CEMETERY VASE BREEDING OF DENGUE VECTORS IN MANILA, REPUBLIC OF THE PHILIPPINES[1,2]

GEORGE W. SCHULTZ

U.S. Naval Medical Research Unit No. 2, APO San Francisco, CA 96528

ABSTRACT. *Aedes albopictus* and *Ae. aegypti* were found breeding abundantly in cement vases within cemeteries in Manila. *Aedes albopictus* dominated in cemeteries containing vegetation which provided both shade and plant debris for the vase water. The highest larval densities for both species were found from August to December, which is from mid-to-late rainy season. *Aedes albopictus* is unable to compete successfully with *Ae. aegypti* in residential areas with sparce vegetation and thus is very limited in its distribution within the city. Biting activity of both species is similar, with peaks occurring between 0530–0600 h and 1730–1800 h.

INTRODUCTION

Aedes aegypti (Linn) and *Ae. albopictus* (Skuse), both recognized vectors of dengue in Southeast Asia (Rosen et al. 1985), are present in the city of Manila. In previous vector surveys in Manila, *Ae. aegypti* was found to be the dominant container breeder within the residential areas, while *Ae. albopictus* comprised less than 1% of the mosquitoes found. However, one area within the city where *Ae. albopictus* was found to breed abundantly was in cemeteries. There are several large cemeteries within Manila and its surrounding suburbs. The tombs within these cemeteries are always above ground and sometimes multilayered. Cement vases capable of holding water are often attached to the tombs.

The present study was conducted over a 1-year period in 5 of the larger cemeteries. Our objectives were: 1) to determine seasonal changes in larval composition and densities, 2) to determine seasonal species composition and densities by adult biting activity and 3) to establish the range of *Ae. aegypti* and *Ae. albopictus* along transects from cemeteries into adjacent residential areas.

MATERIALS AND METHODS

Five cemeteries in different parts of Manila and its suburbs were monitored from October 1986 to December 1987 (Fig. 1). North and South Cemeteries are located in Manila, while Pasay and Paranaque Cemeteries are south of Manila. Laloma and Paranaque Cemeteries were used for adult man-biting experiments.

Twenty-five vases in each cemetery were surveyed every other month. The same vases were used in each survey and were examined for presence or absence of water, total number of mosquito larvae and other organisms present. After removing the larvae, the vase water was replaced. The larvae were returned to the laboratory, reared to adults and identified.

In 2 cemeteries (Laloma on July 8, 1987, and South on September 22, 1987) where *Ae. albopictus* was more abundant, 10 vases on the inside perimeter wall were sampled. Thirty additional containers were sampled in the residential area outside the cemetery, 10 each at 100, 200 and 300 meters from the cemetery wall. All larvae were returned to the laboratory for rearing and identification.Man-biting collections were made one day each month alternating between Laloma and Paranaque Cemeteries. Twelve (30-min) collections from 0400 to 2100 h were made by 8 people with 1-h breaks between each collection. They collected mosquitoes from their own legs using oral aspirators and red-filtered flashlights during hours of darkness. Mosquitoes were returned to the laboratory for identification.

RESULTS AND DISCUSSION

In each cemetery, the presence of water in the vases was directly related to the amount of rainfall (Table 1). Most vases had water present during the rainy season months of June through December, while most were dry from February through April. Of the vases with water, 91% had larvae present from June through December, while only 35% had larvae present from February through April. The mean number of larvae per positive vase was generally the same in each of the 4 cemeteries, exhibiting high densities from August to December and low densities from

[1] This study was supported through funds provided by the Naval Medical Research and Development Command, Navy Department for Work Unit 3M161102B510.AF429. The opinions and assertions contained herein are those of the author and are not to be construed as official or reflecting the views of the U.S. Navy Department or the Naval Service at large.

[2] Reprint requests to Publications office, U.S. Naval Medical Research Unit No. 2, APO San Francisco, CA 96528–5000.

