CHARACTERISTICS TERISTICS OF HOF HABITAT, DISTRIBUTION, AND DIVERSIAND DIVERSITTYY OF ANOPHELES OF ANOPHELES SPP IN KEMELSPP IN KEMELAK BINDUNG AK BINDUNG LLANGIANGIT VILLT VILLAAGE,GE, OGAN KOGAN KOMERING ULOMERING ULU REGENCYU REGENCY, SOUTH SUM, SOUTH SUMAATRATRA

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CHARACTERISTICS OF HABITAT, DISTRIBUTION, AND DIVERSITY OF ANOPHELES SPP IN KEMELAK BINDUNG LANGIT VILLAGE, OGAN KOMERING ULU REGENCY, SOUTH SUMATRA

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CHARACTERISTICS OF HABITAT, DISTRIBUTION, AND DIVERSITY OF ANOPHELES SPP IN KEMELAK BINDUNG LANGIT VILLAGE, OGAN KOMERING ULU REGENCY, SOUTH SUMATRA

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Abstract
Malaria is an infectious disease caused by *Plasmodium* and is transmitted through the bite of a female *Anopheles* vector. Ogan Komering Ulu (OKU) is a district in South Sumatra that is endemic to malaria. The study aims to determine habitat type, environmental factors that influence larvae development, and distribution of *Anopheles* larvae. The experiment was conducted from January to February 2019 in the Kelurahan Kemelak Bindung Langit, OKU. Species identification was carried out in the Entomology Laboratory, Baturaja Health Research and Development Center, OKU. Sampling locations were determined based on field observations, through simple purposive sampling. Identification of mosquito larvae which were maintained in the laboratory, showed that they originated from four *Anopheles* species namely *An. vagus*, *An. barbirostris*, *An. kochi*, and male *Anopheles*. The dominant habitat (76,89%) was rice fields. The characteristics of larval breeding habitats included water pH of 5-6, water temperature of 28^0C-32^0C, light intensity of 756 - 761 mmHg, visual clear water, muddy substrates, and habitat distance with houses of 10 -60 m. The *Anopheles* type diversity index (H ') was low (0.04-0.36). The larval density was the highest in RT 1 and RT 2 (as many as 2.5 larvae/cauldrons), and the lowest in RW 3 locations (as many as 0.1 larvae/cauldron), which had the same habitat type, namely, rice fields. The highest dominance index (C) was found in male *Anopheles* (C = 1), and the lowest was detected in *An. kochi* (C = 0.02) and *An. barbirostris* (C = 0.01). The pattern of the spread of *Anopheles* based on the Morishita index was grouped (Id> 1) and uniform (Id <1).

Keywords: Anopheles sp.; malaria; habitat characteristics; distribution; species diversity; morishita index

1. Introduction

Insects are fauna identified as 70% inhabiting the surface of the earth. Some groups of insects, such as mosquitoes, are dangerous to human health (Kardinan & Dhalimi, 2010). Malaria is an infectious disease caused by parasites from the genus *Plasmodium*. These parasites live and multiply in human blood cells. Malaria is transmitted through the bite of a female *Anopheles* mosquito vector; and affects individuals of all ages, including infants, children, and pregnant women (Putra, 2011).

South Sumatra Province has 17 districts and cities, of which 8 are included in malaria endemic areas. Data show that 8 people per 1000 residents of South Sumatra are at risk of contracting malaria. In 2012, the values of the Annual Parasitic Incident (API) were 0.62 and

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0.44 per 1.000 indicents in South Sumatra and Ogan Komering Ulu (OKU) Regency, respectively. The Lengkiti Subdistrict is one of the sub-districts in OKU district and consists of 21 villages, where in a high number of positive malaria cases have been reported. The API value for Lengkiti Regency is 13.02 per 1,000 events (Mahdalena & Tanwirotun, 2016).

The role of *Anopheles* as a malaria vector differs for each region, and is influenced by geographical and environmental conditions. Each region has different species, bioecology, habitat, distribution, and density. The existence and survival of *Anopheles* larvae are strongly influenced by the condition of the parent breeding site (Nurhayati, Hasanudin, & Anwar, 2015).

