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The Abundance of Mosquito Larval Species (Diptera: Culicidae) and the Physicochemical Characteristics of Their Habitat in Rice Field at Dramaga Sub-District, Bogor Regency

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A B S T R A C T

This study aims to identify the species diversity, density, and distribution and analyze mosquito larvae' habitat's physicochemical characteristics in the Dramaga sub-district, Bogor Regency rice fields. This research used purposive sampling by taking samples from 92 breeding sites in four villages of the Dramaga district. The physicochemical characteristics of larval habitats, including pH, temperature, Total dissolved solids (TDS), and Electrical Conductivity (EC), were measured in the field. Breeding sites are marked using a Garmin Montana 680 GPS for further processing. Larvae were collected and identified until species level. The result showed *Anopheles vagus*, *An. barbirostris*, An. *indefinitus, Culex. vishnui, Cx. fuscocephala, Cx. tritaeniorhynchus, Cx. sitiens, Cx. hutchinsoni* and *Armigeres* sp. were found in the rice fields of the Dramaga district. The highest diversity and density of larvae was found in Cikarawang Village. The highest relative abundance of mosquito larvae was *An. Vagus* and *Cx. vishnui*. The physicochemical characteristics of larval habitats, such as pH, TDS, and EC, did not correlate with the larval abundance. However, the temperature of the larval habitat had a negative correlation between temperature and larval density.

INTRODUCTION

Vector-borne diseases contribute to 17% of the estimated worldwide load of infectious diseases and over 700,000 mortality, and 80% of the world's population is at risk of one or more of them (WHO, 2017). Vector-borne diseases such as Dengue Fever, Filariasis, and Chikungunya are also reported in Bogor Regency, West Java (Dinas et al., 2020). Dramaga sub-district is one of the sub-districts in Bogor Regency, which has a relatively high population density of 110,374 people (BPS et al., 2021). Population density can be a factor in the spread of vector-borne disease transmission.

Dramaga sub-district has a relatively large area of rice fields. One of the crucial breeding habitats for mosquitoes in their life cycle is the waters for laying eggs and continuing their aquatic life stages (larvae and pupae). Rice fields are exploited as breeding sites by mosquito species linked with transmitting diseases affecting human and domestic animals (Pramanik et al., 2006). Larvae and pupae of *Anopheles* and *Culex* mosquitoes can be found in rice fields. *Culex* is a vector for Japanese Encephalitis. According to Liu *et al.* (2010), extensive paddy fields are an important ecological factor of Japanese encephalitis in most endemic Asian countries.

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The knowledge of the ecological features of the breeding habitats, such as hydrogen concentration (pH), temperature, total dissolved solid (TDS), electrical conductivity (EC), and other relevant environmental factors that have a direct infuence on the abundance of mosquitoes can help in designing optimal vector control strategies (Akeju et al., 2022). These factors must also successfully support the development of the immature stages, from the first-instar larvae to the emergency of the adult stage of the mosquitoes. The immature stages of *Anopheles* mosquitoes have a body temperature that varies depending on the outside temperature; this makes them depend on the temperature of the aquatic habitat (Abiodun et al., 2016). Ecological studies of mosquito larvae in the rice fields of Dramaga District will be considered in preparing vector control strategies in Dramaga Sub-District, Bogor Regency. This study aims to identify the species diversity, density, and distribution and analyze mosquito larvae' habitat's physicochemical characteristics in the Dramaga sub-district, Bogor Regency rice fields.

METHODS

Time and Study Area

The research was conducted in December 2020 – March 2021. The collection of mosquito larvae was carried out in the rice fields of Dramaga Sub-District (Cikarawang Village, Ciherang Village, Babakan Village, and Dramaga Village).

Collection and Identification

Larvae were collected by purposive sampling in rice fields with stagnant water in four sub-districts in Dramaga District, with rice fields being potential habitats for mosquito larvae. Samples were taken from rice fields with stagnant water using a 350 ml dipper. Sampling was conducted ten times at each mosquito larvae collection location coordinate point. All collected larvae were transported to Laboratory of Medical Entomology School of Veterinary Medicine and Biomedical Sciences IPB University and kept at room temperature until the fourth instar and then identified using morphological key identification of larval mosquitoes in Indonesia (O’Connor & Soepanto, 1999a; O'Connor & Soepanto, 1999b; Ministry of Health Republic Indonesia 2008).

