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Effect of Climate Change on Mansonia Mosquitoes Distribution on Filariasis Transmission Potential (Zoonosis) in Pajaten Hamlet, Keleyan, Socah Bangkalan, Madura

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ABSTRACT

This study examines how climate change affects the distribution of Mansonia genus mosquitoes and their potential role in filariasis transmission in Pajaten Hamlet, Keleyan, Socah Bangkalan, Madura, Indonesia. Filariasis is an endemic disease in the area that is spread through mosquito bites and possibly zoonotic transmission. This study examines the biting behavior of Mansonia mosquitoes in bionomics and its relationship with environmental parameters such as temperature and humidity. The study also took into account the impact of local community activities, habitat characteristics and climatic conditions, including a longer rainy season in 2022. The methodology of this study included mosquito collection, species identification, and data analysis. The results showed an increase in the population of Mansonia mosquitoes in Pajaten Hamlet, especially during the rainy season. Morphological identification revealed the characteristics of Mansonia mosquitoes, with a focus on nocturnal biting behavior. Dissection of adult mosquitoes provided insights into the reproductive process of Mansonia mosquitoes. The influence of climate and environmental conditions on mosquito abundance was also discussed, emphasizing the correlation between mosquito prevalence and factors such as swamp water availability and vegetation. The study also highlights the importance of sanitation in the spread of filariasis and proposes control measures tailored to local conditions. This study conclude that the impact of climate change on the Mansonia mosquitoes spread and emphasizes the need for proactive measures in filariasis control. Control strategies, including habitat clearance, use of bed nets, and deworming of potential reservoirs, are suggested to break the chain of disease transmission. This study makes a valuable contribution to developing effective strategies to control filariasis in the context of climate change.

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INTRODUCTION

Indonesia is one of the countries in the Southeast Asian region that has filariasis endemic areas, namely three species *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori*. Filariasis is the process of transmitting infectious diseases transmitted by filarial worms that enter through mosquito bites as vectors. Thus, zoonotic research, which is transmitted by mosquitoes from human to human, can also be from animals (cats and primates) to humans. Environmental conditions and the behavior of local communities play an important role in the transmission of parasitic diseases where mosquitoes are vectors of transmission. People in

Pajaten hamlet, Keleyan village, go to the rice fields in the morning and the gardens at night. This has the potential for direct contact with vector mosquitoes, given their developmental habitat around rice fields and plantations (Ridha *et al*., 2018).

Bloodsucking activity at night and fluctuating at certain hours is characteristic of Mansonia mosquito species. Mansonia has activity at early sunset in the afternoon until sunrise before noon based on the time of sucking blood. Blood sucking activity is different for each species of Mansonia mosquito due to the influence of temperature, and air humidity which can cause an increase or decrease in the presence of Mansonia mosquitoes in a place. The permanent habitat of the Mansonia mosquito is a swamp, where there is water all year round. This causes mosquitoes to use the place as a habitat. The preadult stage of these mosquitoes develops in swamps. Mansonia mosquito larvae take oxygen through the roots of aquatic plants. These larvae thrust their chitinized siphons into the roots of plants. Mansonia mosquitoes love lotus plants, kale and elephant grass. This corresponds to the presence of such plants along the swamp where the research was conducted. Pejaten Keleyan Socah Hamlet is a village surrounded by mango and bamboo plantations as well as a large expanse of rice fields with almost all residents raising livestock both cows, goats, and sheep. In addition, along the swamp stream are plantations of mangoes, bamboo trees, kale plants surrounded by vast rice fields. Resident activities in the garden start from midnight to morning. The density of local population, namely houses with livestock cages as well as environmental sanitation and personal hygiene from the Pejaten hamlet community plays a role in the presence of Mansonia mosquitoes around the environment. In addition, the influence of environmental factors, especially air temperature and humidity with a longer rainy season in 2022 (Supriyono *et al*., 2017).

Bionomic biting behavior of mosquito populations because the average bite rate increases according to temperature changes, mosquito reproductive activities change characterized by faster mosquito breeding and the maturity period of parasites in the mosquito's body will be shorter. One of the requirements for mosquitoes to become filariasis vectors is that they must have a relative lifespan that must be longer than the extrinsic incubation period, this is because filarial larvae take 8-12 days to become infective larvae. According to research conducted by Yulius, *et al* in the Yapen Islands, stated that temperature and humidity affect the biting habits and age of mosquitoes so that the microfilariae in the mosquito's body have enough time to grow into L3 infective larvae (Dalilah *et al*., 2017).

