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Diversity and abundance model according to habitat characteristics of filariasis vector, *Mansonia* spp. in Banyuasin, South Sumatera, Indonesia

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Abstract. Filariasis is an infectious disease caused by filariae worm transmitted by a mosquito as vectors. *Mansonia* is one of the genera of filariasis vectors. The high risk of filariasis transmission is the existence of habitat character which is qualified for *Mansonia* spp. One of filariasis endemic area is Banyuasin, South Sumatera, as much as 2.02% microfilaria rate. This study was conducted to estimate the number of vector abundance influenced by habitat characteristic. The data collection was from two villages: Sedang and Muara Sugih, from April 2017 – May 2018. Mosquitos were caught using aspirators and humans as baits. Ecological factors were the physical environment such as temperature measured by thermometer and humidity measured by sling hygrometer. Water parameter and geographic factors were analyzed. Abundance model of *Mansonia* spp described using regression test for multivariate analysis. Data analysis was performed and presented in form of frequency tables. The number of samples was 4.956 mosquitoes. There were six species such as *Mansonia uniformis, Mansonia annulifera, Mansonia indiana, Mansonia dives, Mansonia bonneae,* and *Mansonia annulata*. Sedang Village was dominated by *Mansonia uniformis* (41.25%) whereas, Muara Sugih Village was by *Mansonia bonneae* (45.66%). The ideal habitat characteristics for *Mansonia* spp were environmental conditions with high temperature and humidity, low water turbidity, low water temperature, low pH, TDS, and high TSS. The diversity and abundance of *Mansonia* spp as a potential vector of filariasis *Brugia malayi* in Banyuasin regency was closely related to environmental characteristics such as temperature, humidity, water parameters, and plant species.

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1. Introduction

Filariasis is an infectious disease caused by filariae with mosquito as vectors [1]. There are 23 species of mosquitoes that can be vectors of filariasis transmission. Mansonia is one of the genera of filariasis vectors [2–5]. Based on data from the Ministry of Health of the Republic of Indonesia in 2014, more than 14 thousand filariasis patients are found in 418 districts. 241 of which are filariasis-endemic areas with high transmission risk (with microfilaria rate more than 1% of the population) [6]. The high risk of filariasis transmission is one of them is caused by the existence of habitat character which is qualified as the habitat of filariasis vector transmission. The disease still dominates tropical countries. Generally, these vectors live well in lowland areas, especially rice fields, swamps, and forests. By a large demographic characteristic of low land, Indonesia has the potential to become an endemic area of mosquitoes to breed and become a filariasis infection agent [6].

In 2014, the province of South Sumatera has an incidence of 173 cases of chronic filariasis. 142 cases of chronic filariasis came from Banyuasin regency. Based on data from the Banyuasin Health Office 2016, until 1983-2002 microfilaria rate is 2.02%. Banyuasin is as filariasis endemic area [7]. This rate is correlated with the temperature and humidity of the biological environment, thus affecting the diversity and abundance of vectors in endemic areas.

Ecological factors such as temperature and humidity have a significant role in the transmission of filariasis. High temperature and humidity are important for the survival of most vectors. The development of lymphatic filariasis parasites in the mosquito body takes 2 weeks at 27°C and 90% humidity [8–10]. The larval development period varies according to the season. In order to tackle the chain of filarial transmission in an endemic area, it is required to determine the proliferation of filariasis vectors' factors.

2. Methods

2.1. Study area

This study was conducted in Banyuasin regency, South Sumatera province, Indonesia. The study was located in two places with different ecological backgrounds. The first site was held in Sedang Village, Suak Tapeh Subdistrict, Banyuasin, located at 29º 49'39 " LS and 104º25'38 "BT, with an area of 6.402 m^2, dominated by swamp areas (figure 1). The second location was held in Muara Sugih Village, Tanjung Lago Sub-district, Banyuasin, located at 2º47'48 "LS and 101º45'72" BT, with an area of 1.439 m^2, dominated by rice fields (figure 2).

