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LABORATORY EVALUATION OF A JUVENILE HORMONE MIMIC, PYRIPROXYFEN, AGAINST *CHIRONOMUS FUSCICEPS* (DIPTERA: CHIRONOMIDAE)

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ABSTRACT. The efficacy of the insect growth regulator, pyriproxyfen, against *Chironomus fusciceps* was examined in the laboratory. A series of 6 concentrations (0.1–0.00001 ppm) was used. A positive relationship between mortality and concentration was observed in the pupal stage as well as in the larval stage. Pyriproxyfen caused 50 and 90% emergence inhibition of *C. fusciceps* at 0.00177 and 0.05369 ppm, respectively.

Chironomids are very widely distributed and frequently the most abundant insects in fresh water, and some species can develop under extreme conditions of temperature, pH, salinity, and depth (Armitage et al. 1995). *Chironomus fusciceps* Yamamoto is an example of such species which breed in the sulphur-containing waters of high temperature and low pH in the Unzen volcanic area, Nagasaki, Japan (Yamamoto 1990). The immatures of this species inhabit streams receiving water from hot springs. Because of the high water temperature throughout the year, this species can breed year-round and produce many adults even during winter. The adults are attracted in large numbers to light, causing great discomfort in residential areas including hotels at Unzen.

Insect growth regulators, because of their high activity, low persistence in the environment, and safety to nontarget organisms, have become an important tool for the control of nuisance chironomids. Their efficacy has been tested in both the laboratory and field (Ali and Lord 1980, Tabaru 1985, Ali et al. 1993, Trayler et al. 1994).

A laboratory experiment was conducted to evaluate the efficacy of pyriproxyfen against *C. fusciceps.* The lethal effects of pyriproxyfen on immatures were analyzed, and concentrations of 50 and 90% emergence inhibition were estimated.

The larvae of *C. fusciceps* used in the experiment were collected together with sand in December 1990 from a stream in the Unzen volcanic area, Obama-cho, Nagasaki prefecture, Japan. Water from hot springs flows into the stream, and, when the larval collection was made, the water temperature of the stream was 26°C at pH = 3. The larvae were reared in glass vials (9 cm diam × 6 cm deep) containing the sand (5 mm deep) and 200 ml of water from the stream. Fifty mature larvae were introduced into each vial and no food was supplied. Fourteen glass vials were continuously aerated by a tube and kept in a water bath controlled at 27–28°C during the experiment. The water volume was kept constant by adding distilled water to each glass vial. The pH of the treated water was 2–3 during the experiment.

A 0.2% pyriproxyfen stock solution in ethanol was serially diluted. A series of 6 concentrations (0.1–0.00001 ppm) was obtained by adding 0.5 ml of the ethanol solutions to the water. Each concentration and the control were made in du-

Table 1. Daily changes in the number of emerging adults and dead pupae for 16 days after treatment with 6 different concentrations of pyriproxyfen.

Concentration (ppm)	Emerging adults													
	Days after treatment													
	1	2	3	4	5	6	7	8	9	10	13	14	15	16
0.1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
0.05	0	0	0	0	1	1	2	3	0	0	1	2	0	0
0.01	0	0	0	3	14	11	5	2	1	1	1	0	0	0
0.001	0	1	6	47	12	7	1	0	0	0	1	0	0	0
0.0001	0	0	4	52	16	6	7	0	0	0	2	1	0	1
0.00001	0	0	6	64	11	8	0	0	0	0	3	0	0	0
Control	0	1	10	79	7	2	0	0	0	0	0	0	0	0

[1] A = emerging adult, L = dead larva, P = dead pupa.

plicate for a test. The number of pupal skins on the water surface and dead pupae were counted and removed daily for 16 days after treatment. The numbers of larvae and pupae in the sand were not counted. After the last observation, the sand was checked for larvae and pupae; no surviving larvae and pupae were found. Thus, the number of dead larvae was calculated from the initial number of larvae and the numbers of dead pupae and emerging adults. The test was conducted once, and the results from 2 replications were pooled and analyzed.

The daily changes in the number of emerging adults and dead pupae for 16 days after the treatment are given in Table 1. The effects of pyriproxyfen were shown clearly by the total number of emerging adults and the peak of adult emergence. The total number of emerging adults decreased according to the increase in concentration. The peak of adult emergence was observed at 4 days after treatment in the control and in the lower 3 concentrations. In higher concentrations of 0.01 and 0.05 ppm, adult emergence was delayed and the peak was observed at 5 and 8 days, respectively.

The daily changes in the number of dead pupae in the higher concentrations suggest the delayed development of mature larvae. Dead pupae appeared at 8, 9, and 14 days after treatment in the higher concentrations (0.05 and 0.1 ppm), whereas they were collected at 2–8 days after treatment in the lower concentrations (0.00001, 0.0001, and 0.001 ppm).

The mortality of pupae became higher with increasing concentration, although the number of dead pupae was greatest in the intermediate concentration of 0.01 ppm. A positive correlation between larval mortality and the insect growth regulator concentration also existed, suggesting that pyriproxyfen is lethal not only to the pupae but also to the larvae of *C. fusciceps*.

The inhibition rates of adult emergence were calculated and the Probit analysis was performed. The concentrations of 50 and 90% emergence inhibition (EI) were estimated as 0.00177 and 0.05369 ppm, respectively (r^2 = 0.91). The estimated value of EI_{90} of pyriproxyfen against *C. fusciceps* was 5 times higher than that observed in *Polypedilum nubifer* (Skuse) (Trayler et al. 1994) and nearly the same as that of Stauffer MV-678 against *Chironomus decorus* Johannsen (Ali and Lord 1980).

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Table 1. Extended.

Dead pupae																	Mortality of pupae
Days after treatment														Total[1]			
1	2	3	4	5	6	7	8	9	10	13	14	15	16	A	L	P	
0	0	0	0	0	0	0	3	3	0	0	2	0	0	2	90	8	0.80
0	0	0	0	0	0	0	1	1	0	0	0	0	0	10	88	2	0.17
0	0	0	6	0	7	0	3	1	0	0	0	0	0	38	45	17	0.31
0	2	1	1	0	4	0	0	0	0	0	0	0	0	75	17	8	0.10
0	2	0	0	0	0	0	4	0	0	0	0	0	0	89	5	6	0.06
0	0	0	5	0	2	0	0	0	0	0	0	0	0	92	1	7	0.07
0	0	1	0	0	0	0	0	0	0	0	0	0	0	99	0	1	0.01