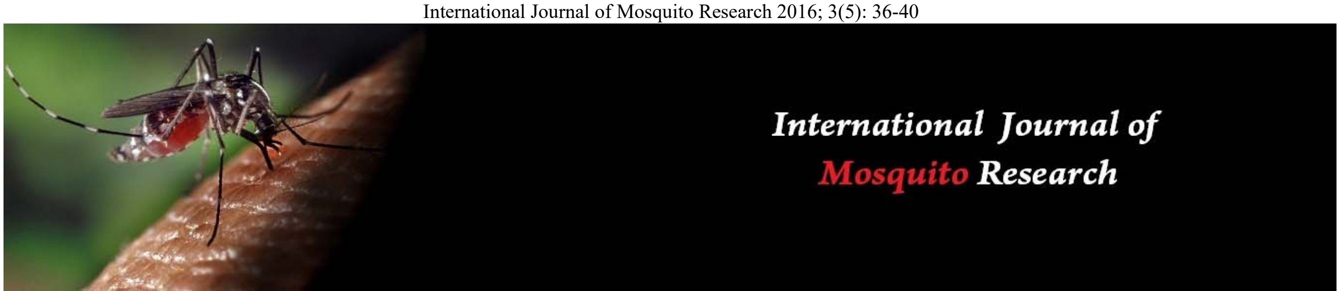
International Journal of Mosquito Research 2016; 3(5): 36-40



ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2016; 3(5): 36-40

Received: 07-07-2016
Accepted: 08-08-2016

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The microhabitat preferences of mosquito genus *Aedes* (Diptera: Culicidae) in Padang, West Sumatra, Indonesia

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Abstract
The dengue hemorrhagic fever is a contagious disease with the cases still increases in Indonesia. The disease transmits through bites of mosquitos *Aedes* spp. The rate of infection is mostly influenced by environmental factors. We conducted the study of microhabitat and density indicators of *Aedes* in Padang, West Sumatra, Indonesia, from December 2015 to January 2016. This study aimed to determine the most favorable water container, a breeding site, water source as well as physical and chemical factors required for growing larvae *Aedes* mosquito. Environmental parameters of the larval habitats including water temperature, air temperature, humidity, water pH and existence of larva were observed with visual encounter. In total 100 houses were surveyed, the presence of *Aedes* larvae were highest in the inside of the house. Density of larva was highest in cement made tub (15%) and plastic made tub (6%). The water tub was supplied by household wells have relatively high occurance density of *Aedes* larvae (15%) than supplied by the regional water company (6%). The present results indicated that the measured environment conditions such as water temperature, air temperature, humidity, and water pH were not significantly associated with larva density in different habitats.

Keywords: *Aedes*, container, dengue, microhabitat, household

1. Introduction

Aedes aegypti L. is a mosquito that belongs to the Order Diptera and Family Culicidae. This species is the main vector of Dengue and Dengue haemorrhagic fevers in the Americas and Asia [1]. This disease spreads rapidly during rainy season and decreases at dry season [8]. There are many factors likely contribute to this immense growth, such as water and air temperature, humidity and pH. Another factor that influencing the growth of *Aedes* spp. larvae is societal factors such as urbanization and highest case [9]. Other factors are more climatic, such as increase in global temperature. All of these factors could give great impacts on dengue transmissions around the world [21].

The Dengue Haemorrhagic Fever is prevalent in West Sumatra with the highest case found in Padang City [5]. The most cases were recorded in 2013 (127 cases), these cases were recorded in Korong Gadang sub-district [5]. The *Aedes* spp. required good microhabitat for its life cycle [9]. Microhabitat is a habitat which provides direct influence on *Aedes* spp. life cycle, such as water temperature, air temperature, humidity, and water pH as well as container for brooding. The most efficient way of reducing the population of the mosquitoes that carry dengue fever is by removing the breeding sites and control the factors that are responsible for increasing in breeding activity [22-25]. Many studies have shown that the environmental conditions strongly control the density and distribution of the mosquito, *Aedes aegypti* [26-28].

The relationship between climatic factors and the biology of the *Aedes aegypti* mosquito were studied by many researchers, and they concluded that the temperature, humidity and rainfall significantly influence the mosquito density, their life-cycle, breeding habitats, survival and dengue viral development [29, 30]. Therefore, it is important to understand the relationship between microhabitat of the mosquito genus *Aedes* and fluctuation in climate conditions. This will assist to developing the strategies of mosquito reduction in order to decrease dengue fever as a public health issue in Padang. This study was aimed to determine the most favorable water container, a breeding site, water source as well as physic and chemical factors required for growing larvae of *Aedes* mosquito. As the result it could be as the references for integration pest management in Indonesia.

