(approx. 20 cm deep) located within a large permanent swamp that was approximately 0.5 km NE of Black Spruce Bog. The swamp was surrounded by fallen trees and large coniferous trees and contained water that was highly acidic (pH 5.5). Mosquito species associated with *Ae. punctor* included *Ae. abserratus, Ae. canadensis canadensis* and *Culiseta morsitans* (Theobald).

Identifications were made from 4th instar larvae and confirmed with adult female specimens that emerged from field-collected pupae. The area was revisited 2 years later on May 9, 1986 and several 4th instar larvae of both species were again collected from the same breeding habitats.

Both habitat types and associated mosquito species are consistent with those reported from neighboring New York where *Ae. communis* and *Ae. punctor* are very common and abundant throughout the high elevations (in excess of 457 m) of the Adirondack Mountains, occurring in cool temporary pools with acidic water in heavily wooded mixed or coniferous forests (Barnes et al. 1950, Means 1979). *Aedes communis* and *Ae. punctor* have also been reported from nearby Maine, Massachusetts and New Hampshire and as far south as Pennsylvania and New Jersey in the eastern portion of their ranges (Carpenter and LaCasse 1955, Darsie and Ward 1981).

In Canada, both species are abundant and widely distributed throughout forested areas. *Aedes communis* is most frequently found in deciduous forest pools in which there is a high tannic acid content while *Ae. punctor* is more consistently collected in coniferous forest pools, usually surrounding sphagnum bogs, where they are associated with *Ae. abserratus* and *Ae. cinereus* Meigen (Wood et al. 1979).

These collection records bring the total number of mosquito species known to occur in Connecticut to 46 and the total number of *Aedes* spp. to 23 (Wallis 1960, Darsie and Ward 1981). Larval and adult specimens have been deposited in the collection of The Connecticut Agricultural Experiment Station.

I thank J. Hare, P. Moore, D. Stasiak and W. Telford for their technical field assistance.

References Cited

Barnes, R. C., H. L. Fellton and C. A. Wilson. 1950. An annotated list of the mosquitoes of New York. Mosq. News 10:69–84.

Carpenter, S. J. and W. J. LaCasse. 1955. Mosquitoes of North America (north of Mexico). Univ. of Calif. Press, Berkeley and Los Angeles. 360 pp.

Darsie, R. F., Jr. and R. A. Ward. 1981. Identification and geographical distribution of mosquitoes of North America, north of Mexico. Mosq. Syst. Suppl. 1:1–313.

Means, R. G. 1979. Mosquitoes of New York. Part I. The genus *Aedes* Meigen with identification keys to genera of Culicidae. N.Y. State Mus. Bull. 430a, 221 pp.

Wallis, R. C. 1960. Mosquitoes in Connecticut. Conn. Agric. Exp. Stn. Bull. 632, 30 pp.

Wood, D. M., P. T. Dang and R. A. Ellis. 1979. The insects and arachnids of Canada, Part 6. The mosquitoes of Canada, Diptera: Culicidae. Agriculture Canada Pub. 1686, 390 pp.

ACTIVITY OF *CULEX QUINQUEFASCIATUS* IN AN UNDERGROUND STORM DRAIN IN SAN ANTONIO, TEXAS[1]

DANIEL STRICKMAN[2] AND JERRY T. LANG[3]

Published information on *Culex quinquefasciatus* Say repeatedly affirms that this species responds directly to cool temperatures by extending the length of its life cycle, rather than by interrupting development with a true state of diapause (Eldridge 1966, 1968; Wilton and Smith 1985). Observations of winter activity in populations of *Cx. quinquefasciatus* in Texas (Hayes and Hsi 1975, Strickman 1983) corroborate the belief that this mosquito can resume activity any time the weather warms sufficiently. With this background, we suspected that a protected site might harbor either concentrations of inactive mosquitoes or a confined population of active adults.

