**RESEARCH NOTE**

# DENGUE VECTOR SURVEILLANCE IN WEST COAST AND KUDAT DIVISION, SABAH, MALAYSIA

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**Abstract.** Ovitrap surveillance was conducted to investigate distribution and abundance of *Aedes* spp in West Coast and Kudat divisions of Sabah, Malaysia. Ovitraps were placed in 21 study sites across six districts in the West Coast division (Kota Belud, Kota Kinabalu, Papar, Penampang, Putatan and Tuaran) and two districts in Kudat division (Kota Marudu and Kudat). Ovitrap indices ranged from 33.3% to 100.0% and mean number of larvae per ovitrap from (mean ± SD) 4.53 ± 3.10 to 78.93 ± 11.77. Generally, *Ae. albopictus* was the dominant dengue vector in all study sites with a small population of *Ae. aegypti* in Taman St. Peter, Kudat. High populations of *Aedes* spp in both divisions should prompt an immediate employment of a strategic integrated vector management program in West Coast and Kudat divisions of Sabah, Malaysia.

**Keywords:** dengue vector, ovitrap surveillance, *Aedes*, Malaysia

## INTRODUCTION

Dengue has been noted as the world's fastest growing vector-borne disease with a 30-fold increment of cases reported over the past 50 years (WPRO, 2015). In Malaysia, a total of 101,357 dengue cases were reported in 2016 (MOH, 2016), and recently, zika virus was reported in many Southeast Asian countries, including Malaysia, where as of January 2017, eight confirmed zika cases were reported (MOH, 2017). In Malaysia, both diseases are transmitted by *Aedes* mosquitoes, specifically *Ae. aegypti* and *Ae. albopictus*.

Endemic peak of dengue and emergence of zika are thought to be caused by escalating population of *Aedes* spp. Increase in *Aedes* mosquito population is largely contributed by massive urbanization and climate change, which create favorable breeding opportunities and conditions for mosquitoes (Banu *et al*, 2011; Mudin, 2015).

Conducting surveillance studies be-

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forehand are vital in carrying out effective vector control measures (Wan-Norafikah *et al*, 2010). Through these surveillance studies, improved understanding of *Aedes* mosquito dynamics can be achieved and better intervention measures introduced (Lim *et al*, 2010). In Malaysia, numerous surveillance studies had been conducted on the distribution of *Aedes* mosquitoes, but mostly centered in endemic and congested areas, such as Kuala Lumpur, Selangor and Penang (Chen *et al*, 2006b; Saifur *et al*, 2012; Lau *et al*, 2013). Surveillance studies conducted in Sabah are scarce, non-extensive and not up to date. A comprehensive *Aedes* surveillance in Sabah covering all divisions, namely, Interior, Kudat, Sandakan, Tawau, and West Coast, had been carried out almost 40 years ago and was outdated (King, 1978). A more updated *Aedes* surveillance was done in 2012, but only focused on one study site (Wan-Norafikah *et al*, 2012).

Thus, this study surveyed the distribution and abundance of *Aedes* mosquitoes in West Coast and Kudat divisions of Sabah.

## MATERIALS AND METHODS

**Study sites**

Sabah is divided into five main administrative divisions, namely, Interior, Kudat, Sandakan, Tawau, and West Coast, and the two main divisions; West Coast and Kudat, were selected as study sites (Table 1). West Coast division is situated in northwest Sabah, with seven districts Kota Belud, Kota Kinabalu, Papar, Penampang, Putatan, Ranau, and Tuaran; residential areas located in Kota Belud, Kota Kinabalu, Papar, Penampang, Putatan and Tuaran were chosen. Kudat division is located at the northern tip of Sabah, and within the division, there are three districts, Kota Marudu, Kudat and Pitas, with only residential areas in Kudat and Kota Marudu districts were chosen. Ovitrap surveillance was conducted in 21 residential areas across the eight districts (Fig 1). The surveillance period was from 10 to 20 July 2017.

**Ovitrap surveillance**

Ovitrap was prepared according to Lee (1992). In brief, an ovitrap consisted of 300-ml plastic container with an opening of 7.8 cm in diameter, base diameter of 6.5 cm and 9.0 cm height, painted black on the outside with a hardboard oviposition paddle (10 cm × 2.5 cm × 0.3 cm) placed diagonally inside and filled with tap water to a level of 5.5 cm. These ovitraps were placed in ≥ 10% of the houses in each study site, outside but within the immediate vicinity of the house, *ie* car porch and corridor connected to the house entrance (Chen *et al*, 2005). All ovitraps were collected after 5 days.

