Habitat characteristic and density of larva *Aedes albopictus* in Curug, Tangerang District, Banten Province, Indonesia 2018

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Abstract. Yuliani DM, Hadi UK, Soviana S, Retnani EB. 2021. Habitat characteristic and density of larva *Aedes albopictus* in Curug, Tangerang District, Banten Province, Indonesia 2018. *Biodiversitas* 22: 5350-5357. *Aedes albopictus*, an aggressive, strong, anthropophilic, exophilic, and exophagic mosquito, was an important vector of dengue fever, chikungunya and yellow fever; it became public health problem all over the world. Larvae of *Ae. albopictus* live in water-filled various types of containers. The study aimed to measure habitat characteristics and the density of larvae of *Ae. albopictus* in Curug Subdistrict, Tangerang District. This research was conducted in seven endemic villages of Curug Subdistrict, from January to July 2018. Mosquito larvae were collected in 100 houses in every village, the total samples were 700 houses, and observed all outdoor water containers. In this study, 2990 containers consisted of 1545 (51.67%) controllable containers and 1445 (48.33%) disposable containers. Containers positive for *Ae. albopictus* were 1320 containers from 597 (45.23%) controllable containers and 723 (54.77%) disposable containers. The larval density indices were 44.96% (Container Index, CI) and 188.57% (Breteau Index, BI). The analysis Maya index in seven villages in Curug Subdistrict showed that 72.57% belonged to the moderate category, so that the area had the potential as breeding sites of *Ae. albopictus*. Habitat characteristics of *Ae. albopictus* in Curug Subdistrict was mostly in disposable containers outside the house.

Keywords: *Aedes albopictus*, containers, larvae, habitat, outdoor

INTRODUCTION

Aedes albopictus (Skuse), an aggressive, strong, anthropophilic, exophagic, and exophilic mosquito, was an important vector of dengue fever, chikungunya disease, and yellow fever and became public health problem all over the world (Schuffenecker et al. 2006). These species live in the tropical and temperate region in Southeast Asia, the Western of Pacific Islands, the Indian subcontinent and spread to all continents except Antarctica (Caminade et al. 2012).

Aedes albopictus was difficult to find and control because it has a small size, diverse habitat types, including small containers and used tires (Rochlin et al. 2013). This species lives on the edge of the forest and breeds in natural habitats, such as tree holes, bamboo stumps and tropical plants and is known as a vector in rural areas (Higa 2011). *Ae. albopictus* adapts well to urban environments, where its larvae live in artificial containers, such as used tires, jars, or water storage containers, and became an important main vector in urban areas (Bagny et al. 2009).

Just like any other vector, *Ae. albopictus* required water as a habitat to breed, although it was very sensitive to environmental changes (Bagny et al. 2009). The water volume in the container and the length of time the container filled with water were important implications for larval survival (Westby and Juliano 2017). Natural or artificial

containers exist in the environment, with fluctuating temperatures, water volumes, nutrients and other factors (Sunahara and Mogi 2002). These factors influence the selection of the oviposition site, resistance and strength of the offspring. Research conducted by Sunahara et al. (2002) showed that the differentiation of mosquito habitat containers is based on the type of container. Larvae of *Ae. albopictus* is commonly found in natural containers or artificial containers outside the house with large amounts of organic waste (Rattanarithikul and Panthusiri 1994).

Efforts to interfere with breeding sites were an important strategy to reduce the population of *Aedes* spp. The existence of environmental changes such as temperature, climate change, and rainfall affect habitat effectiveness, development time and resistance of larvae and adults. These factors determine the effectiveness of disease transmission (Afrane et al. 2007).

Entomological surveillance could be one of the vector control methods to determine changes in the abundance and distribution of vector-borne disease by monitoring container habitats in suburban and urban areas (Rozilawati et al. 2015). There were entomological indicators to measure the density of *Aedes* spp. larvae, such as Container Index (CI), House Index (HI), Breteau Index (BI). These indices are very effective in monitoring potential dengue areas where cases of Dengue Hemorrhagic Fever (DHF) often occur so that they could be prevented the emergence

of dengue new cases (WHO-SEARO 2004). If the density of mosquito larvae was high, the risk of being infected with the dengue virus became high. Maya index (MI) is used to determine the risk level of disease transmission. MI identifies whether the area was a high, moderate, or low risk as a breeding place for larvae based on environmental hygiene (hygiene risk index, HRI) and breeding risk index (BRI), and the availability of area that might be potential as mosquito breeding places (Miller et al. 1992).

