ORIGINAL ARTICLE

Density Of Eggs and Larvae of Aedes Spp. and the Characteristics of their Larvae Habitat in Endemic Dengue Area In Ternate City

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ABSTRACT

Introduction: Dengue Fever (DF) is a disease spread by *Aedes* spp. caused by dengue virus infection. The study aimed to identify the density of egg and larval *Aedes* spp. stages and the characteristics of their habitat in dengue-endemic areas in Ternate City in September 2021. **Methods:** the research was conducted in four dengue-endemic villages in Ternate City, including Sangaji, Maliaro, Bastiong Karance, and Bastiong Talangame. In 80 households, egg density was determined utilizing ovitrap placement of up to two pieces per dwelling, one inside and one outside the house. After a week of ovitrap installation, the filter paper was collected, and the ovitrap index value was calculated. The value of the House Index (HI), Container Index (CI), and Breuteu Index (BI) was used to calculate the larval density. The type and materials of the containers were used to assess the parameters of the larval environment. **Results:** The ovitrap index value in the four sub-districts was categorized as moderate level 3 (27.50% -36.25%). The highest larval density was found in Sangaji Village (HI = 81%), while the lowest was in Bastion Talangame Village (HI = 70%). The highest CI and BI values were found in Bastiong Karance Village (CI=51.5% and BI=190%), and the lowest was in Maliaro Village (CI=37.5% and BI=128%). Density figures in all endemic villages have a high larval density with a value of 8. **Conclusion:** There was no significant difference (p>0.05) between the types and the materials of containers in each village in DF endemic areas. The high density of the egg and larval stage and the information characteristic of habitat *Aedes* spp. Could be considered the basis of information dengue vector prevention and control in Ternate City.
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Keywords: Eggs and larvae, *Aedes* spp., Oviposition trap, Habitat characteristics

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INTRODUCTION

Dengue Fever (DF) is a mosquito-borne virus that causes hemorrhagic fever. This disease is a significant vector-borne disease because it occurs throughout the year and has a high morbidity and mortality rate. DF is spread to humans by the Aedes aegypti mosquito, the primary vector, and the Aedes albopictus mosquito, the secondary vector. Mosquitoes of both species have been found in tropical and sub-tropical regions worldwide. They are well adapted, where the larvae can breed in natural and artificial containers near human habitation. (1).

The first case of DF in Indonesia was documented in Surabaya in 1968, and it quickly spread throughout the country. (2). Based on national data in indonesia, DF cases in 2020 reached 108,303 with a morbidity or incidence rate (IR) of 40 people per 100,000 population. The mortality rate due to DF in 2020 was reported as many as 747 people with a case fatality rate (CFR) of 0.7%. North Maluku Province is one of Indonesia's provinces with a high DF mortality rate, with a CFR of 1.9 percent and an IR of 33.2 per 100,000 people (3). The distribution of DF cases occurred in all districts/cities in North Maluku, and Ternate City had the highest number of DF cases in 2020, with 169 cases and one death (3).

Many efforts have been made to control dengue cases in Indonesia. The critical point in management of dengue control (5). Vector control can be carried out using a source reduction approach, environmental management, and personal protection (6). Moreover, (7) showed that mosquito control could be done through several approaches, including environmental, chemical, and biological controls or integrated vector control management.

The abundance of Aedes spp. Vectors have a significant influence on how quickly DF spreads. The home index (HI), container index (CI), and breteau index (BI) can all be used to predict the likelihood of an Aedes mosquito-borne outbreak. This index is determined by the presence or absence of Aedes mosquito larvae in different containers in each household. This indicator indicates the presence of Aedes mosquitos, which pose a risk of DF transmission, and can be used to guide vector control efforts. Entomological survey of Aedes spp. The immature stage (eggs and larvae) can provide important information in controlling dengue cases. Knowledge of the reproduction of Aedes spp. Can provide a better understanding of population density and its distribution. The epidemiology of dengue fever in Ternate City in 10 years (2009-2018) was reported as many as 918 patients with 31 deaths. The higher cases are higher in men (507 people) than women (411 people), and the highest is in the 5-14 years age group (507 people) (4). The high incidence of DF every year requires collaboration between programs and related sectors and community participation as an effort to control DF.

