Density and habitat characterization of *Aedes* sp. breeding places in dengue Endemic Area in Bandar Lampung

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**Abstract.** *Aedes* sp. are vectors of the dengue virus that causes Dengue Haemorrhagic Fever (DHF). The purpose of this study was to analyze habitat characteristics of *Aedes* sp. based on the entomological index and measure the density and species of larvae *Aedes* sp. The research was analytic observational with a cross-sectional study conducted in 3 subdistricts of endemic in Bandar Lampung. The results showed that from 3 locations, namely Sukarame, Kemiling and Tanjung Seneng, the House Index (HI) values were 41, 38, 31, respectively. The Container Index (CI) values were 14, 12, 10 respectively and the Breteau index (BI) values were 105, 77, 60 respectively. The result of density figure (DF) were 5-6 which means the density of *Aedes* sp. were moderate to high. The result of identification of larvae were 3 species of mosquitoes were *Aedes aegypti*, *Aedes albopictus* and *Culex quinquefasciatus*. The dominant species of larvae were found are *Ae. aegypti*. The characteristics of larval habitat as a risk factor for increasing the density of mosquito in Bandar Lampung are buckets or container made of plastic or cement and dispenser, light colour, direct light exposure, 1-20 liters water volume, no cover container, no drainage, and no fish rearing.

1. **Introduction**

Dengue Hemorrhagic Fever (DHF) is one of the public health problems in Indonesia whose incidence and sufferers are increasing and the area of spread is increasingly widespread. This disease has spread in 433 of 497 districts / cities in Indonesia [1]. DHF is caused by the dengue virus and is spread by mosquitoes. The types of mosquitoes that have been reported as primary vectors of this disease are *Aedes aegypti* and *Aedes albopictus*, while other types such as *Aedes polynesiensis*, *Aedes scutellaris* and *Aedes (vinlaya) niveus* are secondary vectors [2].

Dengue virus transmission occurs not only from mosquitoes to humans, but also occurs from female mosquitoes to male mosquitoes transsexually as well as from mother to offspring transovarially. Efforts to prevent dengue virus infection are focused on avoiding vector mosquito bites and controlling vector mosquitoes in their breeding habitat. Control of vector mosquitoes can be carried out by environmental control, biological control and chemical control. Environmental control is done by limiting the space for mosquitoes to breed [3].

Bandar Lampung is one of the leading cities which is the center of growth in Southern Sumatra causing high mobilization and population density. This has an impact on increasing the risk of spreading infectious diseases, especially dengue. Dengue cases are often an extraordinary event in Bandar Lampung City. During 2016-2020, dengue cases continued to increase and reached 5135 cases in 2020. Various prevention and countermeasures have been carried out including patient tracking (epidemiological investigations) within 100 meters of the patient's house, selective larvicidation,
fogging focus, periodic larvae checks, establishment of DHF working group, mobilizing the control mosquito breeding place with 3M and counseling about dengue disease [4].

Therefore, efforts to improve environmental health towards a Healthy City need to be continuously carried out by various parties from the government to the community in order to produce a decent life for residents in Bandar Lampung City. Community understanding and knowledge need to be improved in order to create a clean and healthy lifestyle [5]. So that this research is expected to provide scientific data on bioecological factors such as density and habitat characteristics of the Aedes sp mosquito as a DHF vector. This bioecological factor is closely related to the lifestyle in the community, so the results of this study can be a recommendation to control dengue disease effectively and efficiently.

2. Method

2.1. Research site and sample

The research will be conducted in 3 dengue endemic districts in Bandar Lampung City. The sample of selected houses is houses that are located in a radius of 100 meters from the houses of dengue patients with a total of 100 houses. In each house examined, epidemiological data will be collected from Aedes sp. larvae and pupae.

2.2. Research method

The Survey method using single larvae method in any water reservoirs are found larvae. Identification of larval habitat characteristics was carried out by conducting house to house entomological surveys, namely directly examining water containers that have the potential as mosquito larvae habitats. The variables observed were the location of the container, the type of container, material of the container, the colour of the container, exposure to light, the volume of water, the presence of a cover, drainage for the past week, fish rearing and larvacidal using [6].

2.2.1. Collection and Identification of larvae. In the larval survey, larvae counting and collection were also carried out in each container where larvae were found. The counting of the larvae directly using counter for 1 minute than we take the larvae for collection, if the number of larvae is more than 4, then 4 larvae are taken, if the number of larvae is less than 4 then all larvae will be collected [7] put the larvae into the collection bottle which contains 70% alcohol and has been labeled. The collected larvae were then identified by taking the larvae from the vial using a needle and placing it on a glass object than observing and examining the morphology of the larva identification key book [8].

