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THE ANALYSIS OF CHARACTERISTICS, HABITAT SPATIAL DISTRIBUTION, AND THE IMPACTS ON ANOPHELES SP. LARVAE DENCITIES AT PERIMETER AND BUFFER AREA IN THE MOTA'AIN CROSS-BORDER STATION OF PORT HEALTH OFFICE KUPANG 2021

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ABSTRAK

Nusa Tenggara Timur (NTT) masih menjadi penyumbang kasus Malaria terbesar ketiga di Indonesia, dengan prevalensi 12%, Papua (18,4%) dan Papua Barat (26,1%). Berbatasan langsung dengan Republik Demokratik Timor Leste (RDTL) dengan Mota'ain sebagai titik perlintasan utama, meningkatkan risiko penularan penyakit menular. Mota'ain yang berada di daerah pesisir, rawa-rawa, daerah aliran sungai, bekas tambak, dan persawahan berpotensi menjadi Anopheles sp. habitat. Penelitian ini bertujuan untuk mengkaji karakteristik dan sebaran spasial habitat potensial perkembangbiakan Anopheles sp. di Mota'ain. Penelitian ini merupakan penelitian deskriptif analitik dengan desain cross sectional. Daerah bionomi nyamuk Anopheles sp yang meliputi rawa-rawa, persawahan, muara sekitar lingkar, dan daerah penyangga sempadan Mota'ain dijadikan sebagai sampel penelitian. Uji regresi spasial digunakan untuk menganalisis data, dan hasilnya mengungkapkan tiga titik habitat larva Anopheles sp, yaitu kolam ikan, rawa, dan daerah aliran sungai. Di daerah penyangga, 24 (80%) habitat larva ditemukan dalam radius 200 meter, dan 24 (80%) habitat larva ditemukan dalam radius 400 meter 6 (20%). Tidak ada habitat yang ditemukan di sekitar perimeter. Dengan indeks habitat 50%, kepadatan larva Anopheles sp per tangkapan berkisar antara 0,04-12,03. Larva Anopheles sp yang ditemukan antara lain Anopheles Barbirostris, Anopheles Subpictus, dan Anopheles Vagus. Rawa memiliki habitat paling banyak (3.004,7 m2), sedangkan DAS paling sedikit (3.004,7 m2) (2,93 m2). Uji Regresi Spasial menunjukkan bahwa luas habitat (p = 0,014), pH air (p = 0,015), dan salinitas (p = 0,00012) signifikan. Artinya luas habitat, pH air, dan salinitas semuanya berpengaruh terhadap Anopheles sp. densitas, sedangkan suhu tidak berpengaruh (p = 0,778). Membersihkan tanaman air dan mempekerjakan larva predator untuk mencegah perkembangbiakan larva.

Keywords:
Spatial; anopheles sp habitat; anopheles sp; larva.

ABSTRACT

East Nusa Tenggara (NTT) is still the third largest contributor to Malaria cases in Indonesia, with a prevalence of 12%, Papua (18.4%) and West Papua (26.1%). Directly border with The Democratic Republic of Timor Leste (RDTL) with Mota'ain as the main crossing point, increases the risk of infectious diseases transmission. Mota'ain is located in coastal areas, swamps, river basins, former fish ponds,

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and rice fields potentially to be Anopheles sp. habitats. The purpose of this research is to examine the characteristics and spatial distribution of potential breeding habitats for Anopheles sp. in Mota'ain. This is a descriptive analytic study with a cross-sectional design. The Anopheles sp mosquito bionomic area, which included swamps, rice fields, estuaries around the perimeter, and the buffer area of the Mota'ain border, served as the research sample. The spatial regression test was used to analyze the data, and the results revealed three points of Anopheles sp larvae habitats, namely fish ponds, swamps, and river basin. In the buffer area, 24 (80%) of the larvae habitats were found within a 200-meter radius, and 24 (80%) of the larvae habitats were found within a 400-meter radius 6 (20%). There was no habitat found around the perimeter. With a habitat index of 50%, the density of Anopheles sp larvae per catch ranged from 0.04 to 12.03. Anopheles sp larvae discovered included Anopheles Barbirostris, Anopheles Subpictus, and Anopheles Vagus. Swamps have the most habitat (3,004.7 m2), while river basins have the least (3,004.7 m2) (2.93 m2). The Spatial Regression Test revealed that habitat area (p = 0.014), water pH (p = 0.015), and salinity (p = 0.00012) were significant. This means that habitat area, water pH, and salinity all have an effect on Anopheles sp. density, whereas temperature has no effect (p = 0.778). Cleaning aquatic plants and employing larval predators to prevent larval breeding.

