A PHYSICAL BARRIER FOR CONTROLLING MOSQUITOES WHICH BREED IN URBAN STORM DRAINS

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ABSTRACT. A physical control method to prevent entrance and exit of adult mosquitoes from breeding areas within the storm drain line was tested. Open-ended fabric tubes were placed in lateral pipes which connected the catch basins to the storm drain line. One end of the tube was allowed to collapse and caused a barrier to adult movement but permitted water flow. After tube installation in the line, the number of adult mosquitoes trapped was reduced by 87–96%. Effectiveness of the barrier system was confirmed by an 80–89% reduction in adults trapped in yards of houses adjacent to the storm drain line.

INTRODUCTION

Most urban areas have incorporated complex systems of underground pipelines to channel storm runoff water away from the streets to disposal sites. When properly designed and constructed, storm drain systems are adequate for their intended purpose. However, parts of these systems can also be major sources of mosquito production, as in the case of open drainage basins (Smith and Shisler 1981). One of the most difficult problems for mosquito abatement personnel is the limited access to portions of the underground system where mosquito breeding is occurring.

Improper design or construction can lead to storm drain lines which retain standing water throughout the summer months, when water flow is minimum. Such lines offer perfect environmental conditions for the production of tremendous numbers of adult mosquitoes (Hazelrigg and Pelsue 1980, Mulligan and Schaefer 1981). Access to these lines for chemical control is limited to manhole openings which are city blocks apart. The success of chemical applications also is sometimes hampered by insecticide-resistance and by the high potential for development of resistance if this strategy is the sole basis of control programs.

There is a need for improved planning in the design and construction of future drain lines as well as for the development of alternate control strategies, e.g. biological and physical controls, in existing lines. The purpose of this study was to evaluate the use of physical barriers for blocking the entrance to, and the exit of, adult mosquitoes from the storm drain line.

MATERIALS AND METHODS

The study area, located within the city of Fresno, CA, was a 2 km section of a storm drain line to which 21 sloped-bottom, catch basins were connected and which had 20 manhole chambers. Most catch basins were connected by lateral lines to the manhole chambers. The spacing between manhole chambers varied from 50–250 m. This same storm drain section was utilized for studies on population estimation and chemical control during 1980 (Mulligan and Schaefer 1981).

Adult mosquito populations were monitored by collections with miniature, CDC-type traps (Bio-Quip #2802 EVS). Traps were operated overnight (ca. 1600–0900 h) with new batteries and ca. 1 kg dry ice each. The species and numbers of each sex were determined in the laboratory. When a collection was large (> ca. 1000), the number was estimated by counting and weighing a subsample.

Traps were placed at the same locations as in the previous study. Two disparate areas of the drain line were sampled. A single trap was placed in each of 2 manholes where there was constant, deep, standing water. Single traps were placed in each of 3 manholes where water was absent or intermittent. Traps placed in the latter manholes presumably measured the adult population which was dispersing (Mulligan and Schaefer 1981). Traps were also placed in the yards of 3 houses, which were adjacent to the study area. The populations of adults were sampled throughout the winter of 1980–81 and on through November 1981.

Physical barriers were 110 cm long, open-ended tubes constructed of rip-stop nylon and sewn so that the circumferences were slightly larger than that of the concrete, lateral pipes in which they were placed. These lateral pipes were of 3 standard diameters (38, 46 and 61 cm) and the tubes were constructed accordingly. A springsteel band (1.0–1.5 mm thick and 3.2 cm wide) was slipped into a sewn sleeve on one end of each tube and this served to hold the tube firmly against the inside circumference of the pipe. The opposite end of the tube collapsed to present a physical barrier to adult movement, but also allowed water to flow through unrestricted. The tube was placed in the end of the lateral pipe which discharged into the storm drain line, whenever there was access through the manhole chamber (Fig. 1). In 6 cases the lateral lines discharged into the storm drain line at points between manhole chambers and physical access was insufficient; whereupon, the tubes were placed in the entry