Measurement of Mosquito Larval Habitat Physicochemical Characteristics

Physicochemical characteristics parameter measurement of the mosquito larvae' habitat was carried out by taking the larvae and their water using a dipper at coordinate points in the rice fields in Dramaga District. Measurements were made on the water using a portable pH meter, TDS, and EC meter. These measurements were carried out to collect data on temperature, pH value, electrical conductivity as an indication of the amount of dissolved ions, and dissolved solids as an indication of the amount of dissolved substances in water in rice fields.

Mosquito Larval Habitat Mapping

The mapping process involves recording the mosquito larvae collection points as Waypoints (WPT) using the Garmin Montana 680 Global Positioning System (GPS). Subsequently, a database management system links spatial and attribute data, utilizing Microsoft Excel software with a storage format akin to Geographic Information Systems (GIS). A thematic map depicting distribution is generated using ArcGIS 10.7.1 software. To determine the proximity between the larval habitat and the nearest settlement, the Google Earth application is utilized for distance calculations.

Data Analysis

A descriptive analysis examined the species diversity, density, and distribution. Relative abundance of interpretations refers to the DAFOR scale (Hearnshaw & Hughey, 2010). The habitat traits of mosquito larvae were subjected to Pearson correlation testing with mosquito abundance at each location, performed using Jamovi 1.6.15 software**.**

RESULTS AND DISCUSSION

Description of Research Locations and Distribution of Mosquito Larvae

The research location was in the rice fields of Dramaga District, Bogor Regency, namely in Cikarawang Village, Babakan Village, Dramaga Village, and Ciherang Village (Figure 1).

This study found 92 positive points out of 178 potential locations for mosquito larvae habitats. A total of 14,805 mosquito larvae were collected from these positive points. A total of 7 species of mosquito larvae were found at 59 positive points out of 97 potential habitat points in Cikarang Village. Besides rice fields, the Cikarawang Village is covered by two rivers and lakes. The Cikawang sub-district also has abundant farms adjoining settlements. This supports the availability of blood for mosquitoes to breed.