Introduction

Death due to malaria is estimated to be around 367.000 to 750.000 people each year, and deaths in children under five are the most common cause of malaria in Africa (Rahmawati & Tarigan, 2013). The World Malaria Report 2018 reported that the total number of malaria cases in developing countries exceeded 300.000 cases in 2017. An increase of more than 100,000 cases between 2016 and 2017 occurred in 21 countries (Rahmawati & Tarigan, 2013). According to WHO, the Africa region has the greatest burden with 213 million cases (93%) of malaria in 2018, and was followed by the WHO Southeast Asia region (3.4%) (Chami et al., 2022). East Nusa Tenggara Province, as it is known, is still one of the biggest contributors to malaria in Indonesia. The result of Basic Health Research (RISKESDAS) from the Agency for Health Research and Development (2008) showed that the East Nusa Tenggara Province was the third of 33 provinces with the highest prevalence of clinical malaria in Indonesia, namely 12,0%, while the province of West Papua was 26,1 % and Papua province was 18,4 %. According to data in 2012, the annual parasite incidence (API) of East Nusa Tenggara Province was in the moderate endemic category at 21,7 per thousand population. In particular, at Silawan Primary Health Center in the East Tasifeto sub-district in Belu regency, which is the focus area of research, in the last few months, there were no confirmed cases of malaria in their report, but this area is included in the Malaria Reception area category, which is an area where transmission occurs quickly because of the high density of Anopheles mosquito as the vector for the spread of malaria.

Mota'ain Cross-Border Station is the main and largest gate of the official border between the two countries. While the traffic gets busier every day, Mota'ain has become a priority for monitoring goods, people, and transportation equipment. The location of Mota'ain itself is in a coastal area, and there are several points of swamps, former fish ponds, and rice fields that have potential as

bionomic Anopheles sp. Therefore, this study will take the location of scooping larvae in the Cross-Border Station area specifically in swamps, rice fields, and estuaries.

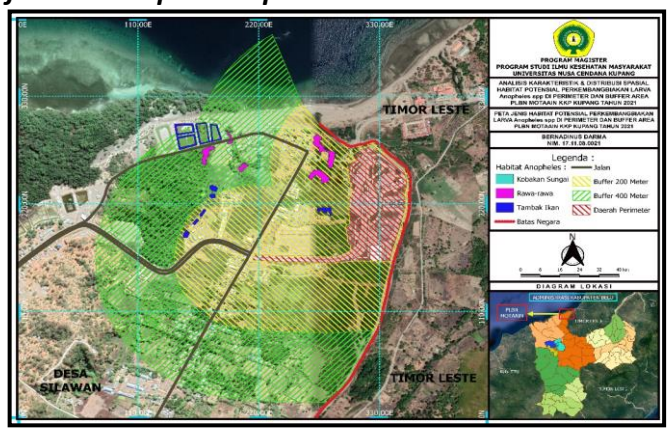
Methods

Descriptive analytic is the type of this research with a cross sectional study design which is located in Mota'ain cross-border Station of Port Health Office Kupang, especially at swamps, rice fields and estuaries area from April to May 2021. The population of this study is all habitats included the perimeter and buffer area of the Mota'ain cross-border Station - Port Health Office Kupang. The sample in this study is the bionomic area of the Anopheles spp mosquito, namely the habitat of swamps, rice fields and estuaries that are included in the perimeter and buffer area of the Mota'ain cross-border Station - Port Health Office Kupang. Data that has been collected will be analyzed by displaying the coordinates of Anopheles spp larvae and mosquitoes, marking the location and coordinates of Anopheles spp larvae habitat and density of Anopheles spp larvae using a GPS (geographical positioning system). The results in the study are displayed in spatial form, such as location images and then narrated according to the research variables.

Results and Discussion

A. Potential Anopheles sp. Larvae Habitats in Mota'ain Cross-Border Station of Port Health Office Kupang's Perimeter and Buffer Area

Figure 1 Map of Larva Anopheles sp. Habitats in Mota'ain Cross-Border Station



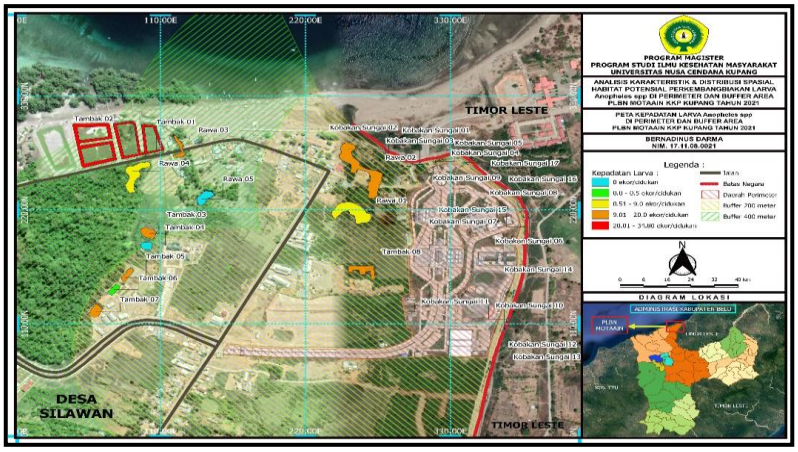
Based on the research results, there are 3 types of habitats for Anopheles sp. larvae. which are fish ponds (8 habitats), swamps (5 habitats) and the River puddle (17 habitats). Based on the buffer area, the largest number of Anopheles sp. larvae habitats is in 200 m buffer area with 24 habitats for Anopheles sp. larvae (80%). In the 400 m buffer area, there are 6 habitats (20%), while in the perimeter area there is no Anopheles sp.