2.2.2. Data analysis. Density of Aedes sp. assessed from the Entomology Index (EI) which consists of the Container Index (CI), House Index (HI), Breteau Index (BI). The result of the population density of the vector Aedes sp were compared with the Density Figure which was expression on scale of 1-9 (Tabel 1) [6]. EI have relevance to the dynamics of dengue transmission in a region. HI and BI are used to determine priority areas for vector control, if HI > 5% and or BI > 20% then the area is categorized as sensitive to DD and highly infested with larvae. BI is also used as a predictor of outbreaks, if BI > 50% then the area has the potential to experience outbreaks and becomes a control priority [9]. The relationship between larval habitat characteristics and the presence of larvae and types of larvae were analyzed by Chi-square correlation test with R program.

| Density Figure | 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           |
3. Result and discussion

3.1. Dengue endemic area in Bandar Lampung

Bandar Lampung city with a land area of 169.21 km² is the main gateway to the island of Sumatra which has an important role in land transportation routes from Java. Bandar Lampung is divided into 20 sub-districts and 126 urban villages with a population of 1,166,066 [10]. With the mobilization and high population density, Bandar Lampung has the potential to be a good area for the development of an infectious disease, one of which is dengue. According to data from the Bandar Lampung City Health Office, the number of dengue cases reached 5135 cases in 2020 and for the last 5 years Bandar Lampung has become a dengue endemic area in Lampung Province [4]. Figure 1 shows the number of dengue cases in 20 sub-districts in Bandar Lampung. The figure shows that in every sub-district there are cases of dengue which fluctuate greatly every year. Figure 2 shows the distribution of endemic areas in Bandar Lampung for 5 years. From the figure, it can be seen that most areas in Bandar Lampung are classified as high endemic areas, and 3 areas that have continuously had the highest cases for 5 years are Sukarame, Kemiling and Tanjung Seneng.

| Sub-district  | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------------|------|------|------|------|------|
| Sukarame      |      |      |      |      |      |
| Kemiling      |      |      |      |      |      |
| Tanjung Seneng|      |      |      |      |      |

Figure 1. The pattern of dengue incidence in Bandar Lampung in 2016-2020.
Figure 2. Dengue Endemic Area in Bandar Lampung from 2016-2020.

3.2. Density of larval on endemic area on Bandar Lampung

The density of Aedes sp larvae in Sukarame and Kemiling areas is on a scale of 6, while Tanjung Seneng is on a scale of 5. These results illustrate that the density of Aedes spp. classified as high in Sukarame and Kemiling, while Tanjung Seneng had a medium larval density. Sukarame area has a House Index (HI) is 41%, a Container Index (CI) is 14% and a Breteau index is 105%. Meanwhile, Kemiling has an HI value is 38%, CI is 12% and BI is 77%. Then for the Tanjung Seneng area, HI is 31%, CI is 10% and BI is 60% (Table 2).

House Index (HI) was obtained from the percentage of houses that found larvae. The HI value describes the spread of mosquitoes in an area. The higher the HI value, the higher the risk of community contact with dengue vector mosquitoes so that the higher the incidence of dengue fever in
The results of the CI value were obtained from the container found by the larvae. The CI value can evaluate the success rate of the dengue control program in an area, while the BI value is the percentage between containers that are positive for larvae and the number of houses inspected. The BI value indicates an area with an extraordinary incidence of dengue.

Table 2. Density of larvae in Bandar Lampung.

| Location     | HI (%) | CI (%) | BI (%) | DF  |
|--------------|--------|--------|--------|-----|
| Sukarame     | 41     | 14     | 105    | 6.3 |
| Kemiling     | 38     | 12     | 77     | 6   |
| Tanjung Seneng | 31    | 10     | 60     | 5.3 |

Note: HI : House Index  
CI : Container Index  
BI : Bretaeu Index  
DF : Density Figure

The results obtained from the 300 houses examined were 41 houses where mosquito larvae were found (13.6%) and from the 749 containers examined were 105 containers that were positive for mosquito larvae (14.02%). Based on the number of houses examined, *Aedes* spp is the dominant mosquito species found in Bandar Lampung. *Aedes aegypti* dominates in all areas (12%, 8.67% and 8.33%). *Aedes albopictus* mosquito which is a secondary vector of dengue was also found quite a lot (2.33%, 4.67% and 1.67%). Another type of larva found in the three areas is *Culex quinquefasciatus* (2.33%, 2.33% and 1.67%). Meanwhile, based on the number of containers examined, the results obtained were similar, namely *Ae. aegypti* which dominates in all sample areas (Table 3).