2. Materials and Methods

This research was conducted in korong Gadang, Padang, West Sumatra, Indonesia. The altitudes of the location range is from 150 to 1000 m above sea level [31]. Annual rainfall is about 296,00 mm per month, while the highest rain fall is in July to October [33]. Korong Gadang was the most case of DHF (Dengue Haemorrhagic Fever) in 2013 based on data from public health department of Padang.

Sampling of the mosquito larvae and pupae stages were conducted from Desember 2015 to January 2016. During this time, sampling would include the dry and rainy seasons, and also effective to check the life cycle of mosquitoes for further countermeasures of DHF. Data were obtained by the surveyed in 100 houses and repeated four times. Existence of larva were observed with visual encounter. Types of microhabitats were characterized by shape of container, outside and inside of the house and possibility of water source. The following environmental factors were measured for each site, such as water temperature, air temperature, humidity, and water pH. Larvae and pupae were collected and rearing under laboratory conditions. Larvae were allowed to pupa and emerge into adults in mosquito rearing containers according to the standard procedures for rearing mosquitoes [31]. The emerging adults were later identified with the aid of published identification keys of Phua *et al*. [33], adult mosquitoes were identified based on morphological features. The results were recorded for each site and habitat.

Data was analyzed using fisher exact test to find the relationship between microhabitat (environment factors) and density of the mosquito genus *Aedes*. A descriptive analysis was conducted to determined the best microhabitat (shape, location and water source) and relationship between environmental factors (water temperature, air temperature, humidity and water pH) with *Aedes* density.

3. Results

Based on our survey at 100 houses in Padang, west Sumatra, Indonesia, we found the presence of the larvae of the mosquito larvae genus *Aedes* relatively high inside the house. The results related to the common habit of people in this area which is a open water tub (average size: 70 cm length, 70 cm width and 100 cm height) inside the house. The water tub from each house was made from cement or plastic. The larvae of this genus occured in all the two type of water containers, but the frequency of occurance was higher in cement made water tub (15%) than plastic made water tub (6%) (see Table 1).

The household water sources in this study were catagorized into two types, which were household wells and regional water company. The water tub which was supplied by household wells have relatively higher occurance frequency of *Aedes* larvae than supplied by the regional water company, 15% and 6% respectively (see Table 1).

Environmental factors of each place contains genus *Aedes* larvae were measured. The water temperature ranged from 27 °C−30 °C (Figure 1) were highly occupied by *Aedes* larvae. This range of temperature is the optimum temperature for *Aedes* larvae to grow up [8]. Air temperature did not directly affect the presence of larvae in water tub. The larvae of genus *Aedes* were found a lot near the house with high air temperature (>30 °C) (see Fig. 2). The result of Fisher exact test which was conducted in the first week had no relationship between air temperature and the presence of larvae of *Aedes* spp., $p=6.69 > 0.05$ (Table 3). Similar results were also found for in the second, third and fourth week with $p = 0.13$, $p = 0.41$ and $p = 0.3$ respectively.

The larvae of *Aedes* spp. prefer the place with humidity around 81,5% to 89,5%, because it is considered appropriate for its growth [7]. Because of our sampling time in bad humidity (<81,5%), so we found that the existed *Aedes* spp. larvae linked with humidity showed negative result.

Another factor that influencing the growth of *Aedes* spp. larvae is water pH. Good values of water pH for growth of larvae were 6−8 [8]. If the value that found in the environment was below or above, then it will influence on the growth of *Aedes* spp. larvae. The acid water has caused dead of plankton which is food for the *Aedes* spp. larvae [11] The results from all observation was $p = 1 > 0.05$ (Table 3). The Fisher exact test results showed a negative association between the presence larvae of *Aedes* spp and water pH.

Table 1: The percentage of water tubs containing larvae based on shape, location, and water source

Shape	Cement		Plastic		%
Location	Indoor (%)	Outdoor (%)	Indoor (%)	Outdoor (%)	
Water Source	%	%	%	%	
Household wells	7%	3%	3%	2%	15%
Regional water company	3%	2%	1%	0%	6%
Total	10%	5%	4%	2%	21%

Table 2: The environmental conditions of water tubs microhabitat

Microhabitat	Simbols	Cement		Plastic	
		Indoor	Outdoor	Indoor	Outdoor
		Household wells	Regional water company	Household wells	Regional water company
Water Temperature	°C	26-30	25-29	26-30	25-29
Air Temperature	°C	28.7-33.8	29.9-35.3	26-33.5	28.8-34.9
Humidity	%	54-77	58-64	57-80	49-75
Water pH		6-7	6-7	6-7	6-7

