# SEASONAL INCIDENCE AND HORIZONTAL DISTRIBUTION PATTERNS OF OVIPOSITION BY *AEDES AEGYPTI* IN AN URBAN ENVIRONMENT IN TRINIDAD, WEST INDIES

DAVE D. CHADEE

*Insect Vector Control Division, Ministry of Health, 3 Queen Street, St. Joseph, Trinidad, W.I.*

ABSTRACT. The oviposition patterns of *Aedes aegypti* in ovitraps placed along 5 horizontal transects were monitored weekly for 52 wk (January to December 1988) in St. Joseph, Trinidad. Of the 2,550 ovitraps exposed, 270 were lost and 1,177 (52%) out of 2,280 were used by gravid females, containing 38,118 eggs. During the dry season 43% (16,265 eggs) of the eggs were collected whereas during the wet season 57% (21,853 eggs) were collected. Ovitraps exposed under eaves, under houses and in the open yard attracted similar oviposition occurrences and proportions of eggs. Inspections of the 52 properties within St. Joseph revealed that 17 (House Index = 32.7%) harbored *Ae. aegypti* pre-adult stages. The container index was 5.5%. This study revealed no evidence of behavioral changes in the container preferences of *Ae. aegypti* in St. Joseph, Trinidad, after 12 years of treating with fenthion and temephos.

## INTRODUCTION

Small black jars designed for use as "ovitraps" (Fay and Eliason 1966) have become a standard surveillance tool for *Aedes aegypti* (Linn.) but the criteria for their placement at specific locations are not clear. Various workers have suggested that in urban surveys, ovitraps should be placed at ground level in backyards, near other oviposition sites, avoiding exposure to excessive rain, sunlight or wind (Fay and Eliason 1966, Jakob and Bevier 1969a).

Further guidelines were given by Jakob and Bevier (1969a) for placement of ovitraps in the field, but most workers continue to place ovitraps using other criteria, such as along transects within cities (Jakob and Bevier 1969b, Tanner 1969).

From 1976 to 1987, an intensive *Ae. aegypti* eradication program was carried out in Trinidad, involving source reduction and insecticide treatments in both domestic and peridomestic environments. McClelland (1967) suggested that such insecticide application may cause shifts in the site selection of *Ae. aegypti*, from treated to untreated and atypical oviposition sites.

The present study was conducted to determine the container preferences of *Ae. aegypti* after larvicidal applications of temephos and fenthion for 12 years, and to hopefully ascertain the most suitable sites for ovitraps under field conditions in one locality, St. Joseph, Trinidad, West Indies.

## MATERIALS AND METHODS

*Study area:* Ovitrap surveys of *Ae. aegypti* were conducted from January to December 1988 in the small town of St. Joseph (10° 30′N, 61° 25′W). Details of the study area, meteorology and *Ae. aegypti* populations have been described by Chadee and Corbet (1987).

*Ovitrapping:* Five sites (A–E) were selected, each site consisting of 2 houses raised on stilts and separated by an exposed yard space. At each site 10 ovitraps were placed at ground level along an east-west transect: 4 traps under the houses, 3 under eaves and 3 exposed in the yard. Each ovitrap consisted of a cylindrical, black plastic cup (13 cm height × 9 cm diam), containing 450 ml of tap water and a removable paddle (Chadee and Corbet 1987). An overflow hole, 3 cm from the top, prevented the ovitrap being filled to the brim. The location of each transect and ovitrap was coded A to E and 1 to 10, respectively, making it possible to monitor the distribution of oviposition among the different sites.

All ovitraps were inspected and serviced weekly for 52 consecutive weeks from January to December 1988. At each inspection, the code-numbered paddle was removed, the ovipot itself scrubbed (to remove any eggs), refilled with 450 ml tap water and reset with an egg-free paddle, rough-side exposed. Each paddle retrieved was placed in a plastic bag and taken to the Insect Vector Control Division (IVCD) laboratory where all mosquito eggs on them were examined under a microscope (×40), counted and identified by the characteristic chorionic pattern of *Ae. aegypti* (Pratt and Kidwell 1969). Counts of *Ae. aegypti* eggs were compared for each transect, as well as individual traps within the transect and for the 3 types of locations: under houses, under eaves and in open yards. The results were analyzed with a G-test by transforming the data into contingency tables (Sokal and Rohlf 1980) to determine location preferences and oviposition patterns.

