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Distribution of *Aedes* Mosquitoes in Three Selected Localities in Malaysia

(Taburan Nyamuk *Aedes* di Tiga Lokaliti Terpilih di Malaysia)

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ABSTRACT

Aedes aegypti *and* Aedes albopictus *are the principle dengue vectors in Malaysia. The presence and distribution of* Aedes *larvae were studied in three different localities in Kelantan, Terengganu and Sabah, Malaysia in October 2008, November 2008 and June 2009. Two hundred (200) ovitraps per locality were placed randomly indoors and outdoors, depending on the environment of each locality. The highest mean number of* Ae. aegypti *and* Ae. albopictus *larvae per recovered ovitrap for both indoors and outdoors was obtained from Kg. Paya Rambai, Kelantan. The indoor populations of* Ae. aegypti *as well as the indoor and outdoor populations of* Ae. albopictus *in Kg. Paya Rambai, Kelantan were significantly higher than the other two study sites (p<0.05) by 1.03- and 4.67-folds, 2.36- and 5.84-folds and 1.98- and 4.00-folds, respectively. Both* Ae. aegypti *and* Ae. albopictus *were also found to breed within the same ovitraps placed indoors and outdoors in all study sites ranging from 15.22% to 31.82% of the total positive ovitraps. This study showed that both species could serve as the vectors of dengue in all study sites as indicated by the high populations recorded. The reliability and sensitivity of ovitraps in* Aedes *surveillance was also proven.*

Keywords: Dengue; Malaysia; mixed breeding; ovitrap surveillance

ABSTRAK

Aedes aegypti *dan* Aedes albopictus *adalah vektor denggi yang utama di Malaysia. Kewujudan dan taburan larva* Aedes *telah dikaji di tiga lokaliti berlainan di Kelantan, Terengganu dan Sabah, Malaysia pada bulan Oktober 2008, November 2008 dan Jun 2009. Dua ratus (200) ovitrap telah dipasang di setiap lokaliti dengan kesemuanya diletakkan secara rambang di dalam dan di luar rumah, bergantung kepada keadaan persekitaran di setiap lokaliti. Bilangan min tertinggi untuk larva* Ae. aegypti *dan* Ae. albopictus *bagi ovitrap yang dikutip semula dari dalam dan luar rumah telah diperoleh dari Kg. Paya Rambai, Kelantan. Populasi* Ae. aegypti *di dalam rumah serta populasi* Ae. albopictus *di dalam dan di luar rumah di Kg. Paya Rambai, Kelantan adalah lebih tinggi secara bererti (p<0.05) berbanding dua kawasan kajian yang lain sebanyak 1.03- dan 4.67-kali, 2.36- dan 5.84-kali dan 1.98- dan 4.00-kali setiap satu. Kedua-dua* Ae. aegypti *dan* Ae. albopictus *juga didapati membiak di dalam ovitrap yang sama yang diletakkan di dalam dan di luar rumah di semua kawasan kajian iaitu di antara 15.22% dan 31.82% daripada jumlah ovitrap yang dikesan positif. Kajian ini menunjukkan bahawa kedua-dua spesies berpotensi sebagai vektor denggi di semua kawasan kajian seperti yang diperlihatkan melalui kadar populasi tinggi yang direkodkan. Kebolehpercayaan dan kepekaan ovitrap dalam kajian survei* Aedes *juga telah dibuktikan.*

Kata kunci: Denggi; kajian survei ovitrap; Malaysia; pembiakan bercampur

INTRODUCTION

Dengue is a serious public health problem in many countries throughout the world including Malaysia. Global incidence of dengue has grown dramatically in recent decades (WHO 2009). In Malaysia, dengue cases are reported in all states each year. Up to 19th May 2012, 9,607 dengue cases with 20 deaths were recorded in Malaysia, compared to 7,963 dengue cases with 12 deaths for the same duration in 2011 (Ministry of Health Malaysia 2012).

Aedes aegypti and *Aedes albopictus* are the principal dengue vectors (Rudnick et al. 1965). These dengue vectors are widely distributed in Malaysia (Nazni et al. 2009). *Ae. aegypti* tends to breed in water storage containers and any variety of assorted water-holding containers found in and around homes (Lenhart et al. 2005), whereas *Ae. albopictus* breeds in both man-made containers and in natural containers (Perich et al. 2003).

Ovitraps are important surveillance tool used in detecting and monitoring *Aedes* populations. The ovitrap has been proven to be more sensitive in detecting *Aedes* mosquito, as well as being cost-effective and operationally viable in vector surveillance (Braga et al. 2000). Hence, the objective of this study was to provide updated baseline information on the presence and density of *Aedes* in selected dengue prone areas by utilizing the ovitraps.