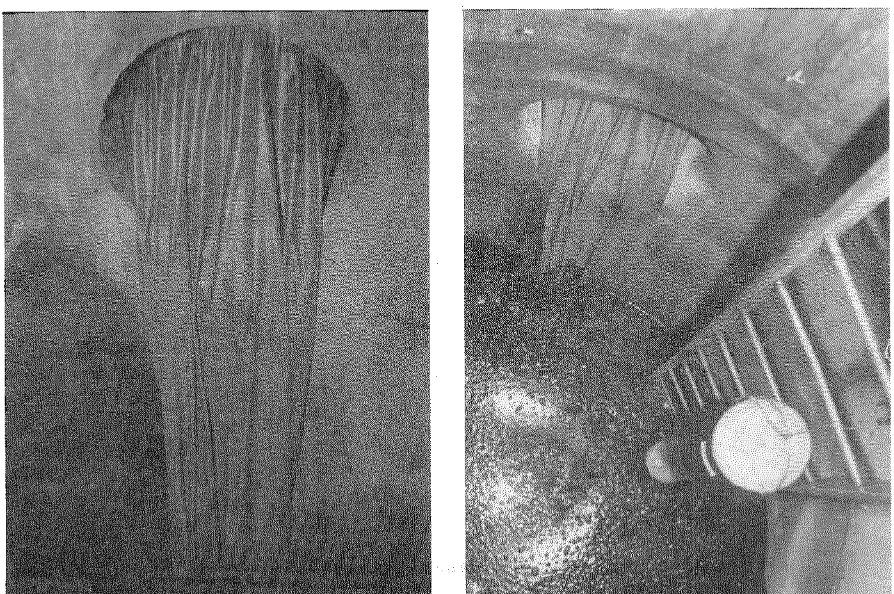

Fig. 1. Left: Collapsible, nylon tube installed at discharge end of lateral pipe from catch basin to storm drain. Right: A manhole chamber which held deep, standing water throughout year. Note collapsible tube and the light—CO_2 trap used to monitor adult mosquito population.

of the lateral pipe at the point where water enters from the catch basin. The tubes were placed within the pipes on July 28 and 29, 1981.

To further isolate the drain line from adult mosquito exit and entry, the ca. 3 cm diam hole in each manhole lid was sealed with tape.

RESULTS AND DISCUSSION

Monthly means, ± SE, were derived from weekly, replicate captures of adult mosquitoes for each of the 3 sampling areas: deep water, intermittent water and yards. Data from the previous study, July–October 1980, are included. Figure 2 shows the mean numbers of adults trapped from the deep water area within the drain line. Means (not shown) from the intermittent water area displayed the same collection pattern as the deep water area, though with numbers proportionally 10X lower. Figure 3 shows the monthly adult means trapped from yards of houses adjacent to the drain line.

Culex quinquefasciatus Say was the only mosquito species captured within the drain line during 1980–81. The adult population declined in November 1980, with the onset of cold weather, and remained low throughout the winter. Mean numbers of adults captured were 8, 1, 0, 1 and 2 for the months of December through April, respectively. While large numbers of adults were not found to overwinter in the line, 13% of the females collected during this period were

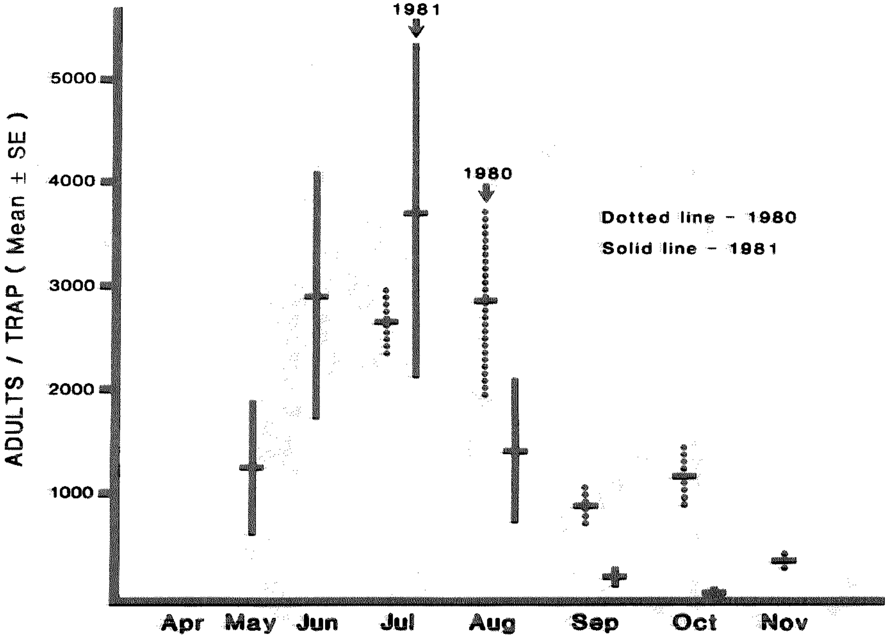

Fig. 2. Monthly means ± SE of *Culex quinquefasciatus* adults captured from deep water area within a Fresno, CA storm drain line. Arrow 1980 indicates initiation of adulticide applications (8–15, 8–29 and 9–12–80) and arrow 1981 denotes installation of collapsible tubes in the line.