Curug Subdistrict in Tangerang District had seven villages. Entomological and environmental data which identifies the risk transmission of Chikungunya and DHF were not available in Curug Subdistrict. The study aimed to measure habitat characteristics and the density of larvae *Ae. albopictus* to fulfill entomological and environmental data in Curug Subdistrict, Tangerang District, Banten Province, Indonesia.

MATERIALS AND METHODS

Study area

This research was conducted in Curug Subdistrict, Tangerang District, Banten Province, Indonesia which consists of 7 villages namely Binong Village, Sukabakti Village, Kadu Village, Kadu Jaya Village, Cukanggalih Village, Curug Kulon Village and Curug Wetan Village (Figure 1). The study was conducted in two seasons, the rainy season (January to March 2018) and the dry season (May to July 2018).

Procedures

Mosquito larvae were collected from 100 houses with the verbal consent of the household in every village, total sample was 700 houses, and observed all outdoor water

containers, such as buckets, drums, cans and used tires, leaf petals and others. The larvae found in each container were taken and put into plastic containers, labeled at each location, and identified in the laboratory.

Data analysis

Data of habitat characteristics consist of the type and number of positive containers for larvae. Maya index (MI) is used to estimate high-risk areas for larval breeding. Hygiene risk index (HRI) and breeding risk index (BRI) were indicators for MI. The two indicators were categorized into high, medium, and low, which formed by 3 x 3 table (Table 1). The containers observed in this study were categorized into controllable containers and disposable containers. Controllable containers (CC) could be controlled by draining and closing the container so that vectors cannot breed, such as buckets, flowerpots, gutters, water well, drums, and food animal container. A disposable container (DC) could not be controlled by humans, usually located outside the house and cannot be used for household purposes, but when filled with water, it could become a breeding place for vectors such as bamboo stumps and fish ponds (Miller et al. 1992).

$$BRI = \frac{\text{Total of controllable containers (CC)}}{\text{Average of CC Larval positive}}$$

$$HRI = \frac{\text{Total of disposable containers (DC)}}{\text{Average of DC Larvae positive}}$$

$$CI = \frac{\text{Total positive larval containers}}{\text{Total containers observed}} \times 100\%$$

$$BI = \frac{\text{Total positive larval containers}}{\text{Total houses observed}} \times 100\%$$

Figure 1. Map of Curug Subdistrict, Tangerang District, Banten Province, Indonesia

Table 1. 3x3 Matrix for calculation of Maya Index

HRI	BRI			
	1 (low)		2 (moderate)	3 (high)
	1 (low)	BRI1/HRI1 (low)	BRI2/HRI1 (low)	BRI3/HRI1 (moderate)
	2 (moderate)	BRI1/HRI2 (low)	BRI2/HRI2 (moderate)	BRI3/HRI2 (high)
	3 (high)	BRI1/HRI3 (moderate)	BRI2/HRI3 (high)	BRI3/HRI3 (high)

Note: Larval density of *Ae. albopictus* was measured using the Container Index (Kemenkes RI 2011).

RESULTS AND DISCUSSION

The type of containers

The types of containers found as breeding places for mosquitoes from January to July 2018 in 700 houses located in seven villages are presented in Table 2. The number of containers in this study was 2990 containers consisting of 1545 (51.67%) controllable containers and 1445 (48.33%) disposable containers. Total 1320 (44.15%) containers were positive for *Ae. Albopictus*; 597 (45.23%) controllable containers and 723 (54.77%) disposable containers.

Controllable containers found outside the houses in this study were flower pots (22.33%), buckets (22.14%), gutters (20.84%), animal food containers (15.01%), plastic drums (10.1%), and water wells (9.58%). The disposable containers in this research were used cans (19.24%), used bottles (16.75%), used buckets (15.57%), fish ponds (14.05%), bamboo stumps (12.52%), used tires (12.46%), and used drums (9.41%).

Container base material

The basic materials for containers outside the house in this research were cement, plastic, ceramics, metal, glasses, rubber, and natural materials. Container base material of larva *Ae. albopictus* positive controllable containers were

plastic (78.4%) and cement (21.6%) and disposable containers were cement (4.56%), ceramics (3.87%), plastic (17.01%), metal (32.65%), glasses (18.81%), rubber (13.28%) and natural (9.82%). The container base material data is presented in Figure 2.

Container color

The basic colors based on the type of containers were dark and bright. Containers with colors of black, blue, brown and red were included in dark colors, otherwise they were classified as bright colors. The results of this study showed that controllable containers with larva *Ae. albopictus* positive were dark (66.5%) and bright (33.5%) and disposable containers were dark (66.94%) and bright (33.06%), presented in Figure 3.