Materials and Methods

STUDY SITES

Ovitrap surveillance was conducted in dengue prone areas of three states in Malaysia: Kg. Paya Rambai in Kota Bharu, Kelantan; Kg. Ladang-Pasir Panjang in Kuala Terengganu, Terengganu; and Sepanggar-Karamunsing in Kota Kinabalu, Sabah. The selection of these areas were based on the frequent dengue cases reported annually as provided by the vector borne-diseases control programme (VBDCP) of each state.

OVITRAP SURVEILLANCE

Standardized ovitraps as described by Lee (1992) had been utilized in this study. The ovitrap comprises of 300 mL black plastic container. The opening was 6.8 cm in diameter, the base diameter was also 6.8 cm and 9.1 cm in height. An oviposition paddle made from hardboard (10 cm × 2.5 cm × 0.3 cm) consisting of two different types of surfaces was placed diagonally into each ovitrap with the rough surface of the oviposition paddle upwards. Each ovitrap was filled with tap water to a level of 5.5 cm. 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. Two hundred (200) ovitraps per locality were placed randomly indoors and outdoors which were either partially or totally shaded to avoid from direct sunlight and heavy rain that may cause water spillage. In this study, 'indoors' refers to the interior of the premise (house, flat), while 'outdoors' refers to the outside of the premise but confined to the immediate vicinity of the house.

As this study was originally performed to provide baseline data of *Aedes* in all study sites to VBDCP of respective states, therefore only one ovitrap surveillance was conducted in each study site selected. The ovitrap surveillance were conducted in October 2008, November 2008 and June 2009.

IDENTIFICATION OF LARVAE

All ovitraps were collected after 5 days of deployment and brought back to the laboratory. The contents were poured into individual plastic containers, together with the paddle and topped up with fresh water. A mixture of liver powder, cereals and yeast as well as a small piece of partially-cooked cow liver were added into each container as larval food. The containers were kept covered to avoid other mosquitoes in the vicinity from ovipositing in the containers. All hatched larvae were reared and subsequently counted and identified at fourth instar larvae. The larval numbers were recorded individually for every positive ovitrap.

ANALYSIS OF DATA

Data obtained in this study were analyzed as:

1. Ovitrap Index (OI): the percentage of positive ovitraps to the total number of recovered ovitraps for each study site
2. Mean number of *Ae. aegypti* and / or *Ae. albopictus* larvae per recovered ovitrap

Available statistical programme was used in performing the one-way ANOVA analysis. All levels of statistical significance were determined at $p = 0.05$.

Results and Discussion

Table 1 shows the ovitrap index (OI), the mean number of larvae per recovered ovitrap and the ratio of *Ae. aegypti* to *Ae. albopictus* collected in every study site. Kg. Paya Rambai, Kelantan had the highest OI for both indoors and outdoors with 65.12% and 77.19%, respectively. Our results showed that both *Aedes* species in all study sites preferred to breed outside rather than inside the premises which supported similar findings by Chareonviriyaphap et al. (2003) in Thailand. In parallel to this, the highest mean number of *Ae. aegypti* and *Ae. albopictus* larvae per recovered ovitrap for both indoors and outdoors was also obtained from Kg. Paya Rambai, Kelantan. There

TABLE 1. Ovitrap index (OI), mean number larvae per recovered ovitrap and ratio of *Aedes aegypti* to *Aedes albopictus* for indoors and outdoors in three study areas

Study site	Ovitrap placement	Ovitrap Index (OI) (%)	Mean number larvae per recovered ovitrap		*Ae. aegypti* : *Ae. albopictus*
			Ae. aegypti	*Ae. albopictus*	
Kg. Paya Rambai, Kelantan	Indoors	65.12	4.06 ± 0.81 [a]	7.47 ± 1.02 [c]	1.00 : 1.84
	Outdoors	77.19	3.07 ± 0.58 [b]	10.57 ± 1.01 [d]	1.00 : 3.44
Kg. Ladang-Pasir Panjang, Terengganu	Indoors	39.00	3.96 ± 0.89 [a]	3.16 ± 0.78 [c]	1.25 : 1.00
	Outdoors	50.00	3.18 ± 0.55 [b]	2.64 ± 0.57 [d]	1.20 : 1.00
Sepanggar-Karamunsing, Sabah	Indoors	23.36	0.87 ± 0.27 [a]	1.28 ± 0.33 [c]	1.00 : 1.48
	Outdoors	73.02	2.52 ± 1.05 [b]	5.35 ± 0.87 [d]	1.00 : 2.12

