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RESEARCH NOTE

Vertical dispersal of *Aedes (Stegomyia)* spp. in high-rise apartments in Putrajaya, Malaysia

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Abstract. A preliminary study on the vertical dispersal of *Aedes* populations in high-rise apartments was carried out in Presint 9, Putrajaya, Malaysia. Ovitraps were placed indoors within four blocks of high-rise apartments from the ground floors (0.0 – 3.0 m) until up to the tenth floors (28.1 – 30.0 m). *Aedes aegypti* was the dominant species found in the ovitraps (87.85%), while *Aedes albopictus* was found in lower numbers. From total number of larvae collected (650), 40.92% of these larvae were obtained from the fourth block; Block D. The peak density of *Aedes* sp. was observed at level 6 (16.1 – 18.0 m), while *Ae. aegypti* was found until the tenth floor (28.1 – 30.0 m). In contrast, *Ae. albopictus* was found only up to the sixth floor (16.1 – 18.0 m). A poor correlation of the mean number of *Aedes* larvae collected with the level of high-rise apartments occupied (N=40; ρ=-0.349) was also observed which indicated the possibility of lesser *Aedes* populations to be found at higher level of high-rise apartments. Therefore, larger scale studies are strongly recommended to examine the vertical dispersal of *Aedes* mosquitoes.

To date, dengue continues as one of the most serious public health problems in many tropical countries including Malaysia. The first recorded dengue outbreak in Malaysia occurred in 1973. Since then, the number of dengue cases has increased throughout the years until it exceeded 10,000 cases in 1996 (Lee *et al.*, 2008). For the year of 2010, until 28th August 2010, there were 32,688 dengue cases reported throughout Malaysia including 103 deaths (Ministry of Health Malaysia, 2010). Both *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse) have been incriminated as the vectors of dengue (Rudnick *et al.*, 1965).

Populations of both *Ae. aegypti* and *Ae. albopictus* are widespread throughout the world (Vezzani & Carbajo, 2008). *Aedes aegypti* and *Ae. albopictus* are sympatric species that occupy similar ecological niches (Klowden, 1993). In fact, both species have been found to coexist in the same container (Chen *et al.*, 2006a). In

Malaysia, both species are abundant in urban and rural areas (Nazni *et al.*, 2009).

Monitoring of *Aedes* populations is one of the important activities conducted in vector control programmes. Ovitraps have been designated as a surveillance tool for monitoring *Aedes* populations (Focks, 2003; Dibo *et al.*, 2005). The use of ovitraps in the surveillance of *Aedes* sp. was recommended by the World Health Organization (WHO, 1972; Cheng *et al.*, 1982). Many studies on *Aedes* distribution and surveillance have been conducted worldwide. However, there is still little information on the adaptations of *Aedes* mosquitoes at different level of buildings occupied by human either indoors or outdoors. Therefore, this study is the first attempt to evaluate the vertical dispersal of *Aedes* sp. in high-rise apartments using standardized ovitraps in Presint 9, Putrajaya and thus to provide a basic information on the presence of *Aedes* populations as dengue vectors which could later facilitate the vector control programme in the study area.

Putrajaya is an administrative city of Malaysia covering an area of 4,931 hectares of land (Nazni *et al.*, 2009). Presint 9, Putrajaya (N02°56.369' E101°40.265') which is located at about 45 km from Kuala Lumpur city centre, is one of the earliest and highly populated suburban residential areas in Putrajaya, Malaysia. It is supported with good infrastructures, a systematic underground drainage system and well-accessible by all means of communication.

Presint 9 that coveres about 463.43 acre of land was selected as a study area based on the frequent reports of dengue cases in this locality. In 2009, there were 115 dengue cases reported in Presint 9, Putrajaya from a total number of 271 dengue cases in Putrajaya. Until 4th September 2010, 75 dengue cases were recorded in Putrajaya where 36 of them were reported from Presint 9 (Putrajaya Health Office, personal communication).

