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Aedes Mosquito Surveillance using Ovitrap in Selected High-Risk Areas in Bau District, Sarawak

Emelie Shalin Patrick[1*], Ahmad Umayr Ahmad Zaki[1], Minhalina Batrisyia Abdul Majid[1], Bibiana Tuya Charles[1], Ahmad Adam Mukhriz Ahmad Fuad[1], Nurzawani Md Sofwan[1*]
**Corresponding Author*

Environmental Health Programme, Faculty of Health Sciences,
Universiti Teknologi MARA Sarawak Branch, 94300 Kota Samarahan, Sarawak, Malaysia

shalinemelie@gmail.com, ahumayrzaki@gmail.com, minhalina604@gmail.com, bibianat.charles@gmail.com, paudaka6@gmail.com, nurzawani@uitm.edu.my
Tel: +6019-9349767

Abstract
This study investigated the distribution of Aedes species in two high-risk areas in Bau District: Pasar Bau (public area) and Kampung Podam (household area), using ovitrap surveillance over five weeks. A total of 180 ovitraps were deployed indoors and outdoors across both sites. Kampung Podam recorded a higher Ovitrap Index (OI) and Positive House Index (PHI), indicating more favorable breeding conditions in household environments. *Aedes albopictus* was the dominant species at both sites, while *Ae. aegypti* was found in indoor areas in Pasar Bau. Kampung Podam's Level 3 OI (>30%) highlights the need for prioritized household-based vector control efforts.

Keywords: *Aedes* mosquitoes; ovitrap surveillance; dengue risk; vector indices

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1.0 Introduction

Dengue fever remains a significant threat in tropical and subtropical regions. It is endemic in more than 125 countries worldwide, with documented transmission across all areas (Gwee et al., 2021). In Malaysia, with the first major outbreak documented as early as 1902, it remains a significant health concern (Abu Bakar et al., 2022). Malaysia reported the highest dengue incidence rates in the Western Pacific region, with approximately 330,000 cases in 2020 (Majeed et al., 2023). This alarming figure highlights the persistent and significant challenge that dengue poses to public health in the country. Sarawak has also experienced a high incidence of dengue, with rates ranging from 14.65 per 100,000 population in 2021 to 122.22 per 100,000 in 2016 (Teh et al., 2024). Dengue has remained endemic in Sarawak during the past decade, with periodic outbreaks driven by its tropical climate and substantial annual rainfall. Bau

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District faces a potential rise in dengue burden if current trends continue. In June 2022, 16 dengue cases were reported, and two outbreak events occurred in 2021 in Pasar Bau and Kampung Podam, involving a total of 14 cases.

The most prominent dengue control programme in Malaysia is vector surveillance via the ovitrap surveillance system due to its low cost and simplistic nature. The outcome of the surveillance provides the distribution and abundance of *Ae. aegypti* and *Ae. albopictus* in dengue-endemic areas. It also determines larval habitats and spatiotemporal risk factors related to dengue transmission (Sasmita et al, 2021). Common surveillance such as house inspection is unable to locate the breeding sites of *Ae. albopictus* due to its peri-domestic nature which can underestimate the larval prevalence (Lian et al., 2006).

This paper aims to determine the presence and distribution of *Aedes* species in two high-risk areas of Bau District, Sarawak through ovitrap surveillance. The objectives of this study are to assess *Aedes* mosquito population in the public and household areas and to identify breeding preferences of *Ae. aegypti* and *Ae. albopictuss using vector indices*. This study is anticipated to provide valuable information for health authorities to develop targeted mosquito control interventions tailored to specific localities.

