SHORT COMMUNICATION

DISPERSAL OF *Aedes aegypti* L. and *Aedes albopictus* SKUSE (DIPTERA: CULICIDAE) IN A UNIVERSITY CAMPUS IN SELANGOR, MALAYSIA

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ABSTRACT

This study was carried out to determine the dispersal of *Aedes aegypti* and *Ae. albopictus* in a university campus located in Selangor, Malaysia. An ovitrap surveillance was conducted for both horizontal and vertical dispersal study, respectively. Results showed that *Ae. albopictus* population was more abundant than *Ae. aegypti* population in the entire environment of the campus. However, mixed breeding of both species of *Aedes* larvae was also detected within 23.53% of ovitraps recovered. Meanwhile, the results of vertical dispersal study showed that *Ae. aegypti* was the predominant indoor breeder in Residential College 2 (RC 2). Hence, mosquito control activities within the university campus should be continuously conducted and monitored to prevent the transmission of any *Aedes*-borne diseases among the university staff, students and visitors.

Keywords: Dispersal, *Aedes*, ovitraps, transmission, Malaysia.

ABSTRAK

Kajian ini telah dijalankan untuk mengenalpasti penyebaran nyamuk *Aedes aegypti* dan *Ae. albopictus* di dalam sebuah kampus universiti yang terletak di Selangor, Malaysia. Kajian taburan ovitrap telah dilaksanakan bagi kedua-dua kajian penyebaran mendatar dan menegak. Keputusan menunjukkan bahawa populasi *Ae. albopictus* adalah lebih banyak berbanding dengan populasi *Ae. aegypti* dalam persekitaran kampus secara keseluruhan. Walau bagaimanapun, pembiakan bercampur bagi jentik-jentik antara kedua-dua spesis *Aedes* juga telah dikesan di dalam 23.53% ovitrap yang telah dikutip semula. Manakala, keputusan kajian penyebaran menegak menunjukkan bahawa *Ae. aegypti* adalah penternak dalaman yang pra-dominan di Kolej Kediaman 2 (KK2). Sehubungan itu, aktiviti-aktiviti kawalan nyamuk di dalam kampus universiti perlu dilaksanakan dan dipantau secara berterusan bagi mencegah

sebarang transmisi penyakit bawaan *Aedes* di kalangan kakitangan, pelajar dan pelawat universiti.

Kata kunci: Penyebaran, *Aedes*, ovitrap, transmisi, Malaysia.

INTRODUCTION

Dengue fever (DF), dengue haemorrhagic fever (DHF) and chikungunya are important mosquito-borne diseases worldwide including Malaysia. For the year of 2020, until 27th June 2020, there were 54,391 dengue cases with 92 deaths and 1,172 chikungunya cases reported in Malaysia (Ministry of Health Malaysia 2020). *Aedes aegypti* and *Ae. albopictus* are the two major vectors involved in the transmission of DF and DHF (Chen et al. 2005; Nor Aliza et al. 2019; Noor Afizah et al. 2015). *Aedes aegypti* breeds in domestic containers containing clear water within and near human habitats (Dada et al. 2014), whereas *Ae. albopictus* prefers to breed in containers present outdoors especially in vegetation surroundings (Nyamah et al. 2010; Vijayakumar et al. 2014).

In order to reduce and minimize the transmission of mosquito-borne diseases, effective and viable vector control approaches such as elimination of mosquito breeding habitats and the use of insecticides are crucial (de Jesus et al. 2020). Above all, mosquito surveillance is the main component of all these integrated vector management strategies (Wijegunawardana et al. 2019). Vector surveillance is conducted to estimate the establishment, density, biting rates and spread of vectors like mosquitoes (Gao et al. 2019). A systematic and continuous vector surveillance is the most reliable method not only in monitoring the population of mosquito vectors (Roslan et al. 2017), but also in predicting the transmission risk of mosquito-borne diseases to human populations (Schoener et al. 2019).

Ovitraps are used to monitor the presence of mosquito populations and their densities based on the number of deposited eggs (Bellini et al. 1996). The ovitrap surveillance technique is the most used sampling method to monitor container breeder mosquitoes such as *Aedes* (Cheng et al. 1982; Mackay et al. 2013; Service 1992). According to Lee (1992a) and Rozilawati et al. (2015), ovitraps was also found to be more effective and sensitive method at times when *Aedes* infestations were low.

There are thousands of staff, students and visitors that are coming into a university campus every day or even staying at the residential colleges inside the campus. These human populations are the main blood sources for mosquitoes. Effective vector control activities to control mosquito populations within an area could be achieved only if the mosquito species and their densities in the target environment are identified and understood. Hence, this study aimed to determine the dispersal and abundance of medically important mosquitoes in a university campus located in Selangor, Malaysia. This study would provide a baseline data on mosquito populations in the study site for further mosquito studies and mosquito control in the future.

