An Evaluation of Squoxin on Insect Drift[1]

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ABSTRACT

An analysis of 54 drift net samples obtained over a 72-hr period in riffle areas of the St. Joe River, Idaho, showed that a distributed concentration of 0.1 mg/liter (100 parts per billion) of 1,1′-methylenedi-2-naphthol for a 13-hr period cause no significant increase in insect drift during the sampling period. Eight species of insects in the orders Trichoptera and Ephemeroptera represented 87% of the total drift insects. All species drifted in greater abundance during the night.

AN EVALUATION OF SQUOXIN ON INSECT DRIFT

A study was conducted 9–11 July 1968 to determine the effects of "squoxin" (1,1′-methylenedi-2-naphthol) on insect drift. At low concentrations this chemical will kill northern squawfish, *Ptychocheilus oregonensis,* and not harm game fish (MacPhee and Ruelle 1969). This study was conducted commensurate with eradication of squawfish from a section of the St. Joe River in northern Idaho (MacPhee and Reid 1971).

Drift with diel cycles is a phenomenon of many stream insects (Waters 1962, 1969; Elliott 1970; Brusven 1970). Hoffman and Surber (1948), Coutant (1964), Gibson and Chapman (1972) and others have shown that certain toxicants, e.g., insecticides, cause pronounced increases in insect drift. An abnormal increase in drift immediately after introduction of a fish toxicant would suggest excessive acute stress and possible toxic effects to insects.

An evaluation of the effects of squoxin on insect drift is an important ecological consideration because aquatic insects are the principal food of many fishes and are integral components in the stream ecosystem. Excessive aquatic insect drift caused by squoxin could ultimately disrupt the normal food chain in streams.

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MATERIALS AND METHODS

A 35-km section of the St. Joe River, located between Marble Creek and St. Joe City, was treated with squoxin at a maximum distributed concentration of 0.1 mg/liter. The river through this section has a mean width of 83 m and mean depth of 1.3 m; pools average 4.6 m deep. Riffle substrates are rubble and gravel.

A single drift net (0.3 × 0.6 m, fitted with a nylon bag with 0.8-mm pore size) was placed in approximately center channel in each of the three riffle sites. A control station (Station I) was located 0.96 km above and two test stations (Stations II and III), 1.1 and 6.56 km below the point of squoxin application. Squoxin was applied for 13 hr.

Water velocities through the three nets were approximately 0.78, 0.30 and 0.72 m/sec, respectively. Discharge varied from 35–38 m^3/sec and water temperature ranged from 16–20 C during the study. Drift samples were collected at 4-hr intervals for three consecutive 24-hr periods. The initial 24-hr period was sampled prior to the introduction of squoxin and served to standardize drift-net catchability. Samples were preserved in 70% alcohol in the field and subsequently sorted and identified in the laboratory.

A goodness of fit test was used to determine significant differences between treated and control drift samples for major insect species. Data for Stations II and III were analyzed separately and in combination. Combined values for the two stations reduce variability and increase sample size. Observed and empirically determined expected values were compared in a 2 × 3 contingency table by a chi-square test of significance. No significant change due to treatment with the selective squawfish toxicant was deemed to exist for populations which had chi-square values smaller than 5.991, $p < .05$, 2 d.f.

Water analysis has shown that 1,1′-methy-

TABLE 1.—*Principal drift taxa exposed to 0.1 mg/liter of 1,1'-methylenedi-2-naphthol for a 13-hr period; percentage change in drift net counts following treatment relative to expected values calculated for Stations II and III; and chi-square interpretation of significance (P = 0.05) for a 3-day period*

		Station II		Station III		Stations II and III	
	Number of insects[b]	Percentage of insects following treatment[c]	Statistical interpretation	Percentage of insects following treatment[c]	Statistical interpretation	Percentage of insects following treatment[c]	Statistical interpretation
Class Insecta (all drift spp.)	7,038	90.8	Significant decrease	107.2	Significant increase	99.0	Not significant
Order Ephemeroptera	5,369	89.2	Significant decrease	109.5	Significant increase	98.5	Significant decrease
Ephemerella flavilinea	1,152	82.6	Significant decrease	94.6	Not significant	88.0	Significant decrease
Ephemerella tibialis	818	75.0	Significant decrease	104.3	Not significant	96.7	Not significant
Epeorus longimanus	2,284	82.8	Significant decrease	112.7	Significant increase	96.8	Not significant
Cinygmula sp.	242	92.9	Not significant	97.7	Not significant	96.2	Not significant
Baetis spp.[a]	636	94.6	Significant decrease	101.4	Not significant	97.4	Significant decrease
Order Trichoptera	1,249	90.8	Significant decrease	95.4	Not significant	94.9	Not significant
Hydropsyche sp.	628	81.1	Significant decrease	100.7	Not significant	95.8	Significant decrease
Brachycentrus sp.	363	103.9	Significant increase	50.8	Significant decrease	93.0	Significant decrease