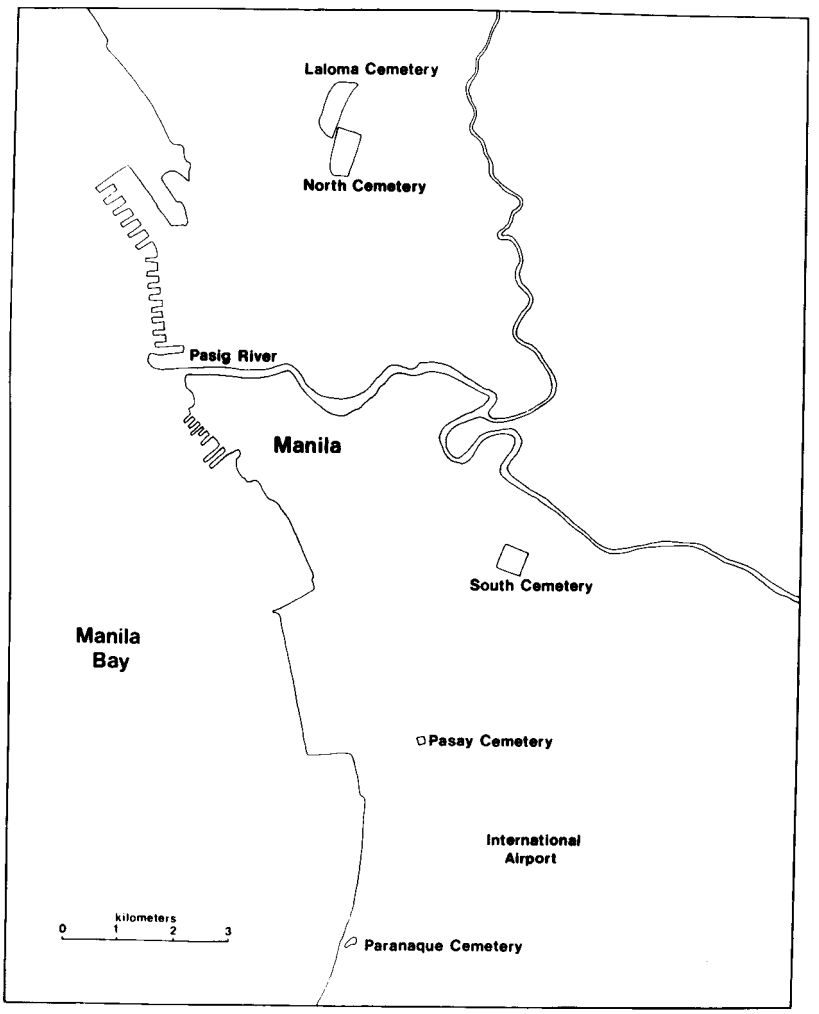

Fig. 1. Map of Manila showing location of 5 cemeteries studied.

Table 1. Comparison of 4 cemeteries surveyed from October 1986 to December 1987 showing percentage of vases with water, mean number of larvae per positive vase, and percentage of *Aedes albopictus* and *Ae. aegypti* collected.