The study site selected was a university campus located in Selangor, Malaysia. It is located at the northern part of Selangor and about 30 kilometers from Kuala Lumpur City Centre. For horizontal dispersal study, it covers an area of 40 acres of the campus which includes the academic building, clinical building, laboratory research building, Residential College 1 (RC 1) and Residential College 2 (RC 2). Meanwhile, for vertical dispersal study, RC 2 was the only study site. RC 2 is a medical students' hostel with almost 600 residents of

undergraduate and postgraduate students as well as staff. RC 2 is an apartment of 12 levels. At each level, there are eight houses and two study rooms. The total area of the ground floor is 1,287.50 square meter, whereas the total area of the first floor until the eighth floor is 949.81 square meter. Trees, ornamental plants and shrubs are found at surrounding areas of RC 2. A detention pond of 1500 square meter area is also present behind RC 2.

Ovitraps as described by Lee (1992a) were used in this study. For horizontal dispersal study, ovitrap surveillance was conducted once. A total of 48 ovitraps were placed randomly within the campus compound area, either indoors or outdoors. These ovitraps were collected after five days and brought to the entomology laboratory of Universiti Teknologi MARA (UiTM) Sungai Buloh. For vertical dispersal study, ovitrap surveillance was conducted for one week at the study site. Eight floors within a block of RC 2 which includes the ground floor up to the seventh floor were occupied for this study. Three ovitraps were placed randomly at each floor and all ovitraps were placed indoors. For this study, "indoors" refer to those parts of the apartment block under its roof (Lee 1992b). These ovitraps were collected after five days and brought back to the same entomology laboratory.

All contents of the recovered ovitraps were poured into individual plastic containers, respectively. Fresh water was added into each container and the larvae were allowed to hatch and reared in these containers. All containers were kept covered. Fish food pellets were added into each container as larval food. The hatched larvae were subsequently counted and morphologically identified at third instar using the taxonomic key by Jeffery et al. (2012). The larval number was recorded individually for each positive ovitrap. Only hatched larvae were counted in the study, as the larval stage is closely associated with the actual field mosquito populations since not all eggs will hatch (Wan-Norafikah et al. 2009).

Data of ovitrap surveillance were calculated as below:

(a) Ovitrap Index (OI): the percentage of positive ovitraps to the total number of ovitraps recovered from each study site.
(b) Mean number of every species of larvae per recovered ovitrap.
(c) Percentage of positive ovitrap with single breeding: number of positive ovitraps with breeding of individual species to the total of positive ovitraps.
(d) Percentage of positive ovitrap with mixed breeding: number of positive ovitraps with co-breeding to the total of positive ovitraps.
(e) Ratio of mixed breeding: quotient of the mean number of larvae per recovered ovitrap of the more dominant species to the mean number of larvae per recovered ovitrap of the less dominant species.

One-way ANOVA analysis was carried out using the statistical software programme (IBM SPSS Statistics version 23.0). All levels of statistical significance were ascertained at $P = 0.05$.

Table 1 demonstrated the ovitrap index and mean number of larvae per ovitrap of *Aedes* sp. collected from 1-week horizontal ovitrap surveillance in a university campus in Selangor, Malaysia. A total of 47 ovitraps were recovered with 17 positive ovitraps. The ovitrap index was 34.04%. All larvae collected from positive ovitraps were identified as either *Ae. aegypti* or *Ae. albopictus*.

Table 1. Ovitrap index and mean number of larvae per ovitrap of *Aedes* sp. collected during 1-week horizontal ovitrap surveillance in a university campus in Selangor, Malaysia

No. of recovered ovitrap	**Ovitrap Index, %**	**Total no. of larvae**	***Ae. aegypti***			***Ae. albopictus***			***Ae. aegypti* : *Ae. albopictus* in population**
			No. of larvae	**%**	**Mean number larvae per recovered ovitrap**	**No. of larvae**	**%**	**Mean number larvae per recovered ovitrap**	
47	34.04	171	5	2.92	0.11	166	97.08	3.53	1 : 33.20

Table 2 illustrated the percentage and ratio of *Ae. aegypti* and *Ae. albopictus* in mixed breeding during ovitrap surveillance conducted in a university campus in Selangor, Malaysia. A total of four positive ovitraps (23.53%) were detected with mixed breeding of *Aedes* sp. The ratio of *Ae. aegypti* to *Ae. albopictus* in mixed breeding of positive ovitraps was 1:11.

Table 2. Mixed breeding of *Aedes* sp. collected during 1-week horizontal ovitrap surveillance in a university campus in Selangor, Malaysia

No. of recovered ovitrap	**Total no. of positive ovitrap**	**No. (and percentage,%) of positive ovitrap**			**Ratio of *Ae. aegypti* and *Ae. albopictus* in mixed breeding**
		Ae. aegypti	***Ae. albopictus***	**Mixed breeding of *Ae. aegypti* and *Ae. albopictus***	
47	17	1 (5.88)	12 (70.59)	4 (23.53)	1:11

Table 3 showed the number and percentage of *Aedes* larvae collected at different level (height) of Residential College 2 (RC 2) in a university campus in Selangor, Malaysia during the 1-week vertical ovitrap surveillance. There were only three positive ovitraps reported which were recovered from level 1, 3 and 8, respectively. All larvae collected from these positive ovitraps were *Ae. aegypti*.