Mosquito breeding sites have different characteristics that will affect Aedes spp. in their oviposition. Ae. aegypti has an oviposition preference in containers filled with clear water in the house, while Ae. albopictus tends to oviposition in natural containers or artificial outdoors habitats that contain more organic waste.

Mosquitoes have a huge negative impact on human quality of life because to their abundance (8). This research aims to obtain data on the entomological index of the immature stage in Ternate City, including; the occurrence of larvae, the density of larvae, the presence of mosquito eggs, and the characteristics of habitat mosquito breeding sites. The entomological index calculates the density of Aedes spp. Larvae in specific settlements are an essential factor to consider when establishing effective vector management strategies. In addition, this research is expected to be an input for programs to find alternatives to reduce the number of dengue cases in Ternate City.

MATERIALS AND METHODS

The study was conducted with a cross-sectional approach where observations. Ovitrap index data was obtained by counting the number of positive filter papers divided by all ovitraps installed. The value of the density figure (DF) is calculated using the values of the house index (HI), the container index (CI), and the Breateu Index (BI). The DF criteria are derived from the sum of the HI, CI, and BI values expressed on a scale of 1 to 9, which are divided into three groups: low density (DF=1), medium density (DF=2-5), and high density (DF=6 -9) (9).

Time and Place

The research was conducted in September and October 2019 in four dengue-endemic villages in Ternate City. The criteria for the sub-districts used as samples are endemic villages with high-density residential spaces. The sample villages are Sangaji, Maliaro, Bastiong Karance, and Bastiong Talangame

Research procedure

Egg Survey

Ovitrap installation in 80 houses was carried out in each village. The ovitrap is made from a black plastic jar, with water and filter paper placed on the inner wall of the glass as a breeding place for Aedes spp. Lay their eggs. Two ovitraps were installed in each house, one was put inside the house, and the other was placed outside the house. After a week of ovitrap installation, the filter paper of ovitraps was collected, and the ovitrap index value was calculated.

$$\text{Ovitrap Index (OI)} = \frac{\text{Number of positive ovitrap}}{\text{Number of ovitrap}} \times 100\%$$

The ovitrap index criteria were divided into four categories, with level 1 indicating that IO was less than 5%, level 2 indicating that OI was less than 20%, level 3 indicating that IO was less than 40%, and level 4 indicating that OI was less than 40%.

Larvae Survey

Larval observations were carried out in 100 houses in each village. The direct visual observation method was used to observe the existence or absence of larvae in the container both inside and outside the house, as well as the container's type and materials. The criteria of larval density were determined based on the density figure by calculating the house index (HI), container index (CI), and Breatou Index (BI). HI, CI and BI can be calculated using the formula:

$$\text{HI} = \frac{\text{Number of positive larva houses}}{\text{Number of houses inspected}} \times 100\%$$

$$\text{CI} = \frac{\text{Number of positive larva containers}}{\text{Number of containers inspected}} \times 100\%$$

$$\text{BI} = \frac{\text{Number of positive larva containers}}{\text{Number of houses inspected}} \times 100\%$$

The density level of mosquito larvae in 100 observed dwellings was represented by the density figure (DF). On a range of 1 to 9, the DF criteria were obtained from the sum of the HI, CI, and BI values, which were classified into three categories: low density (DF=1), medium density (DF=2-5), and high density (DF=6-9) on a scale of 1 to 9 (9). The mosquito larval density category based on the density figure is presented in Table I.