Changes in the environment cause the individuals in it will adapt. Genetic characteristics are directly related to the presence of a population in the environment. These include, among others, the harmony of reproduction, distribution, adaptation and survival. Genetic factors in studying ecology have an important role because of genetic diversity will greatly determine the existence of a population in the environment. The age distribution in the population will greatly affect the natality and mortality which in turn affects the population density. In nature the environment is always limited (biotic and abiotic factors limit growth). The existence of limiting factors causes growth in nature to have certain patterns. Exponential growth in nature can occur for a while, then some biotic and abiotic factors such as food sources, partners, competition, climate and other factors limit it.

Malaria vectors can be grouped based on breeding location into three types, namely rice fields, hills or forests, and beaches or river flows. The behavior and breeding characteristics of malaria vectors are important to know and could be used as basis in determining interventions for vector control. Munif (2005) stated that environmental conditions affect the composition and type of *Anopheles* species in various types of habitats.

Kemelak OKU village has many paddy fields or swamps that are the source of life for the people. Puddles in rice fields or swamps with typical turbidity are habitats for *Anopheles* spp to lay eggs and incubate larvae (Permadi, Lasbudi, & Yahya, 2018). Data from the Ministry of Health of the Republic of Indonesia (2017) shows that Kemelak Bindung Langit Village is one of malaria endemic areas in the medium category. Based on the statements stated above, this study was important conducted to investigate the habitat characteristics, distribution, and diversity of *Anopheles* spp. in the village of Kemelak Bindung Langit, OKU.

2. Methods

The study was conducted from January to February 2019, in the Kemelak Bindung Langit Village, OKU Regency, South Sumatra. The village has an area of 30-35 ha and consists of 426 family heads and 12 neighborhoods. Four sampling locations were determined based on observations through purposive sampling. Areas that are thought to be larval habitats include rice fields, tire treads of motor vehicles, rivers, fish ponds, old wells, duck ponds, waterways, and swamps.

Larvae were collected as follows (1) In habitats with a large amount of larvae were collected based on the WHO standards with a tool that is 300 ml in size and 13 cm in diameter and equipped with a 1 m long stick, (2) In habitats with limited amount of water, larvae were collected using a pipette and put placed directly into a plaque bottle. Collection was repeated 10 times (Mandasari, 2012). The collected larvae of *Anopheles* spp were maintained in a sugar solution and fed in the form of beef liver pellets. The larvae were grown until the adult stage for identification. Maintenance and species identification were carried out at the Entomology Laboratory of the Baturaja Health Research and Development Center.

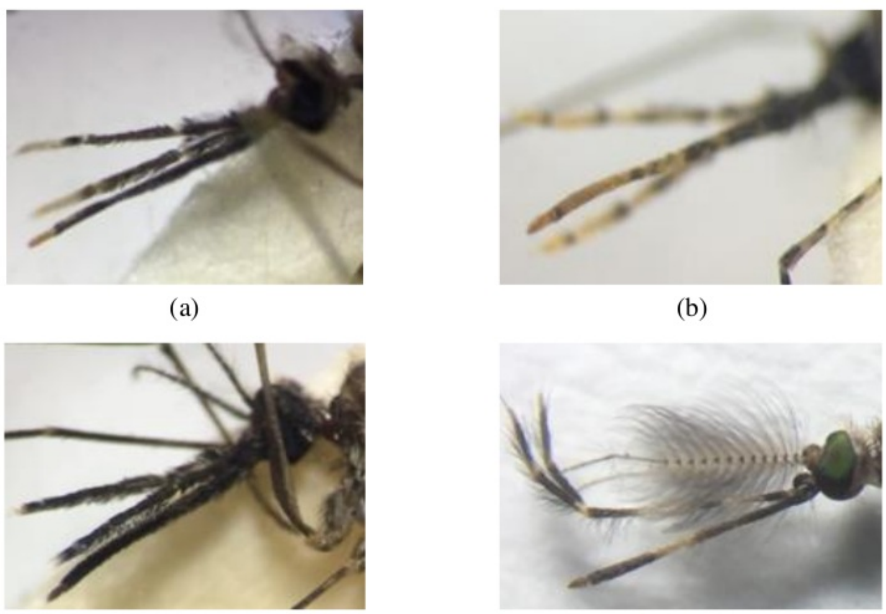
Identification of *Anopheles* type was conducted using the mosquito identification book by O'Connor & Soepanto (1999). The physical parameters observed were water pH, temperature, and turbidity, as well as light intensity, presence of aquatic plants and larvae predators, and distance of larval habitats with population settlement.