2.0 Literature Review

The emergence and transmissibility of arboviruses, specifically the dengue virus, are rapid and widespread due to these mosquitoes' ability to inhabit and exploit human urbanisation and the global transportation network (Lwande et al., 2020). Another contributing factor is the mosquito's tendency to associate closely with human habitation, and the acquired human host specificity allowed the virulence and transmissibility of dengue fever to increase. *Ae. aegypti*, a primary vector for dengue virus, thrives close to human habitation, mainly in urban and suburban areas due to its anthropophilic nature. They prefer artificial containers inside houses. *Ae. albopictus*, a secondary vector of dengue virus, is a sylvatic species that has recently adapted to urban and semi-urban settings; however, it prefers natural containers such as tree stumps or leaf reservoirs but may also breed in artificial containers to some extent (Manel et al., 2024). Numerous ovitrap surveillance studies have focused on urban hotspots such as Bandung, Indonesia (Sasmita et al., 2021), and Klang, Malaysia (Ishak et al., 2022). This study focuses on semi-urban areas in Bau District to identify local variations in vector distribution.

Mosquito-based surveillance involves collecting data on mosquito species to better understand their role as disease vectors, including their anatomy, distribution, habitat preferences, behavior, virulence, and susceptibility to insecticides (Coulibaly et al., 2023). Standard surveillance techniques include capturing mosquito eggs, larvae, or adults using various tools, with ovitraps among the most widely used methods for collecting eggs and larvae. Ovitraps simulate natural *Aedes* mosquito breeding sites, attracting females to deposit eggs. This method is particularly effective for forecasting dengue outbreaks, especially in areas with low levels of *Aedes* infestation, and is widely applied for dengue control efforts. In Malaysia, larval identification remains the primary method for dengue surveillance; however, it has limitations due to the specific biology of *Aedes* species and the often-hidden nature of their breeding sites (Wickramasinghe, 2025). Entomological data in the form of vector-related indices are calculated from ovitrap surveillance. The indices represent the vector's abundance and disease control activities (Morales-Pérez et al, 2020).

3.0 Methodology

3.1 Study Area

Bau District, situated within the Kuching Division, spans approximately 884.4 square kilometers and has an estimated population of 53,600 between 2020 and 2023. Two sites were selected: Pasar Bau, a public area, and Kampung Podam, a household area located in the Serembu locality. Pasar Bau is a hub of commercial activity, featuring grocery stores, eateries, and public service facilities. The area consists of a blend of traditional wooden structures and modern concrete shophouses. Kampung Podam consists of 146 houses, predominantly constructed from concrete, though some wooden dwellings remain. These two areas were chosen for their history of dengue outbreaks over the past four years, based on statistics from the Bau District Health Office, allowing for a comparative analysis across differing sites' backgrounds. The limitation of this study lies in the restricted study area and surveillance period mainly due to logistical and time contraints.

3.2 Ovitrap Surveillance

Fig. 1. Ovitraps placement in the indoor (left) and outdoor (right) settings.

Ovitrap surveillance was carried out over five weeks from April to May 2025. Nine premises within a 200-meter radius of the index case were randomly selected each week for deployment of ovitraps. A total of 180 ovitraps were placed across both indoor and outdoor settings, as shown in Fig. 1. An ovitrap consists of a black plastic container filled two-thirds with preserved tap water and a diagonally positioned wooden paddle. An outdoor ovitrap was placed at a shady corner of a veranda, or an indoor ovitrap was placed in the house or a commercial premise. Each ovitrap was assigned a unique serial number, address, and Global Positioning System (GPS) coordinates for data tracking.

3.3 Larvae Identification

After five days, the ovitraps were collected and transported to the Vector Laboratory at the Bau District Health Office for larval rearing until their adult stage for larvae identification. The wooden paddles from each ovitrap were inspected in the laboratory for the presence of mosquito eggs. Positive ovitraps were then filled with preserved tap water to support larval growth. They were kept under controlled environmental conditions until the larvae reached the third or fourth instar, an ideal stage for morphological identification. Larval species identification was then carried out using a light microscope.

3.4 Vector Indices

Ovitrap index (OI) was calculated based on the number of ovitraps containing *Aedes* eggs divided by the total number of ovitraps installed. The OI were categorized into three levels: Level 1 for OI less than 10%, Level 2 for OI between 10% to 30% and Level 3 for OI above 30%, each indicating the corresponding action required by the Health Department. The Positive House Index (PHI) for households was determined by dividing the number of houses with positive ovitraps by the total number of houses surveyed. Similarly, the PHI for public areas was determined by dividing the number of public locations with positive ovitraps by the total number of public locations examined.

