CONTROL OF NUISANCE MIDGES IN A CHANNEL RECEIVING TREATED MUNICIPAL SEWAGE

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ABSTRACT. In 1972–73, the effectiveness of Dursban insecticide for the control of larvae of the chironomid midge, *Chironomus riparius*, was evaluated in a channel downstream from a sewage treatment plant outfall. Densities were below 400/m² prior to July reaching 15,000/m² from July to November; these densities correlated with high summer and fall water temperatures. Chlorpyrifos EC was applied 12 times through a pressurized hose system placed on the bottom of the channel. At 0.3 lb/acre-ft (0.1 ppm), it reduced larval density for 7–14 days. Continued suppression required applications at intervals of less than 21 days, the developmental period of *C. riparius*.

INTRODUCTION

For several years, chironomid midges have given rise to complaints in certain areas along the North Shore Channel, especially downstream from the Metropolitan Sanitary District of Greater Chicago's (MSDGC) North Side Sewage Treatment Plant outfall. The channel and the treatment plant effluent favor propagation of chironomid larvae to nuisance levels.

Although these midges do not bite or feed, and are not known to transmit disease, their large numbers create a nuisance in residential and recreational areas and have potential economic impact in industrial situations through interference with the processing of paper, plastics, food products, and automotive refinishing operations (Grodhaus 1963). Many of these industrial activities are adjacent to or within ready dispersal distance from the channel. Therefore, in 1972 an extensive abatement and monitoring program to control midge infestations was initiated by the MSDGC.

The voluminous literature on the control of midges, reviewed by Muirhead-Thomson (1971), is not applicable to the North Shore Channel because the flow sweeps away insecticides. There is, in fact, little information available pertaining to the control of midge larvae in a flowing stream, and few insecticides are labelled for such use. Reported here are the results of a 2-year study (1972–73) on control of nuisance midges in the North Shore Channel.

MATERIALS AND METHODS

STUDY AREA. The North Shore Channel originates in Wilmette, Illinois, and flows 7.56 miles in a southerly direction before merging with the North Branch of the Chicago River (Figure 1). The channel has a width of approximately 60–80 ft, depth of 9 ft, and a natural bottom; it is non-grouted on the sides; water velocity is 0.5–2.0 ft/sec. The natural flow is augmented at a point about 4.5 mi above its junction with the North Branch of the Chicago River by the effluent from the North Side Sewage Treatment Plant. The plant provides secondary treatment for an average flow of 300 million gal/day. The sewage is a combination of domestic and industrial wastes. Also entering the channel are street and combined sewer overflows, and a limited amount of fresh water from Lake Michigan at Wilmette.

The bottom deposits are primarily rubble, gravel, and sand, with small amounts of sludge and decaying plant debris. The banks are fairly steep, eroded in many areas, and lined with trees or covered with grass. The channel possesses such characteristics of an over-enriched lake as high

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levels of nitrates and phosphates and seasonal oxygen depletion in summer.

BOTTOM SAMPLING. Single bottom samples were taken with a Ponar grab sampler (15 x 15 cm^2), transferred to 1 gal plastic containers, transported to the laboratory and stored at 10° C until processed. All samples were washed through a Number 30, U. S. standard sieve, and counted within 3 to 4 days from time of sampling. Samples were taken from the center and from either side of the channel at each station.

There were 14 sampling locations (Figure 1). Stations 1 and 2, the untreated controls, were 0.1 and 0.2 mi below the treatment plant outfall, respectively, and 0.1–0.2 mi above the 1st application bridge. Samples were collected at monthly intervals from stations 3–14 in 1972 and 1–14 in 1973; none was collected from 1 and 2 in 1972. In addition to monthly samples, 1 to 4- day, pre- and post-treatment samples were taken at the 14 sampling stations periodically in 1972 and 1973.

CHLORPYRIFOS TREATMENT. Chlorpyrifos EC (4 lb/gal, Dow Chemical Company) was applied 8 times during the breeding season in 1972 and 5 times in 1973 at 4 bridge sites (Howard, Touhy, Devon, Peterson) along the North Shore Channel. Application rates were calculated to give an initial concentration of 0.1 ppm (0.3 lb/acre-ft).

METHOD OF APPLICATION. Chlorpyrifos is pumped under pressure directly to a set of hoses containing numerous openings that are placed on the bottom of the channel. Four gal chlorpyrifos EC were first mixed with water in 8 55-gal drums. The injection time per bridge was 60 min (7.3 gal/min). A maximum channel velocity of <1 ft/sec is necessary for the insecticide to be effective (Polls 1973, unpublished). Therefore, applications were made when stream velocity was ca. 0.55 ft/sec or less.

EXPOSURE TUBES. To assess mortality of midge larvae *in situ* following treatment, exposure tubes were constructed utilizing 2 widemouth, lipped, pint, polypropylene containers. The containers were cut in half and the 2 cut ends with the lips were cemented together. The ends were screened off with soft mesh nurse's stockings and held in place by a rubber band. The resulting tube was 6 in long by 2 in wide. Two attached 20-oz lead weights caused the container to sink to the bottom of the channel. Since it was desirable for the container to move freely in the current, 4 ft lengths of nylon fishing cord were knotted separately around one end of the tube. The 4 lengths were then brought to a point and tied to an overhanging branch along the channel. Several pretreatment trials were made in the channel to test the ability of midge larvae (100/tube) to withstand confinement within the container for 48 to 72 h.