Table 3: Fisher Exact test of environmental conditions for four week

No	Microhabitat	Value of weeks			
		I	II	III	IV
1	Water temperature	0,5	0,02	0,03	0,3
2	Air temperature	6,69	0,13	0,41	0,3
3	Humidity	2	1	1	1
4	Water pH	1	1	1	1

Information

P > P table (0.05) not found correlation between microhabitat and presence of *Aedes* spp. larvae

P < P table (0.05) have correlation between microhabitat and presence of *Aedes* spp. Larvae

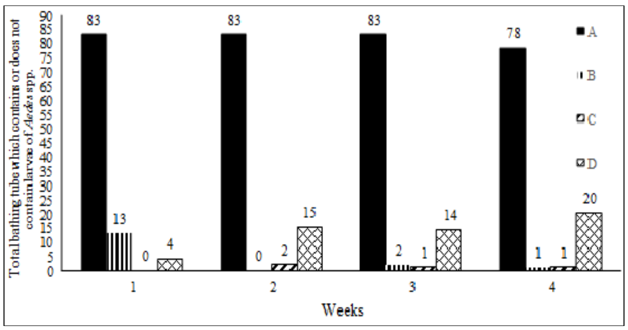

Fig 1: Total water tubs that contains or does not contain larvae of *Aedes* spp. in good water temperature (27 °C-30 °C) and fine (<27 °C /> 30 °C)

Information

A. The amount of water tub that does not contain mosquito larvae at a good temperature (27 °C-30 °C)
B. Amount water tub containing mosquito larvae at a good temperature (27 °C-30 °C)
C. Total water tubcontaining mosquito larvae at a temperature not good (<27 °C /> 30 °C)
D. Number of water tubthat does not contain mosquito larvae at a temperature not good (<27 °C /> 30 °C)

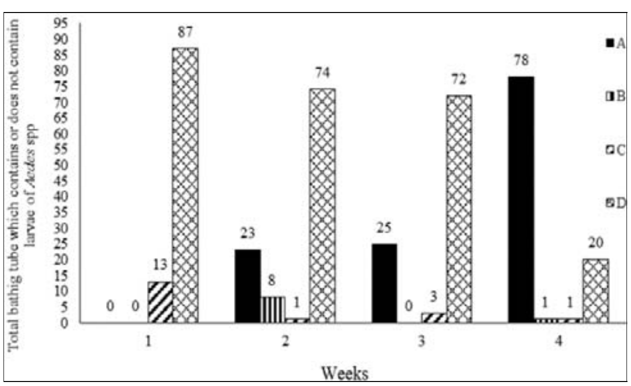

Fig 2: Total water tub that contains or does not contain larvae of *Aedes* spp. at good air temperature (20 °C-30 °C) and fine (<20 °C /> 30 °C)

Information

A. The amount of water tub that does not contain mosquito larvae in both air temperature (20 °C-30 °C)
B. Amount water tub containing mosquito larvae in both air temperature (20 °C-30 °C)
C. Total water tub containing mosquito larvae at a temperature of the air is not good (<20 °C /> 30 °C)
D. Number of water tub that does not contain mosquito larvae at a temperature of the air is not good (<20 °C /> 30 °C)

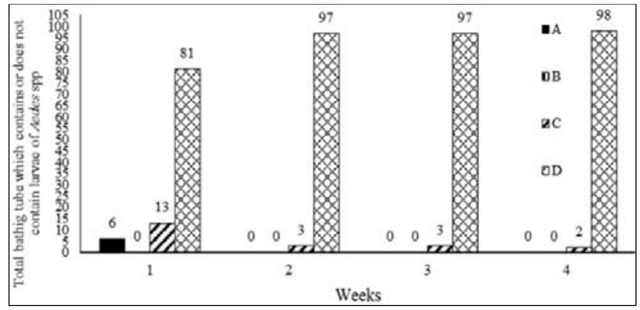

Fig 3: Total water tub that contains or does not contain larvae of *Aedes* spp. at good air humidity (81,5%-89,5%) and not good air humidity (< 81,5% / > 89,5%)

Information

A. The amount of water tub that does not contain mosquito larvae in water good air humidity (6 -7.8)
B. Amount water tub containing mosquito larvae in water good air humidity (6 -7.8)
C. Total water tub containing mosquito larvae in not good air humidity (< 6 / > 7.8)
D. Number of water tub that does not contain mosquito larvae in not good air humidity (< 6 / > 7.8)