B. Anopheles SP. Larvae Density in Mota'ain Cross-Border Station of Port Health Office Kupang's Perimeter and Buffer Area

Scooping the larvae using a scoop or dipper with a volume of 350 ml in various habitats was carried out to determine the distribution and population density of Anopheles larvae. The habitat for Anopheles larvae in Mota'ain Cross-border Station of Port Health Office Kupang was found in the form of fish ponds, swamps, and river basins. The number of Anopheles larvae collected in Mota'ain Cross-border Station during the study period was 1,716 individuals. The density of Anopheles larvae for each type

of habitat varied from 0.04 per holding to 12.03 per holding. The highest average larvae per scoop in the fish pond habitat type was 15.56 per scoop, and the lowest average larvae per scoop was in the river basin habitat type, which was 0.04 per scoop.

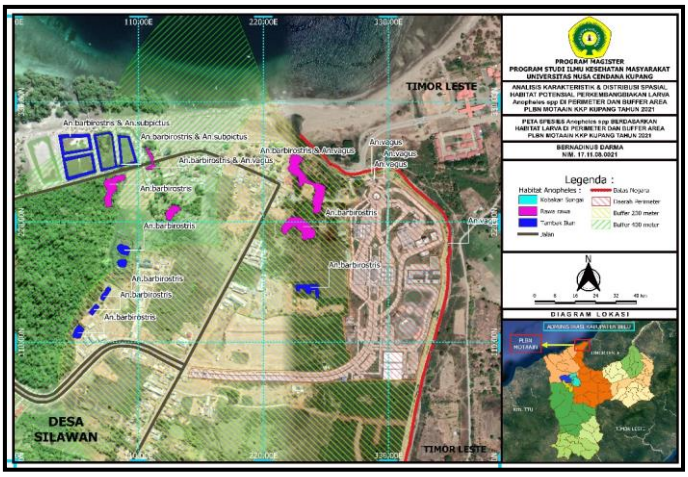
Figure 2 Map of Anopheles sp. Larvae Density in Mota'ain Cross-border Station



Based on the results of the Anopheles sp. larva density survey, it was found that several habitats did not contain Anopheles sp. larvae, which included the puddle habitat, 13 habitats, swamps, 1 habitat, and fish ponds, 1 habitat. It is known that the habitat index for Anopheles sp. larvae in Mota'ain Cross-Border Station is 0.5.

C. Anopheles sp. Types in Mota'ain Cross-Border Station of Port Health Office Kupang's Perimeter and Buffer Area

Figure 3 Map of Anopheles sp. Larvae Types in Mota'ain Cross-border Station

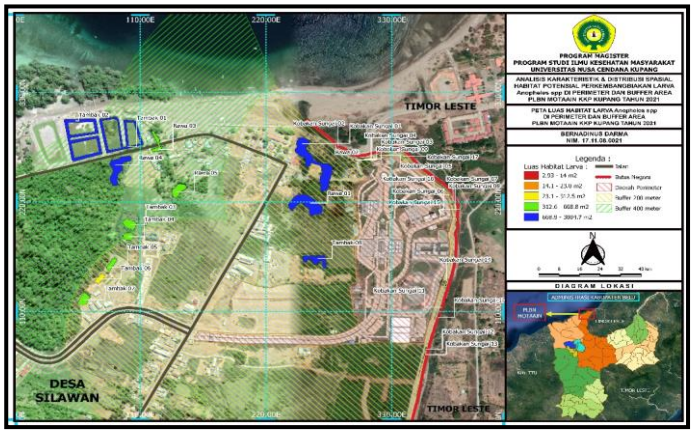


Based on the identification results of Anopheles sp. larvae in Mota'ain Cross-border Station, the most common (many caught) types of Anopheles sp. larvae sequentially are An. barbirostris with a density of 9.95 per scoop, An. subpictus larvae with a density of 3.54 per scoop, and An. vagus with a density of 0.73 per scoop.

D. Anopheles sp. Larvae Habitats in Mota'ain Cross-Border Station of Port Health Office Kupang's Buffer Area

Based on the calculation of the habitat area of Anopheles sp. larvae in the Mota'ain Cross-border Station that is shown in figure 4, it can be seen that the most extensive habitat is swamp habitat 02, with a habitat area of 3,004.7 square meters, and the smallest habitat is puddlehabitat 02, with an area of 2.93 square meters. The total area of Anopheles sp. larvae habitat in the buffer area of Mota'ain Cross-border Station is 15,542 m2 (1.55 Ha).