	1986		1987					
	Oct.	Dec.	Feb.	Apr.	Jun.	Aug.	Oct.	Dec.
Paranaque Cemetery								
% of vases with water	100.0	64.0	20.0	24.0	76.0	92.0	92.0	100.0
Mean no. larvae/positive vase	109.8	102.4	229.0	0.0	9.7	53.5	58.9	90.3
% *Ae. albopictus*	21.2	18.7	0.0	0.0	0.0	0.0	3.0	8.8
% *Ae. aegypti*	78.8	81.3	100.0	0.0	100.0	100.0	97.0	91.2
Pasay Cemetery								
% of vases with water	100.0	64.0	40.0	28.0	84.0	100.0	84.0	96.0
Mean no. larvae/positive vase	56.8	53.9	18.9	28.2	5.0	54.8	24.8	57.5
% *Ae. albopictus*	85.5	93.5	52.8	50.0	0.0	12.5	37.0	64.1
% *Ae. aegypti*	14.5	6.5	47.2	50.0	100.0	87.5	63.0	35.9
South Cemetery								
% of vases with water	100.0	36.0	4.0	0.0	56.0	90.9	86.4	81.8
Mean no. larvae/positive vase	57.8	141.1	13.0	0.0	9.3	101.0	54.8	127.4
% *Ae. albopictus*	100.0	100.0	100.0	0.0	82.1	71.8	95.7	89.8
% *Ae. aegypti*	0.0	0.0	0.0	0.0	17.9	28.2	4.3	10.2
North Cemetery								
% of vases with water	100.0	52.0	8.0	0.0	83.3	95.8	100.0	91.7
Mean no. larvae/positive vase	42.2	100.1	0.0	0.0	4.1	40.8	31.4	65.0
% *Ae. albopictus*	100.0	100.0	0.0	0.0	94.4	84.2	69.1	91.0
% *Ae. aegypti*	0.0	0.0	0.0	0.0	5.6	15.8	30.9	9.0

April to June. The major difference found was in the dominant species present in different cemeteries. Paranaque Cemetery is dominantly *Ae. aegypti* at all times of the year; South and North Cemeteries are dominantly *Ae. albopictus;* Pasay Cemetery had both species present but at different times of the year (Table 1). It was not unusual for positive vases to have both species present at the same time. For example, 31.6% of the vases with larvae contained both species, while 44.1% contained only *Ae. albopictus* and 24.4% had only *Ae. aegypti.* The only other mosquito present was *Culex quinquefasciatus*, Say which was found in only 3 vases.

The difference in species dominance between Paranaque and North and South Cemeteries could be attributed to the amount of vegetation present at each cemetery. In Paranaque Cemetery, with the exception of a few coconut trees, there are virtually no bushes or grasses growing between the vaults (Fig. 2A). The vases in this cemetery usually contained no vegetative matter. North and South Cemeteries, in addition to numerous trees, often had bushes and long grasses growing between the vaults (Fig. 2B). Most vases at these 2 cemeteries contained varying amounts of vegetative matter. Pasay Cemetery had more vegetation than Paranaque but less than North or South Cemeteries. Likewise, in other Southeast Asian cities, *Ae. albopictus* is rarely found within the city but becomes abundant in the outskirts where vegetation is plentiful (Gilotra et al. 1967, Tonn et al. 1969, Nelson et al. 1976).

Table 2. Species composition in containers found within and near the Laloma and South Cemeteries.

Distance from cemetery (m)	Dominant species	%	Total collected
Laloma Cemetery			
In cemetery	*Ae. albopictus*	88.5	130
100	*Ae. aegypti*	100.0	67
200	*Ae. aegypti*	100.0	44
300	*Ae. aegypti*	100.0	203
South Cemetery			
In cemetery	*Ae. albopictus*	81.6	98
100	*Ae. aegypti*	100.0	154
200	*Ae. aegypti*	100.0	37
300	*Ae. aegypti*	100.0	179

In cemeteries where *Ae. albopictus* was the dominant species, extensive spreading into surrounding residential areas did not occur (Table 2). The distribution of *Ae. albopictus* in Manila seems confined to areas such as cemeteries; it does not appear able to compete with *Ae. aegypti* in residential areas with sparse vegetation. In contrast, *Ae. aegypti* was able to compete in all cemeteries to some degree.

The adult populations in Laloma Cemetery have trends similar to the larval populations in the adjacent North Cemetery (Table 3). *Aedes albopictus* is the dominant species with higher