Data were analyzed to determine (1) the diversity index of Shannon Wiener species in accordance with the method of Magurran (1988), (2) index of species density in accordance with the Ministry of Health of the Republic of Indonesia (2003); (3) dominance index in accordance with the method of Odum (1993); and (4) distribution patterns based on the Morishita index in accordance with the method of Odum (1993).

3. Results and Discussion

3.1 Morphology of Anopheles spp. Based on Habitat

Based on observations in 19 sampling locations, only 10 were positive as habitat for *Anopheles* larvae. The 10 locations a rice fields, waterways, tire and the *Anopheles* spp present were *An. vagus*, *An. barbirostris*, *An. kochi*, and male *Anopheles* (Figure 1). The type of *Anopheles* was determined based on differences in morphology of the proboscis.



(a) (b) (c) (d)

Figure 1. Morphology of *Anopheles* based on type of the proboscis: (a) *An. vagus*, (b) *An. kochi*, (c) *An. barbirostris*, and (d) male *Anopheles*

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3.2 Types and Characteristics of Habitats

Anopheles preferred laying larvae in rice fields, drains, and tire treads, and the characteristics of these habitats were determined based on physical and chemical factors observed. Among the total 228 observed populations, 183 were located in rice fields, 7 were located in water channels, and 38 were located in vehicle tire treads.

The types of *Anopheles* found in rice fields included *An. vagus* ♀ (44.81%), *An. barbirostris* ♀ (0.55%), and *Anopheles* ♂ (54.64 %). The species found in the vehicle tire included *An. vagus* ♀ (52.63%), *An. kochi* ♀ (2.63%), and *Anopheles* ♂ (44.74%). Although only 2 types of *Anopheles*, namely *An. vagus* ♀ and *Anopheles* ♂ were found in water channels, their populations tended to be high (42.86% and 57.14% respectively). Table 1 shows the results.

Table 1. Habitat, type, and percentage of *Anopheles* in each habitat

Species	Type of habitat					
	Rice fields	%	Water channel	%	Vehicle tire tread	%
Anopheles vagus ♀	82	44.81	3	42.86	20	52.63
Anopheles barbirostris ♀	1	0.55	-	-	-	
Anopheles kochi ♀	-	-	-	-	1	2.63
Anopheles ♂	100	54.64	4	57.14	17	44.74
Total	183	100	7	100	38	100

(Source: Maretasari, 2019)

Rice fields were the preferred habitat for *Anopheles* breeding, followed by stagnant water on the vehicle's tread, while waterways were the least preferred. This finding is presumably due to the availability of nutrients and the number of predators. The presence of water vegetation in rice fields has made them a comfortable place for teh growth and development of larvae. The physical and chemical characteristics of the habitats of *Anopheles* are shown in Table 2.

Mardiana, Shinta, Wigati, Enny, & Sukijo (2002) stated that rice fields are a good breeding place for *Anopheles* larvae. In general, the types of *Anopheles* found in this habitat are *An. vagus* and *An. barbirostris*.

Table 2. Habitat characteristics based on physical and chemical factors

Type of habitat	Number of habitat	Distance (m)	pH	Temp (°C)	Light intensity (mmHg)	Water physics	Substrate	Type of *Anopheles spp.*
Rice field	7	15-60	5-6	29-31	756-761	Clear-turbid	Mud	*An. vagus* ♀ *An.barbirostris* ♀ *Anopheles* ♂

Type of habitat	Number of habitat	Distance (m)	pH	Temp (°C)	Light intensity (mmHg)	Water physics	Substrate	Type of *Anopheles spp.*
Water channels	1	10	6	31	760	Turbid	Mud	*An. vagus* ♀ *Anopheles* ♂
Vehicle's tread	2	20	5	28-32	759	Turbid	Mud	*An. vagus* ♀ *An. kochi* ♀ *Anopheles* ♂