Figure 4 Map Of Anopheles Sp. Larvae Habitats In The Buffer Area Of Mota'ain Cross-Border Station



Based on the results of the analysis using the Spatial Regression method by the GeoDa application in order to see the correlation between larvae density and habitat area, a significant or significant correlation was obtained with a p. value = 0.014 (p < 0.05).

E. Environmental (chemical) Quality of Anopheles sp. Larvae Habitat (Temperature, pH and Salinity) in Mota'ain Cross-border Station of Port Health Office Kupang's Perimeter and Buffer Area

Table 1
Environmental Quality (Temperature, pH and Salinity) of Anopheles sp. Larvae Habitat in Mota'ain Cross-border Station

No	Temperature (C0)	pH	Salinity (%)	Temperature (C0)
1	Puddle01	26.9	7.2	1
2	Puddle02	27.3	7	1
3	Puddle03	27	7.5	1
4	Puddle04	27.3	7.2	0
5	Puddle05	26.5	7.6	0
6	Puddle06	27.1	7	0
7	Puddle07	25.7	7.2	0
8	Puddle08	26.4	7	0
9	Puddle09	25.6	7.6	0
10	Puddle10	25	7	0
11	Puddle11	25.3	7.5	0
12	Puddle12	25.6	7	0

13	Puddle13	26.3	7.3	0
14	Puddle14	27	7	0
15	Puddle15	26.3	7	0
16	Puddle16	25.7	7.2	0
17	Puddle17	25.7	7	0
18	Swamp 01	24.5	7.3	3
19	Swamp 02	27.1	7.1	5
20	Swamp 03	25.2	7	3
21	Swamp 04	25.7	7	2
22	Rawa 05	24.9	7.3	6
23	Fish Pond 01	27.3	6.9	17
24	Fish Pond 02	27.3	6.7	15
25	Fish Pond 03	25.8	6.9	10
26	Fish Pond 04	25.3	7	3
27	Fish Pond 05	25.7	7.1	7
28	Fish Pond 06	25.6	7.2	2
29	Fish Pond 07	25.1	6.7	1
30	Fish Pond 08	25.9	6.9	1

Based on Table 1. Chemical quality in the habitat of Anopheles sp. larvae in Mota'ain Cross-border Station, it is known that the water temperature varies between 25 °C and 27.3 °C. Chemical parameters in the form of pH ranged from 6.9 to 7.6 while chemical parameters in the form of salinity ranged from 0% to 17%. Especially for the salinity parameter, there is a significant comparison between the habitats in the research location. It can be seen that the fish pond habitat 01 and fish pond 02 are the habitats with the highest salinity concentration, namely 17% and 15%. Based on the results of the analysis using the Spatial Regression method using the GeoDa application to see the relationship between larva density and chemical parameters such as pH and salinity, a significant or significant correlation was obtained with p. value = 0.01503 (pH) and p. value = 0.00012 (Salinity). For the results of the analysis of larva density with water temperature, an insignificant or insignificant correlation was obtained with a p value = 0.778 ($p > 0.05$).

Discussion

1. Potential Anopheles sp. Larvae Habitats in Mota'ain Cross-Border Station of Port Health Office Kupang's Perimeter and Buffer Area

The results showed that there were three locations of Anopheles sp. habitat, namely river puddle, which was the dominant habitat or the most found in the research location, with as many as 17 habitats (56.7%). For the habitat of Anopheles sp. larvae in fish ponds, there were 8 habitats (26.6%), while for the habitat of Anopheles sp. larvae in swamps, there were 5 habitats (16.7%). Puddle is one of the habitats that is the most abundant. This shows that Anopheles sp. breeding will be very risky for health problems, especially for people who live near the location and also for officers in Mota'ain Cross-Border Station of Port Health Office Kupang. The risk will be higher if prevention activities are not carried out early on. The highest percentage of Anopheles sp. larvae habitats was in the 200 meter buffer area, with a percentage of 80%, while the 400 meter buffer is only 20%. This study also obtained results that showed all breeding habitats in the Mota'ain Cross-border

Station area of Port Health Office Kupang were found to be potential species of malaria vectors. Fish ponds and swamps are the closest habitat types found to people's houses, with a range of 200–400 meters. This indicates that people's houses have a high risk of malaria transmission because they are located within a radius of the flying distance of Anopheles sp. The radius of active flight distance of Anopheles sp. is 200–400 meters.

