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Diversity and Abundance of Outdoor Mosquitoes and Their Relationship to Rainfall Index in Binong Village, Tangerang District

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ABSTRACT

Mosquitoes are distributed worldwide in tropical and temperate regions. The abundance of mosquitoes, provides a significant level of risk in transmitting pathogens and nuisance to humans. The aims of this study were (1) to measure the abundance and dominance of outdoor mosquitoes during daytime and (2) analyse the correlation of mosquito density and rainfall index. This research was conducted in Binong village for six months, since January to June 2018. Human Landing Collection (HLC) method was used from 6:00 AM to 06:00 PM outside the house, by five collectors, once in every two weeks. The results of the study showed there were four species of outdoor mosquitoes during the day such as *Aedes albopictus* which has the highest abundance, followed by *Armigeres subalbatus*, *Aedes aegypti* and *Culex quinquefasciatus*. The highest abundance of *Ae. albopictus* occurred in May (80.53%), *Ar. subalbatus* in January (21.28%), *Ae. aegypti* in June (16.30%) and *Cx quinquefasciatus* in March (2.65%). The correlations between rainfall index and density of *Ae. albopictus* ($r = 0.195$ and $p = 0.712$), *Ar. subalbatus* ($r = 0.025$ and $p = 0.963$), and *Ae. aegypti* ($r = 0.181$ and $p = 0.731$) were not significant. Only *Cx. quinquefasciatus* showed a significant correlation with rainfall index ($r = 0.894$ and $p = 0.016$). *Cx. quinquefasciatus* was found at several sites because of the existence of ditches which served as breeding place of *Cx. quinquefasciatus*. The ditches were also easily stagnated when it rains. Meanwhile, the breeding place of *Ae. albopictus* and *Ae. aegypti* were hidden and the eggs were dry resistant.

***Keywords**: Aedes albopictus, rainfall index, density of mosquito, outdoors*

1. INTRODUCTION

Mosquitoes are distributed worldwide in both tropical and temperate regions [1]. The abundance of mosquitoes in nature, provides a significant level of risk in the transmission of pathogens and nuisance to humans and increasing human morbidity and mortality to a disease epidemic [2]. Mosquitoes are vectors of several pathogens that cause disease in humans, namely malaria, dengue fever, Japanese encephalitis, and chikungunya [3].

Mosquitoes are small, smooth, slender insects, their legs are long and slim, and have mouth parts that can pierce skin and suck blood. Mosquitoes are widespread throughout the world, ranging from the polar regions to the tropics, and can be found at an altitude of 5000 meters above sea level to a depth of 1500 meters below ground level in mining areas [4].

Aedes sp. and *Culex sp.* are very invasive, quick to adapt to artificial environment, and found throughout the world due to human activities [5]. Mosquitoes have the ability to live in urban areas because of (1) availability of places for female mosquitoes to lay their eggs and breed, (2) availability of hosts to suck blood. Changes in the environment can affect mosquito populations. Mechanisms that can influence population dynamics are (1) exogenous, namely rainfall and temperature, and (2) endogenous, namely large mosquito populations [6]. Rainfall and temperature are climate variables that play major roles in the dynamics of urban mosquito populations. Artificial environments can expand the habitat of certain species of mosquitoes, increase their abundance and reduce the diversity of mosquito species which greatly influences the vector ecology and epidemiology of infectious diseases [7]. *Ae. albopictus*, also known as Asian tiger mosquito, is an invasive mosquito that can be found in the tropics and

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temperate regions. The spread of mosquitoes in the last three decades is caused by human activities [8]. In the middle of 1980 to 2000, *Ae. albopictus* was a species that spreads very fast and invasive throughout the world [9]. The development of urban industries in Asia caused *Ae. albopictus* to replace the role of *Ae. aegypti* as a disease vector because it predominantly sucks blood during the day. These mosquitoes are more adaptable in urban environments [10].

Binong Village is one of the dengue endemic villages in Tangerang District, and there was a Chikungunya Outbreak in August 2014. This research was conducted to (1) measure the abundance and dominance of outdoor mosquitoes during daytime and (2) analysed the relationship between mosquito density and rainfall index. The results of this study are expected to develop more effective control models in preventing the spread of vector-borne diseases.