2.2. Sampling of mosquitoes

Data collection was taken from April 2017-May 2018. The design of this study was cross-sectional with a survey approach. The study sample included: all mosquitoes *Mansonia* spp caught, identified using Rampa and Wharton book. The sampling of mosquitoes with human landing collection was done inside and outside the home. Before the trapping began, mosquito scouts were given an explanation of the technique of catching mosquitoes and signing informed consent as a sign of willingness to follow the study.

Thermometers and sling hygrometers are installed in the open (outdoor) to monitor the temperature and humidity. Measurements were made for 24 hours and recorded hourly. The capture was carried out by six people in six homes (three in the house and three outdoors). Using the aspirator and the captured mosquitoes were inserted into a paper cup. It was carried out from 18.00 until 17.00 the next day. The mosquito that had been inserted into a paper cup, then anesthetized with chloroform, later examined under a microscope and identified with morphological key [11].

2.3. Measurement of habitat characteristics

Ecological factors measured as habitat characteristics were the physical environment (temperature, humidity), water parameters (water temperature, turbidity, total dissolved solids, total suspended solids, coliform, pH), aquatic plants, and geographical area observed (land height and land use).

Temperature measurements are carried out daily using a six Bellani® thermometer, calculating the maximum temperature plus the minimum temperature divided by two. Humidity measurements were made using a hygrometer sling by calculating a wet ball thermometer (WBT) and dry ball barometer

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(DBT). The measurement was calibrated until the accuracy of 0.1ºC, according to the difference in the temperature of WBT and DBT. The measurement result was recorded hourly for 24 hours. Water samples from several site locations were taken into the same volume target. The sample was examined in the laboratory to check physical, chemical and microbiological properties.

The geographical condition of the area was observed by determining the location via GPS at the point of data collection, to know the altitude of the area and observing the land use.

Figure 1. Map of Sedang village, district of Suak Tapeh.

Figure 2. Map of Muara Sugih village, Tanjung Lago sub-district.

2.4. Data analysis

These data were multivariate analyzed to obtain the population abundance model of *Mansonia* spp as a potential filariasis vector. Mathematical models which would be obtained were mathematical models of abundance was influenced by significant ecological factors (p <0.05). The statistical analysis is as follows:

$$y=b0+b1x1+b2x2+b3x3+b4x4 + b5x5 + b6x6 +b7x7+b8x8$$

Where:

y = abundance of mosquito *Mansonia* spp

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x1 = temperature
x2 = humidity
x3 = water parameters
x4 = behavior change
x5 = type of aquatic plants
x6 = puddles
x7 = altitude
x8 = land use

3. Results

The collecting samples in Sedang village and Muara Sugih village was obtained as follows:

Table 1. Diversity and abundance of mosquito *Mansonia* spp from Sedang and Muara Sugih village in April 2017-May 2018.

Species	Sedang	(%)	Muara Sugih	(%)
Mansonia annulifera	1585	35.63	3	0.59
Mansonia uniformis	1835	41.25	166	32.70
Mansonia indiana	985	22.14	5	0.98
Mansonia dives	4	0.08	102	20.08
Mansonia bonneae	30	0.7	232	45.66
Mansonia annulata	9	0.20	0	0.00
	4448	100	508	100

Mansonia uniformis were the most dominant (41.25%) in Sedang village. *Mansonia annulifera* (35,63%) and *Mansonia indiana* (22,14%) were much higher than Muara Sugih village. While *Mansonia bonneae* (45,66%), *Mansonia uniformis (32,70%)* and *Mansonia dives* (20,08%) in Muara Sugih were the dominant species. *Mansonia annulata* was the lowest abundant species in these two villages.

Table 2. The abundance of *Mansonia annulifera*.

