AN ASSESSMENT OF STORM WATER DRAINAGE FACILITIES AS SOURCES OF MOSQUITO BREEDING[1]

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ABSTRACT. Storm water drainage facilities have been associated with increased mosquito problems within developing areas of Burlington County, New Jersey. Biweekly larval surveillance was conducted in 35 storm water drainage facilities during the 1979 mosquito breeding season. Data obtained revealed that 80% of these facilities supported mosquito breeding and that 94% of the mosquitoes were vector or nuisance species. Data indicated that certain species are associated with specific types of storm water drainage facilities.

INTRODUCTION

Once known for its agricultural productivity, Burlington County is now in the midst of large-scale industrial and residential expansion.

Since zoning regulations require that storm water drainage facilities be included in new housing projects (O'Carroll, 1978, Schimmenti 1979), one of the byproducts of this increased development is the growth in number of these facilities throughout the county. The authors realize that these methods of storm water management perform a necessary function; however, if improperly designed, constructed or maintained, these facilities possess the potential of becoming additional sources of mosquito breeding (Schimmenti 1979; Chanda and Shisler 1980). Since their function necessitates that they be located within areas of high population density, any mosquito breeding occurring would therefore affect a large number of people. In addition to becoming increasingly costly aerial application of chemicals is difficult to carry out due to the nature of the areas to be treated. In many cases, the construction of these facilities (Schimmenti 1979) also prevents their treatment by ground vehicle.

Through the joint efforts of the Burlington County Mosquito Extermination Commission and the New Jersey Agricultural Experiment Station, a surveillance program was initiated during the summer of 1979 to determine if the existing storm water drainage facilities within Burlington County actually serve as mosquito breeding sites and, if so, to determine what species of mosquitoes they produce.

MATERIALS AND METHODS

A total of 53 storm water drainage facilities was recorded, and their locations were mapped (Fig. 1). The majority are located along the Delaware River, where the highest human population densities occur. Ownership of the individual facilities had to be ascertained so that the owners could be informed of this project.

Once this had been accomplished, each facility was classified as to type and mosquito breeding potential. Three types of storm water drainage facility were defined. Definitions of the facility types are appropriate since there are differences of opinion concerning design criteria

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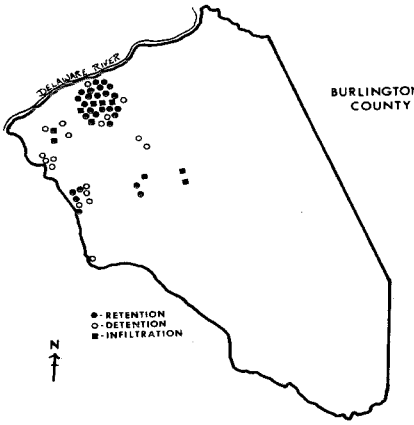

Fig. 1. Location of storm water drainage facilities within Burlington County, New Jersey.

(O'Carroll 1978, Schmidt 1980). The first, the detention basin, is designed to control the flow of storm water by detaining it for a period of time and then gradually releasing this water through a release pipe. This type of facility goes through a continual cycle of holding water and drying down. The retention basin, as the name implies, is designed to retain storm water on a continual basis and is usually never dry. The infiltration basin is designed to operate on the same principle as the detention basin, with the exception of the absence of a release pipe, detained water gradually percolating through the bottom of the basin. During the course of this study, there was no maintenance of any kind observed at any of these facilities. Consequently, most contained emergent vegetation, and in many cases erosion of the banks was occurring. These conditions were observed in all 3 facility types.

Beginning in mid-June, 35 of the 53 facilities were inspected for the presence of mosquito breeding every 2 weeks employing standard dipping procedures. Inspections were continued through August; each of the facilities was inspected a total of 6 times. This period of time, that is, June through August, represents the major portion of the mosquito breeding season in Burlington County for those mosquito species in this study. Of the 35 facilities, 43% were found to contain mosquito breeding in at least 50% of the inspections. Since the locations of the facilities were scattered throughout the county, it took 1 person 2 full working days to accomplish the inspections alone. Larval collections were returned to the lab for identification and the results recorded.

RESULTS AND DISCUSSION

Table 1 details the percentage of each of the 3 facility types found to contain mosquito breeding. Of the 12 detention basins inspected, 75% were found to produce mosquitoes. Of 7 infiltration basins, 86% were found to contain mosquito breeding. Among 16 retention basins included in this survey, 81% produced mosquitoes at some point during the season. A state-wide survey of 332 facilities showed 77% of detention, 63% of infiltration and 53% of retention basins surveyed supported mosquito breeding

Table 1. Summary of mosquito breeding data for three types of storm water drainage facility in Burlington County, New Jersey for 1979.