We chose a study site in southeastern San Antonio, where populations of *Cx. quinquefasciatus* were known to be high. The site is a large square (4 × 4 m) storm drain (designated City Project Number 55) which opens into the San Antonio River. Culverts without catch basins enter the drain under most street intersections. Most of the time, water flowed in a shallow (2 to 6 cm) sheet along the floor of the drain with only a few small pools formed on the cement floor.

Adult mosquitoes in the drain were sampled with a battery-operated light trap (Driggers et al. 1980). The trap was hung 2 m above the

[1] Opinions and assertions contained herein are the private views of the authors and are not to be construed as official, nor as reflecting the views or endorsements of the U.S. Army, or the Department of Defense.

[2] Walter Reed Biosystematics Unit, Museum Support Center, Smithsonian Institution, Washington, DC 20560.

[3] U.S. Air Force Military Airlift Command, HQ MAC/DEMU, Scott AFB, IL 62225–5001.

floor of the drain at a point 1020 m from the San Antonio River (directly below the 300 block of Mt. Vernon Street). Weekly, 24-hour samples were collected from November 8, 1983 to April 12, 1985, except when heavy rains or other conditions made entry dangerous. Adults were identified to species, and categorized as male, gravid female or nongravid female. Determination of gravidity was based on dissection of every female. Those with terminal follicles approximately the size and shape of mature eggs (stage IVb or V of Clements 1963) were considered gravid. None of the 1,563 females captured during the study contained accumulations of fat body typical of overwintering *Cx. pipiens* Linnaeus.

Although variable, the data suggest several trends in the population of *Cx. quinquefasciatus* (Table 1). First, gravid females were the first mosquitoes captured in the spring of both 1984 and 1985. Second, males were present in low numbers during much of the year. Finally, catches of female mosquitoes in the storm drain were greatest during times of moderate temperatures. On the basis of monthly means in Table 1, greatest activity was observed (November 1983; April, May, and November 1984) when underground temperatures were between 20° and 23°C and minimum temperatures above ground were between 10° and 18°C. Numbers of trapped females declined during warmer months (June–October 1984) when underground temperatures were between 23° and 28°C and minimum temperatures above ground were between 18° and 24°C. Adult activity was nearly absent in January and February of both years, though temperatures in the storm drain never declined below freezing. Figure 1 illustrates the level of female activity in relation to temperature for each observation of the study. The highest trap catches are clustered in the middle of the graph, representing times of moderate temperatures both above and below ground.

Weekly, non-quantitative examinations of the storm drain for the presence of larvae were initiated on December 29, 1983. Larvae of *Cx. quinquiefasciatus* were found anywhere in the water of the drain (including flowing along with the current), but were most abundant adjacent to the edge of the floor or in pools, where slower flow allowed the larvae to be stationary. Larvae were present on the following dates: December 29, 1983; January 4; April 3, 18, 24, May 1; June 13; and July 5, 1984. With the exception of the June 13 observation, the presence of larvae corresponded to periods of low rainfall (less than 11 mm in a month) when a number of days passed without flushing of the drain by rainwater.

The local population of *Cx. quinquefasciatus* used the storm drain in a number of ways. Although only an occasional occurrence, larvae developed in the site when rains failed to flush

Table 1. Adult *Culex quinquefasciatus* collected in an Army Miniature Light Trap operated 24 hours once per week in an underground storm drain between November 8, 1983 and April 12, 1985, San Antonio, Texas.