1.1. Materials and Methods

This research was conducted in 1440 houses in Binong Village, Tangerang District, Indonesia (Figure 1). The study was done in two seasons, the rainy season (January to March 2018) and the dry season (April to June 2018). Adult mosquito collection was carried out every 2 weeks from 06.00 AM to 06.00 PM with Human Landing Collection (HLC) method outside the house. Mosquito collection were carried out by five persons, sitting with their pants rolled to their knees and waiting for 20 minutes for mosquitoes to arrive.

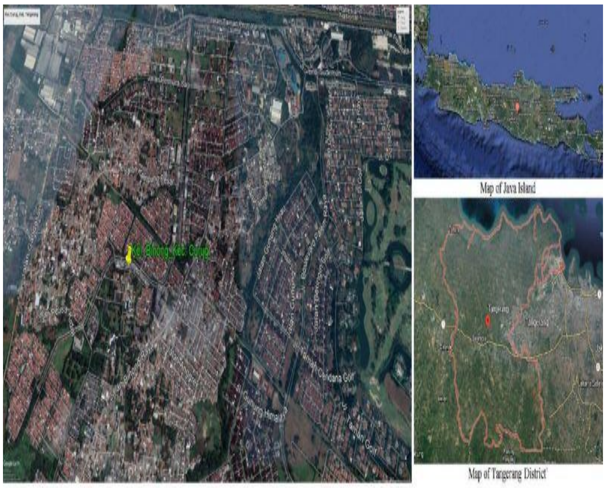

Figure 1 Map of Binong Village, Tangerang District

The mosquitoes that landed on human legs were immediately captured with an aspirator and placed into paper cups and then stored inside a cool box to be transported to the laboratory and identified using a mosquito identification key [11].

Weather data were obtained from the Meteorological, Climatological and Geophysical Agency in Tangerang. The monthly rainfall index value was calculated by multiplying the amount of rainfall per month by the rainy day per month, then divided by the number of days in the month. Data were analysed using Pearson's correlation.

1.2. Our Contribution

This paper presents the diversity of mosquitoes outside the house during the daytime in Binong Village, Tangerang. Tangerang District does not have diversity and abundance data of mosquito species, although most of the area could serve as the breeding places of mosquitoes. Diversity and abundance of mosquitoes outside the house during the daytime can provide information of vector borne disease possibility in Tangerang District. The correlation between mosquito density outside the house during daytime and rainfall index in Binong Village could be useful for the prevention and control programme of vector borne diseases in Binong Village, Tangerang.

1.3. Paper Structure

The rest of the paper is organized as follows. Section 2 introduces the diversity and dominance of mosquitoes outside the house during daytime in Binong village, Tangerang using HLC method every two weeks for six months. Section 3 presents the relationship between density of mosquitoes outside the house during daytime and rainfall index in Binong Village January until June 2018. Finally, section 4 concludes the paper and presents suggestion for future research.

2. RESULTS AND DISCUSSION

The results of mosquito collection outside the house during the daytime were presented in Table 1 and Figure 2. Four species of mosquitoes were collected in Binong Village, namely *Ae. albopictus* which has the highest abundance, followed by *Ar. subalbatus*, *Ae. aegypti*, and *Cx. quinquefasciatus*. Figure 2 showed that the highest abundance of *Ae. albopictus* occurred in May (80.53%), *Ar. subalbatus* in January (21.28%), *Ae. aegypti* in June (16.30%), and *Cx quinquefasciatus* in March (2.65%).

Table 1 Diversity and Abundance of Outdoor Mosquitoes during the Daytime using the HLC method in January-June 2018 in Binong Village, Tangerang District

Species	Month	January	February	March	April	May	June	Total Average ±Sd
Ae. albopictus	Abundance (%)	76.29	75.62	77.88	78.87	80.53	79.77	78.16±1.94
	Frequency	1.00	1.00	1.00	1.00	1.00	1.00	1.00±0.00
	Dominance	76.29	75.62	77.88	78.87	80.53	79.77	78.16±1.94
Ar. subalbatus	Abundance (%)	21.28	17.81	5.31	7.04	5.79	3.93	10.19±7.39
	Frequency	0.94	0.75	0.23	0.29	0.23	0.14	0.43±0.33
	Dominance	20.00	13.36	1.22	2.04	1.33	0.55	6.42±8.24
Ae. aegypti	Abundance (%)	2.43	5.62	14.16	12.21	13.16	16.30	10.65±5.40
	Frequency	0.17	0.31	0.54	0.48	0.48	0.54	0.42±0.15
	Dominance	0.41	1.74	7.65	5.86	6.32	8.80	5.13±3.33
Cx. quinquefasciatus	Abundance (%)	0.00	0.94	2.65	1.88	0.53	0.00	1.00±1.07
	Frequency	0.00	0.06	0.12	0.08	0.02	0.00	0.05±0.05
	Dominance	0.00	0.06	0.31	0.15	0.01	0.00	0.09±0.12
Total Average±SD	Abundance (%)	25.00±35.49	25.00±34.49	25.00±35.60	25.00±36.16	25.00±37.38	25.00±37.17	
	Frequency	0.53±0.52	0.53±0.42	0.47±0.39	0.46±0.39	0.43±0.42	0.42±0.45	
	Dominance	24.18±35.98	22.70±35.78	21.77±37.55	21.73±38.17	22.05±39.08	22.28±38.54	

