

Diversity and distribution bromeliads plants as breeding habitat for mosquito larvae (Diptera: Culicidae) in Bogor, Indonesia

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Abstract. Ikhsan M, Hadi UK, Soviana S. 2020. Diversity and distribution bromeliads plants as breeding habitat for mosquito larvae (Diptera: Culicidae) in Bogor, Indonesia. *Biodiversitas* 21: 3494-3498. Bromeliads leaf structure can hold water and has potential as the breeding ground for mosquitoes. Information regarding the potential of bromeliads as a habitat for mosquito larvae in Indonesia is limited. This study aims to identify the diversity of bromeliads and their potential as breeding habitat for mosquito larvae in West Bogor Sub-district, Bogor City, West Java, Indonesia. Determination of the sample using purposive sampling method. Larvae collections were carried out on bromeliads that were outside the building in December 2019 to Maret 2020. The collection used a 50 ml syringe that was modified using a small pipe. Total bromeliads collected were 117 consisted of *Neoregelia*, *Cryptanthus*, dan *Alcantarea* from 50 observation points. The percentage of mosquito larvae presence from bromeliads was 74.4%. Total larvae collected were 859 larvae consisting of *Aedes albopictus*, *Aedes aegypti*, *Aedes* spp., *Armigeres subalbatus*, and *Culex quinquefasciatus*. The diversity of mosquito larvae found in the bromeliads were low ($H'=0.16$), while the dominant species of mosquito larvae were *Ae. albopictus* (61.55%) and confirmed as the second vector of Dengue Fever in Indonesia. The results of this study indicate that bromeliads have potential as a breeding site for mosquito larvae in West Bogor Sub-district, Bogor City.

Keywords: Bogor, bromeliads, habitat, mosquito larvae

INTRODUCTION

Vector-borne disease is a serious public health concern because of its accelerated spread. The spread of this disease is influenced by human movement (urbanization), human behavior, and ineffective vector control (Gubler 2011; Hemme et al. 2010). Mosquitoes (Diptera: Culicidae) are disease vectors that can be found in various regions or are cosmopolitan. According to Chadee and Martinez (2016), human behavior plays a role in the dynamics of *Ae. aegypti* population in residential areas. Structural changes in the landscape in residential areas have the potential to breed habitat for mosquito larvae as vectors of disease (Quintero et al. 2014). Mosquito larvae require accumulating water to be able to breed such as water reservoirs, bathtubs, jars, flower vases, used items, coconut shells, and gaps in plants that can retain water (phytotelmata) (Hadi and Soviana 2013).

Bromeliads are an ornamental plant that is quite popular today in landscape arrangement of residential areas (Silvestro et al. 2014). Bromeliads belong to the Bromeliaceae family or pineapple plants consisting of 50 genera. Features of bromeliads plants are found in the leaves which have various shades of color (Trubus 2008). However, bromeliads are a plant that is can retain water in the leaves and stems, hence the potential to be a habitat for mosquito larvae (Ladino et al. 2019). According to Docile et al. (2017), bromeliads act as habitats for mosquito vector breeding in densely populated residential areas.

According to Wilke et al. (2018), *Aedes aegypti*, *Wyeomyia mitchellii*, *Wyeomyia vanduzeei*, *Culex quinquefasciatus* and *Culex biscaynensis* are mosquito larvae found in bromeliads in the residential area of Miami-Dade County, Florida. Mosquito larvae collected from 90 bromeliads in the Parque Nacional do Itatiaia (PANTA), Rio de Janeiro, Brazilia consist of 5 genera namely *Anopheles*, *Culex*, *Wyeomyia*, *Runchomyia*, and *Toxorhynchites* (Cardoso et al. 2015). The diversity of mosquito larvae found in bromeliads shows the importance of the bromeliads potential as mosquito larvae habitat. Mosquito larvae infestation in bromeliads can be influenced by the internal conditions of the bromeliads and the surrounding environment (Frank dan Lounibos 2009).

Bogor is a city in Indonesia with high rainfall that supports the potential of bromeliads as a habitat for mosquito larvae breeding. *Aedes*, *Culex*, *Anopheles*, *Armigeres*, and *Mansonia* are important genus of the Culicidae family that act as vectors of disease (Hadi and Koesharto 2006). Mosquitoes are reported as vectors of Dengue Fever (DF) (Liu-Helmersson et al. 2016), Chikungunya (Thiberville et al. 2013), Filariasis (Famakinde 2018), Malaria (Hadi and Koesharto 2006) and Japanese Encephalitis (JE) (Tiwari et al. 2012).

