with seven organophosphorous and one carbamate insecticide on sac and feeding stage fry of Mt. Shasta strain of rainbow trout, *Salmo gairdnerii* Richardson. Fry were treated with dosages approximating field levels for mosquito control, and 10 times the required field dosage. The results indicated that Dibrom® and malathion were most toxic to rainbow trout at field dosage levels. Baytex®, Dylox®, DDVP, AC5727, parathion and Trithion® produced no appreciable mortality at field dosage levels. At ten times field dosage levels, parathion, DDVP, and Trithion® were highly toxic to feeding fry. DDVP at this dosage was also highly toxic to sac fry, but parathion and Trithion® produced no mortality to sac fry at this dosage level.

TABLE 2.—Effect of insecticides on one month old feeding fry rainbow trout.

Insecticide	Dosage (ppm.)	Percent mortality 24 hrs.	48 hrs.	72 hrs.	Remarks
Parathion	0.2	0	0	0	No apparent harmful effects.
Baytex®	0.2	0	0	0	No apparent harmful effects.
Dibrom®	1.0	0	0	0	Some moribund at 24 hrs., but recovered at 72 hrs.
Malathion	1.0	100	..	..	More lethal to feeding stage than sack stage.
Dylox®	1.0	0	0	0	No apparent harmful effects.
DDVP	1.0	0	0	0	Some moribund at 24 hrs., but recovered at 72 hrs.
AC5727	0.5	0	0	0	Some darkening of tail noticed.
Trithion®	0.5	0	7	7	Only slightly lethal to feeding stage.

TABLE 3.—Effect of insecticides on one week old sac fry rainbow trout.[1]

Insecticide [2]	Dosage (ppm.)	Percent mortality 24 hrs.	48 hrs.	72 hrs.	Remarks
Parathion	2.0	0	0	0	No apparent gross effects.
Baytex®	2.0	0	0	0	No apparent harmful effects.
Dibrom®	10.0	100	..	..	Complete mortality in 24 hrs.
Malathion	10.0	100	..	..	Complete mortality in 24 hrs.
Dylox®	10.0	0	0	0	No apparent harmful effects.
DDVP	10.0	100	..	..	Complete mortality in 24 hrs.
AC5727	5.0	0	0	0	Fish affected at 24 hrs. Recovered at 72 hrs. Some darkening of tail.
Trithion®	5.0	0	0	0	No apparent harmful effects.

[1] Concentrations approximate 10 times field dosages for mosquito control.
[2] Trithion®, Parathion, Baytex®, Dibrom®, Malathion, Dylox®, and DDVP are organophosphorus compounds. AC5727 is an experimental carbamate being developed by the Hercules Powder Company.

TABLE 4.—Effect of insecticides on one month old feeding fry rainbow trout.

Insecticide	Dosage (ppm.)	Percent mortality 24 hrs.	48 hrs.	72 hrs.	Remarks
Parathion	2.0	70	80	80	Feeding stage more sus ceptible at this concen tration than sac fry.
Baytex®	2.0	0	0	0	No apparent harmful effect
Dibrom®	10.0	100	..	..	Complete mortality in 2 hrs.
Malathion	10.0	100	..	..	Complete mortality in 2 hrs.
Dylox	10.0	0	0	0	No apparent harmful effect
DDVP	10.0	100	..	..	Complete mortality in 2 hrs.
AC5727	5.0	0	0	0	At 72 hrs. no fish we dead although some we affected.
Trithion®	5.0	73	90	93	Mortality very high in 7 hrs.

Dibrom® was toxic at field dosage levels to sac fry but not to feeding fry. One hundred percent mortality to both stages occurred in 24 hours at 10 times the field dosage.

Malathion was toxic to both stages at all dosages tested.

The results obtained in this study indicate that Dibrom® or malathion should be used to control mountain *Aedes* only in situations where trout populations will not be exposed. At normal dosage levels for mosquito control, apparently the other six compounds tested would create no problem in the field.

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