One day prior to the first chlorpyrifos application in 1973, at least 100 channel midge larvae were placed in each of 4 tubes submerged at 600, 1200, 1800, and 2400 ft downstream from each application site.

Larvae were examined 48 h after application for mortality which was based on prolonged immobility, even with application of a dissecting needle, discoloration, and absence of heartbeat and other internal movements.

RESULTS AND DISCUSSION

ABUNDANCE AND DISTRIBUTION OF MIDGE LARVAE. Three species of midges were found in the North Shore Channel, *Chironomus attenuatus* Walker (=*decorus*), *C. riparius* Meigen, and *Procladius sublettei* Roback. Of several thousand larvae examined from different stations and times, *P. sublettei* constituted less than 1% of the midges present in the channel. *C. attenuatus* was the predominant midge above the outfall in higher quality water and was replaced by *C. riparius* below the outfall. Other macroinvertebrates, mainly oligochaete worms and the isopod, *Asellus intermedius* Forbes, also were present.

During 1972–73, *C. riparius* was present in the North Shore Channel the year-

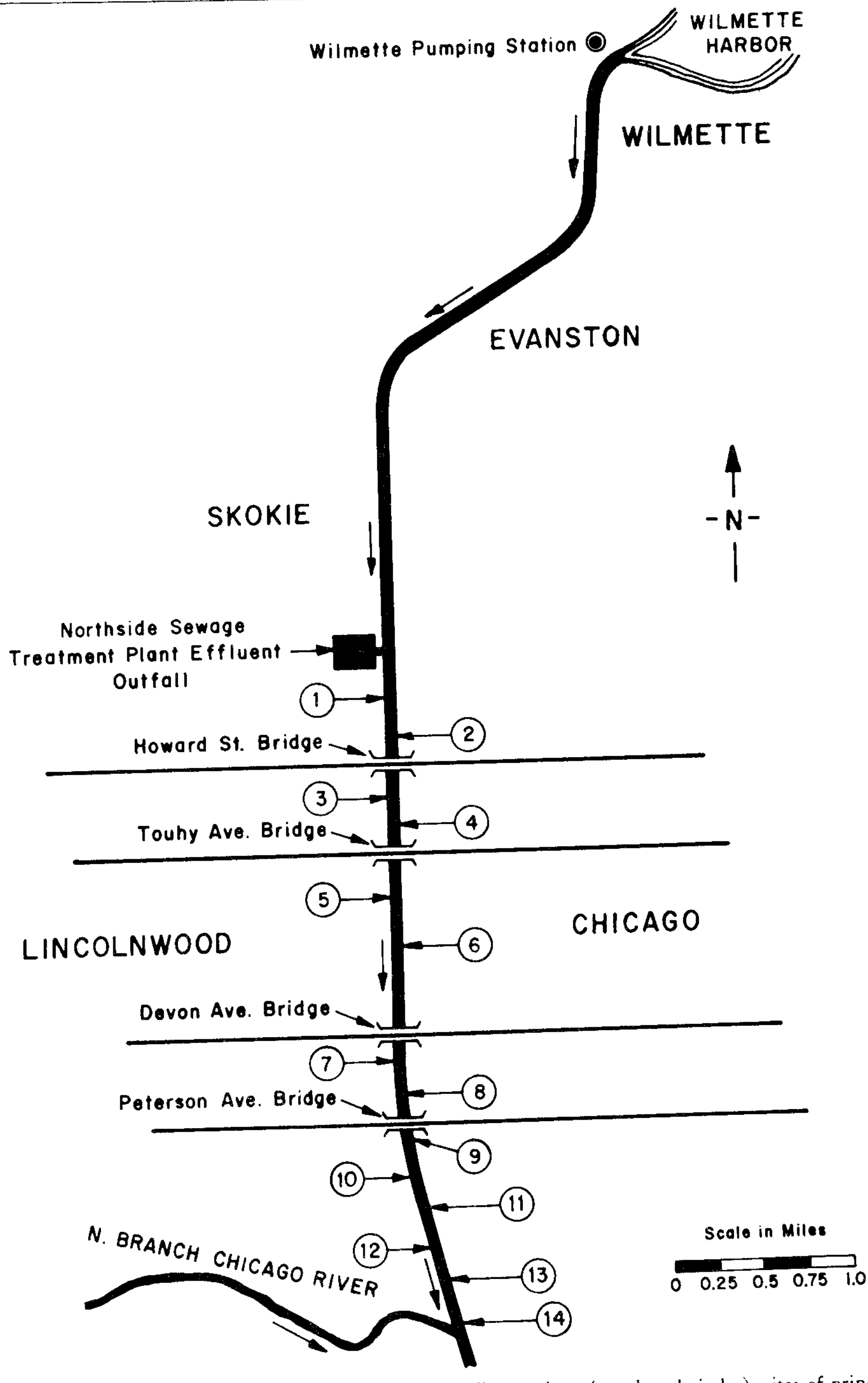

Fig. 1. Map of the North Shore Channel showing sampling stations (numbered circles), sites of principal effluent discharges, and insecticide application sites; 1 and 2 are control stations.

around, with densities below 400/m^2 prior to July and reaching 15,000/m^2 during July to November. The large number of larvae present during July through November in 1972–73 are correlated with high summer and fall temperatures in the channel.