	Type of Facility		
	Detention (12)	Infiltration (7)	Retention (16)
Presence of mosquito breeding	75%	86%	81%
Floodwater species	38%	50%	10%
Nuisance and/or vector species	96%	71%	92%

Numbers in parentheses represent the number of facilities sampled.

(Chanda and Shisler 1980). The species of mosquitoes which were obtained during the course of this surveillance program are shown in Table 2 and are comparable to the species reported by Schmidt (1980).

Table 2. Mosquito species obtained during storm water drainage facility surveillance program—1979.

Species	Classification
Aedes vexans	b,c
Culex pipiens	a,c
Culex restuans	a,c
Culex territans	a
Anopheles punctipennis	a,c
Anopheles quadrimaculatus	a,c
Psorophora columbiae	b,c

a—Standing water species.
b—Floodwater species.
c—Nuisance and/or vector species.

Data obtained were further evaluated to determine percentages of floodwater species and permanent (or standing) water species (Table 1). Again, the data were grouped according to facility type. The numbers in parentheses represent the number of facilities sampled for each facility type. For the detention basins surveyed, 38% of the larvae collected were floodwater species and 62% were standing water species. Of the 7 infiltration basins, an even distribution of the total occurred, with 50% floodwater and 50% standing water species. Among the 16 retention basins surveyed, 10% of the larvae collected were floodwater and the remaining 90% standing water species.

Table 3 details the average number of mosquito larvae per dip collected for the 3 major mosquito species included in this survey: *Aedes vexans, Culex pipiens* and *Cx. restuans*. The numbers in parentheses represent the percentage of time that each of these 3 species were found breeding in the 3 facility types during the months June, July and August. Larval densities of 10 or more per dip are considered "heavy" breeding conditions in Burlington County. As is evident from the data in Table 3, *Cx. restuans* was the

Table 3. Average number of mosquito larvae/dip collected for the three major mosquito species included in this survey.

	June			July			August		
	D	I	R	D	I	R	D	I	R
Ae. vexans	±6.5/dip (33.3%)	0/dip (0%)	±10.0/dip (7.6%)	±11.7/dip (44.4%)	±13.2/dip (100%)	±7.0/dip (11.7%)	±3.6/dip (75.0%)	±5.5/dip (66.6%)	±4.0/dip (12.5%)
Cx. pipiens	±21.5/dip (33.3%)	0/dip (0%)	±12.8/dip (38.4%)	±12.5/dip (77.7%)	±11.0/dip (33.3%)	±13.0/dip (70.5%)	±2.0/dip (25.0%)	±8.0/dip (33.3%)	±5.5/dip (75.0%)
Cx. restuans	±2.0/dip (33.3%)	±11.3/dip (100%)	±15.1/dip (53.8%)	±14.0/dip (33.3%)	±7.5/dip (16.6%)	±12.0/dip (23.5%)	0/dip (0%)	0/dip (0%)	0/dip (0%)

D—Detention facilities.
I—Infiltration facilities.
R—Retention facilities.
Numbers in parentheses represent the percentage of time that each of these 3 species were found breeding in the 3 facility types during the months of June, July and August.

dominant species in June, both in relative numbers in the breeding sites and in the percentage of time this species was present in larval samples. This is especially evident in the infiltration and retention facilities; *Cx. restuans* was the only species present in samples taken from infiltration facilities during the month of June, with a relative density of ± 11.3/dip. In the case of the retention facilities included in this survey, during the month of June *Cx. restuans* larvae were present in 53.8% of the samples taken, with a relative density of ± 15.1 larvae/dip. During the months of July and August, the relative numbers of *Cx. restuans* larvae collected decreased, as did the frequency of this species' presence within samples from all 3 facility types. *Cx. restuans* larvae were replaced by *Ae. vexans* and *Cx. pipiens,* both in relative numbers and in the frequency of their occurrence within samples. This trend follows the seasonal distribution for these 3 species in Burlington County. *Cx. restuans* are present in greater density early in the breeding season; as the season progresses relative numbers of *Cx. restuans* decrease and those of *Ae. vexans* and *Cx. pipiens* increase.