(Source: Maretasari, 2019)

Table 2 shows that *Anopheles* larvae live in clear and muddy substrate water with pH of 5–6, temperature of 28–32^{0}C, and light intensity of 756–761 mmHg. Mading & Kazwaini (2014) explained that the general breeding habitats of *Anopheles* larvae are waters with direct sunlight exposure, which has an impact on increasing the water temperature. Sunlight and temperature affect the levels of dissolved oxygen in water and are important for the survival of larvae. The higher the temperature is, the lower the oxygen solubility is. At extreme temperatures *Anopheles* larvae cannot develop properly and can even cause death. The optimum average temperature for mosquito development is 25–27^{o}C (Soekirno, Ariati, & Mardiana, 2002; Susanto, 2013) and growth will stop if the temperature is less than 10°C or more than 40°C. Mosquito metabolism is influenced by environmental temperature. Mosquitoes cannot regulate their body temperature and adjust to changes outside their body (Santoso, 2012).

Imron & Munif (2010) reported on paddy planted rice fields discovered 33 mosquito species, which consist of 10 *Anopheles spp*., 5 malaria vectors, 13 *Culex spp.,* 4 *Aedes spp.,* and 1 kind of *Mansonia* and *Ficalbia*. *An. aconitus*, *An. indefinites,* and *An. Anullaris will certainly be found in rice paddies and irrigation*.

The presence of vegetation on the water surface plays a role in protecting larvae from predators and maintaining extreme temperatures. Susanna (2010) reported that the presence of aquatic plants is very important for mosquito larvae. The presence of vegetation in breeding places acts as a shelter, foraging, and shelter from the sun which can cause an increase in water temperature (Mading & Kazwaini, 2014). The existence of plants around the waters will affect the presence of oxygen needed by aquatic biota. This condition allows aquatic animals to live and grow well and become predators (Ernamaiyanti, Kasry, & Abidin, 2010).

According to Bustam & Erniwati (2012), Anopheles larvae can tolerate the lowest pH of 4 and the highest pH of 11 and The environmental pH for the breeding of Anopheles larvae is 6-8 (WHO, 1975). In this study, the pH of water is 5–6. This finding is in accordance with the results obtained by Pandji, Endang, & Firda (2012), who stated that water pH of 6.5–9 is conducive to the development of aquatic animals including *Anopheles* larvae. Habitat for breeding Anopheles spp. namely pH 7 and is a suitable condition for larvae. Water pH affects the level of water fertility and microorganisms. At low pH (high acidity) the oxygen reserves will decrease and the rate of oxygen consumption decreases also (Rahman, Ihsak, & Ibrahim, 2013).

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Based on the criteria for water temperature at the time of observation, no significant difference in water temperature was in water temperature was found among rice fields. water channel, and vehicle tread. The highest number of *Anopheles* larvae was ound in was found in water with temperature of 29^0C-31^0C. The temperature at the sampling location was included in the good category for breeding mosquito larvae and providing good conditions for hatching mosquito eggs.

Purnawati (2016) stated that the water temperature of mosquito breeding habitats affects the hatchability of *Anopheles* eggs. The best hatchability occurs at high water temperatures.

Light intensity is a limiting factor for the presence of mosquito larvae. Species of mosquito larvae have different tolerance to light intensity. In this, the light intensity ranged from 756 mmHg to 761 mmHg. According to Hariyanto (2000), sunlight exerts different effects on the growth of *Anopheles* larvae. Some types of *Anopheles* prefer open spaces or shade. *Anopheles punctulatus* and *Anopheles hyrcanus* prefer open spaces, *Anopheles sundaicus* prefers shady places, and *Anopheles barbirostis* can live under open or shaded conditions.