*Container preferences:* In a general survey of the town, 52 house properties were inspected weekly by 6 mosquito evaluators to determine the numbers, types, positions and conditions of containers that might serve as breeding sites.

Table 1. Monthly rainfall and oviposition patterns of *Aedes aegypti* collected from St. Joseph, Trinidad, in 1988.

| Month | No. ovitraps positive/set | % | No. eggs recovered | Rainfall (mm) |
|---|---|---|---|---|
| *Dry season (1988)* | | | | |
| December | 169/200 | 85 | 6,712 | 48.4 |
| January | 19/200 | 10 | 505 | 37.2 |
| February | 133/250 | 53 | 4,789 | 4.1 |
| March | 75/200 | 38 | 1,754 | 8.5 |
| April | 100/200 | 50 | 2,505 | 69.7 |
| Sub-total | 496/1,050 | 47 | 16,265 | 167.9 |
| *Wet season* | | | | |
| May | 68/250 | 27 | 1,560 | 287.2 |
| June | 66/200 | 33 | 1,935 | 276.7 |
| July | 92/200 | 46 | 2,555 | 286.1 |
| August | 156/200 | 78 | 5,572 | 252.6 |
| September | 65/200 | 33 | 2,209 | 488.4 |
| October | 98/200 | 49 | 2,619 | 216.7 |
| November | 136/250 | 54 | 5,403 | 191.2 |
| Sub-total | 681/1,500 | 45 | 21,853 | 1,998.9 |
| Total | 1,177/2,550 | 46 | 38,118 | 2,166.8 |

Table 2. Oviposition of *Ae. aegypti* in the yard, under eaves and under houses in St. Joseph, Trinidad (January to December 1988).

| | Localities | | | |
|---|---|---|---|---|
| | Yard | Under eaves | Under house | Total |
| No. traps visited | 765 | 765 | 1,020 | 2,550* |
| No. of positive traps | 376 | 349 | 452 | 1,177 |
| % positive | 49 | 46 | 44 | 46 |
| Total no. of eggs laid | 11,391 | 11,591 | 15,136 | 38,118 |
| Mean no. of eggs/positive ovitrap | 30 | 33 | 33 | 32 |
| % of total eggs collected | 30 | 30.4 | 39.7 | 100.0 |

* 270 traps lost.

Table 3. Locations within premises of *Aedes aegypti* preferred containers in St. Joseph, Trinidad, in 1988.

| Types of containers | No. of containers | No. positive | % | Locations | |
|---|---|---|---|---|---|
| | | | | Under eaves | Yard |
| Drums | 132 | 38 | 29 | 25 | 13 |
| Tanks and cisterns | 33 | 9 | 27 | 7 | 2 |
| Buckets and tubs | 107 | 0 | 0 | 0 | 0 |
| Tires | 100 | 0 | 0 | 0 | 0 |
| Small miscellaneous containers* | 518 | 2 | 0.4 | 0 | 2 |
| Total | 890 | 49 | 5.5 | 32 | 17 |

* Cans, pans, tins, etc.

Samples of larvae and pupae from all positive containers were taken to the IVCD laboratory for identification.

## RESULTS

During 1988, the monthly number of eggs obtained from the exposed ovitraps ranged from 505 to 6,712, with a mean of 3,177 eggs per month (Table 1). Rainfall totalled 2,167 mm, averaging 34 mm/month in the dry season (December–April) and 286 mm/month in the wet season (May–November) (Table 1).

During 2,550 ovitrap-weeks along 5 transects, 270 ovitraps were lost. A total of 38,118 *Ae. aegypti* eggs was found in 1,177/2,280 (52%) of ovitraps. The seasonal pattern of oviposition fluctuated from 9.5% of ovitraps positive in January to 85% of ovitraps positive in December and with a significant difference ($G = 54.8$; d.f. $= 2$; $P < 0.001$) in the oviposition rates between the wet and dry seasons (Table 1). No significant differences were detected between the 5 ovitrapping transects (G = 1.03) and similar population densities of *Ae. aegypti* were present at all ovitrapping transacts.