Table 3. Distribution of larvae in Bandar Lampung.

| Variable                  | Sukarame | Kemiling | Tanjung Seneng |
|---------------------------|----------|----------|----------------|
| Houses                    | 300      | 300      | 300            |
| *Aedes aegypti*           | 36       | 26       | 25             |
| *Aedes albopictus*        | 7        | 14       | 5              |
| *Culex quinquefasciatus*  | 7        | 7        | 5              |
| Container                 | 749      | 640      | 607            |
| *Aedes aegypti*           | 86       | 45       | 49             |
| *Aedes albopictus*        | 12       | 24       | 6              |
| *Culex quinquefasciatus*  | 7        | 8        | 5              |

3.3. Characteristics of larval habitat on the presence of larvae

The Result of larval habitat characteristics on the presence of larvae showed that mosquito larvae in three dominant sample areas were found in the house (16.01%, 13.92% and 11.22%) (Table 4). Statistically, there was no significant correlation between the location of the container and the presence of mosquito larvae in the three sample areas (0.101, 0.464, 0.370, p>0.05). The dominant type of container found was a container of water reservoir in the three sample areas (16.01%, 12.76% and 12.60%). Statistically, there was no significant correlation in the Sukarame and Kemiling areas (0.101, 0.614, p>0.05), but there was a significant correlation in the Tanjung Seneng area (0.034, p<0.05). The dominant types of containers found by larvae were plastic and cement. Statistically, in Kemiling there was a significant correlation (0.022, p<0.05), while the other 2 regions did not. The preferred color of the container as a breeding place is a bright container. Statistically, the Kemiling
and Tanjung Seneng have significant correlation (0.000, 0.032, p<0.05), but in the Sukarame area there was not significant correlation (0.718, p>0.05).

There were more larvae found in containers that were not exposed to direct sunlight, statistically there was significant correlation in Sukarame and Kemiling (0.004, 0.010, p<0.05). The volume of water that the larvae prefer as a breeding place is 1-20 liters, statistically there is significant correlation in the Sukarame area (0.006, p<0.05). The open container is a container where many larvae are found, statistically there is significant correlation in the Tanjung Seneng area (0.001, p<0.05). The container that was not drained within a week was the preferred container for larvae. It was statistically proven that there was significant correlation in the three regions (0.000, 0.005, 0.000 p<0.05). The volume of predatory fish larvae also affected the presence of larvae, especially in the Tanjung Seneng area, statistically stated that there was significant correlation (0.041, p<0.05). Larvicide administration in the container did not affect the presence of larvae in the three areas, with statistically stated that there was no significant correlation (0.259, 0.227, 0.231, p>0.05).

Table 4. The relationship between larvae habitat characteristic and larvae presence.

| Variable                          | Sukarame | Kemiling | Tanjung Senang |
|-----------------------------------|----------|----------|----------------|
| Location of Container             |          |          |                |
| Outside                           | 287      | 31       | 0.101          |
| Inside                            | 462      | 74       | 0.160          |
| Type of container Water reservoirs|          |          |                |
| Cement                            | 107      | 17       | 0.159          |
| Plastic                           | 546      | 72       | 0.131          |
| Iron                              | 26       | 5        | 0.192          |
| Rubber                            | 23       | 4        | 0.173          |
| Wooden                            | 3        | 0        | 0.000          |
| Glass                             | 44       | 7        | 0.159          |
| Colour of container Light         |          |          |                |
| Light                             | 389      | 57       | 0.146          |
| Dark                              | 361      | 48       | 0.133          |
| Light exposure direct             |          |          |                |
| <1 L                              | 255      | 20       | 0.078          |
| 1-20 L                            | 286      | 48       | 0.168          |
| 20-100 L                          | 167      | 33       | 0.197          |
| >100 L                            | 41       | 3        | 0.073          |
| Present of Cover                  |          |          |                |
| Yes                               | 173      | 34       | 0.196          |
| Non Water reservoirs Material of container| | | |
The geographical condition of Bandar Lampung City which has a high level of mobilization and population density requires regional readiness to face the risk of a disease epidemic. Therefore, disease prevention and extraordinary events, both infectious and non-infectious diseases, must be a special concern in the city of Bandar Lampung, especially in the prevention of dengue disease. The main factors of dengue virus transmission in an area include the presence of viruses, hosts and vectors. Transmission of dengue virus from infected humans to other humans becomes more risky in areas with high mobilization, especially in endemic areas [12]. Endemic areas are areas where in the last 3 years there have been cases or deaths caused by dengue sequentially, although the number is only one. The high population growth rate also increases the risk of dengue transmission [13]. The host of the dengue virus is humans in urban or rural areas. in line with the host, the main vector of this virus is the Aedes spp mosquito which is cosmopolitan and its habitat is adjacent to the human environment.