Container cover

The results showed that the containers larva *Ae. albopictus* positive, which covered was 17.76% controllable and 19.36% disposable containers. The larva *Ae. albopictus* positive containers which not covered were 82.24% controllable and 80.64% disposable containers, presented in Figure 4. The cover on the containers played an important role during oviposition, containers with covers make it difficult for mosquitoes to oviposition compared to containers without covers.

Table 2. Types and total of controllable containers and disposable containers with *Ae. albopictus* larvae found in 7 Villages in Curug Subdistrict, Tangerang District, Banten, Indonesia January to July 2018

Type of containers	Total containers	Containers (%)	Larva <i>Ae. albopictus</i> positive containers	Larva <i>Ae. albopictus</i> positive based on type of container CC/DC (%)	Larva <i>Ae. albopictus</i> positive based on total CC/DC (%)
Controllable containers (CC)		51.67			45.23
Buckets	342	22.14	182	53.22	30.49
Flower Pots	345	22.33	130	37.68	21.78
Gutter	322	20.84	105	32.61	17.59
Plastic Drums	156	10.1	60	38.46	10.05
Water Wells	148	9.58	58	39.19	9.71
Food Animal Containers	232	15.01	62	26.72	10.38
Total CC	1545		597		
Disposable containers (DC)		48.33			54.77
Used Cans	278	19.24	161	57.91	22.27
Used Bottles	242	16.75	136	56.2	18.81
Used Tires	180	12.46	96	53.33	13.28
Used Buckets	225	15.57	123	54.67	17.01
Fish Ponds	203	14.05	61	30.05	8.44
Used Drums	136	9.41	75	55.15	10.37
Bamboo Stumps	181	12.52	71	39.23	9.82
Total DC	1445		723		
Total	2990		1320		44.15

Figure 2. *Ae. albopictus* larvae were found in controllable (A) and disposable (B) containers in 7 villages in Curug Subdistrict, Tangerang District, Banten, Indonesia from January to July 2018, according to container base material

Figure 3. Larvae of *Ae. albopictus* found in controllable (A) and disposable (B) containers in 7 Villages in Curug Subdistrict, Tangerang District, Banten, Indonesia from January to July 2018, according to container color

Figure 4. *Ae. albopictus* larvae were found in controllable (A) and disposable (B) containers in 7 Villages in Curug Subdistrict, Tangerang District, Banten, Indonesia from January to July 2018, according to the presence of container covers

Figure 5. Density of larvae of *Ae. albopictus* in 7 villages in Curug Subdistrict, Tangerang District, Banten, Indonesia from January to July 2018. A. Container index, B. Breteau index

Density of larva *Ae. albopictus*

Larva density of *Ae. albopictus* in 7 villages from January to July 2018 presented in Figure 5. The average larval density in 7 villages was CI 44.96% and BI 188.57%.

Maya index

The Maya Index (MI) was calculated based on environmental hygiene (HRI) and places that potential as mosquito breeding habitats (BRI). Environmental sanitation analysis showed that BRI in 7 villages were in the medium category (84.71%) and high category (15.29%). The HRI was medium category (85.86%) and high category (14.14%). Maya index from 700 houses in Curug subdistrict, 72.57% in the medium category and

27.43% in the high category had a risk for *Aedes* spp to breed (Tables 3 and 4).

Discussion

Curug Subdistrict is a rural area with lots of vegetation outside the house, which could be suitable breeding places for *Aedes* mosquitoes. The containers were outside the house and neglected from people's observation.

Mukhtar et al. (2018) reported that fast urbanization, limited water and poor waste disposal around the house increased the breeding habitat of *Aedes* mosquitoes. Lack of knowledge about the *Aedes* mosquito, its life cycle and breeding habitat contributes to an increased positive container. Li et al. (2014) reported the density of larval *Ae. albopictus* increased because of urbanization.