Table 2 summarizes the ovitrap results. All the mosquito eggs collected were identified as *Ae. aegypti*. No significant (G = 0.41) differences were detected in the number of eggs or occurrence of positive ovitraps in the open yard, under eaves or under houses [G-test by transforming the data into 3 × 3 contingency tables (Sokal and Rohlf 1980)]. The mean number of *Ae. aegypti* was 30–33 eggs per positive ovitrap during both the wet and dry seasons (Table 2).

In the 52 house premises survey, 890 containers were identified as potential breeding sites for *Ae. aegypti*, mainly drums (14%), tubs and buckets (12%), tires (11%), cisterns and tanks (4%) and small miscellaneous containers. The House index was 17/52 = 32.7% positive, with 49 positive containers (Container index 5.5%). Although potential breeding sites were also found on the periphery of house lots, only *Culex quinquefasciatus* Say immatures were collected.

Drums represented the most favored container used by *Ae. aegypti* with 38/49 (78%) being positive. However, of the 132 drums found, 93 and 39 were found in the yard and under eaves, respectively. Of these, 13 (35%) were found positive in the yard and 25 (65%) under the eaves. The combined results show that 38/132 (29%) of drums were positive (Table 3).

## DISCUSSION

Gravid *Ae. aegypti* search extensively within premises for oviposition sites and their flight is not limited to within houses but also covers open spaces (yards) in Trinidad. Similar dispersion patterns have been recorded during *Ae. aegypti* mark-release-recapture studies showing a relatively short flight range of 23–50 m (Morlan and Hayes 1958, Nayar 1981).

In Trinidad, the *Ae. aegypti* population is domestic in habit and genetically heterogenous (Wallis et al. 1984). After 12 years of insecticide applications, there is no evidence of major changes in the *Ae. aegypti* populations in St. Joseph, Trinidad, since, all of the positive ovitraps and artificial containers (drums, cans, tyres) were found within urban premises. A similar pattern has been reported in Puerto Rico (Moore 1983).

The number of eggs laid per positive ovitrap during any one week was highly variable, 4–337 eggs in ovitraps under eaves, 1–261 eggs in ovitraps under houses and 1–240 eggs in ovitraps in the yard. But, despite the differences in the physical locations of these ovitraps, the average number of eggs laid per positive ovitrap per week remained almost the same during both seasons, ranging from 30 to 33. A similar average number of eggs per positive ovitrap was found in Texas, despite variations in the total numbers of eggs collected per month (Micks and Moon 1980). Similar numbers of eggs (less than 30 per positive ovitrap) were collected in ovitraps exposed for 2-h intervals during diel oviposition periodicity studies conducted in Trinidad (see Fig. 5 in Chadee and Corbet 1987).

Evidently females laid only a part of their full egg complement in any given ovitrap, since the fecundity of a nulliparous *Ae. aegypti* ranges from 60 to 120 eggs (Christophers 1960, Gillett 1962), which is far more than the mean number of eggs/ovitrap/week. Our data indicate that *Ae. aegypti* females oviposit in multiple sites and each ovitrap probably received eggs from more than one female.

In St. Joseph, the equivalent use of ovitraps in each of the 3 sampling situations suggests that environmental factors such as the exposure to direct sunlight is irrelevant to the placement of ovitraps. Corbet and Chadee (1990) similarly showed no effect of sunlight on oviposition, in that no difference was detected in oviposition patterns in traps placed in sites facing east or west. These findings are probably related to the fact that peak oviposition occurs mainly at 600–800 and 1600–1800 hours (Chadee and Corbet 1987). Even so ovitrap placement in partial shade, as proposed by Fay and Eliason (1966), Jakob and Bevier (1969a) and others, has the advantage of reducing desiccation.

The difference in oviposition levels found between drums and ovitraps exposed to the sun and in the shade may have been due not to light levels *per se* but perhaps to differences in temperature and humidity, in view of the different material (steel vs. plastic) and volume (208 liters vs. 450 ml) of the drums as opposed to ovitraps.

The results of the present study raise important questions regarding the positioning of ovitraps for adequate surveillance of *Ae. aegypti*. Tonn et al. (1969) and Macdonald and Rajapaksa (1972) working in Thailand and Borneo, respectively, concentrated on between-house studies and did not take the positioning of containers in and around houses into consideration, though the latter suggested that such information was desirable.

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