Month	Number of observations	Mean number (±S.D.) of mosquitoes				Mean (±S.D.) temperature (°C)		Total ppt. (mm)
		Females			Males	At the site	Min. on night of collection	
		Gravid	Non-gravid	Total				
Nov. 1983	3	6.3 ± 1.5	47.7 ± 65.6	54.0 ± 67.0	3.3 ± 4.2	21.3 ± 1.5	10.7 ± 3.7	44
Dec.	5	8.6 ± 10.7	4.8 ± 6.2	13.4 ± 16.6	0.2 ± 0.4	14.8 ± 3.6	2.4 ± 5.7	10
Jan. 1984	4	0 ± 0	0 ± 0	0 ± 0	0 ± 0	12.8 ± 1.0	0.8 ± 5.1	43
Feb.	5	0.2 ± 0.4	0 ± 0	0.2 ± 0.4	0 ± 0	13.6 ± 1.5	5.0 ± 4.3	12
Mar.	4	1.0 ± 2.0	0 ± 0	1.0 ± 2.0	0 ± 0	17.0 ± 1.4	11.9 ± 5.5	25
Apr.	4	8.2 ± 7.5	44.5 ± 55.3	52.8 ± 55.0	3.8 ± 3.8	19.2 ± 1.0	15.1 ± 3.6	7
May	5	42.8 ± 25.9	79.4 ± 78.1	122.2 ± 80.4	0 ± 0	22.2 ± 1.3	17.7 ± 4.8	47
Jun.	2	8.0 ± 4.2	20.0 ± 14.1	28.0 ± 18.4	1.0 ± 0.0	24.0 ± 0.0	20.8 ± 2.0	25
Jul.	3	7.0 ± 2.0	13.3 ± 7.6	20.3 ± 8.1	5.3 ± 3.1	27.0 ± 1.0	23.3 ± 1.0	2
Aug.	5	5.8 ± 2.9	11.8 ± 8.3	17.6 ± 10.5	1.0 ± 1.4	27.2 ± 0.5	23.1 ± 1.0	21
Sep.	3	11.0 ± 2.0	8.0 ± 8.7	19.0 ± 10.4	2.3 ± 2.1	25.7 ± 1.5	18.3 ± 3.5	24
Oct.	3	4.0 ± 3.0	1.3 ± 1.5	5.3 ± 2.3	1.7 ± 1.5	23.3 ± 1.2	20.7 ± 2.9	159
Nov.	5	17.0 ± 11.9	14.0 ± 21.7	31.0 ± 30.0	1.4 ± 1.7	20.2 ± 3.2	13.4 ± 8.8	35
Dec.	3	11.3 ± 9.7	0.7 ± 1.2	12.0 ± 9.5	1.3 ± 1.5	17.3 ± 1.2	12.8 ± 9.7	64
Jan. 1985	5	0 ± 0	0 ± 0	0 ± 0	0 ± 0	14.2 ± 2.2	3.0 ± 5.9	65
Feb.	3	0 ± 0	0 ± 0	0 ± 0	0 ± 0	12.7 ± 2.1	9.8 ± 7.6	34
Mar.	4	3.0 ± 5.4	0 ± 0	3.0 ± 5.4	0 ± 0	17.0 ± 1.4	14.2 ± 6.3	62
Apr.	2	13.0 ± 0.0	0 ± 0	13.0 ± 0	0.5 ± 0.7	20.0 ± 0	20.0 ± 7.1	96