[a] *Baetis* spp. = (*B. bicaudatus* and *B. tricaudatus*)—species separation not always possible because of damaged specimens.
[b] Total insects of all samples (54) from three stations for three days.
[c] Observed divided by expected numbers of insects × 100.

lenedi-2-naphthol degrades rapidly in natural waters (Keating 1972). Therefore, it is probable that organisms at Station III, 6.56 km below the application site, were exposed to lower concentrations of squoxin than organisms at Station II, 1.1 km below the site of application.

RESULTS AND DISCUSSION

Combined counts from test Stations II and III for class, principal orders and species reveal no significant increase in drift during the 3-day observation period (Table 1). However, when the two test stations were analyzed separately, significant increases were noted at Station III for Class Insecta, for the Order Ephemeroptera and the mayfly *Epeorus longimanus,* and at Station II for the trichopteran *Brachycentrus* sp. Although these increases were statistically significant, the maximum increase for any one species was less than 13%. The significant increase in drift of higher taxa, e.g., Class Insecta and Order Ephemeroptera for Station III was influenced by the preponderance of *E. longimanus* in the sample (Table 1), as the other principal species either decreased or did not change significantly.

Aquatic members in the orders Diptera, Ephemeroptera, Plecoptera, Coleoptera and Trichoptera were taken in drift nets during the study; however, only Ephemeroptera and Trichoptera were significantly represented. Eight species in the latter two orders represented 87% of the drifting insects. Additional species, sparsely represented in drift but not listed in Table 1, were the mayflies *Rithrogena hageni* Eaton and *Centroptilum* sp.; the caddisflies, *Micrasema* sp., *Rhyacophila* sp. and *Lepidostoma* sp.; the dipteran, *Atherix* sp.; and the beetles *Lara* sp., *Optioservus* sp. and *Haliplus* sp. These species were included in the totals of Class and Orders, however. In no case did their drift propensity reflect sensitivity to squoxin.

More insects drifted at night than during the day (Fig. 1). No differences in drift were