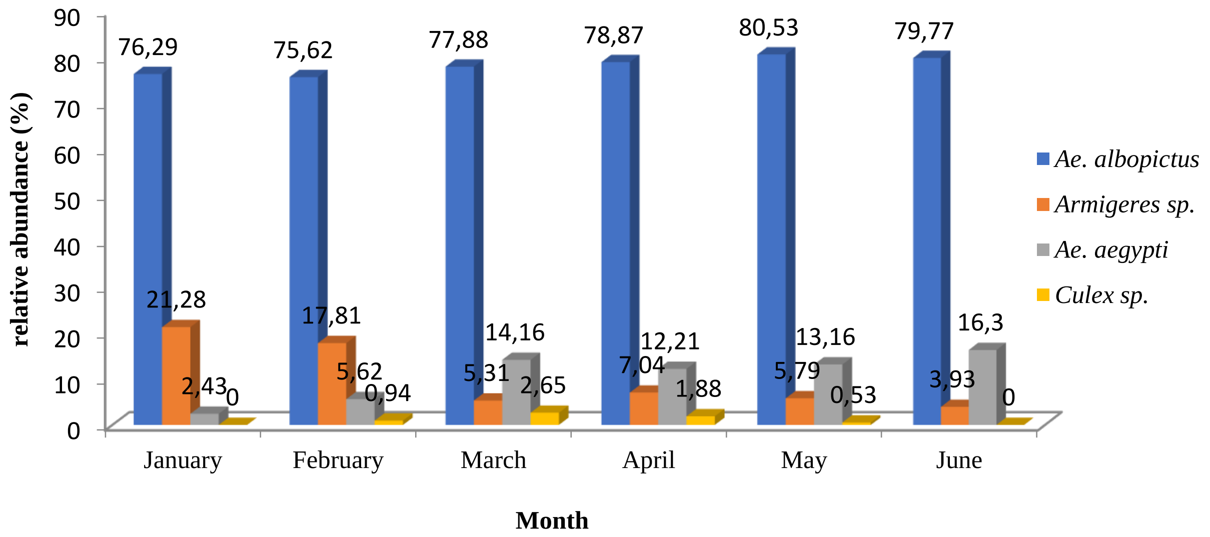

Figure 2 The abundance of outdoor mosquitoes during daytime using the HLC method January-June 2018 in Binong Village, Tangerang District

Diversity of mosquitoes which had been collected during daytime in Binong Village for six months, includes *Ae. albopictus* which had the highest abundance, followed by *Ar. subalbatus*, *Ae. aegypti*, and *Cx. quinquefasciatus*. The mosquito with the highest abundance and dominance was *Ae. albopictus* in May, while the mosquito that has the lowest abundance was *Cx. quinquefasciatus* in March. Observed behaviour of *Ae. albopictus* includes sucking blood outside the house (exophagic) and resting outside the house (exophilic). Delatte *et al.* [12] reported that *Ae. albopictus* was exophagic and exophilic in La Reunion (France).

