

Diversity of Mosquito Larvae Breeding Sites in Several Sampling Locations in Donggala Regency, Central Sulawesi, Indonesia

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ABSTRACT

Mosquitoes live in accordance to physical and biological environment. The aim of this study was to find out the diversity of mosquito larvae. The study was conducted on September 29 to October 31, 2014. Data was collected in six types of sampling locations, which are forest sampling location near settlements, forest sampling location located remotely from settlements, non-forest sampling location near settlements, non-forest sampling location located remotely from settlements, coastal area sampling location near settlements, and coastal sampling location located remotely from settlements. Mosquito larvae breeding sites in forest sampling location located remotely from settlements were river, rock holes, taro leaf axil, and coconut shells. In this breeding site, there were *Anopheles*, *Uranotaenia*, and *Aedes* larvae found. Breeding sites in non-forest sampling location near settlements were river, bamboo, taro leaf axil, and larvae found were four, namely; *Anopheles*, *Culex*, *Malaya*, and *Uranotaenia*. Breeding sites in non-forest sampling location located remotely from settlements were river, banana leaf axil and coconut shells, and the mosquito larvae found were four, namely; *Anopheles*, *Culex*, *Armigeres*, and *Aedes*. In coastal sampling location located near settlements, breeding sites were puddles, ponds, banana and taro leaf axil, river, mangrove, and ponds, and the mosquito larvae found were four, namely; *Anopheles*, *Culex*, *Mansonia*, and *Aedes*. Breeding sites of coastal sampling location located remotely from settlements were dikes and the mosquito larvae found were only two, namely; *Anopheles* and *Culex*. Characteristics of mosquito larvae breeding places were specific.

Keywords: *diversity, breeding sites, sampling locations*

1. INTRODUCTION

Mosquitoes are widespread in the world, and they live in accordance to the physical and biological environment of their breeding sites [1]. Mosquito-borne diseases are affected by rainfall, temperature, and humidity, which affect the activity and metabolism of mosquitoes [2]. Mosquito breeding sites are strongly influenced by rainfall. Increasing temperature will accelerate the life cycle of mosquitoes and can increase transmission of disease by mosquitoes. Increasing temperatures will affect water temperature of mosquito breeding sites, which in turn accelerates the hatching of eggs [2]. The environment can be a breeding site for mosquito larvae. In general, the environment can be divided into physical, chemical, and biological environment. Each of these environment contributes to the presence of mosquitoes [3]. The changes in rainfall, temperature, humidity, and wind direction can influence the development of mosquitoes, such as increasing breeding sites, mosquito biting behaviour, mosquito life cycle, all of which can influence disease transmission pattern [4]. The aim of this study was to find out the diversity of mosquito larvae in six sampling sites,

forest near settlements, forest located remotely from settlements, on non-forest location both near settlements and remote from settlements and also on coastal area just near and far distance from settlements.

1.1. Materials and Methods

The data was a preliminary of Vector and Reservoir Study conducted on September 29 to October 31, 2014, in Banawa Selatan Sub-District, Donggala Regency, Central Sulawesi Province. The data was collected in six type of sampling locations, which are forest sampling location located near settlements, forest sampling location remotely located from settlements, non-forest sampling location located near settlements, non-forest sampling location remotely located from settlements, coastal area sampling location located near settlements, coastal area sampling location remotely located from settlements.

Mosquito larvae collection was carried out in mosquito breeding sites, such as; rice fields, swamps, river flows, rock holes, ponds, and puddles using mosquito dipper, aquatic nets, plankton nets, and larvae pipette. During larva

collection, water temperature and vegetation of aquatic plants was recorded. The larvae collected from the field were transported to the laboratory and reared until adulthood. Keys for the identification of mosquitoes based on Rattanarithikul *et al.* [5, 6].



Figure 1 Donggala Regency, Central Sulawesi Province

1.2. Our Contribution

This paper described some information about the diversity of mosquito larvae breeding sites. Breeding sites in six different ecosystems were chosen and several mosquito larvae species were found.