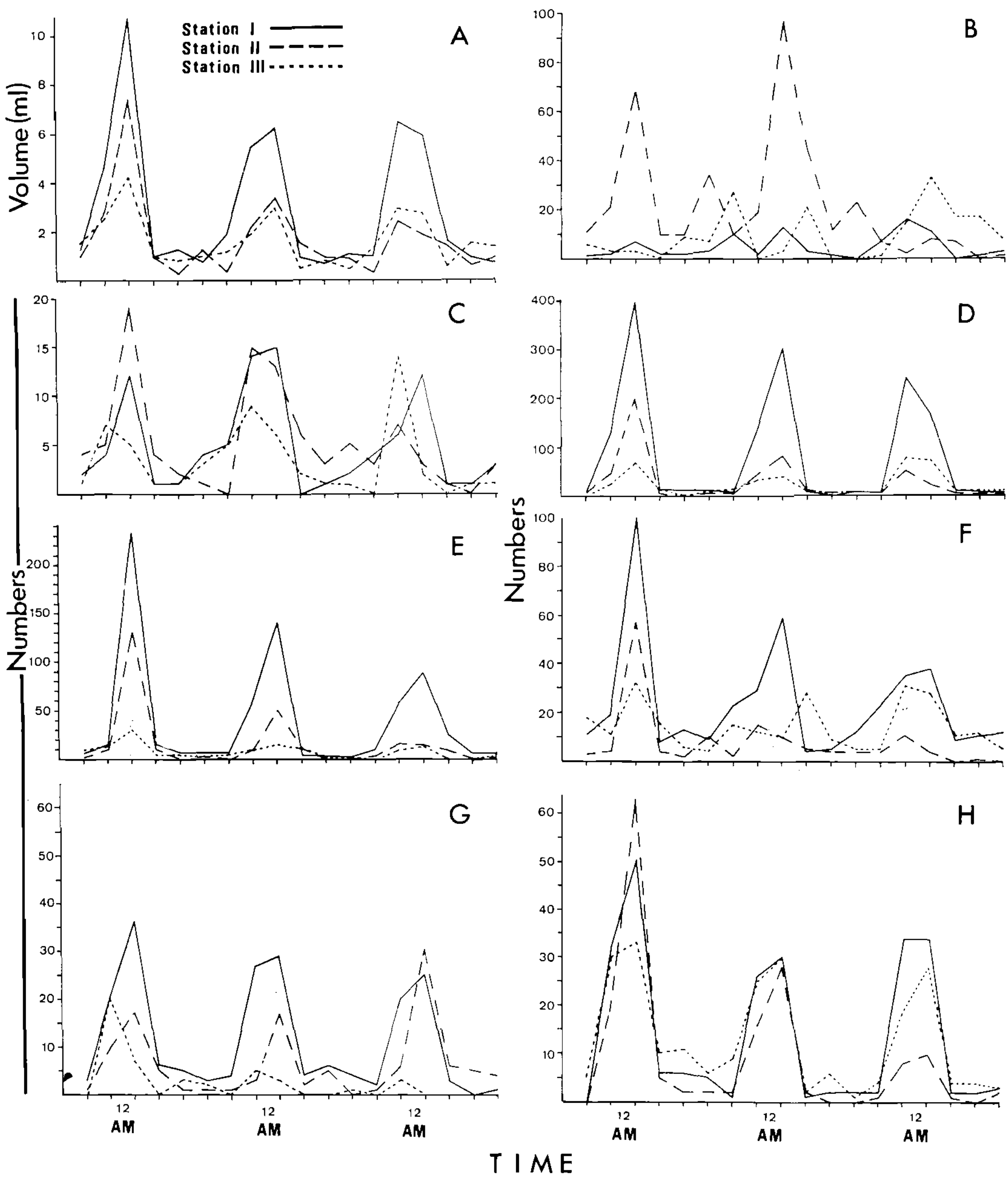

FIGURE 1.—Diel insect drift for three days from three stations on the St. Joe River before, during and after squoxin application. A. Volume of all insects; B. *Baetis* spp.; C. *Cinygmula* sp.; D. *Epeorus longimanus*; E. *Ephemerella flavilinea*; F. *Ephemerella tibialis*; G. *Brachycentrus* sp.; H. *Hydropsyche* sp.

noted for different age classes of insects. Greatest drift occurred during the 24-hr period preceding squoxin treatment and decreased during the subsequent two days both at the control and the two test stations. This suggests that some factor other than squoxin was responsible for the decrease. If insects were adversely affected by this chemical, increases in drift would be expected.

Principal drift species were individually graphed to depict diel drift trends and possible sensitivity to squoxin (Fig. 1B-H). *Epeorus longimanus* (Eaton), *Ephemerella flavilinea* (McDunnough), *E. tibialis* McDunnough, *Cinygmula* sp., and *Baetis* spp. were the principal mayflies in drift (Fig. 1B-F); all showed peak drift at night. Greatest numbers of drift of the different species occurred at Station I (control) except for *Baetis* spp. which were most numerous at Station II. Differences in daily drift between the two stations for *Baetis* is likely the result of differences in standing crop and habitat characteristics of the two reaches. Peak drift decreased or remained approximately similar for all stations. Although absolute counts of *Baetis* spp. at Station II were greatest during treatment, the percentage of *Baetis* spp. was smaller relative to the control and pretreatment drift. Chi-square analysis of the control and pretreatment drift indicated a significant decrease for Station II and Stations II and III combined (Table 1) and no change in drift at Station III. Although there was a noticeable increase in drift during the 12–4 A.M. sampling period between 9 and 10 July for Station II (Fig. 1B), the accumulative daily total between the two days was not appreciably different. Thus, squoxin treatment did not adversely affect drift of *Baetis* spp.

The trichopterans, *Hydropsyche* sp. and *Brachycentrus* sp., were similar to mayflies in their diel drift cycles, with greatest drift occurring during the night (Fig. 1G-H). The small sample size at Station III probably exaggerates the percentage of decrease of *Brachycentrus* (Table 1; Fig. 1G). Small sample size is also believed responsible for the significant increase at Station II. Squoxin apparently did not adversely affect drift of Trichoptera.

Insects do not necessarily drift in relation to their abundance. Because of behavioral and morphological characteristics, certain species, although abundant, maintain high substrate fidelity and are not readily transported in the water column unless killed or disturbed. This was apparently the case with some trichopterans, e.g., *Psychoglypha* and *Diocosmoecus* which were observed feeding on dead squawfish several hours after squoxin treatment (Brusven and Scoggan 1969). While stoneflies, beetles and dipterans are part of the benthic community in the St. Joe River, they were sparsely represented in drift and apparently unaffected by squoxin.

Drift-net analysis provided a useful means for evaluating the effects of squoxin on benthos. If benthos were adversely affected by this chemical, large increases in drift would have been expected; such was not the case. Therefore, we conclude that squoxin at concentrations of 0.1 mg/liter for a 13-hr period had little or no acute effect on drift of aquatic insects represented in this study.

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