Breaking the chain of transmission and treatment of disability in people with filariasis is one way of control. Among them are carried out by administering mass preventive drugs and vector control. Integrated vector control and treatment of patients with medication and care to prevent and limit disability is a way for people with filariasis. Knowledge of vector bionomics is very necessary in vector control, satisfactory results if there is a match between vector behavior as a target and the control method applied. Reservoirs are also very important to know their role. Reservoirs in the life cycle of filarial worms have great potential as intermediate hosts for filariasis transmission, so it is necessary to identify reservoirs and their role in filariasis transmission. WHO in 2020 as a lymphatic filariasis-free year. Various ways for this target to be met with mass treatment for lymphatic filariasis ranging from early detection, treatment and eradication of mosquito vectors, but both diseases have not been eliminated until now. This is the reason researchers found the existence of a host reservoir of filarial parasites that may be a potential source of transmission for humans. Also important to the question is whether there could be animals, other than cats, that could host the reservoir (Widiyanti *et al*., 2016).

The vector of filariasis transmission, namely Mansonia mosquitoes, has a role in zoonosis, parasitic diseases including filariasis which are related to environmental conditions and local community behavior (Rehena *et al*., 2021). People in Pejaten Hamlet who usually go to gardens, rice fields and maintain livestock and close settlement conditions with animal cages have the potential to have direct contact with vector mosquitoes, considering their development habitat around plantations, rice fields or near livestock pens. This study aims to determine the effect of climate change on the distribution of Mansonia genus mosquitoes in the potential transmission (zoonosis) of filariasis in the hamlet of Pajaten Keleyan Socah Bangkalan Madura. So that if one day there is a case of filariasis it becomes the basis for determining the right strategy.

MATERIALS AND METHODS

Mansonia Mosquito Collection

The collection of mosquitoes is carried out by taking them using nets from various places in Pajaten Keleyan Socah Hamlet, namely inside the house on black clothes, larvae and eggs attached to plant roots to find air and bushes of trees, gutters and drinking water troughs in cowsheds, pools of water in plants and gutters pooled around people's homes.

Mansonia Mosquito Species Identification

Mansonia mosquitoes are identified based on procedures caught and dissected mosquitoes, namely identification of eggs, larvae, pupae, and adult mosquitoes as well as surgery of salivary glands, large abdomen, and ovaries. Mosquito sampling was carried out three times at intervals of two weeks at the same location.

Data Processing

The data obtained were tabulated and analyzed descriptively, testing the difference in proportion was also carried out to see the difference in larval composition between the stages of collection.

RESULTS AND DISCUSSION

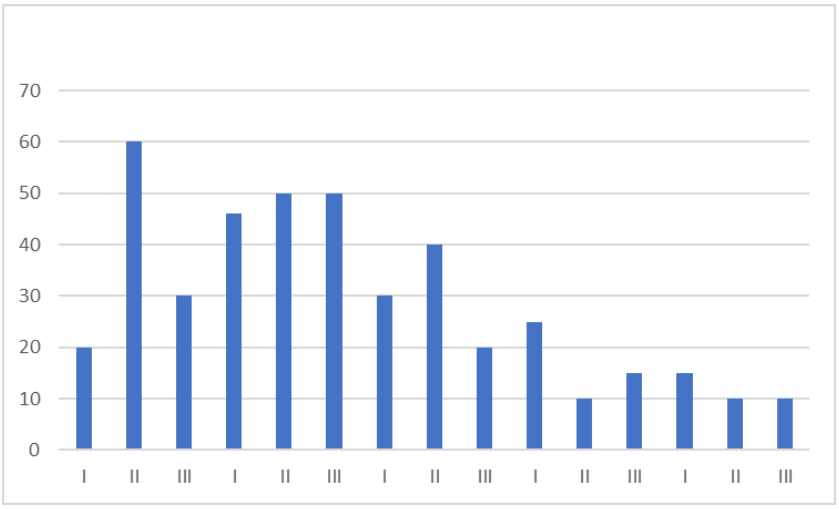

Figure 1. Distribution of mosquito larvae found in several places in Pajaten Hamlet and surrounding areas.

Table 1. Mansonia mosquito behavior found in several places in Pajaten Hamlet and surrounding areas.

Behaviors	Time and Place
Sucking the blood of people inside the house in the afternoon before sunset	16.30–18:45
Sucking inside the house at night	Tends to 19:00–20:45
Eating behavior	Biting humans, night time from 16.00-02.00, peak: 19.00-04.00.
Breed behavior	Laying eggs in pools of water is concave, in hollows of trees, and in brackish water.
Rest behavior	Inside the house on black clothes. Bushes of trees near the animal enclosure
Presence/location of Larvae/containers	In ponds of water where there are plants, larvae attach to plant roots to find air, such as kale around cow and goat sheds, lotuses, and long grass.