1.3. Paper Structure

The rest of the paper is organized as follows. Section 2 introduces the preliminaries used in this paper, which include mosquito larvae collection in breeding sites; such as forest sampling location located near settlements, forest sampling location remotely located from settlements, non-forest sampling location located near settlements, non-forest sampling location remotely located from settlements, coastal area sampling location located near settlements, coastal area sampling location remotely located from settlements. Section 3 presents mosquito species that has different breeding sites based on geographic zones. Finally, section 4 concludes the paper.

2. RESULTS AND DISCUSSION

2.1. Ecosystem of Forest Located Near Settlements

Table 1 showed that there were several types of breeding sites that exist in the ecosystem of forest located near settlements, including; rivers, ponds, bamboo trees, puddles river, leaf axil, water springs. Mosquito larvae found per dipper consisted of several genera, namely; *Anopheles*, *Culex*, *Malaya*, and *Aedes*. The larvae of *Anopheles barbirostris* were found in ponds in forest ecosystem located near the settlement.

Table 1 Characteristics of mosquito larvae breeding sites in forest ecosystem located near settlements, South Banawa District, Donggala, Central Sulawesi, September-October 2014

Breeding Sites	Physical-Biological Character of Aquatic Environment	Mosquito Species	Number of Mosquito(es)
River	Depth: 15 cm	<i>Anopheles vagus</i>	3
		<i>Culex</i> sp.	8
Bamboo	Depth: 3 cm	<i>Malaya</i> sp.	2
River Puddle	Width: 6 m ² , depth : 20 cm, pH : 7,83, Temperature : 26,5 °C, plant litter	<i>Anopheles flavirostris</i>	8
		<i>Anopheles ludlowae</i>	5
		<i>Culex</i> sp.	16
Leaf Axil	Temperature: 27 °C	<i>Malaya</i> sp.	1
		<i>Aedes</i> sp.	1
Ponds	Width: 1000 m ² , depth: 30-100 cm, direct sunlight, turbid water condition, water hyacinth plants	<i>Anopheles barbirostris</i>	3
River Flow	Depth: 20 cm	<i>Anopheles barbumbrosus</i>	1
Water Springs	Depth: 25 cm, temperature : 25 °C	<i>Culex mimulus</i>	2
Puddle	Depth: 10 cm	<i>Culex halifaxi</i>	4

Table 2 Characteristics of mosquito larvae breeding sites in forest ecosystem located remotely from the settlement, South Banawa District, Donggala, Central Sulawesi, 2014

Breeding Sites	Physical-Biological Character of Aquatic Environment	Mosquito Species	Number of Mosquito(es)
Puddles along the river	Depth; 15 cm, Temperature: 26,5 °C, direct sunlight	<i>Uranotaenia</i> sp.	1
		<i>Culex hutchinsoni</i>	1
		<i>Anopheles maculatus</i>	1
		<i>Culex fuscocephalus</i>	3
		<i>Anopheles barbumbrosus</i>	1
		<i>Culex bitaeniorhyncus</i>	3
Bamboo	Depth: 3 cm	No mosquito larva was found	0
Leaf Axil	Temperature: 26,5 °C	No mosquito larva was found	0
Taro Leaf Axil	Temperature: 27 °C	<i>Malaya</i> sp.	1

2.2. Ecosystem of Forest Remotely Located from Settlements

Table 2 showed mosquito larvae which were obtained from several breeding sites located in forest sampling location remotely located from settlements. It showed that there were some types of breeding sites that exist in forest sampling location remotely located from settlements, including; river, rock hole, river flow, river, coconut shell, and leaf axil. Mosquito larvae found per dipper consisted of several genera, namely; *Anopheles*, *Uranotaenia*, and *Aedes*.