a ($F = 8.88$, $p<0.05$, df = 2)
b ($F = 0.21$, $p>0.05$, df = 2)
c ($F = 20.87$, $p<0.05$, df = 2)
d ($F = 24.55$, $p<0.05$, df = 2)

was no significant difference for outdoor populations of *Ae. aegypti* among all study sites selected ($p>0.05$). In contrast, the indoor populations of *Ae. aegypti* as well as the indoor and outdoor populations of *Ae. albopictus* in Kg. Paya Rambai, Kelantan were significantly higher than other study sites by 1.03- and 4.67-folds, 2.36- to 5.84-folds and 1.98- to 4.00-folds, respectively ($p<0.05$). The population ratios of *Ae. aegypti* to *Ae. albopictus* larvae in Kg. Paya Rambai, Kelantan and Sepanggar-Karamunsing, Sabah were generally different to one another for both indoors and outdoors, respectively, but not for indoor and outdoor populations in Kg. Ladang-Pasir Panjang, Terengganu. These results showed that *Ae. albopictus* in Kg. Paya Rambai, Kelantan and Sepanggar-Karamunsing, Sabah readily lay eggs inside and outside the premises. Sulaiman et al. (1991) reported similar observations where *Ae. albopictus* were also found to oviposit inside the human dwellings.

Table 2 describes the distribution of *Aedes* larvae in positive ovitraps collected from all study sites. Higher percentages of positive ovitraps with only *Ae. albopictus* populations have been observed in both indoor and outdoor populations in Kg. Paya Rambai, Kelantan and Sepanggar-Karamunsing, Sabah but not for Kg. Ladang-Pasir Panjang, Terengganu. An equal number of positive ovitraps consisting only *Ae. aegypti* or *Ae. albopictus* larvae was recorded for indoor populations in Kg. Ladang-Pasir Panjang, Terengganu (35.90%) while the outdoor populations were dominated by *Ae. aegypti* (50.00% positive ovitraps). These results indicated that the populations of *Ae. albopictus* in Kg. Paya Rambai, Kelantan and Sepanggar-Karamunsing, Sabah were more dominant compared to *Ae. aegypti* populations. In contrast, *Ae. aegypti* populations have been found to be more dominant than *Ae. albopictus* populations inside and outside the premises in Kg. Ladang-Pasir Panjang, Terengganu. In other words, an early invasion of outdoor populations by *Ae. aegypti* had been observed in Kuala Terengganu, Terengganu. These results also showed that although ovitraps were placed indoors, some of the gravid females of *Ae. aegypti* still preferred to lay eggs outdoors and enter the houses just for the blood feeding (Dibo et al. 2005). *Ae. aegypti* may eventually replace *Ae. albopictus* if this process is allowed to continue (Lee 1992). This is because previous experience had shown that *Ae. aegypti* appeared to be replacing *Ae. albopictus* in such major centres as Bangkok, Manila and Singapore (Rudnick 1967).

Ae. aegypti and *Ae. albopictus* are sympatric species which occupy similar ecological niches (Klowden 1993). In line with this, mixed breeding was found in both indoor and outdoor populations in all study sites which was from 15.22% to 31.82% of the total positive ovitraps respectively. These results were not much different with 20.00% mixed population from 75 positive ovitraps recovered from Kg. Banjar, a settlement area in Selangor, Malaysia as reported by Chen et al. (2006) as well as the studies by Chareonviriyaphap et al. (2003) who also found the overlapping of *Ae. aegypti* and *Ae. albopictus* habitats, mainly in the south of Thailand with approximately 20.00%. However, results obtained in this study were much higher than the findings by Chang and Jute (1994) who reported only 9.00% of shared breeding between *Ae. aegypti* and *Ae. albopictus* larvae in house surveys. In contrast, results obtained from this study were not as much as 55.40% extensive sharing from the total positive ovitraps recorded by Yap and Thiruvengadam (1979). Other than that, these results also indirectly showed that ovitrap is a sensitive tool to attract more than one species of gravid female mosquitoes to lay eggs in the container (Chen et al. 2006). As reported by Masuh et al. (2008), the use of ovitraps had been proven as a practical mean to collect *Aedes* eggs.