Anopheles in its breeding from egg to adult requires two different habitats: in water and on land. Larvae life in water is strongly influenced by the life system in the water, as well as adult mosquitoes on land. Anopheles mosquitoes have different resting and breeding places. A. subpictus and A. sundaicus have habitats in coastal areas and in brackish waters, A. maculatus in hilly areas, and A. aconitus and A. barbirostris in rice fields. The movement of adult mosquitoes is regulated by environmental factors such as temperature and humidity, the attractiveness of the host, and the attractiveness of standing water as a breeding ground. Therefore, distribution, flight distance, behavior, survival, and ability to transmit disease are strongly influenced by these factors (Shinta & Baharudin, 2019). Basically, Anopheles sp. larvae are found in puddles exposed to sunlight or shade, not too dirty, brackish water, in permanent habitats such as swamps, grass-covered ditches, rice fields, rivers where the water doesn't flow, and ponds. In addition, it is found in temporary habitats such as puddles, animal footprints, and water reservoirs. This is the best location or habitat for Anopheles mosquitoes to be able to breed properly so that the larvae can become mosquitoes, which can then pose a risk to health problems for the community and also for the living environment.

Research conducted shows that there are four types of potential breeding habitat for Anopheles sp., namely lagoons, ditches, abandoned fish ponds, and swamps. The Anopheles species found consisted of five species, which are an. vagus, an. subpictus, an. sundaicus, an. indefinite and an. peditaeniatus. The type of potential breeding habitat is dominated by abandoned fish ponds with mud substrates where the water does not flow, located around settlements that were surrounded by grass, shrubs, and trees. (Shinta & Baharudin, 2019) reported that in Saketa Village, South Halmahera Regency, a potential breeding habitat for Anopheles sp. is a puddle with mud substrate and non-flowing water. This is similar to the condition of the Mota'ain cross-border station area, which as a potential breeding habitat is abandoned fish ponds with mud substrate and stagnant water. A mud substrate is a layer that can hold water for a long time. The thin layer of silt that composes the substrate covers the subsoil, thereby increasing water retention and providing opportunities for mosquito eggs to develop and complete their life cycle.

Biologically, mosquitoes have an adaptability system. Anopheles mosquitoes can be disrupted if their habitat undergoes a change, including if there are activities or developments carried out by humans around the mosquito habitat. This is because mosquitoes are synanthropic, meaning they have sensitivity to environmental changes, including changes in human behavior. Environmental conditions in breeding habitats affect the presence, type, and density or population of larvae. Generally, mosquito species reproduce

by using temporary inundation to obtain the necessary resources and lower predation pressure (Gazali, 2022). Habitat characteristics of mosquito larvae are needed to understand the interaction dynamics of various types of vectors that pose a threat, and studies of their predators are needed for the development of early vector control at the larva level (Susanto, 2022).

2. Anopheles Sp. Larvae Density in the Perimeter and Buffer Area in Mota'ain Cross-Border Station of Port Health Office Kupang

The results of the research conducted in the Mota'ain Cross-Border Station of Port Health Office Kupang showed that the density of larvae was found at several points that had already become habitats or locations for breeding grounds of Anopheles sp. mosquitoes to breed, as well as others, which are fish ponds, swamps, and river basins. The number of larvae collected by scooping them with dippers in various habitats during the study was 1,716 from a total of 300 holdings. There were three types of Anopheles larvae found: An. barbirostris, An. subpictus, and An. vagus. Based on the identification results of Anopheles sp. in the Mota'ain Cross-Border Station which can be found in Table 1, showed that the most dominant species of Anopheles sp. (a lot of them caught) sequentially were An. barbirostris with a density of 9.95 per scoop, An. subpictus larvae with a density of 3.53 per scoop, and An. vagus with a density of 0.73 per scoop.

The density of larvae varies greatly and has its own characteristics according to conditions that can increase the density level of Anopheles mosquito larvae. This study provides a clear description of how the density level of larvae will cause health problems such as increasing malaria cases for people who live in and settle around the buffer area of 200–400 meters. Not only that, but it can also provide data support for early prevention activities in order to eradicate the breeding place of Anopheles sp. Based on the results of the Anopheles sp larva density survey, it was found that several habitats did not contain Anopheles sp larvae, such as the puddlehabitat, which contained as many as 13 habitats; swamps, 1 habitat; and fish ponds, 1 habitat. The closest habitat index for Anopheles sp. larvae in Mota'ain Cross-Border Station is 0.5. According to the government quality standard for the habitat index, or the percentage of positive breeding habitat for Anopheles larvae is <1 (Nagy et al., 2022). It is concluded that the habitat index for Anopheles larvae in Mota'ain Cross-Border Station is under the requirements.