Table 3. Category of HRI, BRI and Maya Index in 7 Villages in Curug Subdistrict, Tangerang District, Banten, Indonesia

Villages	Σ Houses	Σ Containers	CC	DC	BRI (%)			HRI (%)			MI (%)		
					L	M	H	L	M	H	L	M	H
Binong	100	415	208	207	0	83	17	0	92	8	0	75	25
Curug Kulon	100	476	251	225	0	84	16	0	85	15	0	70	30
Curug Wetan	100	540	296	244	0	82	18	0	82	18	0	69	31
Sukabakti	100	496	255	241	0	87	13	0	81	19	0	73	27
Cukanggalih	100	369	193	176	0	83	17	0	91	9	0	76	24
Kadu	100	339	175	164	0	85	15	0	91	9	0	77	23
Kadu Jaya	100	355	167	188	0	89	11	0	79	21	0	68	32
Total	700	2990	1545	1445	0	593	107	0	601	99	0	508	192

Note: CC: controllable container, DC: disposable container, BRI: breeding risk index, HRI: hygiene risk index, MI: maya index

Table 4. Recapitulation Category of BRI, HRI and MI from 7 Villages in Curug Subdistrict, Tangerang District, Banten, Indonesia

Category	BRI		HRI		MI	
	Σ Houses	% Houses	Σ Houses	% Houses	Σ Houses	% Houses
Low	0	0	0	0	0	0
Moderate	593	84.71	601	85.86	508	72.57
High	107	15.29	99	14.14	192	27.43
Total Houses	700	100	700	100	700	100

Note: BRI: breeding risk index, HRI: hygiene risk index, MI: maya index

Chareonviriyaphap et al. (2003) reported that in Thailand during the dry season, *Aedes* mosquitoes prefer to breed in artificial containers, such as used bottles and used cans, while in the rainy season, coconut leaves and other plants were became breeding places for this mosquito. Larvae of *Ae. albopictus* was significantly outdoors than indoors. Research in Southern Thailand reported that discarded containers showed the highest specific container index, followed by plant pots, plant saucers, tires, and plastic buckets. These containers as breeding places for mosquitoes and increase the risk of adult emergence of mosquitoes (Thammapalo et al. 2021). Adeleke et al. (2010) reported that the larva growth of *Ae. aegypti* and *Ae. albopictus* were determined by the availability of water, water reservoirs (containers) and the envmetalment (rainfall and climate).

Yenus et al. (2021) reported that more positive containers as breeding places for mosquitoes outside the house than inside the house, although the number of containers inside the house was more than outside the house, but larvae positive containers were more commonly found outside the house in the rainy season. Research conducted in Kenya found >98% of positive containers outside the house (Ngugi et al. 2017). *Aedes* mosquitoes prefer laying eggs in containers outside the house because of the many nutrients needed for larval growth and the increased abundance of pupae (Focks and Alexander 2006). In the dry season, the *Aedes* mosquito breeds only in containers inside the house, but after rains, the breeding habitat spreads to containers outside the house in used tires, used cans (WHO 2011).

This study was to observe containers that had the potential as breeding places for mosquitoes outside the house. The controllable containers in this study were buckets, flowerpots, gutters, plastic drums, water wells, and animal food containers. Controllable containers with the highest positive larvae *Ae. albopictus* were in buckets outside the house (30.94%) and the lowest positive larvae were in water wells (9.71%). People in Curug Subdistrict collected water from the rain using buckets placed outside the house and could be breeding places for *Aedes* mosquitoes. The highest larval *Ae. albopictus* positive from disposable containers was in used cans (22.27%) and the lowest in fish ponds (8.44%). People of Curug Subdistrict neglected envmetalmental sanitation, so there was a lot of household waste, such as used cans, which could be breeding places for mosquitoes outside the house.

Research conducted in India, *Ae. albopictus* was found in used tires in urban areas (Meena et al. 2019). The used tires were filled with water and could not be absorbed, larva could grow without interference and become productive breeding containers (Snr et al. 2011). Djiappi-Tchamen et al. (2021) reported a high prevalence of *Ae. albopictus* was found in used tires, empty cans and containers. Used tires had been reported as the main larval habitat and the most productive for *Ae. albopictus* (Kamgang et al. 2017). Low temperatures, humidity, and lack of light in tires were suitable places for a mosquito to breed (Arunachalam et al. 2012).

Vezzani and Carbajo (2008) reported that larvae of *Ae. albopictus* were found in shaded flower pots in gardens and aquariums in San Antonio National Park. Another study found that the larvae of *Ae. albopictus* on jars, used cans, cans, baskets, plastic bottles, used tires, used pipes, and plastic toys. The abundance of *Ae. albopictus* was lower than *Ae. aegypti*, although taken from the same container (Schweigmann et al. 2004). Westby et al. (2020) reported that there were no *Ae. albopictus* is found in tree hole surveys, but it's found in artificial containers of multiple sizes.