In general, all study sites selected in this study shared some similarities on mosquito populations although the environment of every study site was quite different. For instance, both Kg. Ladang-Pasir Panjang, Terengganu and Kg. Paya Rambai, Kelantan are the villages with wooden- and brick-made houses while Sepanggar-Karamunsing, Sabah comprises a floating settlement area with wooden-made houses as well as few on-land blocks of flats. Both Kg. Ladang-Pasir Panjang, Terengganu and Kg. Paya Rambai, Kelantan shared almost a similar suburban environment

TABLE 2. Distribution of *Aedes* populations in the ovitraps deployed in three study areas

Study site	Ovitrap placement	No. of recovered ovitrap	No. of positive ovitrap	No. and percentage of positive ovitrap with each *Aedes* sp.		No. and percentage of positive ovitrap with mixed breeding	Ratio of *Ae. aegypti* : *Ae. albopictus* in mixed breeding
				Ae. aegypti	*Ae. albopictus*		
Kg. Paya Rambai, Kelantan	Indoors	86	56	16 (28.57%)	30 (53.57%)	10 (17.86%)	1.00 : 1.54
	Outdoors	114	88	7 (7.95%)	53 (60.23%)	28 (31.82%)	1.00 : 1.19
Kg. Ladang-Pasir Panjang, Terengganu	Indoors	100	39	14 (35.90%)	14 (35.90%)	11 (28.21%)	1.64 : 1.00
	Outdoors	100	50	25 (50.00%)	15 (30.00%)	10 (20.00%)	1.00 : 1.24
Sepanggar-Karamunsing, Sabah	Indoors	137	32	8 (25.00%)	17 (53.13%)	7 (21.88%)	1.10 : 1.00
	Outdoors	63	46	5 (10.87%)	34 (73.91%)	7 (15.22%)	1.57 : 1.00

where many ornamental plants and vegetations could be easily found within many premises' compounds that served as the best natural habitats especially for *Ae. albopictus*. Moreover, there were also containers and jars with tap water or rain water stored by the residents in all study sites for daily use where these containers could become as artificial breeding habitats for the dengue vectors if they are not properly covered and managed. Chan et al. (1971) reported that the domestic containers used as water storage, ornamentation or the prevention of pests constituted 95% of the total breeding habitats of both *Ae. aegypti* and *Ae. albopictus* in the urban parts of Singapore. Not only that, containers or receptacles exposed to rain, even when treated, may still be infested by the breeding of mosquito larvae (Morato et al. 2005).

In addition, the drainage systems in both Kg. Ladang-Pasir Panjang, Terengganu and Kg. Paya Rambai, Kelantan were seemed not to be well-managed. On the other hands, for Sepanggar-Karamunsing, Sabah, the concrete drainage system only covers the flats area while for the floating settlement area, most of the man-made waste seemed to be simply dumped into the sea under the houses by the residents. The poor-built and -managed drainage systems as well as the poor attentiveness of some residents towards cleanliness should be improved in order to avoid the formation of stagnant water. The clogged drains with clear stagnant water served as good artificial larval containers for *Aedes* larvae (Chen et al. 2005).

In conclusion, both *Ae. aegypti* and *Ae. albopictus* have the potential to be involved in the spread of dengue viruses in all study sites. However, the populations of *Ae. albopictus* in Kg. Paya Rambai, Kelantan and Sepanggar-Karamunsing, Sabah were more dominant than *Ae. aegypti* populations, respectively. In addition, *Ae. aegypti* populations in Kg. Ladang-Pasir Panjang, Terengganu had the ability to invade *Ae. albopictus* outdoor populations throughout the time. Besides, this study also indirectly confirmed the sensitivity and reliability of ovitrap as a tool in detecting the existence of more than one mosquito species especially *Aedes* populations as well as the abilities of *Aedes* mosquitoes to oviposit within the same ovitrap.

Integrated vector management (IVM) is now used in eliminating the dengue vectors. Among all elements consisted in IVM, source reduction or environmental management is the best practice that should be carried out routinely within the community members to avoid the unnecessary mosquito breeding habitats inside and outside the premises. In line with this, health education involving all residents in the communities should be actively conducted so that their concerns about the seriousness towards the spread of dengue and the importance of their participations in the source reduction activities could be ensured.

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REFERENCES

Braga, I.A., Gomes Ade, C., Nelson, M., Mello Rde, C., Bergamaschi, D.P. & de Souza, J.M. 2000. Comparative study between larval surveys and ovitraps to monitor populations of *Aedes aegypti*. *Revista da Sociedade Brasileira de Medicina Tropical* 33(4): 347-353.

Chan, K.L., Ho, B.C. & Chan, Y.C. 1971. *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in Singapore city. 2. Larval habitats. *Bulletin of the World Health Organization* 44: 629-633.

Chang, M.S. & Jute, N. 1994. Breeding of *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in urban housing of Sibu Town, Sarawak. *The Southeast Asian Journal of Tropical Medicine and Public Health* 25(3): 543-548.