Table 3. Number and percentage (%) of *Aedes* larvae collected at different level (height) of Residential College 2 in a university campus in Selangor, Malaysia during the vertical ovitrap surveillance

Level of Residential College 2 [Height (m)]	**No. of ovitrap per level**	**No. of *Aedes aegypti* larvae (%)**
1 (0.0-3.0)	3	5 (62.50)
2 (3.1-6.0)	3	0
3 (6.1-9.0)	3	2 (25.00)
4 (9.1-12.0)	3	0
5 (12.1-15.0)	3	0
6 (15.1-18.0)	3	0
7 (18.1-21.0)	3	0
8 (21.1-24.0)	3	1 (12.50)
Total	**24**	**8 (100.00)**

In total, 179 *Aedes* larvae were obtained throughout this study which eight of them were found in vertical dispersal while a sum of 171 were found in horizontal dispersal. Both *Ae. aegypti* and *Ae. albopictus* were detected in the horizontal ovitrap surveillance. Nevertheless, only *Ae. aegypti* larvae were detected in the vertical ovitrap surveillance.

After 1 week of horizontal ovitrap surveillance, only 47 ovitraps were recovered for horizontal dispersal. Results from horizontal ovitrap surveillance demonstrated that *Ae. albopictus* as the predominant species compared to *Ae. aegypti* with the ratio of 33.20:1. *Aedes albopictus* larvae were mostly collected from recovered ovitraps placed outdoors mainly near vegetation surroundings. This finding is not surprising as *Ae. albopictus* are usually found in natural containers, tree holes and bamboo stumps near human habitats (Foo et al. 1985).

Furthermore, mixed breeding of *Ae. aegypti* and *Ae. albopictus* within the same ovitrap was also detected in 23.53% of recovered ovitraps. *Aedes albopictus* larvae were found to be more dominant in these recovered ovitraps with mixed breeding compared to *Ae. aegypti* larvae. These results are in parallel with the fact that both *Ae. aegypti* and *Ae. albopictus* are abundant in urban and rural areas (Nazni et al. 2009). Furthermore, mixed breeding of different mosquito larval species indicates the ability of mosquito larvae including *Aedes* species to share the same ecological conditions (Wan-Norafikah et al. 2018).

Meanwhile, a vertical ovitrap surveillance conducted in this study showed that *Aedes* mosquitoes could breed at up to the 8th floor of the building. In this study, only *Ae. aegypti* were found in all positive ovitraps recovered from different floors. According to Lau et al. (2013), *Ae. aegypti* can be found till highest floor which is up to 16 floors in height of 45.1 to 48.0 m. The absence of *Ae. albopictus* could be due to the lack of preferred breeding condition. *Aedes aegypti* prefers to breed in man-made containers containing relatively clear water around human dwellings (Chen et al. 2009; Hasanuddin et al. 1997). Lau et al. (2013) also reported that the high-rise building creates a complete ecosystem and provide an ecological niche with biotic and abiotic components. Biotic components comprise humans, plants and pet animal in houses, while abiotic factors include temperature, humidity and house structure. Both components provide blood meals, water for aquatic stage in house with aquatic plant or unclean rubbish and resting place for adults at various elevations in high-rise building. Additionally, detection of *Aedes* larvae in both horizontal and vertical dispersal studies conducted also

proved that ovitrap is a very sensitive tool as even a single hatched *Aedes* larva could be detected through the deployment of an ovitrap.

In terms of vector control activities conducted within the campus, fogging activities and larviciding are routinely done at least once a month for three consecutive days using S-bioallethrin and temephos, respectively. Nevertheless, comprehensive use of insecticides may cause the resistance development in mosquito vectors (Noor Aslinda et al. 2019; Wan-Norafikah et al. 2013). Therefore, to prevent or reduce development of resistance, a synergist such as piperonyl butoxide is usually being utilized in combination with insecticides especially pyrethroids and rotational use of different classes of insecticides is strongly suggested.

This study indicated the capability of *Aedes* sp. to survive at up to the 8th floor of the residential college 2 (RC 2). This scenario is in line with the fact that *Aedes* sp. are commonly found in human habitations (Ho et al. 2014). Besides that, this study also illustrated a conspicuous number of *Aedes* especially *Ae. albopictus* in the environment of campus. This phenomenon could be due to availability of favorable breeding conditions as there were lots of unmanaged trees in the garden and secluded areas. *Aedes albopictus* is known for its capability to breed in a diverse range of breeding receptacles, preferably with vegetation such as gardens (Wan Fatma & Aminoddin 2019). Findings of this study on *Aedes* density and abundance will facilitate the management team of the campus to remark and concentrate on those potential breeding sites of mosquitoes within the campus that should be eliminated. In fact, the current control tools could be modified or even other more applicable control methods could be selected and applied within the campus to control the mosquito populations more effectively. The abundance of *Aedes* mosquitoes in the campus should not be treated lightly. Current vector control activities like fogging should be appropriately performed and monitored to ensure optimum success in controlling mosquito populations and thus, preventing from any emergence of mosquito-borne arboviral diseases within the university campus.

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