**Identification of larvae**

The ovitraps were brought back to the laboratory at Institute of Biological Sciences, Faculty of Science, University of Malaya, where each ovitrap content together with paddles were transferred into individual plastic container, fresh water added together with a small piece (10 mm in diameter) of fresh beef liver as larval food, the container covered, and larvae were allowed to breed in the laboratory for a further 9-day period (Chen *et al*, 2005). Hatched larvae were counted and identified at the 3$^{rd}$ instar based on standard taxonomic keys by Division of Medical Entomology, Institute for Medical Research (IMR) Malaysia (2000a, 2000b) and Jeffery *et al* (2012).

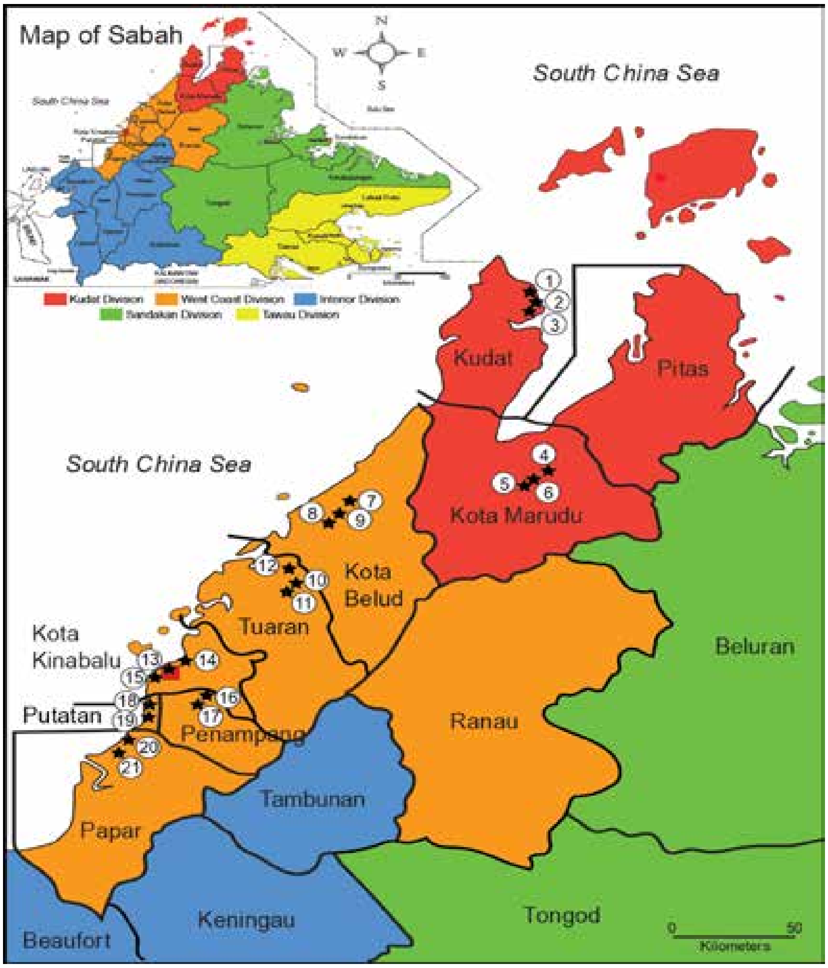
**Data analysis**

Data were analyzed for ovitrap index (OI) (percent positive ovitraps at each

Table 1
Geographical and ecological features of study sites in West Coast and Kudat divisions, Sabah, Malaysia.