Mansonia Mosquitos

Mansonia mosquitoes have a large and long body shape morphology, asymmetrical wing shape, speckled wing shape, body color consists of black or brown mixed with white. Mansonia is located in forest areas, dirty environments and unused fish farming areas. Mansonia eggs lie close together like a raft with a tapered egg shape like a thorn. Mansonia eggs can be found under the surface of water plants as Mansonia mosquitoes like to lay their eggs in swamps. Mansonia eggs hatch after two to four days. The hatched Mansonia eggs then become larvae. The mansonia larvae have a sucking apparatus with a sharp tip and are dark in color. The larval phase lasts for three weeks and then enters the pupal phase.

During the pupa phase, the mosquito has a spine-like respiratory funnel and has ten thorn-shaped segments. It takes one to three days for the pupa phase to become the adult mosquito phase. In the adult mosquito phase, the female mosquito has a palpus that is shorter than the female, while the male mosquito has a palpus that is longer than the proboscis. The wing scales are broad and asymmetrical. The tip of the abdomen is blunt (Gandahusada *et al*., 1998). Mansonia mosquitoes have biting activity at night. Abiotic factors such as air humidity and air temperature greatly affect mosquito activity. The flight distance of Anopheles mosquitoes is about 0.5 - 3 km (Gandahusada *et al*., 1998). Mansonia mosquitoes are aggressive and suck blood when humans are active at night, especially outdoors.

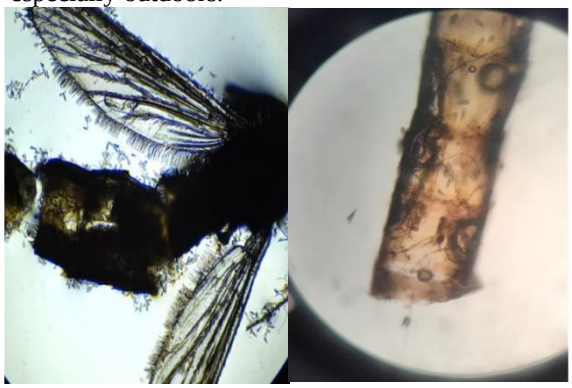

Figure 2. Dissection of adult Mansonia mosquito shows the presence of Mansonia mosquito eggs in the form of round taper / thorny (left) and positive Mansonia mosquito eggs on the large abdomen of Mansonia mosquitoes (right).

Figure 2. shows the dissection of adult Mansonia mosquitoes. Captured adult Mansonia mosquitoes were anesthetized using chloroform and placed on a glass slide, then the mosquito body was cleaned from the wings and legs so that the scales on the wings would not contaminate the specimen. Mosquito samples were then separated with a surgical needle into three parts, namely the head, thorax, and abdomen. Each part of the mosquito's body was dabbed with physiological saline solution and torn/pulled with a surgical needle. Observations under a surgical microscope

were made to see the dilatation of the mosquito uterus in the abdomen to determine the presence of microflora larvae (Sitorus, 2015). The left Figure shows the dissection of Mansonia mosquitoes on the salivary glands, showing Mansonia eggs that come out during dissection with the characteristics of protruding or spiny eggs. The right Figure shows Mansonia eggs spurred on the abdomen (Ramadhani and Bondan, 2015).

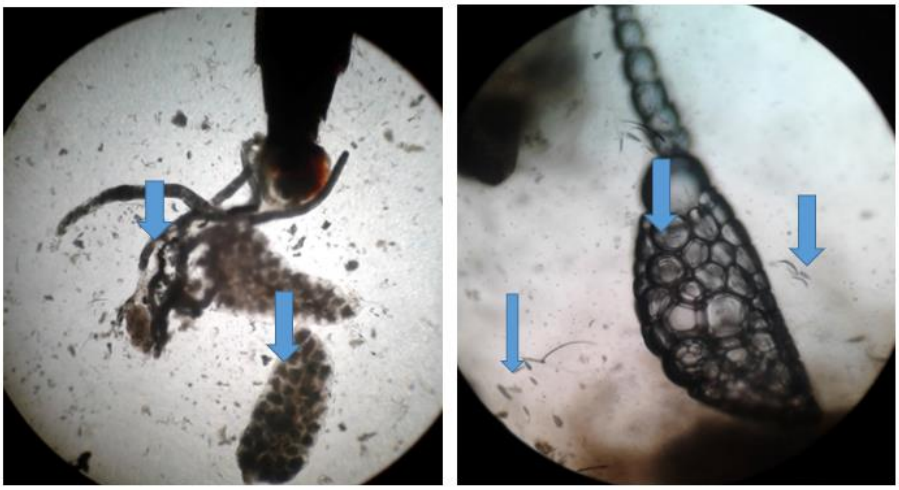

Figure 3. The large abdomen of the Mansonia sp. mosquito *(left)* and the salivary glands of the *Mansonia* sp. mosquito after surgery.