Chareonviriyaphap, T., Akratanakul, P., Nettanomsak, S. & Huntamai, S. 2003. Larval habitats and distribution patterns of *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse) in Thailand. *The Southeast Asian Journal of Tropical Medicine and Public Health* 34(3): 529-535.

Chen, C.D., Nazni, W.A., Lee, H.L., Seleena, B., Mohd Masri, S., Chiang, Y.F. & Sofian-Azirun, M. 2006. Mixed breeding of *Aedes aegypti* (L.) and *Aedes albopictus* Skuse in four dengue endemic areas in Kuala Lumpur and Selangor, Malaysia. *Tropical Biomedicine* 23(2): 224-227.

Chen, C.D., Seleena, B., Mohd Masri, S., Chiang, Y.F., Lee, H.L., Nazni, W.A. & Sofian-Azirun, M. 2005. Dengue vector surveillance in urban residential and settlement areas in Selangor, Malaysia. *Tropical Biomedicine* 22(1): 39-43.

Dibo, M.R., Chiaravalloti-Neto, F., Battigaglia, M., Mondini, A., Favaro, E.A., Barbosa, A.A.C. & Glasser, C.M. 2005. Identification of the best ovitrap installation sites for gravid *Aedes (Stegomyia) aegypti* in residences in Mirassol, state of Sao Paulo, Brazil. *Memorias do Instituto Oswaldo Cruz* 100(4): 339-343.

Klowden, M.J. 1993. Mating and nutritional state affect the reproduction of *Aedes albopictus* mosquitoes. *Journal of the American Mosquito Control Association* 9(2): 169-173.

Lee, H.L. 1992. *Aedes* ovitrap and larval survey in several suburban communities in Selangor, Malaysia. *Mosquito-Borne Diseases Bulletin* 9(1): 9-15.

Lenhart, A.E., Walle, M., Cedillo, H. & Kroeger, A. 2005. Building a better ovitrap for detecting *Aedes aegypti* oviposition. *Acta Tropika* 96: 56-69.

Masuh, H., Seccacini, E. & Zerba, E. 2008. *Aedes aegypti* (Diptera: Culicidae): Monitoring of populations to improve control strategies in Argentina. *Parasitology Research* 103: 167-170.

Ministry of Health Malaysia. 1997. Guidelines on the use of ovitrap for *Aedes* surveillance. (unpublished data).

Ministry of Health Malaysia. 2012. Situasi semasa demam denggi Di Malaysia bagi minggu 20/2012 (13 hingga 19 Mei 2012). *Kenyataan Akhbar Ketua Pengarah Kesihatan Malaysia*. 21st Mei 2012. (unpublished data).

Morato, V.C.G., Teixeira, M.G., Gomes, A.C., Bergamaschi, D.P. & Barreto, M.L. 2005. Infestation of *Aedes aegypti* estimated by oviposition traps in Brazil. *Revista de Saude Publica* 39(4): 553-558.

Nazni, W.A., Lee, H.L., Dayang, H.A.B. & Azahari, A.H. 2009. Cross-mating between Malaysian strains of *Aedes aegypti* and *Aedes albopictus* in the laboratory. The *Southeast Asian Journal of Tropical Medicine and Public Health* 40(1): 40-46.

Perich, M.J., Kardec, A., Braga, I.A., Portal, I.F., Burge, R., Zeichner, B.C., Brogdon, W.A. & Wirtz, R.A. 2003. Field evaluation of a lethal ovitrap against dengue vectors in Brazil. *Medical and Veterinary Entomology* 17: 205-210.

Rudnick, A. 1967. *Aedes aegypti* and haemorrhagic fever. *Bulletin of the World Health Organization* 36: 528-532.

Rudnick, A., Tan, E.E., Lucas, J.K. & Omar, M. 1965. Mosquito-borne haemorrhagic fever in Malaya. *British Medical Journal* 1: 1269-1272.

Sulaiman, S., Pawanchee, Z.A., Jeffery, J., Ghauth, I. & Busparani, V. 1991. Studies on the distribution and abundance of *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) (Diptera: Culicidae) in an endemic area of dengue/dengue haemorrhagic fever in Kuala Lumpur. *Mosquito-Borne Diseases Bulletin* 8(2): 35-39.

World Health Organization 2009. Dengue and dengue haemorrhagic fever. Revised March 2009. Fact sheet No. 117. World Health Organization, Geneva.

Yap, H.H. & Thiruvengadam, V. 1979. Relative abundance of *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse) in different habitats – An ovitrap survey conducted in Georgetown, Penang Island, Malaysia. *Medical Journal of Malaysia* 34: 76-79.

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