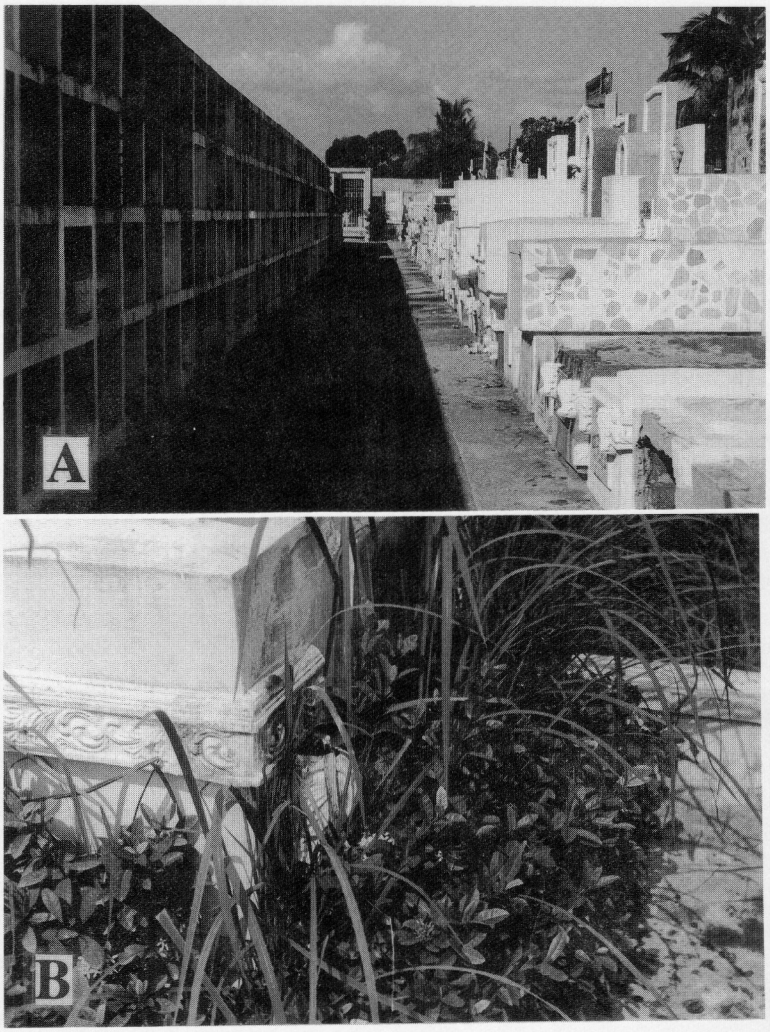

Fig. 2. A. Vases in Paranaque Cemetery showing very little vegetation around vaults. B. Vases in North Cemetery showing abundance of vegetation around vaults.

Table 3. Mean number of *Aedes albopictus* and *Ae. aegypti* biting during 6 man-hours of collecting from 0400 to 2100 h.

Cemetery and species	1986			1987										
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Paranaque Cemetery															
Ae. albopictus	—	47.4	—	0.5	—	0.0	—	0.0	—	0.0	—	4.6	—	5.2	—
Ae. aegypti	—	27.5	—	1.6	—	0.1	—	0.6	—	65.2	—	44.0	—	11.2	—
Laloma Cemetery															
Ae. albopictus	43.9	—	173.0	—	37.0	—	13.5	—	47.4	—	130.9	—	98.4	—	174.4
Ae. aegypti	0.4	—	1.1	—	0.2	—	1.0	—	2.7	—	3.2	—	0.6	—	0.4

biting rates occurring from June through December. The highest biting rates were found in December of both years with about 174 collected in 6 man-hours. *Aedes aegypti* was rarely collected, except with low density populations from June through August. It was dominant in Paranaque Cemetery in 6 of the 7 collections, with July through September having the highest biting rates. The only other mosquito frequently collected biting in the cemeteries was *Cx. quinquefasciatus* (Table 4).