Table I: Density figure (DF) (Focks 2003)

Density figure (DF)	House Index (HI)	Container Index (CI)	Breteau Index (BI)
1	1 – 3	1 – 2	1 – 4
2	4 – 7	3 – 5	5 – 9
3	8 – 17	6 – 9	10 – 19
4	18 – 28	10 – 14	20 – 34
5	29 – 37	15 – 20	35 – 49
6	38 – 49	21 – 27	50 – 74
7	50 – 59	28 – 31	75 – 99
8	60 – 76	32 – 40	100 – 199
9	>77	>41	>200

RESULTS

Egg and Larva Density of *Aedes* spp.

The results of ovitrap observations in four dengue-endemic villages with densely populated residential conditions and very close distances between houses, mosquitoes can move from one house to another to suck blood and provide breeding places. The percentage of ovitrap/village in four endemic villages was presented in Figure 1.

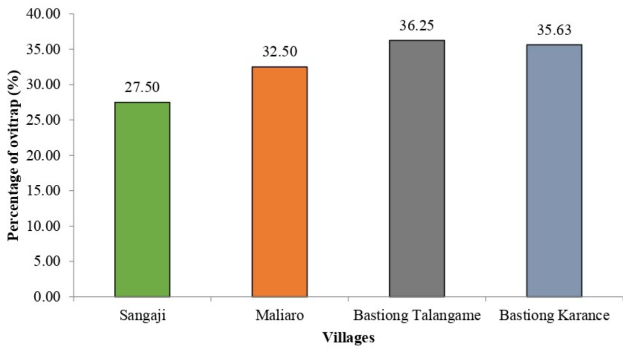

Figure 1: Ovitrap Index (OI) value in Bastiong Karance Village, Bastiong Talangame Village, Maliaro Village, and Sangaji Village, Ternate City

The results of the ovitrap index from the four endemic villages obtained OI values with a range between 27.50% to 36.25%. The highest OI value was found in Bastiong Talangame village (36.25%), while the lowest was found in Sangaji Village (27.5%). The percentage of positive ovitraps inside and outside the home in four DF endemic Village is presented in Table II. In general, the rate of positive ovitraps was found more in the house and only found in one Village, which had a higher percentage of positive ovitraps outside the home than inside the house in Maliaro village.

Aedes spp. Larvae Density

The observations of larvae in 100 houses in four dengue-endemic villages were presented in Table III and IV.

The value of positive containers in houses was highest in Bastiong Talangame Village (50.2%) and the lowest in Maliaro Village (35.8%). Meanwhile, the highest was in Bastiong Karance Village (55.8%) for outdoor containers, and the lowest was in Bastiong Talangame Village (30.9%).

Table II: Ovitrap index values in Sangaji Village, Maliaro Village, Bastiong Talangame Village, and Bastiong Karance, Ternate City

Village	Ovitrap					
	Outdoor		%	Indoor		%
	Total	Positive		Total	Positive	
Sangaji	80	23	28.75	80	21	26.25
Maliaro	80	25	31.25	80	27	33.75
Bastiong Talangame	80	30	37.50	80	28	35.00
Bastiong Karance	80	32	40.00	80	25	31.25
Mean			34.38			31.56

Table III: Distribution of the number of positive containers in Sangaji Village, Maliaro Village, Bastiong Talangame Village, and Bastiong Karance, Ternate City

Villages	Total House	No of positive house	Indoor		Outdoor	
			Total container	No of positive container (%)	Total container	No of positive container (%)
Sangaji	100	81	245	98 (48.0)	125	52 (41.6)
Maliaro	100	71	237	85 (35.8)	341	128 (37.5)
Bastiong Talangame	100	70	245	123 (50.2)	71	22 (30.9)
Bastiong Karance	100	75	240	118 (49.1)	129	72 (55.8)

Table IV: HI, CI, BI, and DF values in Sangaji Village, Maliaro Village, Bastiong Talangame Village, and Bastiong Karance, Ternate City

Villages	HI (%)	CI (%)	BI (%)	DF
Sangaji	81	40.5	150	8
Maliaro	71	37.5	128	8
Bastiong Talangame	70	45.8	145	8
Bastiong Karance	75	51.5	190	8

The highest HI value was found in Sangaji Village (81%), and the lowest HI was found in Bastiong Talangame (70%). The highest CI and BI values were found in Village Bastiong Karance (CI=51.5% and BI=190%), and the lowest CI and BI values were found in Village Maliaro (CI=37.5% and BI 128%).