The variety of diseases that can be transmitted so that the presence of mosquitoes causes unrest in the community. Ecological factors such as the characteristics of breeding habitats affect the dynamics and patterns of vector distribution in a region (Dida et al. 2018). The

potential of bromeliads as a natural container in the breeding of mosquito larvae can affect the success of vector control in an area (Wilke et al. 2018). The limited information about the potential of bromeliads as mosquito larvae habitat is the background of this research. This study aims to identify the distribution of bromeliads and their potential as breeding habitat for mosquito larvae as well as diverse of mosquito larvae found in bromeliads in West Bogor Sub-district, Bogor City.

MATERIALS AND METHODS

Research time and study area

The study was conducted in December 2019 to March 2020 in areas outside the building such as residential areas, commercial areas, and public facilities in West Bogor Sub-district, Bogor City, West Java, Indonesia. The study was conducted by observation and sample collection which included observations of bromeliads distribution, collection of mosquito larvae, and measurement of mosquito larvae diversity in the observed bromeliads.

Procedures

Observation of bromeliads distribution

The observation of bromeliads distribution is carried out by observation which includes identification, enumeration of the location, and the presence of mosquito larvae in the bromeliads. Determination of the bromeliads sample using purposive sampling method.

Collection and identification of mosquito larvae

The collection of mosquito larvae was done by using a 50 ml sized syringe modified to take water contained in each bromeliad. The water volume of each bromeliad was recorded and mosquito larvae were put into a collection bottle containing 70% alcohol and labeled (Wilke et al. 2018). The identification of mosquito larvae was carried out at the Parasitology and Health Entomology Laboratory, IPB University. The collected larvae are placed on a glass object using a needle. The observation was done with a stereo microscope with 100x magnification. The identification of mosquito larvae refers to Pedoman Survei Entomologi Demam Berdarah Dengue dan Kunci Identifikasi Nyamuk *Aedes* (Indonesia Ministry of Health Indonesian 2017), Ektoparasit: Pengenalan, Identifikasi, dan Pengendaliannya (Hadi dan Soviana 2013), and Kunci Identifikasi *Culex* Jentik dan Dewasa di Jawa (Depkes 1989).

Data analysis

The distribution and variety of bromeliads are analyzed descriptively and spatially. Measurement of a diversity of mosquito larvae was analyzed descriptively on the Shannon diversity index (H'), relative abundance, frequency, and species dominance (Odum 1993).

Diversity index (Shannon-Weiner)

$$H' = - \sum - P_i \ln P_i. \text{ where } P_i = \frac{n_i}{N}$$

Where:

n_i = the number of individuals per larval species

N = total number of larvae

H' = Shannon-Weiner diversity index

P_i = abundance index

Relative abundance

The relative abundance is the ratio of the number of individual species of mosquito larvae to the total species of larvae collected and expressed as a percent.

$$\text{Relative abundance} = \frac{\text{the number of individual mosquito larvae of certain species}}{\text{Total species of mosquito larvae collected}} \times 100\%$$

Frequency of species

The frequency of caught mosquito larvae is calculated based on the comparison between the number of collections obtained by certain mosquito larvae and the total collection of mosquito larvae.

$$\text{Frequency} = \frac{\text{the number of collections obtained by certain species of mosquito larvae}}{\text{total mosquito larvae collection}} \times 100\%$$

Species dominance

The number of species dominance is calculated based on the results of multiplication between relative abundance and the frequency of caught by the species at one time of capture.

$$\text{Species dominance} = \text{Relative abundance} \times \text{Frequencies captured}$$

RESULTS AND DISCUSSION

Observation of bromeliads distribution

Observation of bromeliads distribution in West Bogor Sub-district, Bogor City, Indonesia is presented in Table 1. Bromeliads were found at 50 observation points spread over residential areas, commercial areas, and public facilities. The highest distribution of the presence of bromeliads is in the residential area of 30 points or 60% of the total observation points. In commercial areas and public facilities, 10 points (20%) each were found. Bromeliads were observed as many as 117 plants from 3 genera namely *Neoregelia*, *Cryptanthus*, and *Alcantarea*. *Neoregelia* is the most common bromeliad genus, followed by *Alcantarea* and *Cryptanthus*.