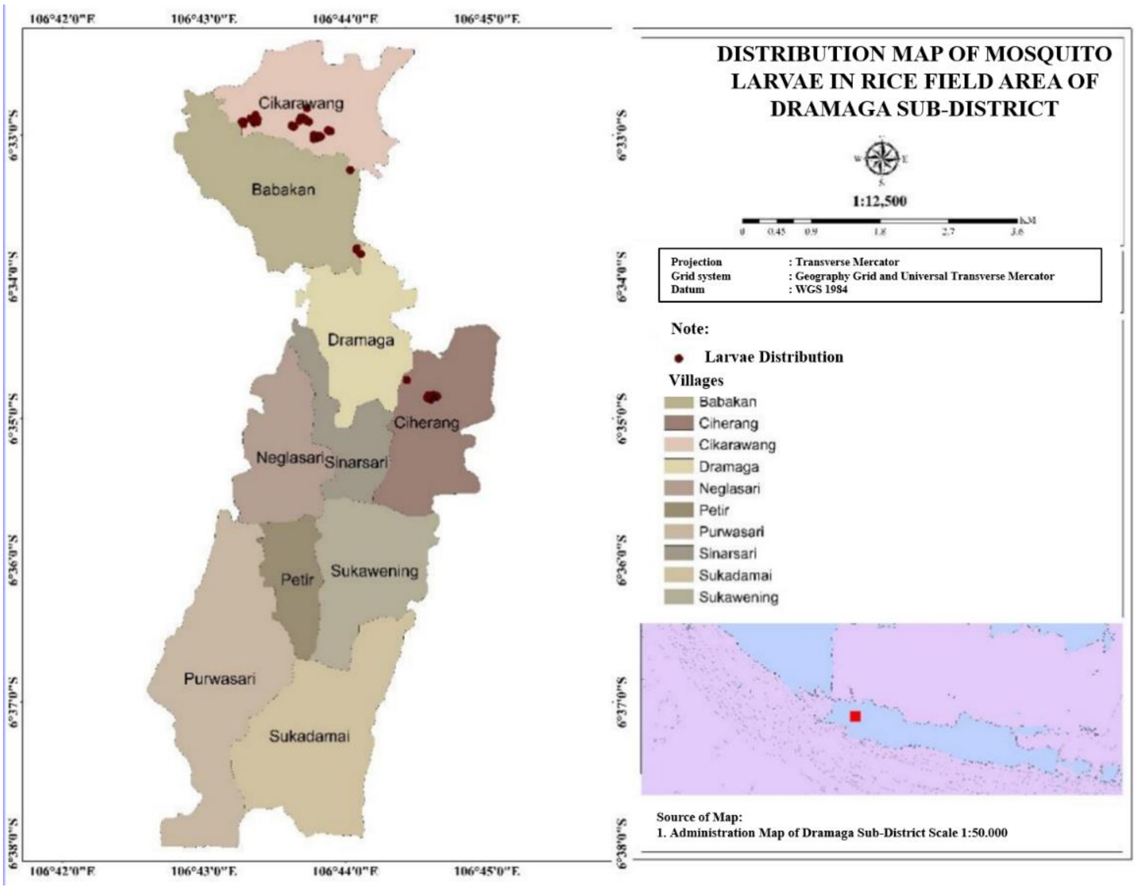

Figure 1 Distribution Map of Mosquito Larvae in Rice Fields, Dramaga Sub-District, Bogor Regency

Four positive points are out of 18 potential habitat points found in Babakan Village. Three species of mosquito larvae were found in the Babakan Village. A positive point out of 12 potential habitat points found in Dramaga Village contains three species of mosquito larvae. The Babakan and Dramaga sub-districts have rice fields that are small and are flanked by settlements and roads. The rice fields of the Babakan Village are close to the Dramaga Campus of IPB University. Cages for various livestock and forest habitats for wild animals are located on the Dramaga Campus of IPB University.

A total of 28 positive points out of 51 potential habitat points in Ciherang Village contain four species of mosquito larvae. It is not easy to find livestock pens in this village. *Armigeres* sp. larvae are found in one of the paddy fields in Ciherang Village. *Armigeres subalbatus* mosquitoes can become JEV vectors (Chen et al., 2000).

The average distance between the larvae collection point and the nearest settlement was found in the Ciherang Village, and the farthest distance was found in the Cikarawang Village. Ciherang Village has the shortest distance of 2.13 m and the farthest distance of up to 58.57 m, while Cikarang Village has the shortest distance of around 3.69 m. Flight distance *An. Vagus* is 783 ± 258 m. *Cx. tritaeniorhynchus* is up to 2214 ± 3565 m (Verdonschot and Besse-Lototskaya 2014). This may indicate that mosquito breeding in rice fields is supported by its affordability with the availability of blood from settlements adjacent to farms.

Species Diversity and Larval Abundance

The diversity of species and abundance of mosquito larvae in the rice fields of Dramaga sub-district is shown in Table 1. In contrast, Figure 2 shows the rarefaction curve of diversity to the number of larvae in four villages in Dramaga District. *An. Vagus* and *Cx. vishnui* are found all over the village. The highest diversity index was found in Cikarang Subdistrict with the highest relative abundance in *An. Vagus* and followed by *Cx. vishnui.* Two species of *Anopheles*, namely *An. barbirostris* and *An. indefinitus* is only found in Cikarang sub-district with a very low relative abundance. *Cx. vishnui* has the highest relative abundance significantly in Ciherang, Babakan, and Dramaga sub-districts. *Armigeres* sp. is only found in rice fields that have yet to be planted with rice in the Ciherang Village.

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Table 1 Species diversity and abundance of mosquito larvae in the rice fields of Dramaga sub-district

Sub-district	Species	RA (%)	RA Inter	Freq	Dom	H’
Cikarawang	*An. vagus*	59.7	Dominance	0.86	51.57	0,924
	An. barbirostris	1.0	Rare	0.08	0.09	(Low)
	An. indefinitus	0.1	Not Present	0.03	0.00	
	Cx. sitiens	0.6	Not Present	0.14	0.09	
	Cx. tritaeniorhynchus	4.2	Rare	0.47	2.00	
	Cx. vishnui	33.8	Abundance	1.00	33.85	
	Cx. pseudovishnui	0.4	Not Present	0.17	0.08	
	Cx. hutchinsoni	0.1	Not Present	0.03	0.00	
Ciherang	*An. vagus*	1.8	Rare	0.07	0.1	0.77
	Cx. vishnui	75.3	Dominance	183	70.1	(Low)
	Cx. fuscocephala	14.9	Occasional	0.24	3.6	
	Armigeres sp.	8.1	Occasional	0.14	1.1	
Babakan	*An. vagus*	0.7	Not Present	0.25	0.2	0.32
	Cx. tritaeniorhynchus	8.1	Occasional	1.00	8.1	(Low)
	Cx. vishnui	91.9	Dominance	1.00	91.9	
Dramaga	*An. vagus*	5.3	Rare	1.00	5.3	0.62
	Cx. tritaeniorhynchus	15.0	Occasional	1.00	15.0	(Low)
	Cx. vishnui	79.6	Dominance	1.00	79.6	

