

Entomological identification of *Aedes* spp. supporting dengue early warning in Samarinda

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Abstract. Dengue fever remains a major public health challenge in tropical urban areas and may increase following environmental disturbances and hydrometeorological disasters that create favorable mosquito breeding habitats. Baseline information on *Aedes species* may also contribute to preparedness and inform future vector surveillance strategies in vulnerable communities. This study aimed to identify the species composition of *Aedes* spp. collected using ovitraps in Lempake Subdistrict, Samarinda, East Kalimantan. A descriptive entomological survey was conducted in residential areas with previous dengue case reports. A total of 98 ovitraps were placed indoors and outdoors and monitored for seven days. Larvae collected from positive ovitraps were identified microscopically based on morphological identification keys. The results identified two medically important dengue vectors, namely *Aedes aegypti* and *Aedes albopictus*. A total of 148 larvae were identified as *Aedes aegypti*, while 140 larvae were identified as *Aedes albopictus*. The slightly higher abundance of *Aedes aegypti* indicates the presence of both vector species within the residential environment, with *Aedes aegypti* being marginally more abundant during the surveillance period. The coexistence of both species demonstrates that dengue vectors are established in the study area. These findings provide baseline entomological information that may support continued vector surveillance and serve as a reference for future monitoring of changes in *Aedes* populations, including under environmental or disaster-related conditions.

Keywords: *Aedes aegypti*, *Aedes albopictus*, dengue, mitigation, ovitrap.

Introduction

Dengue fever remains a major public health problem in tropical and subtropical countries, including Indonesia (World Health Organization, 2026). It is a mosquito-borne viral infection caused by four dengue virus serotypes (DENV-1 to DENV-4) and one of the fastest-spreading vector-borne diseases, transmitted mainly through the bites of infected *Aedes aegypti* and *Aedes albopictus* mosquitoes (Khan et al., 2023). These species are highly adapted to urban and peri-urban environments. Globally, dengue incidence has increased substantially over the past decades, with the World Health Organization reporting more than 7.6 million dengue cases worldwide by April 2024, reflecting the growing burden of dengue transmission in endemic regions (World Health Organization, 2025).

In Indonesia, a total of 148,922 dengue cases were reported in 2023 (World Health Organization, 2025). Indonesia continues to experience recurrent dengue outbreaks with increasing incidence in several provinces. Specifically in East Kalimantan, dengue remains a significant public health concern. Provincial health data reported 5,584 dengue cases with 25 deaths in 2023, while Samarinda recorded 867 confirmed cases and three deaths, placing the

city among the highest dengue-burden areas in the province (Apriyani et al., 2026). The increasing number of dengue cases in East Kalimantan is particularly concerning due to rapid urban development, population mobility, and environmental changes that may facilitate mosquito breeding and disease transmission (Ridha et al., 2024).

Hydrometeorological events such as heavy rainfall and flooding may also increase the availability of stagnant-water habitats that support *Aedes* breeding. These environmental disturbances can elevate the risk of dengue outbreaks and create additional challenges for public health preparedness and disaster risk mitigation in urban communities (Ryan et al., 2019). Lempake Subdistrict is particularly relevant in this context because parts of the area have experienced flooding and rain-related waterlogging associated with heavy rainfall and drainage overflow (ASEAN Disaster Information Network, 2024; Kecamatan Samarinda Utara, 2023). These conditions may contribute to the formation of temporary stagnant-water habitats that can potentially support mosquito breeding. This local vulnerability further emphasizes the value of establishing baseline information on *Aedes* vectors in the area. Although dengue cases remain high in Samarinda, local entomological evidence from Lempake Subdistrict remains limited.

Previous studies in Samarinda have addressed dengue control and factors associated with the presence of *Aedes* larvae; however, detailed information on the species composition of *Aedes* mosquitoes collected through indoor and outdoor ovitrap surveillance in dengue-prone residential settings remains scarce (Apriyani et al., 2026; Rasyid et al., 2024). This information is important because *Aedes aegypti* and *Aedes albopictus* differ in habitat preference, ecological behavior, and vector competence, which may require different surveillance and control approaches.

The novelty of this study lies in providing local baseline data on the species composition of *Aedes* mosquitoes collected through indoor and outdoor ovitrap surveillance in dengue-prone residential areas of Lempake Subdistrict. In addition, this study interprets the entomological findings as baseline information that may support future community-level vector surveillance and dengue preparedness.