The results of this study provide input for improving vector mosquito control by describing the bioecological data of vector mosquitoes clearly and completely. The results showed that the density of Aedes sp mosquitoes was high in the Sukarame and Kemiling areas, while in Tanjung Seneng the density was moderate. This shows that these two areas have a high potential for the spread of dengue disease. These results are also supported by the high values of the House Index (HI) and Breautéu Index (BI). The higher the HI value and the higher the possibility of the community to come into contact with the Aedes sp mosquito which is a dengue vector [9]. The higher the BI value, the higher the potential for dengue outbreaks in an area [11]. The Container index value indicates that the control program in the 3 sample areas was not successful so it is necessary to evaluate and educate the surrounding community to maintain cleanliness so as to reduce the breeding places of Aedes spp. [12].

_Aedes aegypti_ larvae were the most common species found in the three sample areas. The _Ae. aegypti_ is a mosquito that has been widely reported as the main vector of the dengue virus and it is commonly found in densely populated settlements [14]. This is because these breeding places of mosquitoes are containers that are also used by residents. In addition, the species also found were _Aedes albopictus_ which is reported to be a secondary vector of the dengue virus. _Ac. albopictus_ is more commonly found in residential peridomestic environments because of the large number of unused and poorly managed containers and the characteristics of the yard where there is a lot of abandoned vegetation [15]. Apart from the genus _Aedes_ sp, Culex quinquefasciatus were also found in the sample area. Culex mosquitoes are also reported to be found in densely populated settlements. Although not a dengue vector, this mosquito can be a vector of chikungunya virus, Zika virus, and filarial worms [16].

The results of habitat characteristics, water reservoirs are more dominant found larvae and based on the type the most are bathtubs and buckets. In addition, larvae are also found in drinking water dispensers. In places other than air reservoirs, larvae are commonly found in used plastic containers and plant pots filled with air. The people's habit of collecting water is motivated by the lack of water availability, which does not have an air source in each house [17]. This happens a lot in Sukarame and Kemiling sub-districts. The habit of storing water may be a habitat for _Aedes_ spp. larvae.

Selection of the place where _Aedes_ spp. lays eggs is influenced by the basic material of the container. This is because the _Aedes_ sp mosquito has a characteristic in oviposition which is placed in

|                | No | 523 | 71 | 13.56 | 502 | 67 | 13.35 | 566 | 50 | 8.83 |
|----------------|----|-----|----|-------|-----|----|-------|-----|----|------|
| Drainage       | Yes| 418 | 34 | 16.99 | 0.00*| 348 | 29 | 8.33 | 0.005*| 339 | 19 | 5.60 | 0.000*|
|                | No | 243 | 71 | 13.99 |     | 283 | 48 | 16.96 |     | 268 | 43 | 16.04 |     |
| Fish Rearing   | Yes| 77  | 0  | 0.00  | 0.001*| 75  | 0  | 0.00  | 0.002*| 48  | 0  | 0    | 0.041*|
|                | No | 672 | 105| 15.63 |     | 531 | 77 | 14.50 |     | 559 | 62 | 11.09 |     |
| Larvasida      | Yes| 16  | 0  | 0.00  | 0.259| 20  | 0  | 0.00  | 0.227| 23  | 0  | 0    | 0.231|
|                | No | 733 | 105| 14.32 |     | 620 | 77 | 12.41 |     | 583 | 62 | 10.63 |     |
a container. Slippery walls will prevent mosquitoes from laying their eggs. Other studies also mention that the basic materials of plastic and cement may be a breeding ground. In addition, the color of the container can also affect the mosquito's preference for laying eggs [18]. The results of the research in Bandar Lampung showed that the most commonly found containers were light colored larvae, different from previous studies which stated that Aedes sp. prefers to lay eggs on the walls of dark colored containers.

The location of the container where many larvae are found is in the house which is also an air reservoir. This is also in line with the results of containers that are not directly exposed to sunlight, which is a possibility that might occur as a breeding site for Aedes sp. The location of the container generally does not affect the mosquito's preference for oviposition but the availability of food is one of the factors for laying eggs by mosquitoes [19]. Open container conditions are also more likely as a breeding site, mosquitoes will have more places to lay eggs than closed places [20]. There were no mosquito larvae in the containers that were given predatory fish and larvicides.

4. Conclusion
The density of larvae in the dengue-endemic area of Bandar Lampung showed high and medium densities. The dominant species of larvae were found are Ae. aegypti. The characteristics of larvae habitat as a risk factor for increasing the density of mosquito in Bandar Lampung are buckets or container made of plastic or cement and dispenser, light color, direct light exposure, 1-20 liters water volume, no cover container, no drainage, and no fish rearing

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