Environmental quality is defined as environmental conditions in relation to the quality of life. The higher the general environment degree, the higher the quality environment degree. The environment has a great effect on mosquito breeding grounds, especially if there are many landfills that can be the media for mosquito breeding places, such as swamps, rivers, used ponds, and others. Dirty places with clean water that is protected from direct sunlight become breeding places for mosquitoes. This place is preferred as a breeding place because it is located in and near the house. This will also greatly determine the density of mosquito larvae that can support an increasing number and population, making it more risky for society and the environment (Razi et al., 2022). A study conducted showed that the results of 11 scientific studies on risk factors for the incidence of malaria

implied that environmental factors were the dominant factors. The study results from four scientific journals on the density of Anopheles larvae show that the density is mostly found in fish cages and abandoned fish ponds. Temporary breeding sites for Anopheles mosquitoes, such as stagnant water, are suitable for breeding Anopheles larvae and become the main requirement. Placement of eggs by adult female mosquitoes in stagnant water such as puddles, swamps, and ditches that are available both naturally and man-made can increase the mosquito population. Another study conducted by (Lestari et al., 2016) found that breeding places are ponds, former fish cages, lagoons, swamps, buffalo puddles, rice ponds, and rivers. The highest average density of anopheles larvae was found in An. subpictus, which was 4.95 fish or scoop, with the ex-fish cage pond as the breeding place that has the highest average density of anopheles larvae at 27.93 fish or cisterns. The number of Anopheles sp. larvae in permanent and extensive habitats in this study is high because this habitat is always there all the time so that the mosquito population will still exist. On the other hand, small habitats are very dependent on rain and dry up easily when it is hot, so the larvae population will decrease.

3. Anopheles sp. Larvae Density in Mota'ain Cross-Border Station of Port Health Office Kupang's Perimeter and Buffer Area

The most common types of larvae according to the result of a study conducted in the Mota'ain Cross-Border Station of Port Health Office Kupang area, were An. barbirostris with a total density of 9.95 per scoop, An. subpictus with a density of 3.54 per scoop, and An. vagus with a density of 0.73 per scoop. When scooping activities are carried out in habitat locations as breeding places for Anopheles mosquitoes, such as river ponds, swamps, and fish ponds in the community surrounding the Mota'ain Cross-Border Station area, the three larvae mentioned above are dominant. It is because there are naturally grow fast in Anopheles breeding. Instar 1 larvae undergo developmental changes over the course of one day. The features are very small, 1-2 mm long, and transparent in color; the spines (spinae) on the chest (thorax) are not very clear, and the respiratory funnel (shipon) has not blackened.

An. barbirostris larvae and An. vagus larvae were dominant found in 3 (three) types of habitat which are fish ponds, swamps and river puddle. An. barbirostris larvae were discovered in two habitats: fish ponds and swamps. An. vagus larvae were found in two habitats, swamps and river basins, whereas An. subpictus larvae were only found in swampy habitats. This type of larvae is one of the most common types because it is actually a fast-growing species of the Anopheles mosquito. The mosquito goes through a complete metamorphosis process, which includes changes in body shape as it progresses through the stages of egg, larva, pupa, and imago, or adult. Adult mosquitoes live in the air, whereas the other three stages live in water and thrive. Anopheles mosquitoes have natural and artificial habitats in unpolluted pools. The majority of species are more active at night and have a flight range of 1-3 km. The type and density of mosquitoes influence disease transmission by vectors. As a result, observations based on the identification of their larvae can be made to determine

the type and density of existing mosquitoes (Razi et al., 2022).

The larva stage of Anopheles appears to float parallel to the surface of the water, with the spiracles always in contact with the outside of the air. Anopheles larvae will occasionally move down into or under the water to avoid predators or natural enemies, or in response to surface stimuli such as movement. Mosquito larvae require food-containing environments to develop their lives, including microorganisms, particularly yeast bacteria and protozoa that are small enough to enter their mouths. (Ndoen et al., 2010) discovered that the breeding places found in the rice fields were An. vagus and An. barbirostrist based on the results of scooping mosquitoes in various ways in Sawahan village. Mosquitoes caught in the two research villages were exophagic and exophilic. An. vagus breeding sites were discovered in lagoons with An. vagus, while An. vagus larvae were discovered in ponds or tubs used for keeping jellyfish that are no longer in use. An. vagus larvae are the most commonly obtained type of larvae from Sawahan and Damas villages. Another study conducted by (Pahlepi et al., 2020) also showed that the types of larvae that were successfully scooped up were types An. vagus, An. subpictus, and An. maculatus. Mosquito larvae An. subpictus, which can survive in both fresh and brackish water, are frequently found in buffalo puddles, waterways, and rice fields, especially during the rainy season. According to the Indonesian disease vector atlas, larvae of An. subpictus are frequently found in puddles, waterways, fish ponds, cement containers, waterways in gardens, gutters, and are occasionally found in rice fields, well ditches, grassy lakeside, and rivers. Mosquitoes are highly specialized. Anopheles sp. requires conditions that are appropriate for the characteristics of their breeding habitat, including their micro-climate, in order to live as larvae. As a result, even though it belongs to the oriental area, not all oriental mosquito species can be found completely in the research area, namely the Mota'ain Cross-border Station of Port Health Office Kupang area, as other researchers have discovered. Because of these restrictions, only certain Anopheles sp. can live in certain areas.