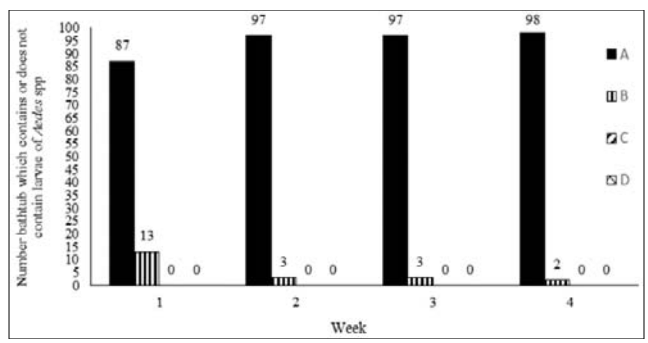

Fig 4: Total water tub that contains or does not contain larvae of *Aedes* spp. at normal water pH (6 -7.8) and the pH of water is not good (< 6 / > 7.8)

Information

A. The amount of water tub that does not contain mosquito larvae in water pH normal (6 -7.8)
B. Amount water tub containing mosquito larvae in water pH normal (6 -7.8)
C. Total water tub containing mosquito larvae in water pH is not good (< 6 / > 7.8)
D. Number of water tub that does not contain mosquito larvae in water pH. is not good (< 6 / > 7.8)

4. Discussion

The mosquitoes while laying their eggs choose certain places supporting the gowth of larvae. The *Aedes aegypti* mosquitoes tend to lay their eggs in the house [12, 13], because its taking rests in the dark, damp and hidden places inside the house or building protected from sunlight directly [7]. The *Aedes* *albopictus* tend to lay their eggs in the outside of house [12, 13]. There are some things which influence aedes in selecting breeding site, such as basic materials of water tub in which the eggs were placed on the wall of reservoir water [4]. Aedes mosquito prefers materials which are made from cement, metal, soil,ceramics and plastic. These materials have some advantage for Aedes larvae laying their eggs for example: easy mossy cement, rough surface and porous walls. The rough surfaces are relatively difficult to clean and easy to overgrown by moss in the condition low light. The low light leads to low temperature in the water [35]. The female mosquito is easy to organize the position of its body as put the eggs in the water tube made from cement in which they put down regularly in the above wall surface [3]. The high proportion of Aedes spp larvae in the water tub is related with the larva's food availability high percentage of larvae of Aedes spp in water tub made by cement or coarse soil is related to the availability of food for larvae. The water tub made from cement was the good microhabitat for aedes larvae because have many foodstuffs for microorganism and moss [17].

The larva's life cycle has some factors which influence larvae growth, such as water and air temperature, humidity and pH. Barry and Juliano [2] mentioned that the water temperature is one of the factor that influence the growth of larvae. Yasuoka and Levins [18] have reported that there was a negative relationship between temperature and density of mosquito the optimum temperature for mosquito's live is 20 °C to 25 °C. Korong Gadang has the temperature average 31.2 °C, which is higher than the optimum temperature for growth larvae of aedes. The optimum air temperature of oviposition is approximately 25 °C [6]. The air temperature in the range 31-35 ^{0}C will decrease the oviposition level of eggs and less air humidity will disturb process metabolism of larva. Another factor having impact for aedes's growth is water pH [16, 19]. The normal water pH is a good condition for growing larvae, however it will kill them if it is too acidic or basic. The acidic pH will influence the availability of larva's food because of the disturbance of plankton as food resources [37].

In Padang city, West Sumatra, the household water supply is from two sources, household wells and Regional Water Company. The household wells were dug around 10−15 m into the ground, and the wall of the well is covered permanently by cement or any concrete materials. If it is not covered by cement, then will easy contamined by bacteria in the soil layer. Meanwhile, in the case of regional water company, the water was treated by chemical compound (such as chlorine, alum and lime) to kill microorganism and algae. So, the presence of Aedes spp. larvae are highest in the water supply from the household wells because have many microorganism and algae. Pant and Self [10] have informed that larvae of mosquito related with species of a plant located in the same habitat. The larvae of mosquito will hold out to live in area with the kind of plants like moss and some kind of hidroponic plants.

5. Conclusion

The results showed that the most favorable microhabitat of *Aedes* larvae was an indoor cement water tub and water source was from dug wells. The results indicated that the measured environment conditions such as water temperature, air temperature, humidity, and water pH were not significantly associated with larva density in different habitats. This study showed that settlement house condition of Korong Gadang is tolerable based on microhabitat and environmental factors of *Aedes* spp.

6. Acknowledgment

Authors are grateful to Rijal Satria for significant help during writing this script.

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