Therefore, this study aimed to identify the species composition of *Aedes* spp. collected using ovitraps in Lempake Subdistrict, Samarinda. The findings are expected to support community-level dengue preparedness by informing targeted indoor and outdoor vector control, public health education, the identification of areas requiring closer routine monitoring, and future entomological assessment following environmental disturbances. These findings may also assist local health authorities and communities in strengthening future dengue surveillance and preparedness strategies.

Methods

Study Design and Study Area

This study employed a descriptive entomological approach to identify *Aedes* mosquito species collected through ovitrap surveillance. The study was conducted in July 2024 in Lempake Subdistrict, Samarinda, East Kalimantan, Indonesia, an area with recurrent dengue cases. The study sites were selected purposively based on previous reports of dengue cases obtained from local health surveillance records. Seven neighborhood units (RTs) in Lempake Subdistrict were included because they had documented dengue cases during the predefined surveillance period and were considered relevant for entomological assessment. The selection was also based on field accessibility and feasibility for household-based indoor and outdoor ovitrap placement.

Ovitrap Preparation

The ovitraps were prepared using dark-colored plastic containers to attract gravid female *Aedes* mosquitoes for oviposition. The outer surface of each container was painted black based on the known preference of *Aedes* spp. for dark oviposition sites. A strip of filter paper measuring approximately 5×15 cm was attached to the inner wall of each container to serve as an egg-laying substrate. Each ovitrap was then filled with a 10% hay infusion solution up to two-thirds of the container volume to increase its attractiveness to ovipositing mosquitoes.

Ovitrap Placement

A total of 98 ovitraps were deployed across seven selected RTs in Lempake Subdistrict. Seven households were selected in each RT, resulting in a total of 49 participating households. At each household, two ovitraps were installed: one indoors and one outdoors, representing domestic and peri-domestic environments, respectively. Thus, 14 ovitraps were deployed in each RT, comprising seven indoor and seven outdoor ovitraps, for an overall total of 49 indoor and 49 outdoor ovitraps. The number of ovitraps was determined operationally based on the number of selected RTs, the number of households included per RT, and the paired indoor–outdoor placement design, rather than through a formal sample-size calculation.

Households were selected purposively based on accessibility, resident permission, and the availability of suitable indoor and outdoor placement locations. Indoor ovitraps were positioned in dark, humid areas, such as room corners and areas near bathrooms, whereas outdoor ovitraps were placed in shaded areas around yards or gardens with limited direct sunlight exposure.

Each ovitrap was labeled according to its placement location. Visible markers were also placed near the ovitraps to facilitate identification and reduce the risk of loss, displacement, or accidental damage. The ovitraps were monitored daily for seven days. During the monitoring period, the containers were left undisturbed and no additional infusion liquid was added. After seven days, the ovitraps were retrieved for laboratory examination. An ovitrap was classified as positive when mosquito larvae were found inside the container.

Larval Collection and Rearing

After the seven-day placement period, the ovitraps were collected and transported to the laboratory for examination. Larvae found directly inside the ovitrap containers were carefully transferred using pipettes into labeled containers. Eggs attached to the filter paper were maintained under suitable laboratory conditions until hatching, after which the resulting larvae were transferred into labeled containers for further identification.

Species Identification

Larval identification was performed under a light microscope using the identification key for *Aedes* mosquitoes issued by the Indonesian Ministry of Health (Kementerian Kesehatan Republik Indonesia, 2017).. Microscopic identification was performed on third- and fourth-instar larvae, in which diagnostic morphological characteristics were more clearly developed. Species differentiation was based primarily on the morphology of the comb scales on the eighth abdominal segment. *Aedes albopictus* larvae were characterized by comb scales with a single denticle, whereas *Aedes aegypti* larvae had comb scales with distinct central and lateral denticles (Khan et al., 2025). Additional morphological characteristics, including the siphon, pecten teeth, and lateral thoracic spines, were also examined. All identified larvae were recorded and grouped according to species.



Data Analysis

Data were analyzed descriptively to determine the distribution and species composition of *Aedes* larvae collected from the ovitraps. The numbers of positive ovitraps and larvae were summarized separately for indoor and outdoor placements in each neighborhood unit. An ovitrap was considered positive when at least one mosquito larva was found inside the container. The mean number of larvae per positive ovitrap was calculated by dividing the total number of larvae collected by the number of positive ovitraps, using the following formula:

$$\text{Larvae per positive ovitrap} = \frac{\text{total number of larvae collected}}{\text{total number of positive ovitraps}}$$

The total numbers and proportions of larvae identified as *Aedes aegypti* and *Aedes albopictus* were also calculated and presented in tabular form.