CHEMICAL CONTROL. It is critical in the chemical control of midges in a stream that the insecticide be applied to the substrate harboring the larvae. Thompson et al. (1970) used the injection method and found it to be highly effective in controlling midges in flowing water. His method employs one hose with a single opening, whereas ours employs a set of hoses containing numerous openings through which insecticide is pumped onto the bottom of the channel.

Chlorpyrifos was selected because it is highly effective against midge larvae, is spared hydrolysis in polluted water by being adsorbed onto organic matter, and is stable to inactivation by microorganisms (Hirakoso 1968, unpublished; Schaefer and Dupras 1970).

In February 1972, chlorpyrifos was applied to a half-mile treatment area in the channel at 0.05 lb/acre-ft (0.02 ppm). However, this proved to be too low a dosage for conditions in the channel. Schaefer and Dupras (1970) stated that in treating polluted water in California, a rule of thumb was to use the amount of chlorpyrifos required to get an initial concentration of 0.1 ppm in the water. Application of 0.3 lb/acre-ft (0.1 ppm) reduced the number of midge larvae but larval densities at this time were low. Chlorpyrifos was applied 6 more times in 1972 with the greatest reductions occurring in August and October (Table 1). Inadequate control of midge larvae from the July 20–21 application was due to the high flow in the channel.

Chlorpyrifos was applied 5 times in 1973. Control of midge larvae was achieved at an application rate of 0.3 lb/acre-ft (Table 2). Lack of control on October 1 was attributed to mechanical problems with the application system. Similar findings have been reported by Mulla et al. (1973) in his study of 2 warm-water lakes in southern California.

It is probable that the midges present in the channel are recruited primarily from channel emergees and not from other sources. New larvae may have been recruited from periodic drifting from upstream control areas, and from eggs deposited in the water shortly after a chemical application, as well as pockets of survivors not reached by the insecticide. These factors coupled with the short life

Table 1. Effect of chlorpyrifos on midge larvae in the North Shore Channel, 1972.

Date of Application	Dosage Rate (lb/acre-ft)	Pre-Treatment Larval Count[a] (No/m^2)	Post-Treatment Larval Count[a] (No/m^2)	Reduction Factor
		Center		
2/28	0.05	181	200	0
3/17	0.30	203	11	95
4/13–14	0.30	135	2	99
6/26–28	0.30	190	42	68
7/20–21	0.30	43	121	0
8/17	0.30	5,547	8	99
9/1	0.30	607	131	78
10/13	0.30	3,247	81	98
		Side		
6/26–28	0.30	395	137	65
7/20–21	0.30	331	117	95
8/17	0.30	1,185	46	96
10/13	0.30	3,789	2	99

[a] Average number of larvae from a total of 12 sampling sites at 4 treatment locations in the channel.

Table 2. Effect of chlorpyrifos on midge larvae in the North Shore Channel, 1973.

Date of Application	Dosage (lb/acre-ft)	Pre-Treatment Larval Count[a] (No/m^2)	Post-Treatment Larval Count[a] (No/m^2)	Reduction Factor
		Center		
7/30	0.30	10,313	0	100
8/20	0.30	2,215	310	86
9/17	0.30	12,451	187	99
10/1	0.30	187	3,648	0
11/26	0.30	16,890	877	95
		Side		
7/30	0.30	9,897	0	100

[a] Average number of larvae from a total of 12 sampling sites at 4 treatment locations in the channel.

cycle of *C. riparius* could cause the rapid build-up of midge larvae following treatment.

Success of a treatment is measured by a significant decrease in larval density following application. This decrease is assumed to result from larvae having been killed, although they may have merely been dislodged and washed downstream. This method may therefore exaggerate the true mortality rate, and translocation of living larvae is not effecting control. In view of this problem and because of the contagious distribution of midge larvae in the channel, and possibly an uneven dispersion of the insecticide, it was desirable to use containers to retain midges at various sites in the channel during and following the period of dosing. Exposure tubes in treated areas contained all dead midge larvae, whereas control tubes contained only living larvae, proving that the treatment was effective. Burton (1964) used a similar device for assessing mortality of *Simulium* larvae in the Volta River after DDT treatment.

Post-treatment bottom samples collected 7 and 14 days following application contained large numbers of midge larvae, indicating that chlorpyrifos was no longer present in lethal concentration. Effective, and sustained control therefore requires applications of chlorpyrifos to be made more frequently than it takes the midges to complete their life cycle, viz. every 21 days or less.

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