Bromeliads conditions that were observed generally contained accumulating water in the leaf axis. This can be seen in Table 2, as many as 101 bromeliads have to accumulate water and 16 are dry conditions. Also, of the 101 bromeliads that contained accumulating water, there are 87 of them with mosquito larvae. This shows the high potential of bromeliads as a habitat for mosquito larvae breeding with the percentage value of 74.4% of the total bromeliads observed.

Table 1. Observation of bromeliads distribution in West Bogor Sub-district, Bogor City, Indonesia

Observation point	Total	Genus bromeliads			Total
		<i>Neoregelia</i>	<i>Cryptanthus</i>	<i>Alcantarea</i>	
Public facilities	10	33	0	4	37
Residential area	30	41	2	8	51
Commercial area	10	18	0	11	29
Total	50	92	2	23	117

Table 2. Water conditions and the existence of mosquito larvae in bromeliads

Water condition	Total bromeliads	Larvae	Bromeliads contain water
Present	101	Present	87
		Not Present	14
Not Present	16	Not Present	
Total	117		101

Variety of mosquito larvae types on bromeliads

Species diversity of mosquito larvae on bromeliads in West Bogor Sub-district, Bogor City are presented in Table 3. Total mosquito larvae collected from bromeliads were 859 larvae consisting of 3 genera namely *Aedes*, *Culex*, and *Armigeres*. *Aedes* genus is the highest mosquito larvae collected, namely 92% of the total mosquito larvae. *Aedes albopictus* is the most abundant species, namely 676 larvae with an abundance percentage of 78.7%. Then followed by *Ae. aegypti*, *Cx. quiquefasciatus*, *Aedes* spp, and *Armigeres subalbatus*. *Aedes* spp. are a mosquito larvae from the *Aedes* genus which is still the first instar stage.

The diversity index of mosquito larvae breeding on bromeliads plants 0.16. This shows the diversity of mosquito larvae is relatively low. *Ae. albopictus* is the dominant species found in bromeliads with a dominance value of 61.55%. Abundance and frequency values of *Ae. albopictus* is the highest compared to other species. The same occurrence was also found in the abundance and frequency values of *Ae. albopictus* is the highest compared to other species.

Discussion

Bromeliads that have been identified in Indonesia are more than 200 species (Trubus 2008). *Neoregelia* is a genus of bromeliads that have the highest diversity of species compared to other genera. *Neoregelia* has a characteristic arrangement of dense leaves and forms a bowl like a rose (Santos-Silva et al. 2017). Bromeliads are the most popular ornamental for plant enthusiasts and are found in Indonesia (Trubus 2008). *Cryptanthus* is a genus of bromeliads known as Earth Stars. The uniqueness of *Cryptanthus* is found in the growth of leaves that fall/crawl to the ground so that it is like a shooting star (Versieux et al. 2013). *Alcantarea* is classified as the largest bromeliad

plant found in Indonesia. This plant can reach up to 2 meters in size. The distinctive feature of this species is that there is a red hue on the leaf's back (Trubus 2008).

Bromeliad is an ornamental plant that is very popular in urban landscape structuring and is most commonly found in residential yards (Wilke et al. 2018). The presence of bromeliads in residential areas is a complex problem related to the role of bromeliads as mosquito larvae habitat (Frank and Lounibios 2009). Bromeliads which are found in West Bogor Sub-district, Bogor City generally contain water in the leaf armpits. According to Mocellin et al. (2009), the volume of water in bromeliads correlates with the number of larvae in bromeliads. The presence of water in the bromeliads can be influenced by the location of the plant, the size or species of the bromeliads. Bromeliads which are located in a closed area contain very little water to dry. This is because the potential for exposure to rainwater is unlikely and only depends on watering the plants. Bromeliads are small in size and have very little water content to dry both in open, shaded, or closed areas.

The water conditions in the leaves axils of the *Neoregelia* genus vary according to the location and size of the plant. However, all *Cryptanthus* found in open-sunlit or shaded areas are classified as dry. This is allegedly due to the wide leaf structure, not tightly arranged, and the condition of leaves falling to the ground (Versieux et al. 2013) causing water to not to be held for long on bromeliads leaves. However, all *Alcantarea* observed contained water in the armpit of the leaf. This is because it has a large size, wide leaf structure, and neatly arranged so that it can hold a lot of rainwater. *Alcantarea* can store water up to 45 liters to prevent dryness (Versiuex et al. 2012).