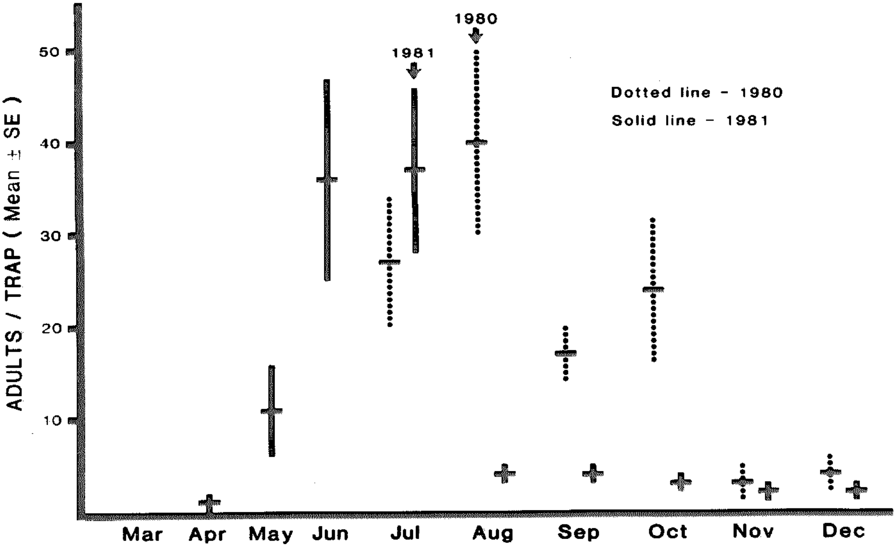

Fig. 3. Monthly means ± SE of *Culex quinquefasciatus* adults captured in yards of houses adjacent to a Fresno, CA storm drain line. Arrow 1980 indicates initiation of adulticide applications (8–15, 8–29 and 9–12–80) and arrow 1981 denotes installation of collapsible tubes in the line.

bloodfed or gravid. Few adults were collected from the yards through the winter, 1 or below from January–April 1981. The numbers of adults captured increased in May and continued to increase through July when 3722 ± 1615 adults/trap were collected from the deep water area and 37 ± 9 were collected from the yards.

After the physical barrier system was installed at the end of July (see arrow 1981, Figs. 2, 3), the numbers of adults captured were reduced. From a combined June–July 1981 pretreatment mean of 3217 ± 944 adults/trap, the capture rate dropped to 128 ± 65 for September–October 1981. This difference was significant ($P > 0.05$) by analysis of variance (ANOVA). Likewise the September–October 1980 mean, 1002 ± 172 adults, was significantly lower than the 1980 pretreatment mean of 3308 ± 540, which combined July and part of August. The reduction of the September–October 1980 mean from its pretreatment mean was attributed to 3 adulticide applications of malathion, on August 15 and 29 and September 12, 1980 (Mulligan and Schaefer 1981). Whereas there was no significant difference by ANOVA between pretreatment means, the September–October 1981 mean was significantly lower than the September–October 1980 mean. The September–October 1981 mean represented a 96% reduction from the pretreatment and an 87% reduction from the 1980 chemical treatment. Thus a real decrease in numbers of adults within the storm drain line occurred after installation of the collapsible tubes.

To determine if temperature was a factor between the 2 years, the daily average temperatures of June–October were compared by a paired t test. There was no significant difference between the means, both mean daily average temperatures were 25°C. During these collection periods, no measurable rainfall was recorded; except for 0.76 mm in October of 1980 and 1981 and 0.25 mm in July 1980. All weather data were obtained from a National Oceanic and Atmospheric Administration station in Fresno and was recorded from within 5 km of the drain line test site. Also no apparent difference in the amount of water in the drain line or in flow of water into the drain line was observed between the 2 years. Since no environmental factor would account for a difference, the physical barrier system alone caused the reduction in numbers of adults captured which occurred after installation.

That the barrier system prevented the exit of adults from the drain line was confirmed by a reduction in numbers of adults collected in the yards (Fig. 3). The September–October 1981 mean of 4 ± 1 adults was 89% less than the 1981 pretreatment mean of 36 ± 9 and 80% less than the September–October 1980 mean of 20 ± 4, and differed significantly from both (ANOVA). There was no significant difference between the September–October 1980 mean and the 1980 pretreatment mean, 34 ± 7 adults/trap.

The more gradual decline of the means from the drain line, as opposed to the steep decline of means from the yards, was expected since the drain line offered an excellent environment for adult longevity and because of the presence of an immature population within the line at the time of installation. Since the major source of adults to the houses was physically blocked, the number trapped in the yards was expected to drop rapidly. The low numbers trapped at the houses after installation may have originated from sources other than the drain line.