| Division | District | Study site | Coordinate | Elevation (m a.s.l.) | Landscape |
|---|---|---|---|---|---|
| West Coast | Kota Belud | Pekan Kota Belud | N 6°21′21.870″, E 116°25′48.326″ | 18.7 | Suburban |
| | | Taman Nikmat | N 6°21′01.285″, E 116°24′31.926″ | 9.5 | Suburban |
| | | Kampung Lebak Moyoh | N 6°21′20.100″, E 116°24′56.220″ | 11.6 | Suburban |
| | Tuaran | Pekan Tuaran | N 6°10′44.701″, E 116°14′00.603″ | 12.8 | Suburban |
| | | Jalan Bolong | N 6°10′44.547″, E 116°13′48.050″ | 11.6 | Suburban |
| | | Kampung Serusup | N 6°12′25.800″, E 116°14′04.200″ | 8.7 | Suburban |
| | Kota Kinabalu | Taman Mutiara | N 5°57′08.845″, E 116°05′18.031″ | 8.1 | Urban |
| | | Jalan Mergastua | N 5°59′15.430″, E 116°06′13.493″ | 7.5 | Urban |
| | | Taman Selesa | N 5°56′08.700″, E 116°04′19.320″ | 7.8 | Urban |
| | Penampang | Taman Sindo | N 5°55′55.531″, E 116°05′28.651″ | 14.1 | Urban |
| | | Taman Palm Villa | N 5°55′22.433″, E 116°05′02.083″ | 11.3 | Urban |
| | Putatan | Kampung Lok Bonu | N 5°54′06.946″, E 116°03′22.421″ | 9.0 | Suburban |
| | | Taman Ceriamas | N 5°53′40.222″, E 116°03′10.542″ | 8.7 | Suburban |
| | Papar | Taman Kinarut | N 5°49′42.473″, E 116°02′26.093″ | 7.5 | Suburban |
| | | Kampung Beringis | N 5°47′12.871″, E 115°59′38.798″ | 8.0 | Suburban |
| Kudat | Kudat | Taman Sri Awana | N 6°54′58.941″, E 116°50′00.272″ | 23.2 | Suburban |
| | | Taman St. Peter | N 6°53′40.452″, E 116°51′14.671″ | 11.9 | Suburban |
| | | Taman Pakka | N 6°53′18.900″, E 116°51′03.480″ | 13.4 | Suburban |
| | Kota Marudu | Pekan Kota Marudu | N 6°29′44.169″, E 116°49′00.460″ | 14.0 | Suburban |
| | | Taman T&G Phase II | N 6°29′06.036″, E 116°45′38.939″ | 18.8 | Suburban |
| | | Jalan Peladang | N 6°29′36.780″, E 116°45′44.220″ | 13.4 | Suburban |

m a.s.l., meter above sea level.




| West Coast Division | | |
|---|---|---|
| **Kota Belud** | **Kota Kinabalu** | **Putatan** |
| (1) Pekan Kota Belud | (7) Taman Mutiara | (12) Kampung Lok Bonu |
| (2) Taman Nikmat | (8) Jalan Mergastua | (13) Taman Ceriamas |
| (3) Kampung Lebak Moyoh | **Taman Selesa** | **Papar** |
| **Tuaran** | (9) Penampang | (14) Taman Kinarut |
| (4) Pekan Tuaran | (10) Taman Sindo | (15) Kampung Beringis |
| (5) Jalan Bolong | (11) Taman Palm Villa | |
| (6) Kampung Serusup | | |
| **Kudat Division** | | |
| **Kudat** | **Kota Marudu** | |
| (16) Taman Seri Awana | (19) Pekan Kota Marudu | |
| (17) Taman St. Peter | (20) Taman T&G Phase II | |
| (18) Taman Pakka | (21) Jalan Peladang | |

Fig 1- Location of study sites in Kudat and West Coast divisions, Sabah, Malaysia.

study site) and mean number of *Aedes* larvae per recovered ovitrap (Chen *et al*, 2006a). All levels of statistical significance were determined with Student *t*-test and performed using a SPSS version 12.0.1 program (SPSS, Chiacago, IL) and a *p*-value < 0.05 is considered significant.

## RESULTS

The surveillance was conducted in urban and suburban residential areas in West Coast and Kudat divisions, Sabah, Malaysia. The residential areas were equipped with proper drainage system and had sparse vegetation.

Among the surveillance sites in Kudat division, Taman St. Peter (93%) and Taman Sri Awana (33%) recorded the highest and lowest OI, respectively (Table 2). As for West Coast division, Jalan Bolong in Tuaran district had the highest OI (100%) while Jalan Mergastua, Kota Kinabalu district and Taman Kinarut, Papar district, both possessed the lowest OI (35%). *Ae. albopictus* was the predominant mosquito species in West Coast and Kudat divisions, while a much lower population of *Ae. aegypti* was found in Taman St. Peter, Kudat district, and none in the residential areas of West Coast division (Table 2).