Results and Discussion

Results

This study was conducted in seven neighborhood units (RTs) and one public facility, namely a mosque area, in Lempake Subdistrict, North Samarinda District, Samarinda City. The neighborhood units were selected based on previous reports of dengue cases in these areas. A total of 98 ovitraps were deployed in paired indoor and outdoor locations across the selected households. The larvae collected from the ovitraps were subsequently processed and identified in the laboratory. The selected ovitrap sampling locations are presented in Figure 1.

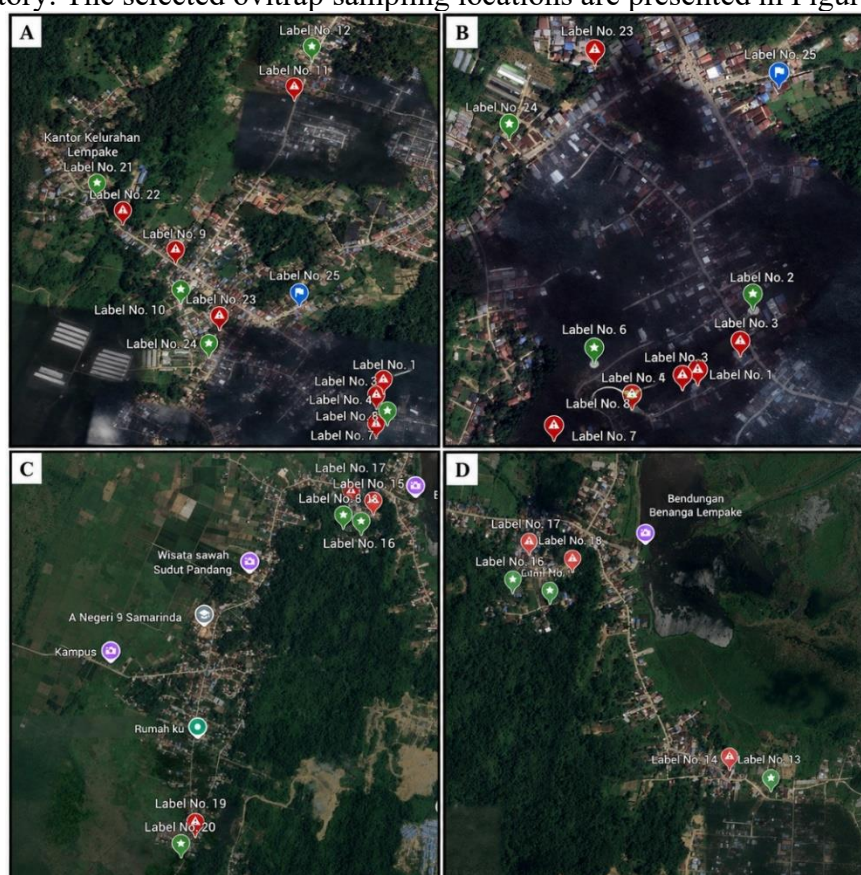


Figure 1. Distribution of ovitrap sampling locations in selected residential areas of Lempake Subdistrict, Samarinda. Panels A–D show the spatial distribution of ovitrap locations across the study area, corresponding to seven selected neighborhood units: (A) RT 10–11, (B) RT 15 and RT 43, (C) RT 22, and (D) RT 28 and RT 36.

Source: Google Maps, annotated by the authors, 2026.

The findings regarding larvae collection across the RTs in Lempake Subdistrict are presented in Table 1.

Table 1. Larval Collection of *Aedes* spp. in Neighborhood Units (RT) in Lempake Subdistrict

RT	Positive Ovitrap		Total Larvae		Larvae per Ovitrap Positive	
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
RT 10	5	2	47	26	9.4	13
RT 11	1	4	23	58	23	14.5
RT 15	1	2	9	39	9	19.5
RT 22	2	2	34	40	17	20
RT 28	0	0	0	0	0	0
RT 36	0	0	0	0	0	0
RT 43	2	1	7	5	3.5	5
Total	11	11	120	168	$\bar{x} = 10.91$	$\bar{x} = 15.27$

Source: Research data

Larvae were detected in both indoor and outdoor ovitraps. Of the 49 ovitraps deployed in each placement category, 11 indoor ovitraps (22.4%) and 11 outdoor ovitraps (22.4%) were positive. A total of 120 larvae were collected from indoor ovitraps and 168 larvae from outdoor ovitraps. Species identification was subsequently performed on the collected larvae, as presented in Table 2.