2.3. Forest Area Ecosystem

In this research, *Anopheles barbirostris* larvae were obtained in ponds in forest ecosystem near the settlement. As many as 16 *Anopheles barbirostris* larvae were found. The ponds were 1000 square meters in size, 30-100 cm deep, exposed to direct sunlight, with turbid water condition. Water hyacinth plants were found in the ponds. One of the factors influencing the location of chosen breeding site is water turbidity. According to Garjito [7] *An. barbirostris* can live in clean and turbid water, whereas Chadijah found *An. barbirostris* in clean water [7]. In forest ecosystem near settlement, water spinach and water hyacinth were found in the river which is suitable for *Ma.uniformis* larvae, but the larvae themselves were absent. However in this ecosystem, adult *Ma.uniformis* mosquitoes were caught at night. Whereas in forest remotely located settlements ecosystem there were no larvae of *An. barbirostris* and *Ma.uniformis*. Wharton [8] states that *Ma.uniformis* larvae are also found in open swamps and ponds which were covered with aquatic plants, especially if ponds or swamps have a depth between 15-100 cm. Water plants that were best for the growth of *Mansonia* mosquito

larvae were *Pistia stratiotes* (apu wood) and *Echornia crassipes* (water hyacinth) [9].

2.4. Ecosystem of Non-Forest Located Near Settlements

Table 3 showed mosquito larvae obtained from several breeding sites located in non-forest sampling location near settlements. It also showed that some types of breeding sites were found in the ecosystem of non-forest near settlements, including; river, rock hole, coconut shell, leaf axil, river flow. The mosquito larvae that were successfully obtained in the field consisted of several genera, namely; *Anopheles*, *Culex*, *Malaya*, and *Uranotaenia*.

2.5. Ecosystem of Non-Forest Located Remotely from Settlements

Mosquito larvae found in non-forest sampling location remotely located from settlements ecosystem is presented in Table 4. The mosquito larvae that were obtained in the field consisted of several genera, namely; *Anopheles*, *Culex*, *Armigeres*, and *Aedes*. The breeding sites found in non-forest remotely located from settlements, including; puddles river, banana leaf axil, stream along the river, and coconut shell. In general, mosquito need water as breeding places. Determination of breeding places depends on the type of mosquito and environmental factors that support the growth of larva. The research that conducted by Suwito [10] suggests that water on bamboo segment, puddle riverside, or rice fields as well as suitable environmental factor are enough to become mosquito breeding places. A total of 288 larvae were obtained from three breeding places, namely; rock hole, fallen tree, and bamboo segment, consisting of *Aedes*, *Culex*, *Uranotaenia* and *Armigeres*. In other site,

were found *Anopheles*, *Culex* and *Mansonia* at river by grass and rice field on its edge. According to research by Bram [11] in Thailand *Culex* larva can be found in various groundwater ponds, both temporary and semi-permanent, such as ponds, puddles. Other places that had been reported

were puddles, ponds with grass around edges, swamps, rock hole, small ponds, rice fields, elephant footprints and bamboo segment.

Table 3 Characteristics of mosquito larvae breeding sites in ecosystem of non-forest location located near settlements, South Banawa District, Donggala, Central Sulawesi, 2014

Breeding Sites	Physical-Biological Characteristic of Environment	Mosquitoes Species	Number of Mosquito(es)
River	Depth: 30 cm, Temperature: 27 °C, Turbid water condition	<i>Anopheles sulawesi</i>	11
		<i>Uranotaenia</i> sp.	1
Rock Hole	Temperature: 25 °C	<i>Uranotaenia</i> sp.	2
River Flow	Depth: 25 cm, Temperature: 26,5 °C, direct sunlight	<i>Anopheles sulawesi</i>	3
		<i>Anopheles flavirostris</i>	5
River	Depth: 15-50 cm	<i>Anopheles ludlowae</i>	4
Coconut shell	Temperature: 25 °C	<i>Aedes</i> sp.	6
Leaf Axil	Temperature: 26,5 °C	<i>Aedes</i> sp.	2

Table 4 Characteristics of mosquito larvae breeding sites in ecosystem of non-forest location located remotely from the settlements, South Banawa District, Donggala, Central Sulawesi, 2014