## DISCUSSION

Surveillance serves as a method to investigate the geographic distribution and density of vectors. It also helps to evaluate performance of existing vector control programs and steers implementation of effective intervention strategies (WHO, 1997). Among various surveillance methods, ovitrap surveillance remains the commonest method used, providing information on *Aedes* and other mosquito species larval density within a short time frame and specific location and further helps to predict dengue and other mosquito-borne burdens (Tham, 2000).

All surveillance sites in this study had OI values exceeding 10%, with the lowest being 33%. OI values >10% indicate prompt actions need to be taken (Lee, 1992), and higher OI values are positive indicators of exceptionally high mosquito breeding and dengue transmission activities (Ho *et al*, 2014). The data collected among the surveillance sites in West Coast and Kudat divisions clearly indicate necessary interventions be implemented immediately by responsible authorities.

In all study sites only the presence of *Ae. albopictus* was found, except at Taman St. Peter in Kudat district where *Ae. albopictus* and *Ae. aegypti* (latter at 6% of the former) were present. Estrada-Franco and Craig (1995) reported rapid urbanization contributes to the evolution of habitat adaptive ability of *Ae. albopictus* that can co-exist with *Ae. aegypti*, thus explaining the co-existence of both species in Taman St. Peter. However, surveillance studies conducted in Alabama, USA in 1991 and Central African Republic in 2013 found *Ae. albopictus* totally replacing *Ae. aegypti* populations (Hobbs *et al*, 1991; Kamgang *et al*, 2013). In a more localized survey, Afizah *et al* (2015) observed only *Ae. albopictus* in Malay and Aboriginal villages of Carey Island, Selangor, Malaysia, with apparent absence of *Ae. aegypti*. All these findings are in line with our findings of *Ae. albopictus* as the sole *Aedes* spp in the majority of the study sites.

Establishment of invasive species of *Ae. albopictus* is thought to be the reason for *Ae. aegypti* depletion in number (Hobbs *et al*, 1991). Ribeiro (1988) and Nasci *et al*, (1989) hypothesized *Ae. albopictus* compete with *Ae. aegypti* through asym-

Table 2
Ovitrap index and numbers of mosquito larvae obtained from West Coast and Kudat divisions, Sabah, Malaysia during 10 - 20 July 2017.

| Division | District | Study site | Number of ovitraps placed | Number of ovitraps collected | Number of positive ovitraps | Ovitrap index (%) | Number of larvae collected | | Mean number (± SEM) of larvae per ovitrap | | Percentage (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | *Ae. aegypti* | *Ae. albopictus* | *Ae. aegypti* | *Ae. albopictus* | *Ae. aegypti* | *Ae. albopictus* |
| West Coast | Kota Belud | Pekan Kota Belud | 15 | 10 | 6 | 60 | 0 | 232 | 0 | 23 ± 9 | 0 | 100 |
| | | Taman Nikmat | 15 | 14 | 12 | 86 | 0 | 546 | 0 | 39 ± 8 | 0 | 100 |
| | | Kampung Lebak Moyoh | 30 | 30 | 17 | 57 | 0 | 179 | 0 | 6 ± 3 | 0 | 100 |
| | Tuaran | Pekan Tuaran | 15 | 15 | 8 | 53 | 0 | 445 | 0 | 30 ± 11 | 0 | 100 |
| | | Jalan Bolong | 15 | 14 | 14 | 100 | 0 | 1,105 | 0 | 79 ± 12 | 0 | 100 |
| | | Kampung Serusup | 30 | 30 | 17 | 57 | 0 | 301 | 0 | 10 ± 3 | 0 | 100 |
| | Kota Kinabalu | Taman Mutiara | 15 | 15 | 14 | 93 | 0 | 986 | 0 | 66 ± 9 | 0 | 100 |
| | | Jalan Mergastua | 15 | 14 | 5 | 36 | 0 | 172 | 0 | 12 ± 5 | 0 | 100 |
| | | Taman Selesa | 30 | 30 | 17 | 57 | 0 | 180 | 0 | 6 ± 2 | 0 | 100 |
| | Penampang | Taman Sindo | 30 | 27 | 14 | 52 | 0 | 299 | 0 | 10 ± 3 | 0 | 100 |
| | | Taman Palm Villa | 15 | 14 | 9 | 64 | 0 | 444 | 0 | 32 ± 9 | 0 | 100 |
| | Putatan | Kampung Lok Bonu | 15 | 15 | 7 | 47 | 0 | 178 | 0 | 12 ± 10 | 0 | 100 |
| | | Taman Ceriamas | 15 | 15 | 7 | 47 | 0 | 68 | 0 | 4 ± 3 | 0 | 100 |
| | Papar | Taman Kinarut | 15 | 14 | 5 | 36 | 0 | 97 | 0 | 7 ± 7 | 0 | 100 |
| | | Kampung Beringis | 15 | 15 | 7 | 47 | 0 | 136 | 0 | 9 ± 5 | 0 | 100 |
| Kudat | Kudat | Taman Sri Awana | 15 | 15 | 5 | 33 | 0 | 262 | 0 | 17 ± 8 | 0 | 100 |
| | | Taman St. Peter | 15 | 14 | 13 | 93 | 36 | 545 | 3 ± 3 | 39 ± 9 | 6 | 94 |
| | | Taman Pakka | 30 | 30 | 17 | 57 | 0 | 313 | 0 | 10 ± 3 | 0 | 100 |
| | Kota Marudu | Pekan Kota Marudu | 15 | 9 | 7 | 78 | 0 | 317 | 0 | 35 ± 12 | 0 | 100 |
| | | Taman T&G Phase II | 15 | 14 | 10 | 71 | 0 | 430 | 0 | 31 ± 7 | 0 | 100 |
| | | Jalan Peladang | 30 | 29 | 19 | 65 | 0 | 142 | 0 | 5 ± 1 | 0 | 100 |