Mosquito breeding was found in water collected in street gutters which fed the drain line and was adjacent to the house trap area. Although these gutters were routinely sprayed with larvicide oil, egg rafts and larvae were noted at weekly inspections. Male mosquitoes, though less long-lived, were collected from the drain line into November. The fact that males were collected 3.5 months after installation of the tubes indicated that some new adult emergence continued in the drain line. Immature stages washed from the gutters undoubtedly provided a source of reinfestation to the drain line.

Improperly sloped street gutters, which accumulated leaf litter and retained water, were not the only problems encountered. Lack of maintenance allowed debris to accrue over several years in the catch basins. Prior to the installation of the tubes, the catch basins had to be cleaned. Street debris which washed into the catch basins presented the potential to either block or hold the fabric tubes open, especially those placed at the catch basin end of the lateral pipe. Such tubes collapsed in a horizontal alignment along the pipe. In contrast, tubes placed at the discharge end of the lateral pipes collapsed and hung vertically (Fig. 1). Where the latter installation was possible, it was preferred; as it minimized the build-up of debris and was easier to check.

The only problem encountered with the design of the barrier was that the spring steel used was not stiff enough to hold the larger (61 cm diam) tubes securely in place in all cases. To remedy this, a straight bar clamp was designed to press the steel band against the lateral pipe. After removal of the tubes in late November, with the start of the rainy season, the tubes were still in good condition and could be reused.

ACKNOWLEDGMENT

During the spring of 1981, a meeting was held in Fresno with personnel of several California mosquito abatement districts which have serious mosquito breeding problems within storm drain lines. One of the possible control strategies discussed was the installation of collapsible tubes (suggested by Dr. J. Hazelrigg), designed to allow the passage of

water but to restrict the movement of adult mosquitoes. This study was a follow-up on that suggestion.

The assistance and cooperation of personnel of the Fresno Mosquito Abatement District and the Fresno Metropolitan Flood Control District is gratefully acknowledged. This work was supported, in part, by a special California State appropriation for mosquito control research.

Literature Cited

Hazelrigg, J. E. and F. W. Pelsue. 1980. A technique for controlling mosquito breeding in underground storm drains using methoprene: Altosid® (California SLN-780183). Proc. Calif. Mosq. and Vector Contr. Assoc. 48:96–8.

Mulligan, F. S., III and C. H. Schaefer. 1981. The breeding of *Culex quinquefasciatus* within the Fresno urban storm drain system. Proc. Calif. Mosq. Vector Contr. Assoc. In press.

Smith, C. M. and J. K. Shisler. 1981. An assessment of storm water drainage facilities as sources of mosquito breeding. Mosq. News 41:226–30.

RELATIVE ABUNDANCE AND SEASONAL DISTRIBUTION OF ADULT MOSQUITOES IN SOUTHERN QUEBEC

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ABSTRACT. The relative abundance and seasonal distribution of adult mosquitoes in southern Quebec, Canada, were studied using CDC light traps baited with carbon dioxide. Samples were collected twice a week from late May to early October 1977. Over 63,000 mosquitoes from 26 species in 7 genera were collected. *Mansonia perturbans, Aedes aurifer* and *Anopheles walkeri* were the most abundant, comprising 60%, 31% and 4% of the total collection respectively.

INTRODUCTION

Cattail marshes are extensively used for human recreation and/or as refuge for waterfowl, and many produce huge numbers of mosquitoes that cause discomfort to humans and many have an economic impact on livestock. This habitat is widespread in central and southeastern Canada, and few data are available on the mosquito fauna near such areas. The purpose of this investigation was to study the seasonal abundance of host-seeking mosquitoes near cattail marshes in southern Quebec.

MATERIALS AND METHODS

Lac Boivin, near the city of Granby (45°14′N; 72°44′W), Quebec, is a typical permanent cattail marsh. It is surrounded by Granby to the south and west, forest and dairy farms to the east, and a nature trail to the north. Cattail (*Typha* spp.) and burreed (*Sparganium* spp.) covered 80% of the surface occupied by emergent aquatic vegetation. The dominant trees bordering the shoreline were willow (*Salix* spp.), rough alder (*Alnus rugosa* (DuRoi) Sprengel), red maple (*Acer rubrum* Linnaeus) and aspen (*Populus tremuloides* Michaux). A more complete description of the vegetation is given by Leprince (1980)[1].

[1] Leprince, D. J. 1980. Les culicides (Diptera) du lac Boivin, Granby, Québec, M.Sc. Thesis, Université de Montréal, 72 pp.