Variable	R	R^2	Equation Line	p-value
Mansonia annulifera	0.625	0.39	Abundance of *Mansonia annulifera*= 123,696-0,222(water turbidity level)-0,805(TSS)+0,045(TDS)-7,775(water plant)-15,538(land use)	0.041

Based on the model above, *Mansonia annulifera* preferred environmental conditions which had characteristics in low water turbidity levels, low TSS, high TDS, *Pistia stratiotes* water plant and farming land use.

Table 3. The abundance of *Mansonia uniformis*.

Variable	R	R^2	Equation Line	p-value
Mansoniau niformis	0.615	0, 378	Abundance of *Mansonia uniformis*=243,680-0,529(water turbidity level)-19,264(pH)-0,243(TSS)-8,797(water plant)-21,554(land use)	0.049

According to the model above, *Mansonia uniformis* preferred environmental conditions with low water turbidity level, low pH, low TSS, *Pistia stratiotes* water plant and farming land use.

Table 4. The abundance of *Mansonia dives*.

Variable	R	R^2	Equation Line	p-value
Mansoniad ives	0,636	0.404	Abundance of *Mansonia dives*= 10,250-0,106(water temperature)-1,241(pH)-0,194(BOD)-0,024(TSS)+0,648 (water plant)	0,033

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Based on the model above, *Mansonia dives* like environmental conditions with low water temperature, low pH, low BOD, low TSS, and *Limnocharus flava* water plant.

Table 5. The abundance of *Mansonia indiana.*

Variable	R	R^2	Equation Line	p-value
Mansoniai ndiana	0.641	0.411	abundance *Mansonia indiana*= 0,517+1,918(temperature)+0,587(COD)-0,195(TSS)-3,553(water plant)-8,022(land use)	0,03

Based on the model above, *Mansonia indiana* like environmental conditions with high temperature, high COD, low TSS, *Pistia stratiotes* water plant and farming land use.

4. Discussions

In previous studies, many species of *Mansonia dives, Mansonia bonneae,* and *Mansonia uniformis* found in the crevices of rocks under the grasses [12]. Additionally, many mosquitoes were found resting on crates placed in protected areas in Malaysian settlements. *Mansonioidea* generally rests much near the ground under the leaves of the grasses. In the Kapuk Village of West Jakarta, *Mansonia uniformis* were more active outside the home than in the home. *Mansonia uniformis* began to actively enter the house and bite humans between the hours of 19:00 to 20:00 and between 22:00 to 23:00. Mosquitoes that rest on the walls of the house, were likely more female mosquitoes with the bloody abdomen. *Mansonia uniformis* were generally outdoors and active at night [13].

The environmental conditions of Banyuasin regency are in accordance with the larvae development. The area of this village was mostly surrounded by swamps and rubber or palm plantations, with stagnant and chronic stagnant types. The potential place for the development of *Mansonia* spp larvae attaches with the aquatic plants. Water plants were very influential on bionomic mosquitoes. Most of the mosquito species, especially *Mansonioides* prepare good habitats to breed in submerged, floating leaves or on plants surface because parts of the plant protect them from physical disturbance and provide mechanical support and suitable conditions for laying eggs [8].

The diversity and abundance of *Mansonia* spp in both villages were varied. It might be influenced by regional characteristics, with its climatic factors and the availability of good breeding places for certain species. It showed the correlation with the availability of breeding places, resting places and favorable climatic factors such as temperature and rainfall. Environmental changes had a direct or indirect impact on mosquito behavior and bionomics. Local climatic parameters play an important role in determining the distribution and abundance of vectors as the spread disease [14,15].

5. Conclusion

In summary, the diversity and abundance of *Mansonia* spp as a potential vector of filariasis *Brugia malayi* in Banyuasin regency was closely related to environmental characteristics. Temperature, humidity, water parameters, and plant species were associated with the availability of breeding grounds, resting places and favorable climatic factors for the proliferation of vectors. This abundance model could be used as a reference in controlling the transmission of filariasis by intervening ecological factors.

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