The Influence of Climate and Environmental Conditions

The results of mosquito capture in Pajaten hamlet, Keleyan Socah village with animal biting traps produced a large number of Mansonia mosquitoes. Morphological analysis of mosquitoes found that the diversity of mosquito species in this village was three genera, namely Mansonia, culex and Aedes species, where Mansonia mosquitoes, which were initially absent, became a large population, possibly due to the long rainy season, the condition of swamp water that was stagnant, livestock pens close to residents' homes and lack of hygiene (Anggraini *et al*., 2022).

The highest mosquito catches occurred in January and the trend was to decrease the number in the following month. This is due to the availability of water in the habitat found in Pajaten Hamlet during the rainy season. This type of mosquito was found sucking blood throughout the night, in the late afternoon both inside and outside the house. The peak of this mosquito's blood-sucking activity occurred at 19.00-19.45. This mosquito is active throughout the night. Furthermore, based on the population of each mosquito caught both inside and outside the house (Sembiring, 2017).

The habitat of the Mansonia mosquito is permanent stagnant water in the form of swamps that always have water throughout the year. This causes the mosquito to use the place as its habitat. The presence of Mansonia mosquito habitat is a major factor in the high population of this mosquito. The life cycle from egg to pupa develops in swamps (Barodji, 2001). Mansonia mosquito larvae take in oxygen through the roots of aquatic plants. They insert a suction device made of chitin into the plant roots. Mansonia mosquitoes favor lotus plants, large grasses that grow around cattle pens, plantations, and rice fields. This is consistent with the presence of these plants along the swamp where the study was conducted (Dalilah *et al*., 2017).

Figure 3. The condition of animal sheds near resident's houses. Cow (left) and goat (right).

The spread of filariasis is related to poor sanitation in villages. Most of the spread of filariasis occurs in rural areas rather than in urban areas. The spread of filariasis is also influenced by environmental conditions such as temperature, vegetation, and land slope that will support vector diversity (Ridha *et al*., 2018). Where the conditions of Pajaten hamlet were accompanied by rain

throughout January 2023 with many puddles along the swamp, where rainfall tends to be dry. There have been no cases of Filariasis in Pajaten Hamlet, but with the emergence of the Mansonia mosquito genus, it is very necessary to control as soon as possible. Filariasis control programs must be adapted to local conditions, both socio-cultural, community and geographical, while still referring to government programs (Rehena *et al*., 2021).

Climate change can affect the spread of vectors and the diseases they transmit, considering that the habitat of Mansonia mosquitoes in this area is permanent stagnant water, controlling the preadult stage (larvae) is an appropriate way to reduce vector population density. Control methods can include clearing mosquito breeding habitat from aquatic plants where Mansonia mosquito larvae get oxygen (Pratiwi *et al*., 2019). Control activities in the form of clearing habitats from stagnant water and plants that live in water can indirectly reduce the diversity of mosquito species and break the chain of transmission of the diseases they transmit. Another control that can be done is the use of mosquito nets as a way for residents to protect themselves from vector mosquito bites. This is an appropriate method considering that the peak blood sucking of vector mosquitoes occurs at night until early morning. Control using insecticide-treated bed nets for malaria vector control can also reduce the incidence rate. People are also advised to reduce activities outside the home at night and are encouraged to use repellents or anti-mosquito drugs. In addition to vector control, it is also necessary to control reservoirs that can be a source of filariasis transmission. Regular deworming of cats can prevent filariasis transmission (Rehena *et al*., 2021).

Figure 4. The left figure shows a swamp as a habitat for Mansonia mosquitoes, the right figure shows the outside area of the animal shed.

The age of the mosquito affects its ability to live in nature, which is related to the ability to develop microfilariae in the mosquito's body, so that the mosquito has the opportunity to become a vector. Mosquitoes can act as vectors if they meet the following requirements: (a) Vector mosquitoes have high human contact, which is indicated by the density of human bites. (b) The vector mosquito is a species whose number is always dominant when compared to other species. (c) The population of the species concerned generally has a fairly long lifespan, which is in percent of mosquitoes. (d) In other places, the species has been confirmed as a vector (Nugraheni, 2017).

CONCLUSION

Humidity, rainfall index, and animal conditions affect the occurrence of Mansonia mosquitoes in Pajaten hamlet, Keleyan Socah village. In addition, the condition of house hygiene and personal hygiene must also be considered to facilitate the control of Mansonia mosquitoes.

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