Table 2. Identification of *Aedes* spp. in Neighborhood Units (RTs) in Lempake Subdistrict

RT	Total Larvae (Indoor)	Total Larvae (Outdoor)	<i>Aedes aegypti</i>	<i>Aedes albopictus</i>
RT 10	47	26	70	3
RT 11	23	58	28	53
RT 15	9	39	9	39
RT 22	34	40	34	40
RT 28	0	0	0	0
RT 36	0	0	0	0
RT 43	7	5	7	5
Total	120	168	148	140

Note: Larvae collected from indoor and outdoor ovitraps were pooled by RT before species identification. Consequently, the species composition of *Ae. aegypti* and *Ae. albopictus* could not be disaggregated according to indoor versus outdoor placement.

Source: Research data

A total of 288 larvae were identified from ovitrap collections in Lempake Subdistrict, Samarinda. Two *Aedes* species were detected, namely *Aedes aegypti* and *Aedes albopictus*. Of the total larvae, 148 (51.4%) were identified as *Aedes aegypti*, while 140 (48.6%) were identified as *Aedes albopictus*. This finding indicates a slight predominance of *Aedes aegypti* compared to *Aedes albopictus*, although both species were found in relatively comparable proportions.

Discussion

The findings of this study confirmed the coexistence of *Aedes aegypti* and *Aedes albopictus* in Lempake Subdistrict, Samarinda. Of the 288 larvae identified, 148 larvae (51.4%) were classified as *Aedes aegypti*, while 140 larvae (48.6%) were classified as *Aedes albopictus*.



Although *Aedes aegypti* was slightly more abundant, the relatively similar proportions indicate that both species may contribute substantially to the local dengue vector population. This coexistence is consistent with the widespread occurrence of both species in tropical urban environments, where their distribution is influenced by human movement, climate suitability, urban development, and the availability of breeding habitats (Kraemer et al., 2015).

The slight predominance of *Aedes aegypti* may reflect its strong adaptation to densely populated residential environments. This species is highly anthropophilic, feeds predominantly on humans, and commonly rests and breeds in or around human dwellings (Egid et al., 2022). Its ability to use artificial water-holding containers and indoor microhabitats increases its contact with humans and enhances its importance as the principal dengue vector in urban settings (Facchinelli et al., 2023). In contrast, *Aedes albopictus* is more commonly associated with outdoor and peri-domestic environments and may feed opportunistically on both humans and animals (Kraemer et al., 2015). Originally associated with forest-edge habitats and natural containers such as tree holes and bamboo stumps, *Aedes albopictus* has adapted successfully to urban environments and can also breed in artificial containers, including discarded tires and water-storage containers (Kristan et al., 2025). These ecological differences may explain why *Aedes aegypti* was slightly more abundant while *Aedes albopictus* remained present in a nearly comparable proportion.

Larvae were recovered from both indoor and outdoor ovitraps, indicating that suitable mosquito breeding habitats were available within houses and in the surrounding residential environment. Previous studies have reported that *Aedes aegypti* is more strongly associated with indoor and domestic habitats, whereas *Aedes albopictus* can use both outdoor and peri-domestic breeding sites (Herath et al., 2022). Therefore, the occurrence of larvae in both placement environments supports the need for vector-control measures that cover both household interiors and surrounding outdoor areas. However, because the species composition in the present analysis was not presented separately according to indoor and outdoor placement, the findings should not be interpreted as a direct comparison of the habitat preferences of the two species. Further studies that stratify species identification by ovitrap placement would provide a more detailed understanding of their local ecological distribution. Future field protocols should retain unique container-level labels throughout larval collection, rearing, and species identification so that each specimen can be linked to its original indoor or outdoor ovitrap, enabling more precise comparisons of microhabitat use between the two vector species.

The relatively high proportion of *Aedes albopictus* also warrants attention. Although this species is generally regarded as a secondary dengue vector compared with *Aedes aegypti*, evidence from vector-competence studies indicates that *Aedes albopictus* is capable of acquiring and transmitting dengue virus and may contribute substantially to transmission under suitable ecological conditions (Fortuna et al., 2024; Garcia-Rejon et al., 2021). A systematic review and meta-analysis reported that, while *Aedes aegypti* remains the primary dengue vector, more recent data showed no significant difference in dengue virus prevalence between the two species (Kristan et al., 2025). The near-balanced species composition found in Lempake may therefore increase the complexity of dengue control because the two species occupy overlapping but not identical ecological niches. Control strategies focused only on indoor habitats may fail to address outdoor breeding sites used by *Aedes albopictus*, while interventions limited to outdoor environments may overlook the domestic behavior of *Aedes aegypti*.