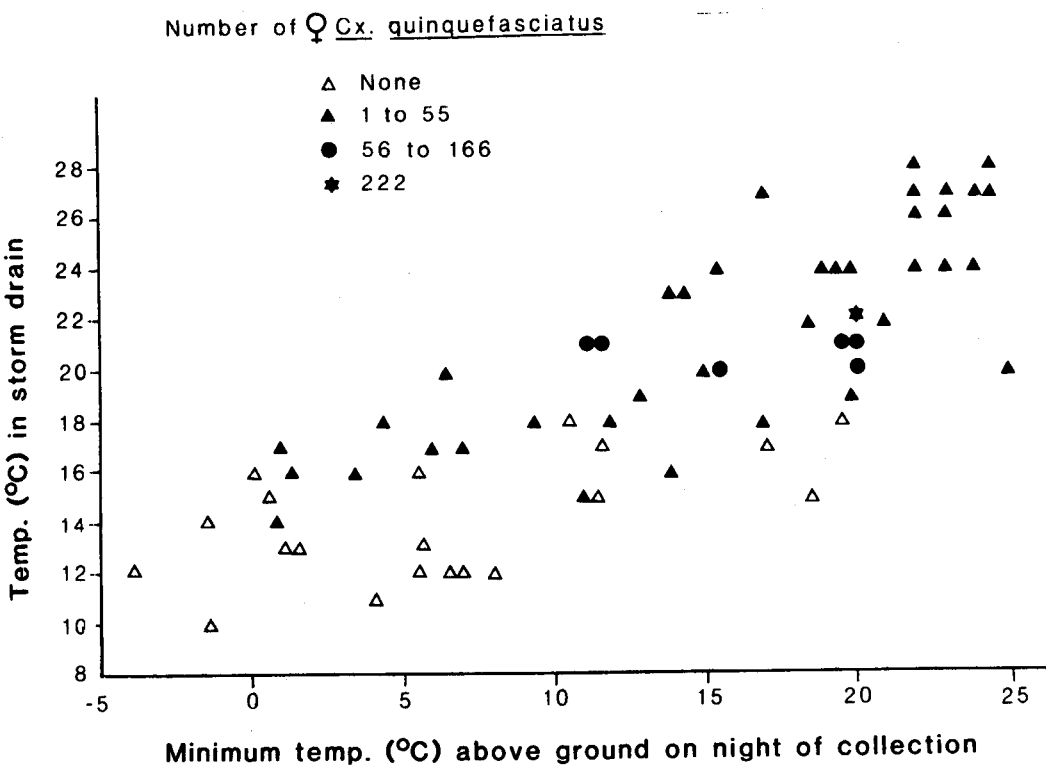

Fig. 1. Effects of temperature on activity of *Cx. quinquefasciatus*.

the storm drain frequently. Some of these larvae probably contributed to the numbers of non-gravid females and males collected in the light trap, but the presence of these categories of mosquitoes during most months of the study suggests that some males and females entered the drain from above-ground sites. Entrance into the drain was apparently greatest during the spring and fall, when cool surface temperatures may have caused mosquitoes to seek the moderate temperatures of the storm drain. Active females were not captured in this study during the coldest months of the year; however, in Houston, Texas, Hunt and Hacker (1984) captured *Cx. quinquefasciatus* in January and February in some of the storm drains they examined. Possibly, the storm drains with active mosquitoes were more sheltered than the drain in our study, but the specific qualities of such winter refuges remain to be discovered.

The authors gratefully acknowledge the following: Terrence J. O'Neill for assistance in the field, Taina Litwak for preparation of the figure, Richard Wilkerson, E. L. Peyton, and Bruce A. Harrison for helpful comments on the manuscript, and the U.S. Air Force and U.S. Army for supporting the study.

References Cited

Clements, A. N. 1963. The physiology of mosquitoes. International Series of Monographs on Pure and Applied Biology, Vol. 17, Macmillan Co., New York.

Driggers, D. P., R. J. O'Connor, J. T. Kardatzke, J. L. Stup and B. A. Schiefer. 1980. The U.S. Army miniature solid state mosquito light trap. Mosq. News 40:172–178.

Eldridge, B. F. 1966. Environmental control of ovarian development in mosquitoes of the *Culex pipiens* complex. Science 151:826–828.

Eldridge, B. F. 1968. The effect of temperature and photoperiod on blood-feeding and ovarian development in mosquitoes of the *Culex pipiens* complex. Am. J. Trop. Med. Hyg. 17:133–140.

Hayes, J. and B. P. Hsi. 1975. Interrelationships between selected meteorologic phenomena and immature stages of *Culex pipiens quinquefasciatus* Say: Study of an isolated population. J. Med. Entomol. 12:299–308.

Hunt, G. J. and C. S. Hacker. 1984. Computer-generated maps as an aid to mosquito control (Diptera: Culicidae). J. Med. Entomol. 21: 489–500.

Strickman, D. 1983. Preliminary report of seasonal oviposition by *Culex quinquefasciatus* in San Antonio, Texas. Mosq. News 43:226–230.

Wilton, D. P. and G. C. Smith. 1985. Ovarian diapause in three geographic strains of *Culex pipiens* (Diptera: Culicidae). J. Med. Entomol. 22:524–528.