The final evaluation involved the determination of the percentage of nuisance and vector species from the total mosquito species identified. Table 2 lists the mosquito species obtained during the course of this study, and classifies them according to habitat and vector and/or nuisance status. *Ae. vexans, Anopheles punctipennis, An. quadrimaculatus* and *Psorophora columbiae* are known nuisance species in New Jersey (Carpenter and La Casse 1955); *Cx. pipiens* has been established as the principal vector of St. Louis encephalitis in New Jersey (Monath 1980) and *Cx. restuans* has been implicated as a possible vector of St. Louis encephalitis in New Jersey (Monath 1980). Data indicate that vector and nuisance species were dominant in all facility types (Table 1). Grouping the totals of all 3 facility types together, it was found that 94% of that total were either nuisance or vector species of mosquitoes, indicating that in 94% of all positive inspections treatment of some kind was necessary. The location of these facilities within areas of high population density would result in a great number of people being affected, and possibly endangered, by the mosquito breeding in storm water drainage facilities.

A survey of fish populations associated with storm water drainage facilities in the county revealed that the facilities in which mosquitoes were found to be breeding prolifically contained populations of *Lepomis gibbosus* (pumpkinseed), *Lepomis macrochirus* (bluegill) and *Carassius auratus* (goldfish). These fish species, in the numbers present, are apparently ineffective for larval control in this habitat.

In conclusion, this survey has shown that the majority of storm water drainage facilities within Burlington County are sources of mosquito breeding. As a result, people close to these facilities must live with mosquito nuisance and the potential threat of disease. Care should be taken in the design, construction and maintenance of these facilities (Schimmenti 1979) so that they perform their intended function, that is, regulate the flow of storm water, without contributing additionally to the myriad of habitats already available to the mosquito for its proliferation.

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References Cited

Carpenter, S. J. and LaCasse, W. J. 1955. Mosquitoes of North America. Berkeley and Los Angeles. University of California Press. Pp. 50, 52, 130–131, 264–265.

Chanda, D. A. and Shisler, J. K. 1980. Mosquito control problems associated with storm water control facilities. Proc. N.J. Mosq. Cont. Assoc. 67:193–200.

Monath, T. P. (Editor). 1980. St. Louis encephalitis. Washington, D.C. American Public Health Association. Pp. 243–244.

O'Carroll, G. H. 1978. The mosquito abatement hazards of detention-retention facilities in New Jersey. Proc. N.J. Mosq. Cont. Assoc. 65:158–165.
Schimmenti, F. G. 1979. Mosquito control problems associated with and general guidelines for detention and retention basins. Proc. N.J. Mosq. Cont. Assoc. 66:139–148.
Schmidt, R. F. 1980. A two year study of multi-purpose water structures in Middlesex County, N.J. Proc. N.J. Mosq. Cont. Assoc. 67:184–192.

MATING COMPETITIVENESS OF IRRADIATED MALES OF *CULEX TARSALIS* IN A FIELD CAGE STUDY[1]

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ABSTRACT. Adult male *Culex tarsalis* irradiated and released into large outdoor field cages at ratios (irradiated: unirradiated) of 1:1, 2:1, and 9:1 were expected to "sire" egg rafts with hatch rates (low hatch/high hatch) of 1:1, 2:1, and 9:1 based on a competitiveness value of 1.0. Male to female sex ratios were 2:1, 3:1, and 2:1, respectively, for each field cage release. The observed hatch rate ratios did not differ significantly from the expected values at each ratio, but the overall reduction in hatch was greater at higher ratios.

Gamma radiation has been used to sterilize male mosquitoes (Morlan et al. 1962, Davis et al. 1959, Ramakrishnan et al. 1962). Darrow (1968) exposed eggs, larvae and pupae of *Culex tarsalis* to gamma radiation to determine its effect on life span and relative fertility. Ainsley et al. (1980) determined that a dose of 5.0 kilorentgens (kR) from a 60-cobalt source achieved a sterility rate of more than 95% in adult male *Cx. tarsalis* and had little effect on survival or mating behavior. Ainsley and Asman (1979) found that the mating competitiveness of irradiated males in small laboratory cages was not significantly affected if the ratios of sterile to fertile males were increased. The present study evaluated the ability of irradiated male *Cx. tarsalis* to compete in large outdoor field cages at various ratios with unsterilized males from the same field population.

METHODS

All mosquitoes were reared from wild pupae collected at Poso West, a study area near Bakersfield, CA (Nelson et al. 1978). A portion of adult males less than 24 hr old was exposed to gamma radiation produced by a Mevatron® linear accelerator at a rate of 250 R/min. The remaining males and females were separated within 24 hr of emergence to prevent mating prior to release. Releases of 3 to 4 day old individuals were made at Bakersfield in large outdoor field cages (Terwedow et al. 1977). Egg rafts were collected daily

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