From a disaster-risk perspective, the coexistence of both vector species may be relevant for future preparedness in flood-prone urban settings such as Samarinda. Heavy rainfall, flooding, and prolonged water stagnation can increase the availability of water-holding habitats

that may support mosquito development (Fortuna et al., 2024; Nasirian, 2025). Under such conditions, *Aedes aegypti* may utilize indoor water-storage containers, whereas *Aedes albopictus* may exploit outdoor and peri-domestic water-holding habitats. Previous studies have shown that extreme weather events and hydrometeorological hazards can influence vector abundance and dengue transmission risk in urban and peri-urban environments (Abbasi, 2025).

Lowe et al. (2021) further reported that the combined effects of hydrometeorological hazards and urbanization were associated with increased dengue risk. Similarly, changes in rainfall and temperature may alter the geographical distribution and transmission potential of *Aedes*-borne diseases (Ryan et al., 2019). Although rainfall volume, flood exposure, and the duration of standing water were not measured in the present study, the detection of both vector species provides baseline entomological information that may be useful for future surveillance and prospective disaster-risk planning in environmentally vulnerable areas.

These baseline findings may have potential relevance for future dengue early-warning surveillance and community-level preparedness in Lempake Subdistrict. Regular ovitrap surveillance may help identify neighborhood units with persistent mosquito activity or high larval abundance, allowing local health authorities to prioritize targeted interventions. Areas with repeatedly positive ovitraps may require more intensive source reduction, environmental sanitation, household inspections, larval monitoring, and public-health education. Vector-control activities should include both indoor water containers and outdoor breeding sites around houses, gardens, yards, and public facilities.

Community participation is also essential because many potential breeding habitats are located within or near residential properties. Community health workers, local volunteers, and residents may be involved in monitoring water-storage containers, removing discarded items that collect rainwater, and reporting increases in mosquito breeding following heavy rainfall or flooding. Post-flood health education should emphasize the rapid removal or management of stagnant water from both domestic and peri-domestic environments. Integrating community observations with routine entomological surveillance may contribute to future integrated dengue surveillance and preparedness efforts.

Continuous entomological surveillance may therefore be useful for monitoring changes in vector abundance, species composition, and breeding-site distribution. Integrated surveillance requires systematic data collection, analysis, interpretation, and dissemination to support public-health decision-making and guide interventions such as vector control, community education, and outbreak preparedness (Leandro & Maciel-De-Freitas, 2024). In Lempake Subdistrict, ovitrap findings may provide useful baseline information for identifying priority locations and adapting control strategies to the distinct ecological characteristics of *Aedes aegypti* and *Aedes albopictus*.

This study has several limitations. The study sites were selected purposively, which may limit the generalizability of the findings beyond the selected areas. In addition, the study was conducted during a single seven-day observation period and did not include longitudinal or seasonal monitoring; therefore, the findings do not represent temporal or seasonal variations in mosquito abundance. The species composition was also not analyzed separately according to indoor and outdoor ovitrap placement. Environmental variables, including rainfall and direct flood exposure, were not measured, and the entomological findings were not correlated with human dengue case data. Furthermore, this study was not designed to evaluate a dengue early-warning system and did not assess alert thresholds or predictive performance. Future research should include repeated sampling across rainy and dry seasons, species-specific comparisons between indoor and outdoor environments, and integration of entomological data with rainfall,

flooding, and human dengue case data. Such an approach may provide a stronger basis for future surveillance and preparedness-oriented dengue control in Samarinda.

Conclusion

This study identified the coexistence of two dengue vector species, *Aedes aegypti* and *Aedes albopictus*, in Lempake Subdistrict, Samarinda, with a slight predominance of *Aedes aegypti*. Larvae were detected in both indoor and outdoor ovitraps, indicating that potential breeding habitats were present within houses and in the surrounding residential environment. The ecological and behavioral differences between the two species highlight the need for integrated vector-control strategies targeting both domestic and peri-domestic breeding sites. Continuous entomological surveillance may provide useful information for dengue preparedness in disaster-prone urban areas. At the local level, routine ovitrap surveillance conducted by Puskesmas in collaboration with community health volunteers could be used to identify RTs with consistently high vector activity and help prioritize source-reduction, environmental management, and health-promotion activities before the rainy season.

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