Note: RA= Relative Abundance; RA Inter: Relative Abundance Interpretation; Freq= Frequency; Dom: Dominance; H’: Diversity Index

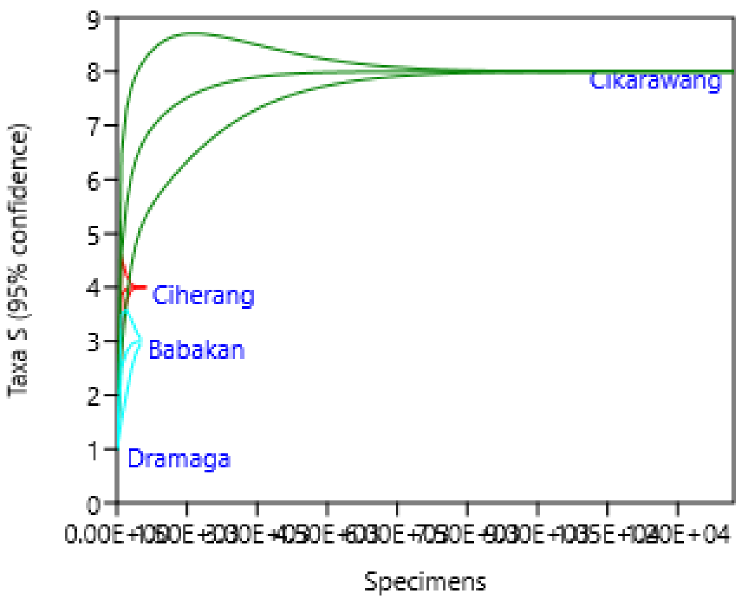

Figure 2 Rarefaction curve of mosquito larvae based on location

The abundance of breeding sites for zoophilic mosquitoes in proximity to livestock pens and human settlements requires careful consideration. This is due to the significant impact that a wide range of hosts and the adaptable blood-feeding behavior of mosquitoes can have on the transmission of mosquito-borne disease (Kiware et al., 2012).

Physicochemical characteristics of mosquito larval habitat

The average of the physicochemical characteristics of the habitat and the density of larvae in each village is presented in Table 2. In contrast, the relationship between the abundance of larvae and the physicochemical characteristics of their habitat is presented in the scatter plot diagram in Figure 3. The larval habitat's temperature in the Dramaga District rice fields ranges from 26.9°C – 32.3°C. The data collected showed a negative correlation between temperature and larval density (r-0.444; p-value <0.001). The habitat's optimum temperature and mosquito larvae growth rate differ for each mosquito species (Lyons et al., 2013).

Table 2 Average physicochemical characteristics of the habitat and larval density in each village

Village	L/D	pH	Temperature (^{0}c)	TDS (ppm)	EC (µS/cm)
Cikarawang (n=59)	22,63	7.38 ± 0.38	29.21 ± 1.38	79.78 ± 41.26	152.58 ± 63.81
Babakan (n=4)	15,18	7.35 ± 0.17	27.88 ± 1.21	65.75 ± 35.62	99.5 ± 54.66
Ciherang (n=28)	2,32	7.43 ± 0.21	29.84 ± 0.78	72.07 ± 19.21	174.69 ± 44.09
Dramaga (n=1)	11,3	6.4	30.4	22	45

Note: L/D= Larvae per dipper

The larval habitat's pH value affects osmoregulation in mosquito larvae's bodies. Pearson correlation test results in this study did not show a relationship between pH and the abundance of mosquito larvae (r=0.167; p-value=0.087). The average dissolved solids value of the larval habitat in this study was 285 ppm – 29 ppm. There was no correlation between mosquito larvae density and TDS (r=0.157; p-value=0.108). Dissolved solids in rice fields can be influenced by the fertilizers, herbicides, and pesticides used and the nature of the soil in rice fields.