This study was conducted in four blocks of high-rise apartments located in different sites within Presint 9. Ten floors of each block were occupied where four ovitraps were placed randomly at every floor. Each floor is about 3 meters in height. Standardized ovitraps as described by Lee (1992a) was used. Every ovitrap was filled with tap water. These ovitraps were used in accordance to the guidelines of Ministry of Health Malaysia (1997). All ovitraps were placed in proximity to other potential breeding containers with minimum physical and environmental disturbance. All ovitraps were placed indoors which were either partially or totally shaded to prevent direct sunlight and heavy rain that may cause water spillage. In this study, "indoor" refers to the interior of the apartment block such as at corridors, stairways, under shoe racks as well as behind the gases and rain storm pipes. These ovitraps were collected after 5 days of exposure and transported back to the laboratory. The contents were poured into individual plastic containers and topped up with fresh water. All hatched larvae were reared and subsequently counted and identified at fourth instar larvae. The counting of these hatched larvae is a proxy measure for total oviposition. All data obtained were analyzed using Kruskal-Wallis; a non-parametric tests with significance level of $P < 0.05$.

A total of 650 *Aedes* larvae were obtained throughout this study, with 571 of them (87.85%) identified as *Ae. aegypti* larvae and 79 (12.15%) as *Ae. albopictus*. These results supported previous studies that *Ae. aegypti* was the dominant indoor species (Chan *et al.*, 1971; Sucharit *et al.*, 1978; Foo *et al.*, 1985; Surendran *et al.*, 2007; Singh *et al.*, 2008). *Aedes aegypti* is a domestic mosquito closely associated with human habitations and is dependent on man for its blood meal (Cheong, 1986; Lee, 1992b). This study also supported previous local findings by Sulaiman *et al.* (1991), Chen *et al.* (2006b) and Lian *et al.* (2006) who found that besides *Ae. aegypti*, *Ae. albopictus* was also found to oviposit inside human dwellings.

Moreover, 40.92% of the total number of larvae identified were collected from the fourth block (Block D), followed by the

second block (Block B) (25.85%), the first block (Block A) (20.15%) and finally the third block (Block C) (13.08%), respectively. *Aedes aegypti* larvae were widely distributed throughout all the occupied apartment blocks as indicated by more than 50.00% of identified larvae from each block (Table 1), while *Ae. albopictus* larvae were absent in the second block. There was no difference for the total number of mosquitoes between all apartment blocks occupied (N=40; d.f.=3; P=0.243). There was also no difference for the total number of *Ae. aegypti* (N=40; d.f.=3; P=0.193) and *Ae. albopictus* (N=40; d.f.=3; P=0.345) collected between all apartment blocks.

In general, *Aedes* larvae were detected in all levels of either one or more of the occupied apartment blocks except for level 9 (25.1 – 27.0 m), as indicated in Table 2. The peak and the lowest density of *Aedes* sp. were recorded at level 6 (16.1 – 18.0 m) and level 10 (28.1 – 30.0 m) of the apartment blocks, respectively. *Aedes aegypti* was found present up to the tenth floor and *Ae. albopictus* up to the sixth floor (16.1 – 18.0 m). These results indicated that *Aedes* mosquitoes could be found at high level of high rise apartments which could have been transported by humans either by way of stairs or lifts. These results were in parallel with studies by Liew & Curtis (2004) who reported on the positive ovitraps with rubidium (Rb)-marked eggs of *Ae. aegypti* and *Ae. albopictus* recovered from the third level until the twenty first level (60.0 m) of a condominium in Singapore where the release point of the marked parental mosquitoes of both species was at the twelve level of the condominium. This study also indirectly showed that *Ae. aegypti* was found to be more robust than

Table 1. Comparison of *Ae. aegypti* and *Ae. albopictus* larvae collected from four apartment blocks in Presint 9, Putrajaya

Apartment block	Total no. of ovitrap per block	No. (and percent, %) of *Ae. aegypti* larvae collected per block	No. (and percent, %) of *Ae. albopictus* larvae collected per block	*Ae. aegypti* : *Ae. albopictus* per block	Total no. (and percent, %) of *Aedes* sp. larvae collected per block
A	40	99 (75.57%)	32 (24.43%)	3.09 : 1.00	131 (20.15%)
B	40	168 (100.00%)	0 (0.00%)	–	168 (25.85%)
C	40	57 (67.06%)	28 (32.94%)	2.04 : 1.00	85 (13.08%)
D	40	247 (92.86%)	19 (7.14%)	13.00 : 1.00	266 (40.92%)

Table 2. Number of *Aedes* larvae captured at different level (height) of high-rise apartments in Presint 9, Putrajaya

