Reduced movement of precocious male Atlantic Salmon parr into sublethal Dimilin-G1®[1] and carrier concentrations[2]

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Larvae of black flies (Simuliidae) live in well oxygenated, fast-flowing streams and rivers. Their population can be controlled by use of insecticides to kill the larvae (JAMNBACK 1973). Because of the fear that conventional broad spectrum insecticides, would damage the environment research has been conducted on more specific chemical control agents such as insect growth regulators (CUMMING AND MCKAGUE 1973, GARRIS and ADKINS 1974, MCKAGUE and WOOD 1974, DOVE and MCKAGUE 1975, LACEY and MULLA 1977). The fish-toxicity of Dimilin[R] [1/], one of these growth regulators is low (ANONYMOUS 1975, SCHOETTGER AND MAUCK 1976); however, the sublethal effects are not known.

In Northern New England and the Atlantic Provinces, black fly larvae inhabit the fast-flowing streams and rivers that Atlantic salmon (Salmo salar) use for spawning and nursery areas. Salmon, which are anadromous, return to fresh water during spring and summer to spawn in the fall. They exhibit a strong homing instinct, returning to spawn in the particular stream section from which their seaward migration began.

Sublethal concentrations of insecticides (SAUNDERS AND SPRAGUE 1967) and metals (SAUNDERS 1969) have been shown to elicit avoidance reactions in salmon. The present study was conducted to determine whether Dimilin-Gl, a candidate larvicide, at larvicidal concentrations would produce a similar behavioral reaction.

MATERIALS AND METHODS

Fish. Subjects were 40 experimentally naive hatchery-raised precocious male Atlantic salmon parr. Dimensions of the olfactometer used limited the size of salmon tested to parr 10-20 cm long; precocious males are equally or more likely to exhibit positive rheotaxis than sexually immature parr). The parr were held in a 370-liter Mini-cool tank (Frigid Units, Inc., Toledo, Ohio) on a 13-h light photoperiod, in 10°C aerated well water, and fed commercial salmon pellets.

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Olfactometer. The fiberglass olfactometer used was similar to that of MILES (1973). It consisted of a 46-cm-diameter holding compartment with a central drain and three evenly spaced, radiating 91-cm flumes. A gate was at the proximal end of each flume, and a mixing chamber for introduced chemicals at the distal end. The holding compartment and flumes were covered with cheesecloth during experiments, and water flow was maintained at 5.1 cm/sec.

Procedures. Dimilin-Gl (a granule formulation of Dimilin, an insect growth regulator manufactured by the Thompson-Hayward chemical Co., Kansas City) was placed in well water for 24 h before use, and then metered into the olfactometer. The concentration in the flow was calculated to be 0.01 ppm Dimilin. A similar quantity of the blank Florex^R carrier (a hardened attapulgite clay manufactured by the Floridin Co., Pittsburgh) was treated similarly. Well water alone was metered into the third flume. The chemical containers were coded so that the experimenters did not know which flumes contained the insecticide, or the carrier during the tests.

Before each trial, one fish was acclimated in the holding compartment with uncontaminated water for 15 min. The gates were opened and the chemicals and positions were recorded. Entry into a flume was recorded when the fish passed a 7-cm neck in the mouth of the flume. A fresh fish was used for each 10 min trial. The apparatus was rotated 120^o after each six trials, and there were 19 trials per session. Each of six sessions was conducted with 18 fish (total per session, 180 fish minutes). Each fish was retested at two-week intervals. All data were subjected to analysis of variance.

RESULTS

The fish spent less time in the chemically treated flumes than in the flume with water alone (Table 1). Times spent in the flume treated with Dimilin-Gl and in the flume treated with blank Florex were similar. Fish choices of the flumes showed a similar pattern, as did the time spent in a flume per choice. The positioning of the three flumes with regard to each 120^o rotation did not influence average time fish spent in the flumes.

TABLE 1

Choice of flumes and time spent in flumes by Atlantic salmon in a flowing-water olfactometer. Values in each column followed by different letters are different at a $P < 0.01$ level.

Test Material	Mean period in flume per session (min)	Mean choices per session (no)	Period in flume of choice (min)
Dimilin-G1	16.9 a	44.5 a	0.38 a
Florex	16.6 a	44.3 a	0.38 a
None	31.3 b	62.8 b	0.50 b

DISCUSSION

These tests indicated behavioral effects of an insecticide and carrier at concentrations at or below projected practical treatment levels for black fly control. The effect observed in the laboratory was a repellency, since the fish chose to swim up treated flumes less frequently than up the untreated flume (water control). When fish did choose a treated flume, the shorter time spent there also indicated a repellency. Repellency, if substantiated with field tests would indicate a possible detrimental effect on fish spawning migrations. Black fly control if it became operational, would occur throughout the spring and summer, depending on the black fly species present in a given locality, at the time when salmon migration occurred.

In as much as the repellency of Dimilin-G1 was no more than that of the Florex alone, the carrier apparently was more important to the behavioral response than was the insecticide. In some past work on sublethal effects of insecticides, the carriers have been considered of minor importance. In the present system, however, the reverse was true, suggesting that carrier effects may be significant factors in other yet unstudied insecticide-fish behavioral systems.

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