In this study, *An. vagus*, *An. kochi*, and *An. barbirostris* preferred shade conditions with moderate sunlight intensity. According to Ibrahim, Ishak, & Rahman (2013), turbid water can inhibit the penetration of light and result in disruption of photosynthesis. Photosynthesis in water affects the presence of dissolved oxygen, and consequently the density of mosquito larvae in breeding sites. About 80% of the habitats of Anopheles larvae have nonflowing water, and muddy substrates. Nurmaini (2003) reported that, habitats with calm or slightly flowing water such as rice fields are the favored breeding places of *An. acunitus, An. vagus*, *An.barbirotus*, and *An. anullaris*. Kazwaini and Martini (2006) also indicated that *Anopheles* mosquitoes prefer waterlogged or watery places with soil substrate, and clear, and flowing or inundated water.

3.3 Diversity, Density, Dominance Index, and Pattern Distribution of Anopheles Larvae

The species diversity index of *Anopheles* larvae was calculated and found to be within 0.04-0.36. The highest species diversity was found in paddy fields, and the lowest was detected in water channels. According to Magurran (1988), places with diversity value <1 are included in the low category by Shannon Winner index. Low diversity is thought to be due to high rainfall during observation. Tulak, Handoko, Hidayat, Hadi, & Hakim (2018) explained that rainfall is one of the factors that influence the proliferation of *Anopheles* spp. The high intensity of rainfall can rinse *Anopheles* larvae thereby reducing their number and diversity.

The density ranged from 0.1 to 2.5 larvae/stab. The difference in the density of the same habitat type is thought to be influenced by physical conditions and water temperature. In additionthe existence of predators is believed to influence the number of larvae. Kazwaini and Martini (2006) reported that the density of *Anopheles* larvae is influenced by the presence of natural predators, such as tadpoles and tin head fish. The presence of predators also affects the breeding of larvae.

The predominance index of *Anopheles* larvae ranged from 0.01 to 1. The dominance index was the highest in male *Anopheles* and the lowest in *An. kochi* and *An. barbirostris*. The dominance index describes index the condition of the actual population density in a place. According to Kazwari and Martini (2006), the high dominance of male *Anopheles* species is

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influenced by their better adaptation to breed in various habitat types than female than female Anopheles.

The distribution pattern of *Anopheles* spp was determined as uniform and group based on the Morishita index. The Morishita (Id) index value of<1 means that the distribution is uniform, and that of Id> 1 shows that the distribution is grouped. The spread pattern tends to be uniform. According to Gama, Amin, & Madaniatul (2013), mosquitoes have a uniform distribution because the environmental, physical, and chemical factors observed are relatively uniform and do not differ from one location to another. Based on these results, the abiotic and biotic environmental characteristics at the observation sites that tend to be uniform are thought to be opportunities for distribution of Anopheles spp in these areas.

Rain can cause the distribution of mosquitoes to be less or spread evenly. According to Mardiana & Perwitasari (2010), the distribution of pre-adult *Anopheles* spp. in various habitats might occur due to changes in seasons. If the rainfall is high for a long time, then mosquito larvae can be carried by water flow, leading to a small number of larvae. By contrast, the dry season causes the breeding area to experience drought so mosquitoes will find a better breeding place.

The mapping results showed that most of the habitats of *Anopheles* spp. are located near residential areas. According to Widjaja (2012), breeding habitats that are close to residential areas are at risk of malaria. In addition, the risk of malaria transmission depends on *Anopheles* flight distance which is usually 2–3 km from the breeding habitat.

4. Conclusion

The following conclusions are established based on the results that the breeding habitats of *Anopheles* sp. in the Kelurahan Kemelak Bindung Langit in OKU Regency, South Sumatra are paddy fields, waterways, and vehicle wheels These habitats have water pH of 5–6, the water temperature of 28–32^{0}C, light intensity of 756–761 mmHg, visual clear water, muddy substrate, and distance of 10-60 m residential places. The species of *Anopheles* found are *An. vagus*, *An. barbirostris*, An, *kochi*, and male *Anopheles*. The dominant habitat is rice fields where the distribution of *Anopheles* larve os group and uniform.

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Author Contributions

Giri Maretasari contributed on sampling, sorting and identification of species. Yuanita Windusari carried out the data analysis and description of habitat characteristics. Laila Hanum developed data analysis of species diversity. Safrina Lamin conducted identification of species and habitat analysis. Dwi Septiawati carried out the habitat analysis.

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