The biting activity of the 2 *Aedes* species is also rather similar, with peak biting times between 0530–0600 h and 1730–1800 h (Fig. 3). The differences were that *Ae. aegypti* had a higher percentage of bites during the morning peak period, while *Ae. albopictus* had a higher percentage of mid-day bites from 0830 to 1630 h. The biting activity pattern of *Ae. aegypti*

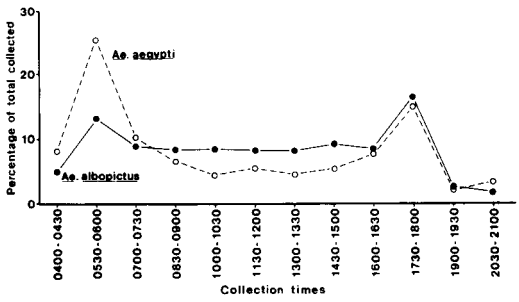

Fig. 3. Biting activity of *Aedes aegypti* and *Ae. albopictus* showing percentage of total collected between 0400–2100 h.

Table 4. Species and numbers collected biting man at Paranaque Cemetery (336 man-hours) and Laloma Cemetery (384 man-hours).

Species	No. collected	
	Paranaque Cemetery	Laloma Cemetery
Aedes aegypti	1,203	78
Ae. albopictus	462	5,747
Ae. vexans	3	0
Ae. lineatopennis	0	1
Culex quinquefasciatus	3,564	1,859
Cx. sitiens	88	46
Cx. annulirostris	50	3
Cx. gelidus	2	2
Cx. pseudovishnui	2	1
Cx. fuscanus	1	0
Cx. vishnui	0	17
Cx. tritaeniorhynchus	0	1
Anopheles litoralis	22	0
An. subpictus	2	0
An. peditaeniatus	0	5
An. lesteri	0	2
Mansonia uniformis	1	3

appears to vary slightly among countries in Asia. In Indonesia (Nelson et al. 1978) and Thailand (Yasuno and Tonn 1970), the 2 peaks occur during mid-morning to early afternoon (0800–1300 h) and mid-afternoon (1500–1700 h). In India (Soman 1978) the early morning (0600–0700 h) and late afternoon (1700–1800 h) peaks are similar to those in the present study, with the morning peak being greater and a third peak occurring between 1000–1100 h.

The larger cemeteries contained several hundred to more than 1,000 vases. Thus, during the rainy season, a large number of *Ae. albopictus* are produced from these sites. Homeless people are also found within the cemeteries, sleeping or living in temporary huts between the tombs. Since both of these species have been identified as efficient vectors of dengue in Southeast Asia, dengue transmission could readily occur in the cemeteries. Vector populations could be reduced drastically either by removing the vases or by filling them with soil.

ACKNOWLEDGMENTS

The author thanks the technicians of the Entomology Department of the U.S. Naval Medical Research Unit No. 2 for their dedication and hard work.

REFERENCES CITED

Gilotra, S. K., L. E. Rozenboom and N. C. Bhattacharya. 1976. Observations on possible competitive displacement between populations of *Aedes aegypti* Linnaeus and *Aedes albopictus* Skuse in Calcutta. Bull. W.H.O. 37:437–446.

Nelson, M. J., C. P. Pant, L. S. Self and S. Usman. 1976. Observations on the breeding habitats of *Aedes aegypti* (L.) in Jakarta, Indonesia. Southeast Asian J. Trop. Med. Public Health 7:424–429.

Nelson, M. J., L. S. Self, C. P. Pant and S. Usman. 1978. Diurnal periodicity of attraction to human bait of *Aedes aegypti* (Diptera: Culicidae) in Jakarta, Indonesia. J. Med. Entomol. 14:504–510.

Rosen, L., L. E. Rosenboom, D. J. Gubler, J. C. Lien and B. N. Chaniotis. 1985. Comparative susceptibility of mosquito species and strains to oral and parenteral infection with dengue and Japanese encephalitis viruses. Am. J. Trop. Med. Hyg. 34:603–615.

Soman, R. S. 1978. Studies on diel periodicity in the landing of *Aedes aegypti* on man in Bangalor city. Indian J. Med. Res. 67:937–941.

Tonn, R. J., P. M. Sheppard, W. W. MacDonald and Y. H. Bang. 1969. Replicate surveys of larval habitats of *Aedes aegypti* in relation to dengue haemorrhagic fever in Bangkok, Thailand. Bull. W.H.O. 40:819–829.