Larvae Habitat Characteristics

Container Type

The results of observations of larval habitat characteristics based on container types were presented in Table V. Container materials found in four dengue endemic villages are presented in Table VI. There were 10 types of container materials found with the highest container material, namely plastic, in all villages. No significant difference was found between the container material

Table V: Type of container and positive percentage of the occurence of mosquito larvae in Sangaji Village, Maliaro Village, Bastiong Talangame Village, and Bastiong Karance Village, Ternate City

Container Type	Villages												p-value
	Sangaji			Maliaro			Bastion Talangame			Bastiong Karance			
	Σ	+	%	Σ	+	%	Σ	+	%	Σ	+	%	
Toilet tub	46	22	5,95	57	34	5,88	41	27	8,54	42	29	7,86	
Bathtub	77	27	7,30	89	27	4,67	36	28	8,86	58	25	6,78	
Fridge Placemats	38	14	3,78	72	30	5,19	45	20	6,33	44	18	4,88	
Dispenser	76	22	5,95	54	15	2,60	49	15	4,75	57	26	7,05	
Bucket	48	25	6,76	45	22	3,81	45	20	6,33	34	18	4,88	0.194
trinkets	15	4	1,08	29	12	2,08	28	11	3,48	26	12	3,25	
Water tank	12	6	1,62	55	18	3,11	20	7	2,22	40	23	6,23	
Drum	32	18	4,86	67	25	4,33	13	6	1,90	21	9	2,44	
Used tires	15	8	2,16	52	16	2,77	23	5	1,58	26	16	4,34	
Used Cans	11	4	1,08	58	14	2,42	16	6	1,90	21	14	3,79	
Total	370	150	40,54	578	213	36,85	316	145	45,89	369	190	51,49	

+ = number of positive larvae containers

Table VI: Material type of container and positive percentage of the occurence of mosquito larvae in Sangaji, Maliaro, Bastiong Talangame, and Bastiong Karance, Ternate City

Container Material	Villages												p-value
	Sangaji			Maliaro			Bastion Talangame			Bastiong Karance			
	Σ	+	%	Σ	+	%	Σ	+	%	Σ	+	%	
Plastic	225	91	24,59	359	89	15,40	231	92	29,11	201	106	28,73	
ceramic	101	33	8,92	98	72	12,46	31	29	9,18	89	45	12,20	
cement	25	18	4,86	41	21	3,63	21	15	4,75	46	22	5,96	
Soil	2	0	0,00	2	0	0,00	2	0	0,00	2	0	0,00	
Metal	2	0	0,00	23	14	2,42	5	3	0,95	3	1	0,27	0.945
Glass	1	0	0,00	3	1	0,17	3	1	0,32	2	0	0,00	
Rubber	15	8	2,16	52	16	2,77	23	5	1,58	26	16	4,34	
Total	370	150	40,54	578	213	36,85	316	145	45,89	369	190	51,49	

+ = number of positive larvae containers

and the presence of larvae in the four villages examined (p>0.05). Mosquito larvae were not found in soil, metal, and glass containers in Sangaji village. Mosquito larvae were also not found in the soil container material in all the villages observed.

DISCUSSION

Vector surveillance is an essential activity in developing strategies to prevent dengue transmission. This study provides information about the population density of Aedes spp. by measuring the density of eggs and larvae in four dengue-endemic villages in Ternate City. The combination of egg and larva surveillance is expected to provide complete information regarding the population of Aedes spp. The data obtained can provide information to policymakers such as the Ternate City Health Office to improve entomological surveillance activities.

