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Influence of 2, 4-D and 2, 4, 5-T on Life History Characteristics of *Chironomus* (Diptera: Chironomidae)

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The herbicides 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5,-T (2,4,5-trichlorophenoyxacetic acid) are extensively used and can reach waterways through drift resulting from aerial application, ditch bank vegetation control, runoff from agricultural and managed forest lands, and direct application for aquatic weed control (BOVEY et al. 1974, FRANK 1972).

Although the lethality of these herbicides to aquatic animals has been studied (CROSLEY and TUCKER 1966, MULLISON 1970), few data on sublethal effects have been obtained. KLEKOWSKI and ZVIRGZDS (1971) determined variability in oxygen consumption for Simocephalus exposed to several concentrations of the sodium salt of 2,4-D. They used high concentrations relative to concentrations observed in nature and found inconsistent response with dose. A more extensive knowledge of sublethal effects is needed since sublethal responses cannot be adequately predicted from data on lethal doses (SCHOBER and LAMPERT 1977).

The purpose of this study was to examine the effect of 2,4-D and 2,4,5-T (butoxyethanol esters) on pupation, emergence, and mortality in Chironomus sp. The combinations of herbicide concentrations and temperatures chosen for study are realistic in terms of values observed in nature.

MATERIALS AND METHODS

Chironomus (midges) were collected from a sewage oxidation pond using a triangular bottom net and transferred to the laboratory for sorting into three size classes. Approximately 10 animals of a single size class were placed in culture dishes with fresh lake water. Animals were acclimated overnight to the fresh water then placed in incubators for acclimation to 20, 25, or 30°C. The day following temperature acclimation, midges were exposed to 1 or 3 ppm (acid equivalent) of 2,4-D (Weedone LV-4) or 2,4,5-T (Weedone 2,4,5-T)[1] in lake water. Fresh herbicide solutions were added daily,

[1]Herbicides were supplied by Amchem Products, Ambler, PA.

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and the number of animals dying, pupating, or emerging was recorded. Midges were fed Tetramin fish food.

Percentage larval mortality, percentage pupating, and percentage of pupae emerging were determined for each dish. Time elapsed until pupation and time from pupation to emergence were determined for each individual. Data were analyzed using Analysis of Variance, fixed effects models, in which variability was partitioned among some combination of temperature, herbicide, dose, and size class as main effects.

RESULTS

A total of 189 culture dishes were examined at the twelve combinations of three temperatures, two concentrations for each herbicide, and two herbicides. Larval mortality did not vary significantly among concentrations for any temperature except 30°C. Greater larval mortality occurred at both concentrations of 2,4-D (Table 1, $P<0.03$). Greater larval mortality was also observed for animals exposed to 2,4,5-T at 30°C; however, the differences between larval mortality for treatments and control were not statistically significant.

TABLE 1

Mean Mortality, Pupation and Emergence per Culture Dish for Chironomus Exposed to 2,4-D or 2,4,5-T

°C	Herbicide	ppm	Larval Mortality(%)	Pupation (%)	Emergence (%)
20	none		46.8		62.8
25	none		67.4		
30	none		58.0	41.9	79.4
30	2,4-D	1	75.6	29.3	44.4
30	2,4-D	3	78.8	21.1	31.9
30	2,4,5-T	1	64.0	35.9	
30	2,4,5-T	3	63.3	36.2	
20	2,4,5-T	3			44.4

Mean percentage of larvae pupating per culture dish did not vary significantly with treatment except for Chironomus exposed to 2,4-D at 30°C (Table 1, $P<0.04$). Percentage pupation was slightly lower for midges exposed to 2,4,5-T but not significantly different from the control.

Percentage of pupae emerging was significantly smaller for midges exposed to 2,4-D at 30°C ($P<0.03$) and for midges exposed to 3 ppm of 2,4,5-T at 20°C ($P<0.04$, Table 1).

Time elapsed from collection until pupation did not vary significantly among doses for any combination of 2,4-D concentrations and temperature. Midges exposed to 2,4,5-T at 20°C required significantly longer to reach pupation (Table 2, $P<0.005$) than controls, while treated animals required significantly less time to reach pupation at 25°C than controls (Table 2, $P<0.005$). A total of 589 individuals emerged in the 2,4-D and 2,4,5-T experiments.

TABLE 2

Mean Days to Pupation for Chironomus sp. Exposed to 2,4,5-T at 20 and 25°C

°C	ppm	Days to Pupation
20	0	11.1
20	1	13.5
20	3	13.3
25	0	13.0
25	1	9.4
25	3	8.4

DISCUSSION

The conditions under which the study was conducted are similar to conditions of exposure to herbicides in nature. Warmer temperatures were chosen since little herbicide exists in waterways during the cooler periods of the year (WHITE et al. 1976). The concentrations studied are in the range of highest values observed in runoff (WHITE et al. 1975) and in waterways (WOJTALIK et al. 1971) although residues most frequently determined from natural waters are many times more dilute than those used in this study (AVERITT and GANSTAD 1976, SCHULTZ and HARMAN 1975, SCHULTZ and WHITNEY 1974). Since water quality can also influence toxicity of pesticides (LEE 1973), lake water was used instead of the sewage pond water which was very high in nutrients. No solvents were used to increase the solubility of the herbicides in water since solvents can also enhance toxicity by facilitating uptake of chemicals (LEE 1973).

Although some differences among control and treatments were observed, the only responses that appeared meaningful were larval mortality, pupation, and emergence at 30°C for 2,4-D. Other differences were either not significant or not consistent over temperature. Although midges can adequately withstand herbicides at lower temperatures, the combined stress of temperature and herbicide is less well tolerated.

Many studies in the literature dealing with gross toxicity indicate that phenoxy herbicides are relatively innocuous to many aquatic organisms (CROSLEY and TUCKER 1966, MULLISON 1970). Although the present study revealed some effect, that effect is likely not important in nature. First, concentrations observed in nature are usually measured in the ppb rather than the ppm range. Second, herbicides dissipate rapidly in many natural waters (AVERITT and GANGSTAD 1976). Midges would not be exposed for long periods. Last, the magnitude of difference between control and treatment is not sufficient to severly limit organisms such as midges which produce large numbers of eggs.

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