metric mating, where male *Ae. albopictus* mated with female *Ae. aegypti* to produce non-viable hybrid offspring and thereby eventually eliminating the competing *Ae. aegypti* population. This was supported by similar findings in Malaysia (Nazni *et al*, 2009). Apart from this mating behavior, *Ae. albopictus* larvae are also capable of suppressing hatching of *Ae. aegypti* eggs and invading their habitats (Braks *et al*, 2004). Hatching of eggs is usually triggered when there is a decline of dissolved oxygen due to respiration of microbes attached to the eggs surfaces (Hawley, 1988). Hatching will cease when *Ae. albopictus* larvae is presence, as they will graze the existing microbes coating *Ae. aegypti* eggs, causing influx of oxygen level (Gillett *et al*, 1977).

*Ae. albopictus* is usually more concentrated in outdoor environment and prefer breeding in natural catchment basins such as tree holes and bamboo stumps (Norzahira *et al*, 2011), whereas *Ae. aegypti* breeds indoor or close to human dwellings and prefers artificial containers such as vases and flower pot plates (Nyamah *et al*, 2010). However, Klowden (1993) noted both *Ae. albopictus* and *Ae. aegypti* are sympatric species and can occupy similar niche. Increasing human outdoor activity is one of the contributing factors of *Ae. aegypti* changing its breeding preference to outdoor locations (Saifur *et al*, 2012). In addition, *Ae. albopictus* is well known for having a wide range of breeding habitats, rural, suburban and urban (Norzahira *et al*, 2011; Ho *et al*, 2014). A number of reports indicated *Ae. albopictus* and *Ae. aegypti* are interchanging their normal breeding sites (Chen *et al*, 2006b; Norzahira *et al*, 2011; Saifur *et al*, 2012).

In this study, residential areas in towns were selected to be surveillance sites as these are places where dengue is prevalent owing to *Aedes* spp preference to dwell in areas congested with people (Chen *et al*, 2005). In addition, residential areas create numerous breeding opportunities for *Aedes* spp, ranging from natural catchment basins to man-made containers such as flower pot plates (Chen *et al*, 2005; Rao and George, 2010). The ovitraps were placed outside the house but within the immediate vicinity. Despite being placed outdoors, there was still a very small population of *Ae. aegypti* collected (only at Taman St. Peter), thus contradicting the standard belief of *Ae. aegypti* breeding indoors and *Ae. albopictus* outdoors (Saleeza *et al*, 2013).

In summary, this study highlights the sensitivity and reliability of ovitraps in monitoring *Aedes* spp population. Our results reveal all residential areas surveyed in Kudat and West Coast divisions were infested with *Aedes* spp and ovitrap indices were alarmingly high (≥10%), indicative of urgent and immediate intervention programs. Integrated vector management ranging from vector surveillance, source reduction, public health education, personal protection and biological and chemical control should be implemented (Lau *et al*, 2013). In addition, proper town planning and home design could assist in eradicating potential breeding sources (Saleeza *et al*, 2013).

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