Breeding Sites	Physical-Biological Character of Aquatic Environment	Mosquito Species	Number of Mosquito(es)
Puddles river	Width: 12 m ² , depth: 10-40 cm, pH: 6,4 Temperature: 24 °C, salinity : 0‰, shade sunlight, no plants	<i>Anopheles vagus</i>	3
		<i>Anopheles ludlowe</i>	2
		<i>Anopheles sulawesi</i>	2
		<i>Uranotaenia</i> sp.	1
		<i>Culex bitaeniorhyncus</i>	16
Puddle Riverside	Depth: 13 cm, Temperature: 26,5 °C, direct sunlight	<i>Anopheles flavirostris</i>	8
		<i>Anopheles vagus</i>	3
		<i>Culex fluscocephalus</i>	4
		<i>Anopheles barbumbrosus</i>	8
Banana Leaf Axil	Temperature: 26,5 °C	<i>Aedes</i> sp.	3
Stream along The River	pH: 7,29, temperature : 26,5 °C	<i>Culex fragilis</i>	6
		<i>Anopheles vagus</i>	1
		<i>Culex halifaxii</i>	10
		<i>Anopheles flavirostris</i>	4
		<i>Anopheles ludlowae</i>	2
Coconut Shell	Temperature: 25 °C	<i>Armigeres subalbatus</i>	11

2.6. Ecosystem of Coastal Area Located Near Settlements

Table 5 showed mosquito larvae obtained from several breeding sites located in coastal sampling location near settlements. The breeding sites found in coastal area near from settlements, including; puddle, ponds, banana leaf axil, taro leaf axil, river puddles, river stream no roots, river stream with roots, and mangrove. The mosquito larvae that were obtained in the field consisted of several genera, namely; *Anopheles*, *Culex*, *Mansonia*, and *Aedes*. In coastal area near settlements, *An. barbirostris* larvae were found in flowing rivers without roots and flowing rivers with roots. There were 25 *Anopheles barbirostris* adults produced as the result of rearing, the larvae were obtained from river with and without roots. In coastal area near settlements, there was no larva of *Ma. uniformis*, but *Ma. genurostris* larvae were found. Rootless streams of river have a depth of about 15-30

cm with water temperature of about 30.5 °C, directly exposed to sunlight, and has pH 7.13. Mangrove forest which was located in coastal area near settlements has a width of 6 ha with salinity concentration of about 26 ‰, and water temperature of 27.9 °C also illuminated by the sun.

2.7. Ecosystem of Coastal Area Located Remotely from Settlements

Table 6 showed mosquitoes larvae obtained from some breeding sites located coastal sampling location located remotely from settlements. On Table 6 it is showed that breeding sites that were found in coastal area located remotely from settlements were in the form of dikes. The mosquito larvae that were successfully obtained in the field consisted of two genera, namely; *Anopheles* and *Culex*.

Table 5 Characteristics of mosquito larvae breeding sites in coastal area located near settlements, South Banawa District, Donggala, Central Sulawesi, 2014

Breeding Sites	Physical-Biological Character of Aquatic Environment	Mosquito Species	Number of Mosquito(es)
Puddle	Width : 4 m ² , depth : 20 cm, pH : 6,28, temperature : 26 °C, sunlight, water, spinach plants	No mosquito larva was found	0
Ponds	Width: 28 m ² , depth: 50 cm, pH: 7,21 temperature: 26,8 °C, shady, water, spinach plants	<i>Culex</i> sp	3
Banana Leaf Axil	Shady	<i>Aedes</i> sp	2
Taro Leaf Axil	pH: 6,16, temperature: 25,5 °C, shady	<i>Mansonia genurostris</i>	3
River Puddles	Depth: 15 cm, Temperature: 26,5 °C, shade sunlight	<i>Culex</i> sp.	4
		<i>Culex bitaeniorhyncus</i>	1
River stream with no roots	Depth: 25 cm. temperature: 27 °C, direct sunlight, turbid water condition	<i>Anopheles barbirostris</i>	25
		<i>Anopheles flavirostris</i>	3
		<i>Anopheles vagus</i>	14
		<i>Culex bitaeniorhyncus</i>	5
River stream with roots	Depth: 23 cm, shady, turbid water condition, temperature : 26 °C	<i>Anopheles barbirostris</i>	2
		<i>Anopheles flavirostris</i>	13
		<i>Culex bitaeniorhyncus</i>	5
Mangrove	Wide: 6 ha, depth: 30-150 cm, pH : 7,03, salinity: 26‰, temperature: 27,9 °C, sunlight, mangrove plants	No mosquito larva was found	0
Ponds	Wide : 2400 m ² , depth : 50-100 cm, pH : 7,42 salinity : 26‰, temperature : 29,0 °C, sunlight, moss	<i>Anopheles subpictus</i>	14
		<i>Culex</i> sp.	25