4.0 Findings

A total of 681 larvae were collected throughout the surveillance period, with an average of 149 and 52 larvae per week collected from household and public areas, respectively. *Aedes* populations were detected in 58 of the 180 ovitraps deployed, with the highest number of positive ovitraps recorded in Kampung Podam (35), followed by Pasar Bau (23). The percentage abundance of *Ae. aegypti* and *Ae. albopictus* collected in positive ovitraps is shown in Table 1. The findings indicate that, *Ae. albopictus* is the dominant species in both locations, accounting for 100% of the mosquito population in Kampung Podam and 91.09% in Pasar Bau, respectively. High percentage of positive ovitraps with *Ae. albopictus* was found in both indoor and outdoor settings in Pasar Bau, indicating its adaptability to both environments. *Ae. aegypti* populations in Pasar Bau were approximately three times more prevalent in ovitraps placed indoors compared to those placed outdoors. This finding is attributed to the fact that the Bau District is a small town surrounded by dense greenery. *Ae. albopictus* thrives in vegetated, peri-domestic, and shaded environments (Egid et al. 2022). In contrast, *Ae. aegypti* is more anthropophilic and often associated with highly urbanized habitats and artificial containers (CDC, 2020; Ortega-López et al. 2024).

Table 1. Dengue vector abundance for indoor and outdoor placements in the study sites

Study site	Ovitrap placement	*Number of specimen (% abundance)*	
		Ae. aegypti	*Ae. albopictus*
Kampung Podam	Indoor	0 (0)	63 (14.13)
	Outdoor	0 (0)	383 (85.87)
Pasar Bau	Indoor	18 (78.26)	138 (58.72)
	Outdoor	5 (21.74)	97 (41.28)

The highest OI at 62.22% was recorded for ovitraps placed outdoors in Kampung Podam, as presented in Table 2. The high OI observed in Kampung Podam can be attributed to its densely populated residential setting and closely spaced housing, which facilitate mosquito movement between homes. This environment supports more frequent human blood feeding, increases the potential for dengue transmission, and enhances mosquito breeding within the household area (WHO, 2024). The mean OI for Kampung Podam and Pasar Bau is 38.9% and 26.1%, respectively, indicating a higher level of mosquito infestation in the household area. Public areas have more efficient solid waste collection services and better drainage systems. Overall, the mean ovitrap positivity in the Bau District indicates a higher *Aedes* population in outdoor environments than in indoor environments. The mean OI for Kampung Podam falls under Level 3, which corresponds to an OI above 30%, a critical threshold used by health authorities, and serves as a warning of a potential dengue outbreak if urgent vector control measures are not implemented.

Table 2. Ovitrap index for indoor and outdoor placements in the study sites

Study site	Ovitrap placement	Ovitrap index (%)
Kampung Podam	Indoor	15.55
	Outdoor	62.22
Pasar Bau	Indoor	24.44
	Outdoor	27.78

Kampung Podam recorded a higher PHI value at 63.38%, compared to 46.62% in Pasar Bau. The higher OI and PHI observed in Kampung Podam indicate that household environments provide more stable and persistent breeding conditions for *Aedes* mosquitoes than public open spaces. This is also aided by the availability of artificial containers around the study areas, which is often caused by loitering, thereby increasing the number of mosquito breeding spots. Zhao et al. (2021) suggested that PHI values exceeding 70% are an alarming signal of infestation on residential premises, which are typical hotspots for human-vector contact.