The frequency of the presence of mosquito larvae on bromeliads was observed to be quite high. Mosquito larvae of the *Aedes* genus have the highest frequency compared to other species in bromeliads. *Ar. subalbatus* and *Cx. quiquefasciatus* is the lowest frequency species found in bromeliads. *Ar. subalbatus* is only found in 2 *Neoregelia* plants. *Cx. quiquefasciatus* is also only found in 2 *Alcantarea* plants. The low frequency of the two mosquito larvae indicates the dominance of *Aedes* larvae on bromeliads as larval breeding habitat in West Bogor Sub-district, Bogor City. According to Madzlan et al. (2016), plants with the ability to retain water such as bromeliads can be a breeding habitat for *Aedes* spp larvae.

In this study *Ae. albopictus* is a species that is consistent and has the highest abundance compared to other species. This shows the potential of bromeliad as a potential habitat in *Ae. albopictus* breeding in urban areas. According to Syahribulan et al. (2012), *Ae. albopictus* is the dominant mosquito found outside the home/building (exophilic). The diversity of mosquito larvae in the bromeliads observed was relatively low. According to Odum (1993), the high dominance of species in a population causes the low diversity of species in that population. However, the high frequency of mosquito larvae found in bromeliads needs to be an important concern. This shows the role of bromeliads as mosquito habitat in West Bogor Sub-district, Bogor City.

Table 3. Species of mosquito larvae on bromeliads in West Bogor Sub-district, Bogor City, Indonesia

Species larvae	Total	H'	RA(%)	Frequency	Dominance (%)
<i>Ae. albopictus</i>	676	0.16	78.7	0.78	61.55
<i>Ae. aegypti</i>	77		9.0	0.35	3.11
<i>Cx. quinquefasciatus</i>	57		6.6	0.03	0.20
<i>Aedes</i> spp	37		4.3	0.15	0.64
<i>Ar. subalbatus</i>	12		1.4	0.02	0.03

Note: H': Diversity Index (Shannon-Weiner), RA: Relative abundance

Aedes albopictus is the dominant species found in bromeliads. Similar results were reported by Xue et al. (2018), *Ae. albopictus* is a species that is consistently found in every bromeliad in the area of the yard. Ceretti et al. (2016) also reported *Ae. albopictus* is the most common species found in bromeliads in the city park of Sao Paulo, Brazillia. Different things are reported by Higa (2011), *Ae. albopictus* was previously considered a vector in rural areas because it is predominantly found in rural areas. Larvae *Ae. albopictus* generally breeds in natural habitats such as tree holes, bamboo embankments, and phytotelmata (Dev et al. 2014). The high population of *Ae. albopictus* found in this study is considered to have adapted so that it can multiply in bromeliads in urban areas. According to Li et al (2014), the high population of *Ae. albopictus* in urban areas today due to the availability of larval habitat that is affected by environmental changes and good adaptability.

A mosquito as a vector of the disease has a good adaptation to the environment. The dynamics of the mosquito population is greatly influenced by the presence of mosquito larvae habitat. West Bogor Sub-district, Bogor City is an environment with high rainfall. The presence of bromeliads supports the availability of habitat for mosquito larvae in residential areas. Bromeliads as an ornamental plant have become a concern in the application of mosquito population control as a vector in residential areas. Knowledge of the relationship between mosquito habitat and human behavior can be a reference in the development of vector control in residential areas.

In conclusion, the highest distribution of the presence of bromeliads is in the residential area on West Bogor Sub-district, Bogor City. Bromeliads were observed from 3 genera namely *Neoregelia*, *Cryptanthus*, and *Alcantarea*. Mosquito larvae found in bromeliads include *Ae. albopictus*, *Ae. aegypti*, *Aedes* spp., *Ar. subalbatus*, and *Cx. quinquefasciatus*. *Ae. albopictus* is the dominant mosquito larvae in bromeliads and confirmed as the second vector of Dengue Fever in Indonesia. The species diversity of mosquito larvae in bromeliads is relatively low but has the potential for high mosquito larvae. Bromeliads need to be an important concern as mosquito larvae habitat in the preparation of vector control programs in urban areas, especially in the rainy season.

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