4. Anopheles sp. Larvae Habitat in Mota'ain Cross-border Station of Port Health Office Kupang's Buffer Area

According to the study results of the spatial testing, the total habitat area of Anopheles sp. larvae in buffer area of the Mota'ain Cross-border Station is 15,542 m2 (1.55 Ha). With the buffer located at a distance of 200–400 meters, this has a great significant impact on increasing health problems for the community surrounding the Mota'ain cross-border Station area. Several habitats or larva locations with various types of larvae can be found in the existing area. The potential habitat of An. vagus larvae was discovered about 200 meters away from a residential area, which is a place or location for former fish processing ponds from mining that are no longer active. The larvae of An. kochi, An. aconitus, and An. vagus can be found in swamps 400 meters away from residential areas, while An. separatus were discovered through an old well around the pond, which is also about 250 meters from the residential area.

The discovery of Anopheles larvae breeding habitat in close proximity to residential areas increases risk of malaria in the Mota'ain Cross-border Station area.

The correlation between habitat distance and malaria patients' housing with three risk zones, with a radius of 0–100 m being a high-risk zone and a radius of 100–200 m being a moderate-risk zone. Tulak et al. (2018) discovered that mosquito larvae of Anopheles sp. have a diverse range of habitat characteristics in the Heram District. Anopheles spp. larvae were discovered in both vegetated and unvegetated waters, clear or cloudy water, and neither flowing nor slow-flowing water. Physical measurements revealed that the larva habitat area ranged from 0.04–28 m2, with a water depth of 5–115 cm and a water temperature of 26.7–33.7 °C. The river habitat had the coldest water temperature, while the puddle had the warmest. Puddle is the smallest and most shallow habitat in terms of both size and depth. It has a surface area of 0.04-0.75 m2, a depth of 5–46 cm, and a temperature range of 26.9–33.6 °C. A pond with an area of 8–28 m2, a water depth of 55–115 cm, and a water temperature ranging from 26.8–32.8 °C is the largest larva habitat.

Based on the results of the analysis using the Spatial Regression method by GeoDa application to know the relationship between larva density and habitat area, a significant relationship was obtained with p value = 0.014 ($p < 0.05$). According to the results of statistical tests, the density of Anopheles Sp. larvae increases as the habitat in the research location expands. Regional topography is the study of the shape of the earth's surface, specifically the relief of the surface of an area distinguished by altitude. The altitude is divided into two sections: lowlands (200 meters above sea level) and highlands (300 meters above sea level). Anopheles sp. disperses from various geographic areas, displaying distinct local differences This is possible because the area's unique geographical conditions can cause changes in the nature of life and adaptation of Anopheles sp (Guswami, 2012). Vector control, which involves interrupting the life cycle of vectors, is one method of malaria control. This is possible if the vector habitat distribution location is known. The wide distribution of vector habitat, from coastal to highland areas, is, however, frequently an impediment to control. In addition, ineffective malaria control is caused by a lack of field staff from relevant agencies as well as a lack of public awareness about the disease. This can be avoided by observing and mapping the distribution of larva habitats while accounting for environmental factors like rainfall. The mapping results can be used as a guide to locate larva habitats in the field when performing vector control.

The results of the analysis using the chi-square test showed that the variables, that is depth ($p = 0.616$), area ($p = 0.532$), and turbidity ($p = 0.481$), did not have a relationship with the density of Anopheles larvae. Temperature ($p = 0.001$), salinity ($p = 0.019$), pH ($p = 0.025$), the presence of vegetation ($p = 0.046$), and the presence of larva predators ($p = 0.046$) all had a relationship with Anopheles larvae density. This study concluded that all chemical and biological environmental characteristics had a relationship with larva density, whereas physical environmental characteristics, with the exception of water temperature, had no relationship with larva density. According to the findings of this study, closing the breeding habitat, cleaning up aquatic plants that can aid in the breeding of larvae and adult mosquitoes, and

utilizing larva predators are all viable options (Purnama & Baskoro, 2012).

5. **Environmental Quality of Anopheles sp. Larvae Habitat (Temperature, pH and Salinity) in Mota'ain Cross-border Station of Port Health Office Kupang's Perimeter and Buffer Area**

Environmental quality in the habitat of Anopheles sp. larvae in Mota'ain Cross-Border Station is known to vary between 25 °C and 27.3 °C, according to research findings. Chemical parameters in the form of pH ranged from 6.9 to 7.6, whereas chemical parameters in the form of salinity ranged from 0% to 17%. There is a significant comparison between the habitats in the research location, particularly for the salinity parameter. It can be seen that fish pond habitat 01 and fish pond 02 have the highest salinity concentrations, at 17 and 15%, respectively. This demonstrates that the chemical quality conditions in the Mota'ain Cross-Border Station of Port Health Office Kupang area are indeed suitable for mosquito breeding, and it is enhanced in warm water conditions. This is similar to research that quality of environment have correlations with malaria cases significantly.