5.0 Discussion

This study demonstrated dominant population of *Ae. albopictus* can be explained by the forest-fringe zone characteristics of the Bau District. The presence of *Ae. aegypti* at Pasar Bau indicates a preference for more urbanized areas with a higher population and greater availability of man-made containers, due to improper waste disposal. In many rural and suburban settings in Southeast Asia, the dominant Aedes species*, Ae. Albopictus* thrives in outdoor and semi-natural environments, especially in areas with abundant vegetation (Pasin et al., 2022). It is originally a sylvatic species that primarily inhabited forested environments, has recently adapted to urban and semi-urban settings but still prefers to breed in natural containers (Russell et al., 2002). This species has gradually adapted to a changing environment, with less vegetation and a more widespread distribution of the human population. Recent study shows that *Ae. albopictus* was found coexisting with *Ae. aegypti* in a city in Brazil (de Souza et al., 2022).

The use of ovitraps in this study allowed for clear delineation of species-specific abundance patterns. *Aedes* populations in Pasar Bau preferred breeding indoors, while those in Kampung Podam preferred outdoor breeding. Kampung Podam, with its rural setting, provides an additional blood supply for mosquitoes from animal sources, due to several backyard poultry farms in that area. Moreover, dense forests and multiple water bodies provided ample breeding habitat. Human factors may have a higher influence on the breeding patterns. Although there is no recent dengue infection have been reported in the study areas, an OI level exceeding 3 indicates a possibility of dengue outbreak at any time.

The OI and PHI are essential entomological indicators used to assess *Aedes* mosquito infestation levels in the area. These findings are consistent with the global patterns reported in dengue-endemic regions, where PHI and OI values above 10% are considered epidemiologically significant (Pasin et al., 2022). Such indices can trigger outbreak warnings and guide vector control strategies. The high vector index values observed in this study emphasize the need for continuous entomological surveillance and targeted interventions, with greater emphasis on household-level control. Continuous entomological monitoring is vital for assessing intervention success and for tracking changing patterns of mosquito distribution and behavior.

6.0 Conclusion & Recommendations

This study investigated the presence, distribution, and breeding preferences of *Aedes* mosquitoes in two high-risk areas within Bau District: Kampung Podam (a household area) and Pasar Bau (a public area) using ovitrap surveillance. The findings revealed a higher Ovitrap Index (OI) and Positive House Index (PHI) in Kampung Podam, indicating that household environments provide more stable and persistent breeding conditions for *Aedes* mosquitoes compared to public area. The dominance of *Ae. albopictus* in both sites, along with the indoor preference of *Ae. aegypti* in Pasar Bau further highlights the adaptability of these vectors. The assessment of breeding preferences further underscored that, *Ae. albopictus* was the dominant species in both study sites. The confinement of *Ae. aegypti* to the urbanized public area and its absence in the more rural Kampung Podam suggest potential ecological displacement by *Ae. albopictus* in less urbanized settings.

However, the study also acknowledges its limitations, such as restricted to a few study locations, the absence of data on risk factors such as type of containers, house density and human density, which hinder the establishment of a correlation between risk factors and *Aedes* prevalence. Reliance on a short study period conducted in two areas of the district may not reflect the broader distribution of *Aedes*. Future research should expand to other areas with different settings and investigate the impact of seasonal changes on *Aedes* presence. The addition of GPS and GIS technologies in future study can explore the spatial distribution of the mosquito population and dengue transmission.

The outcomes of this research can serve as preliminary data for local health authorities, supporting the development of more targeted and sustainable vector control strategies. Continued research in the identified high-risk areas is crucial to address the escalating threat of dengue fever and to implement evidence-based, localized vector management and intervention strategies. The study also recommends that the health authority incorporate biological methods for vector control, such as using the bacterium Wolbachia, which can reduce the transmission or shorten the virus's lifespan. Continuous awareness campaigns targeting various age groups and localities are expected to increase community-based efforts to reduce the breeding of *Aedes* mosquitoes.

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Paper Contribution to the Related Field of Study

This study contributes to the field of vector-borne disease control by providing evidence on the spatial distribution, breeding preferences, and habitat-specific dominance of *Aedes* mosquitoes in household and public environments, supporting more targeted and effective dengue vector surveillance and intervention strategies.

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