The electrical conductivity of the water in mosquito larvae habitats can vary depending on the concentration of dissolved ions, salts, and other substances. Potassium and sodium in the habitat of mosquito larvae have a role in the osmoregulation of mosquito larvae (Ramsay, 1953). Electrical conductivity in this study is in the range of 54 µS/cm – 428 µS/cm. Water EC did not show a correlation with the number of larvae caught from each village (r= -0.13; p-value= 0.087).

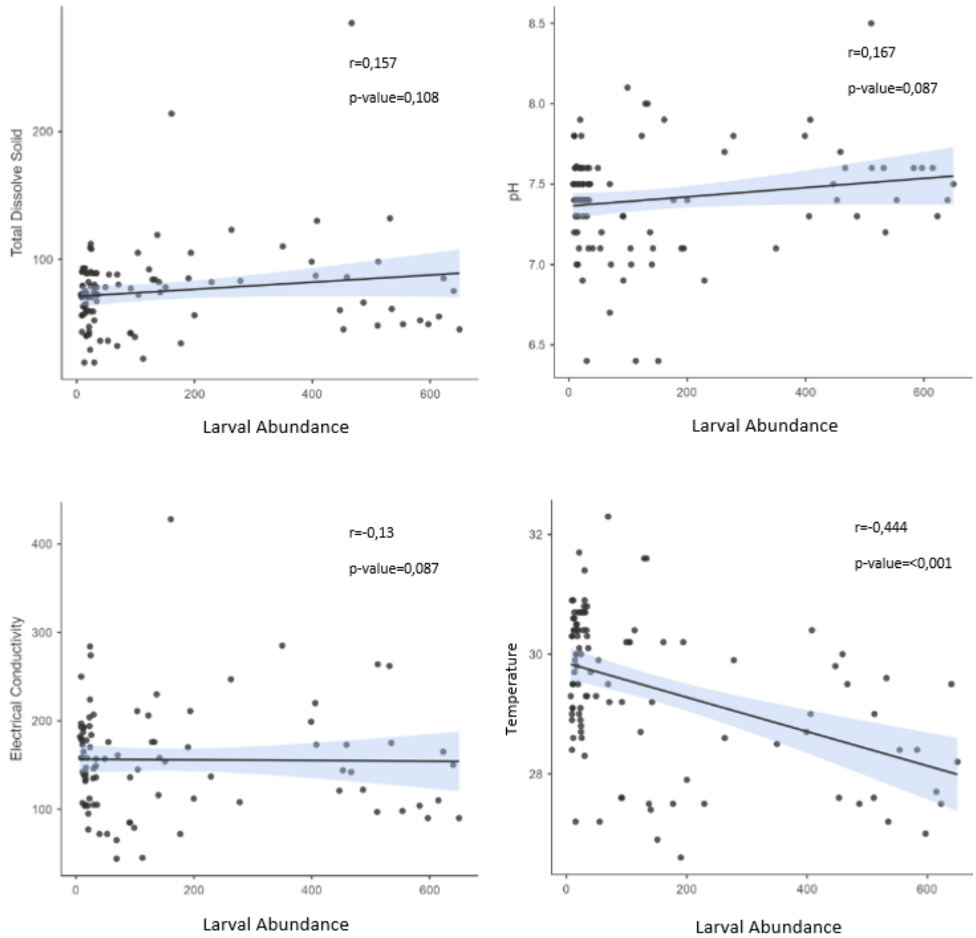

Figure 3 Scatter plot of physicochemical characteristics of larval habitat with the number of larvae

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CONCLUSIONS

Study of mosquito diversity in Dramaga sub-district rice field found *An. Vagus, An. barbirostris, An. indefinitus, Cx. Vishnui, Cx. fuscocephala, Cx. tritaeniorhynchus, Cx. sitiens, Cx. hutchinsoni*, and *Armigeres* sp. The highest diversity and density of larvae were found in the Cikarawang Village. *An. vagus* and *Cx. vishnui* owns the highest relative abundance. The physicochemical characteristics of the measured larval habitat, namely pH, TDS, and EC, did not correlate with the abundance of the larvae. However, the water temperature of the larval habitat had a negative correlation with the density of the larvae.

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