The existence of plants outside the house can be used as a resting place of *Ae. albopictus*. Increasing number of *Ae. albopictus* population might not be separated from the number of mosquito breeding places. Containers found outside the house such as flower pots, jars, drums, and other used items can collect rainwater for *Ae. albopictus* to breed, and the population of mosquitoes will increase in the area. Fontenille and Toto [13] had collected adult mosquitoes in the cities of Douala and Yaounde in South Cameroon and *Ae. albopictus* was the most commonly found species or 35% of the total number of mosquitoes, followed by *Ae. aegypti*, *An. gambiae, Cx. quinquefasciatus, Cx antennatus, Cx. perfuscus, Mansonia uniformis*, and *Mn. africana*. The collection carried out in Younde City obtained more *Ae. albopictus* than in the city of Douala, this was due to higher number of used tires outside the house that could serve as *Ae. albopictus* breeding places. Sawabe *et al.* [14] reported that in 2003-2006 in Japan, out of all mosquitoes found in thirty-seven sampling locations, which were urban and suburban residential areas, 25.5% of them was *Culex pipiens* and 16.9% was *Ae. albopictus*. Delatte *et al.* [12] reported mosquitoes at outdoor location in the urban area of Saint Pierre, La Reunion Island, France, showed *Ae. albopictus* as the most numerous species. This mosquito had a high peak activity at 05.30 PM in the summer and 04.00 PM in the winter. Wilke *et al*. [15] reported in the city parks of Brazil, *Ae albopictus* was a species with high abundance compared to *Cx. quinquefasciatus. Ae fluviatilis*, *Ae. scapularis*, *Cx. nigripalpus*, and *Ae. aegypti*.

Siregar and Makmur [16] conducted a study in two cities, Medan Municipality which had a high DHF incidence rate and Lahat Municipality which had a low DHF incidence rate. *Ae aegypti* was more commonly found in Medan Municipality, whereas *Ae. albopictus* was more commonly found in Lahat Municipality, because there was still many vegetation. Riwu [17] reported that in Bogor Municipality, three genera of mosquitoes were found inside and outside the house, namely *Aedes*, *Culex*, and *Armigeres*. The most dominant mosquito found was *Cx. quinquefasciatus* (49.43%), followed by *Ae. aegypti*, *Ae. albopictus*, *Ar. subalbatus*, and *Cx. tritaeniorhyncus*.

Aedes albopictus displayed opportunistic and zoophilic behaviours. Generally it serves as a weak vector for pathogens in humans such as arbovirus. The density of mosquito population is an important element that contributes to the occurrence of epidemics with limited vector competence. *Ae albopictus* showed a flexible ecology such as the places where larvae develop, blood-sucking behaviour, and adaptation to weather changes that could increase the potential for its spread in new environments which affects its presence among other vectors [18].

The results of correlation analysis between rainfall index and density of *Ae. albopictus, Ar. subalbatus, Ae. aegypti*, and *Cx. quinquefasciatus* are presented in Figure 3. Density of *Ae. albopictus* ($r = 0.195$ and $p = 0.712$), *Ar. subalbatus* ($r = 0.025$ and $p = 0.963$), and *Ae. aegypti* ($r = 0.181$ and $p = 0.731$) showed no significant correlation with rainfall index. Only *Cx. quinquefasciatus* showed a significant correlation with rainfall index ($r = 0.894$ and $p = 0.016$).