Entomological surveillance conducted in 2016 in Sao Paulo, Brazil, reported that stagnant rainwater could be a breeding place for *Ae. aegypti* (Bermudi et al. 2017). Research conducted in India found that household waste containers were an important contribution to the increased density of *Aedes* spp (Banerjee et al. 2013).

The basic materials of containers positive larva *Ae. albopictus* in this study, mostly made of plastic for controlled containers (78.4%) and metal (32.65%) for disposable containers. The dark color in the disposable container (66.94%) was dominant than the bright color (33.06%). The cover on the container played an important role in mosquito breeding. Research conducted in Curug Subdistrict, Tangerang District, showed that disposable containers without cover were the most common for breeding *Ae. albopictus* (80.64%).

Ajeng et al. (2019) reported that in Yogyakarta, mosquitoes like to breed in cement-based containers because the surface tends to be rough, making it easier for mosquitoes to lay eggs. Research conducted in Denpasar, Jakarta and Yogyakarta reported that the characteristics of certain types of containers such as material, color, texture, and properties of closed or open containers were very suitable for breeding *Aedes* larvae (Purnama and Baskoro 2012). Dom et al. (2016) reported that reclaimable containers had more production than rubber containers as mosquitoes breeding places.

Distribution and epidemic risk of arbovirus disease (dengue fever, yellow fever, chikungunya and others) could be estimated by measured larval indicators (CI, BI and HI). These indicators estimate the presence, distribution and density of the *Aedes* population in the area (CDC 2016).

The Breteau index is the number of larval-positive containers per 100 houses inspected and the best index for estimating vector density (Novita et al. 2017). BI values >30-50% were declared high risk for DHF transmission and BI values 5-20% were declared low risk (WHO 2003). The container index described the number of containers that were positive for larvae from the number of containers inspected. CI value >5% had high risk, while CI <5% had a low risk for DHF transmission (WHO 2003).

Measurement of larval density of *Ae. albopictus* in this study obtained CI 44.96% and BI 188.57%. The BI and CI in the study conducted in 7 villages in Curug Subdistrict, Tangerang District, had a high risk of Chikungunya and DHF transmission (BI > 30-50% and CI > 5%).

High HI, BI and CI indicated a high infestation of *Aedes* larvae in the envmetalment. Appropriate and rapid

control strategies must be implemented to prevent or reduce the risk of an outbreak (Chareonviriyaphap et al. 2003). McClure et al. (2018) reported that abundance of *Ae. albopictus* was correlated with the volumetric density of available larval habitat.

The Maya index analyzed aspects of potential mosquito breeding places and environmental sanitation. The high category on the maya index indicated that the house had high potential as a breeding place for mosquitoes with a high number of CC (Controllable Containers) and DC (Disposable Containers). The number of CC and DC houses was directly proportional to BRI and HRI (Miller et al. 1992).

The Maya Index analysis was carried out to the identified potential area as a breeding place for *Aedes* spp. This study found 1545 (51.67%) controllable containers (CC) and 1445 (48.33%) disposable containers (DC), so that the BRI and HRI were high. High BRI and HRI indicated higher potential as breeding places for mosquitoes because of the bad sanitation of outdoor environment. People of Curug Subdistrict only focused on sanitation inside the house, while the sanitation of the environment outside the house had not received attention. Research conducted in Curug Subdistrict, Tangerang District, obtained medium category 72.57%, meaning that the area had a high risk of Chikungunya or DHF transmission.

Research conducted by Dhewantara et al. (2015) in Banjar City found that 97% of households were in the moderate category due to many potential positive containers for *Aedes* spp susceptible to dengue transmission. Pramestuti and Alamsyah (2014) reported that Kutabanjarnegara in Banjarnegara was a moderate risk area based on the analysis of the Maya index in 2014.

Research conducted by Purnama and Baskoro (2012) in Denpasar City by comparing the results of Maya index in 75 houses of DHF patients with 75 houses controls. The study showed that the houses of DHF patients in Denpasar had risk with breeding places for *Aedes* mosquitoes.

Habitat characteristics of *Ae. albopictus* in 7 villages in Curug Subdistrict, Tangerang District, were disposable containers with a metal base material, dark in color and without cover, and had a high risk of transmission of Chikungunya and DHF. The results of the measurement of larval density in 7 villages were 44.96% (Container Index, CI) and 188.57% (Breteau Index, BI). Observations on 700 houses in Curug subdistrict obtained 85.86% of moderate category HRI, 84.71% of moderate category BRI, and analysis of maya index with moderate category of 72.57% so that the area had potential as a breeding place for mosquitoes, as a vector of Dengue and Chikungunya.

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