Level of apartment block [Height (m)]	Apartment block / Species of *Aedes* larvae captured / No. of ovitrap per level per block	Block A		Block B		Block C		Block D	
		Ae. aegypti	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus*	*Ae. aegypti*	*Ae. albopictus*
1 (0.0 – 3.0)	4	24	0	0	0	0	0	78	3
2 (3.1 – 6.0)	4	44	0	68	0	0	0	24	0
3 (6.1 – 9.0)	4	9	10	12	0	0	0	20	0
4 (9.1 – 12.0)	4	0	0	0	0	0	0	11	7
5 (12.1 – 15.0)	4	15	22	18	0	2	0	35	0
6 (15.1 – 18.0)	4	7	0	1	0	45	28	77	9
7 (18.1 – 21.0)	4	0	0	63	0	0	0	0	0
8 (21.1 – 24.0)	4	0	0	1	0	10	0	0	0
9 (24.1 – 27.0)	4	0	0	0	0	0	0	0	0
10 (27.1 – 30.0)	4	0	0	5	0	0	0	2	0
Sub total	40 (per block)	99	32	168	0	57	28	247	19
Total	160	131		168		85		266	
Grand total		650							

Ae. albopictus in terms of breeding in high-rise apartments. Furthermore, high density of *Aedes* sp. observed at the sixth level (16.1 – 18.0 m) in this study supported previous findings by Chadee (2004) who reported that ovitraps placed at the 13.0 – 24.0 m in height both indoors and outdoors were the most preferred levels used by gravid *Ae. aegypti* in high-rise apartments in Trinidad, West Indies. Tinker (1974) suggested that the movement of *Ae. aegypti* mosquitoes above ground level may result from insecticide pressure which caused the absence of untreated containers. However, in our study, the high density of *Aedes* sp. at the sixth level could also be due to the existence of many ornamental plants grown by the residents especially at the corner end of the respective level. These plants are an ideal breeding and resting habitats for *Aedes* mosquitoes especially when there are stagnant and clear water in these flower pots. In other words, as concluded by Chadee (2004), an ecological niche consisting of biotic (humans, plants, and pet animals) and abiotic (structure, temperature, humidity, and wind) components which provide blood meals (food), water for aquatic stages, and resting places for adults (shelter) was not only found at ground level, but also occurred at various levels in high-rise apartments.

Besides that, an analysis using the Spearman's rank correlation coefficient indicated a poor correlation (N=40; ρ=-0.349) between the mean number of *Aedes* larvae collected with the level (height) of apartment blocks. The lack of significant results supported the concept of mosquito breeding at high levels where lesser *Aedes* mosquitoes could be found in higher level of the apartment blocks but this finding should be further investigated so that stronger correlation could be observed.

In general, this study indicated the capability of *Aedes* mosquitoes especially *Ae. aegypti* to survive up to the tenth floor (28.1 – 30.0 m) of high-rise apartments in Presint 9, Putrajaya. Therefore, public awareness among residents should be improved in order to get their participation in eliminating any breeding habitats within their vicinities and thus to protect them from the bite of dengue vectors. This is because until today, source reduction remains as one of the best methods in preventing dengue vectors which require high cooperation from the public. Moreover, besides using insecticides, dengue vector control programmes also often rely heavily on managing larval populations of the mosquito vector which is by eliminating container habitats (Strickman & Kittayapong, 2003).

This study also indirectly proved that ovitraps could detect the presence of *Aedes* spp. in all apartment blocks occupied, although only 40 ovitraps were set up in each apartment block with 4 ovitraps per level. Therefore, use of ovitraps in public areas is still sensitive and reliable in monitoring the presence of vector mosquitoes. Although the results of ovitrap surveillance cannot be used to accurately estimate the total *Aedes* adult populations, the use of ovitraps in *Aedes* egg collections are both sensitive and easy to perform (Romero-Vivas *et al.*, 2007).

It was clearly shown in this study that *Aedes* breeding occurs at upper levels of apartment blocks and there was no clear correlation between the number of larval collection with the height of apartment blocks. Therefore, it is suggested that container surveys to be conducted to obtain further information on the type and frequency of larval sites. In fact, studies to assess the productivity of the pupae collected from the study site are also encouraged.

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