Water salinity has greatly impact on the existence of malaria mosquitoes in a given area. The amount of dissolved salts in a volume of water is used to calculate salinization. Waters are classified as freshwater if the salinity is less than 5‰, brackish waters if the salinity is between 0.5-30‰, marine waters if the salinity is between 30-40‰, and hypersaline waters if the salinity value is between 40-80‰. An. sundaicus, which is common in the Rajabasa District, is a kind of mosquito that prefers brackish water. This is supported by the discovery of suitable breeding sites for Anopheles mosquitoes, such as abandoned ponds, river ponds, swamps, puddles, and fish ponds. The obtained salinity ranges from 5 to 30 ‰. Anopheles larvae live primarily in abandoned river basins with brackish water in the Mota'ain Cross-Border Station area.

Based on the results of the analysis using the Spatial Regression method by GeoDa application to find the relationship between larva density and chemical parameters such as pH and Salinity, a significant relationship was obtained with p value = 0.01503 (pH) and p value = 0.00012 (salinity). The results showed that majority of the high larva densities were found in the pH range of 6.5 - 6.9 while at pH above 7 the larva density was not too dense. There is a relationship between the salinity parameter and larvae density because the ideal salinity for larvae development is between 2-15 %, and the density of larvae at the study site is greatest at salinity levels between 5-25 %. There is no correlation between larva density and water temperature, according to the results of the analysis, with p value = 0.778 ($p > 0.05$). The temperature parameter at the study site had no relationship with larva density because the density of larvae varied at all temperature intervals between 24.7 and 27.3°C . (at 27.3°C there were many larvae but at the same temperature in different habitats). The temperature of the water has a significant impact on larvae breeding. Larvae, in general, prefer warm environments. As a result, Anopheles larvae are more prevalent in the tropics. The time it takes for an anopheles egg to hatch is determined by the temperature of the water. The faster it hatches into instars, the higher the water temperature (within a certain limit).

According to Pius Weraman dkk, environmental factors have significant effects on Anopheles sp breeding and different species in each area, such as habitat, vegetation, the sun, water flow, water surface tension, humidity, air temperature, temperature, and climate. Each Anopheles species has a specific niche. Anopheles sp. has been found in coastal areas up to the mountain area. An. sundaicus, An. subpictus, and An.

indicates that there is a significant positive effect, with the higher the salinity in the study, the higher the larva density. The findings of the research on the characteristics of the habitat at the research site indicate that Anopheles larvae can breed successfully.

The physical environment, as well as various aquatic plants that influence malaria mosquito breeding, such as mosses and algae, are environmental characteristics that influence mosquito breeding sites. Large plants that block the entry of sunlight into the breeding grounds, resulting in low lighting, low temperatures, and high humidity, have an impact on the breeding of malaria mosquitos, in addition to aquatic plants. Mosquitoes prefer this type of environment to rest after sucking the blood of the host and awaiting the egg maturation process. Understanding the various types of mosquitos and their activities in high malaria endemic areas is thus the first step in efforts to control malaria transmitted by these insects.

Conclusion

There are 3 types of Anopheles larvae habitat in Mota'ain cross-border station, which are 8 habitats for fish ponds (26.6%), 5 habitats for swamps (16.7%), and 17 habitats in the type of puddle (56.7%). The results of scooping Anopheles larvae by dippers in various habitats at Mota'ain Cross-Border Station collected 1,716 larvae from a total of 300 scoops during the research. The types of Anopheles larvae in Mota'ain cross-border station are Anopheles barbirostris, Anopheles subpictus, and Anopheles vagus. An. Barbirostris and An. vagus larvae were found in nearly three of the three types of habitats surveyed, namely fish ponds, swamps, and river basins. Furthermore, An. barbirostris larvae were discovered in two habitats: fish ponds and swamps. An. vagus larvae were found in two habitats, swamps and river basins, whereas An. subpictus larvae were only found in swampy habitats.

According to larvae Anopheles habitat area calculation, the most extensive Anopheles sp. larvae habitat in the Mota'ain Cross-Border Station area is swamp habitat 02, with a habitat area of 3,004.7 square meters, and the smallest is puddle habitat 02, with a habitat area of 2.93 square meters. Based on the analysis using the spatial regression method by the GeoDa application, a significant relationship was discovered between the density of Anopheles sp. larvae outside the habitat and the density of Anopheles sp. larvae inside the habitat. The environmental quality of the Anopheles sp. larvae habitat at the Mota'ain Cross-Border Station has been reported to range between 25 and 27.3°C. pH ranged from 6.9 to 7.6, while salinity ranged from 0% to 17%. A significant relationship was obtained with p value = 0.01503 (pH) and p value = 0.00012 (salinity) based on the results of the analysis using the Spatial Regression method by GeoDa application to see the relationship between larva density and chemical parameters such as pH and salinity. The analysis of larva density to water temperature showed an insignificant relationship with p value = 0.778 ($p > 0.05$).

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