Table 6 Characteristics of mosquito larvae breeding sites in coastal area remotely located from settlements, South Banawa District, Donggala, Central Sulawesi, 2014

Breeding Sites	Physical-Biological Character of Aquatic Environment	Mosquito Species	Number of Mosquito(es)
Dike 1	Width : 10.000 m ² , depth : 100-150 cm, pH : 7,09 salinity : 33‰, temperature : 29 °C, sunlight, moss	<i>Culex vishnui</i>	249
Dike 2	pH : 7,32, salinity : 37‰	No mosquito larva was found	0
Dike 3	pH : 7,48, salinity : 31‰	No mosquito larva was found	0
Dike 4	pH : 7,33, salinity : 33‰	No mosquito larva was found	0
Dike 5	Width: 15 ha, depth : 50 cm, pH : 6,7 salinity: 26‰, temperature : 27 °C, sunlight	<i>Anopheles subpictus</i>	17

Each type of mosquito species has a different breeding sites characteristic based on the geographic zone. The difference is related to the ability of mosquito to adapt to the physical-chemical condition of water, especially the availability of food and living condition for premature stage. In addition, weather factor especially rainfall also affects the breeding sites [12].

2.8. Coastal Area Ecosystem

The number of *Anopheles barbirostris* larvae found in rootless river stream rootless was 304 larvae, while the number of *An. barbirostris* larvae found in river stream with roots was 242 larvae. In coastal area located remotely from settlements and non-forest ecosystem there were none of *An. barbirostris* or *Mansonia uniformis* larva found.

In general, larvae are found in horizontal position in a particular body of water, which is at the edge of breeding sites and is usually sheltered by vegetation such as grass and algae that are in the edge of breeding sites. The temperature of river stream in coastal area near settlements, where *Anopheles barbirostris* larvae were found, was 30.5 °C. According to [13], water temperature of 27.5 – 30 °C also assure the breeding of mosquito larvae, specially the genus *Anopheles*. The breeding sites have pH around 7, which is ideal for breeding sites. According to Raharjo [14], *Anopheles* larva can tolerate pH between 7.91-8.09 and the pH range of *Anopheles* mosquito breeding sites in dry season ranged from 6.8 to 8.6. A study that has been done by Monika Noshirma *et al* [15] in Central Sumba showed that breeding sites of *An. barbirostris* larvae in coastal area is are in puddles and undisturbed ponds with moss and algae. According to the Ministry of Health [16], the primary breeding sites of this larvae species are rice fields with

irrigation, ponds, and swamps. The ecological condition of study area was very important, because it reflects the area where the transmission of diseases may be endemic [17]. According to Rifai *et al.* [18], the biological environment, such as aquatic plants, swamps, and mangrove trees, could serve as breeding sites and affect the life of mosquito larvae. Rainfall, temperature, humidity, wind direction, and altitude were essential factors for breeding mosquito larvae. The presence of rain can lead to new breeding sites for mosquitoes so it would increase the transmission of vector-borne diseases [19]. Hidayati [20], states the same thing, that rainfall caused relative humidity to increase and many puddles would appear. These puddles are then used by mosquito larvae as breeding sites. Rain interspersed with heat might increases mosquito larvae breeding sites.

3. CONCLUSION

The characteristics of mosquito larvae breeding sites were different and locally specific depending on the genus and species as well as the environment, temperature, humidity, and climate factors. There are six types of sampling locations, which are forest sampling location near settlements, forest sampling location located remotely from settlements, non-forest sampling location near settlements, non-forest sampling location located remotely from settlements, coastal area sampling location near settlements, and coastal sampling location located remotely from settlements. The Genera of mosquito larvae found were *Culex*, *Anopheles*, *Malaya*, *Aedes*, *Armigeres*, *Mansonia*, *Uranotaenia* with a total of 15 species.

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