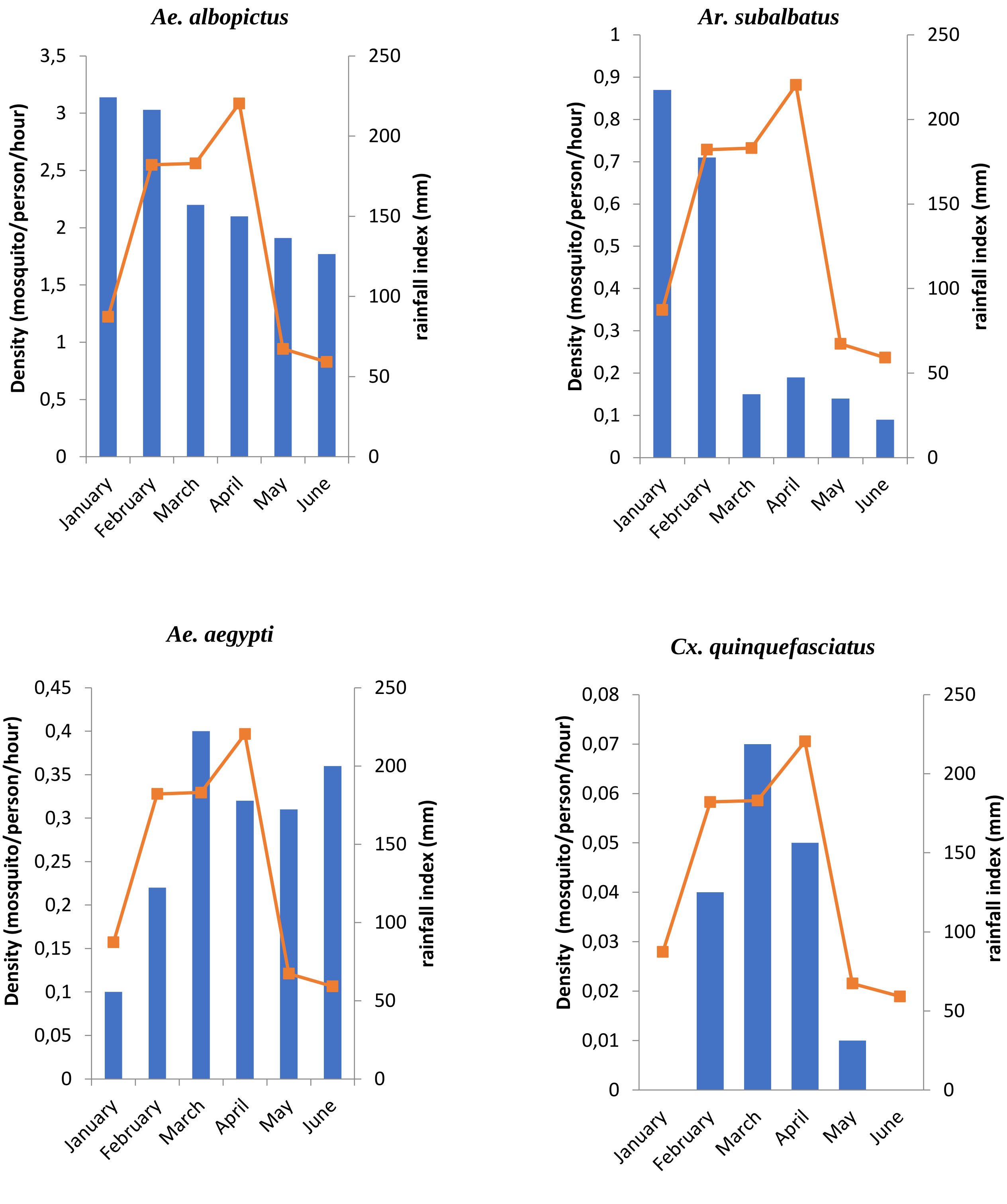

Figure 3 Relationship between mosquito density and rainfall index in January-June 2018 in Binong Village, Tangerang District

Density of *Ae. albopictus, Ar. subalbatus* and *Ae. aegypti* showed no significant correlation (p> 0.05) with rainfall index, due to their hidden breeding places and dry resistant eggs. *Cx. quinquefasciatus* density showed a significant correlation (p <0.05) with rainfall index compared to three other types of mosquitoes, because Binong Village at Tangerang District, which was the location of this study, was an urban residential area, but in some places there were still a lot of vegetation. The ditches outside the house were used as breeding place by *Cx. quinquefasciatus*. The ditches are easily flooded during rain which was one of the factors why *Cx. quinquefasciatus* density had a significant correlation with rainfall index. Correlation between rainfall index and the density of *Ae. albopictus, Ar. subalbatus, Ae. aegyptii*, and *Cx. quinquefasciatus* has also been seen in several other studies.

Wilke *et al.* [15] in Brazil reported that the abundance of *Ae. albopictus* was not influenced by rainfall, but the abundance of *Ae. scapularis* and *Cx. nigripalpus* were affected by rainfall. This was due to variations in climate which provide different resistance for each species. Valdez *et al*. [19] conducted a study using artificial rain method to analyse the effects of rainfall on *Ae. aegypti* populations in Taiwan. The results showed that the population of *Ae. aegypti* during the summer had decreased. In the summer, *Ae. aegypti*'s survival increased, but the eggs became sterile due to prolonged dryness so that the abundance of *Ae. aegypti* was reduced. Poh *et al*. [20] reported in Texas, United States, it was found that weather factors provide significant impact to *Cx. quinquefasciatus*'s abundance.

3. CONCLUSION

Aedes albopictus was the most common mosquito found outside the house during daytime in Binong Village, Tangerang District, followed by *Ar. subalbatus, Ae. aegypti* and *Cx quinquefasciatus*. The density of *Cx. quinquefasciatus* had significant correlation with rainfall index compared to three other types of mosquitoes.

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