The installation of oviposition traps in four villages in the city of Ternate succeeded in determining the density of mosquito larvae. (10) reported that the oviposition trap could detect the presence of Aedes spp. more accurate when the larval survey shows a low infestation rate. The IO scores in the four villages examined were classified as moderate (level 3) with a value of 20% OI < 40%. The abundance of Aedes spp. in the environment settlement can be caused by an environment that was less clean and neglected. Poor environmental management can also contribute to favorable conditions for mosquitoes to breed properly (11)

Ovitrap index values were generally higher inside the house than outside. These results were in line with (12)research that IO inside the home was higher than outside the home. Other researchers reported different finding that higher OI values were found outside the home than inside the house. In Korong Gadang Village, Kuranji District, Padang City, (13) found that the value of IO outside the house was higher than inside the house. However, the IO value was found to be higher in outdoor than indoor in Banyuwangi Regency (14)

A reasonably high IO value found indoors compared to outdoors indicates that Aedes are more likely or prefer to lay eggs indoors. This is due to the favorable environmental conditions for mosquito breeding, such as a densely populated environment, poor ventilation, and sanitation. (12) reported that houses in Sukabumi City with poor sanitation and ventilation had a significant relationship to the ovitrap index value and had a 3.09 times risk of increasing the density of Aedes spp. These mosquitoes are commonly found indoors because these mosquitoes like to rest in hidden, damp, and dark places. In addition, Aedes is an anthropophilic mosquito and sucking blood more than once to complete the gonotrophic cycle (15).

In Indonesia, vector surveillance systems using the house index, container index, and Breteaue index have been in place for a long time to control dengue hemorrhagic fever cases. A high HI index value indicates that many larvae were still vectors in that location. The HI values in the four research locations did not fulfill the standards of the Ministry of Health of the Republic of Indonesia, that HI values 5% or free larvae index (FLI) values 95% (16). The Breteau index is an early warning signal for the dengue fever outbreak in Sri Lanka (17). (18) suggested HI, CI, BI and the FLI as a Stegomya index can be used to evaluate the risk of dengue fever in Indonesia. The density of mosquitoes in the four sub-districts observed was classified based on the density figure as having a high larval density category. High larval infestations in the environment can be the first step in preventing outbreaks (19). Herd immunity, virus strain, vector competence, human-mosquito interaction, human population density; distribution, displacement, and interaction of viruses, vectors, and humans, as well as weather, climate, and environmental variables, are all factors that may influence the relationship between the density of Aedes spp. and the risk of transmission (20).

The Container material influences Aedes spp. oviposition site choice (21). Female mosquito choice in oviposition site is adaptive and can influence population distribution and dynamics. In the four Villages studied, there was no discernible variation between container type and container material. Bathtubs and dispensers were the most common breeding sites found in the research region. The bathtub is a sort of container found in four communities by larvae. The bathtub always provides water to keep it there and make the room conditions moist and favored by mosquitoes. The frequency of bath drying can also be one of the causes of many mosquito larvae in fitness facilities in Trenggalek (22). Research reports on dispenser mats as a habitat for mosquito larvae were reported in West Ranomeeto District, West Sulawesi Province, and Bandar Lampung (23) (24). Drops of water or spills accommodated on the dispenser mat become a breeding ground for mosquitoes. Aedes spp. reported having a preference for laying eggs in small water containers compared to large ones (25)(26). This is related to the number of dissolved solids being more concentrated in a smaller volume of water (27).

CONCLUSION

In conclusion, in this study, it was shown that the ovitrap index value in the four endemic villages was in the moderate criteria. For larval density in all dengue endemic villages, high larval density was found. There is no significant difference between the types and materials of containers in all villages. The description of the density of eggs and larvae in four dengue endemic areas with ovitrap index and high larval density, this indicates that the risk of disease transmitted by Aedes mosquitoes is still high in Ternate City.

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