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Culex quinquefasciatus With the Highest MHD as a Potential Filariasis Vector in Demak, Central Java, Indonesia, a Filariasis Endemic Area

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ABSTRACT

Filariasis is a communicable disease caused by nematode worms and transmitted by mosquitoes. It causes permanent elephantiasis which decreases productivity and carries a stigma. Filariasis becomes one of the health problems in Indonesia. The filariasis elimination program through preventive mass drug administration has been carried out for 5 years, but transmission remains. The distribution, ecology, and biology of vector mosquitoes as well as their potential to spread filariasis vary widely. Therefore, it is important to identify the entomological aspects of vectors in the distribution of filariasis. The purpose of this study was to determine the diversity of mosquitoes, which have the potential to become vectors of filariasis transmission in endemic areas. The research was conducted in two villages in Demak Regency, Central Java Province, in April 2019 through the Human Landing Collection method for 12 hours, starting from 18.00 until 06.00. Mosquitoes were dissected under dissection microscope, and the presence of filarial larvae was observed. Six mosquito species were obtained, namely *Cx. quinquefasciatus*, *Cx. vishnui*, *Cx. tritaeniorhynchus*, *Cx. sitiens*, *Ae. Aegypti*, and *Man. Indiana*. The highest density was found in *Cx. quinquefasciatus*. The man hour density (MHD) of *Cx. quinquefasciatus* ranged 3,000-8,667 mosquitoes/person/hour. There were no filarial larvae found in this study.

Keywords: *filariasis, Cx. quinquefasciatus, Man Hour Density, potential vector, Demak*

1. INTRODUCTION

Filariasis is an infectious disease caused by filarial worms and is mediated by mosquitoes. This chronic disease causes permanent damage in the form of an enlarged organ called elephantiasis [1]. Elephantiasis causes the sufferer to experience a decrease in productivity, thus leading to economic problems. Elephantiasis has even carried a stigma in some areas. The intermediate mosquitoes that transmit filariasis include many species from 4 genera, namely Anopheles, Culex, Aedes, and Mansonia. All these genera can be found in Indonesia which allows the spread of filariasis [2].

In Indonesia, there were 10,681 cases of chronic filariasis spread across 34 provinces [3]. Meanwhile, in Central Java, 397 chronic filariasis cases were found in 34 districts/cities. Demak District of Central Java Province, a filariasis endemic area with 32 chronic cases, ranked third in prevalence after Pekalongan and Brebes [4]. According to the data from the Demak District Health Office, the incidence rate of filariasis in 2017 was 3.68 per 100,000 population and it decreased to 0.68 per 100,000 population in 2018 [5].

The filariasis elimination program through mass drug administration has lasted for 5 years [4], but transmission persists. It should be noted that a number of factors influence the transmission of filariasis, such as the presence of disease agents in the form of filarial worms, human hosts, and the environment that supports the proliferation of vector mosquitoes. Human habits that allow contact with mosquitoes increase the risk of filariasis transmission. A high mosquito density also increases such risk. Additionally, this is influenced by the existence of breeding places in the environment around humans [6]. The distribution, ecology, and biology of vector mosquitoes vary widely, and so does their potential to spread filariasis. Therefore, it is deemed important to examine the entomological aspects of vectors in the distribution of filariasis.

Research on mosquito diversity has previously been conducted. Nurjazuli *et al.* examined the physical and biological environmental conditions in Demak in a spatial analysis. Although no mosquitoes containing filarial larvae were found, the most mosquitoes caught were *Cx. quinquefasciatus* [7]. Fitriyana *et al.* also examined the spatial distribution of potential vectors in Demak. This study found that the highest number of mosquitoes caught were *Cx. vishnui* [8]. Hestiningsih *et al.* studied the Culex sp population in an endemic village in Demak. The results showed that the most species caught was *Cx. quinquefasciatus* [9]. Based on these

different results, this study aimed to determine the diversity of mosquito species collected in filariasis endemic areas and to identify the true vector of filariasis in Demak by locating filarial larvae in mosquitoes.

2. METHODS

This observational study was conducted through a cross sectional design in two locations in Demak district in April 2019. The selection of the locations was based on the number of cases of chronic filariasis (elephantiasis) represented in urban and rural areas. This was descriptive research to describe the diversity of mosquitoes that were potential to be filariasis vectors.

Mosquito catching was carried out by volunteer mosquito catchers using an aspirator. A volunteer acted as both mosquito feeder and catcher. The volunteers wore closed clothes except on the lower legs. If a mosquito landed, it was caught using an aspirator. The trapped mosquitoes were immediately put into a gauze-covered paper cup marked by the location, time, and collection method (Indoor Bait, Indoor Resting, Outdoor Bait, or Outdoor Resting). At each location, arrests were carried out for 12 hours from 6:00 p.m. to 6:00 a.m. For each case of elephantiasis, arrests were carried out in 3 houses, each inside and outside the house. The volunteers should not apply repellants or fragrances on their body, smoke, or burn anything in the vicinity of the fishing grounds.

For the first 40 minutes, the volunteers caught mosquitoes by means of baiting (human landing collection). Mosquitoes perching on the lower limbs were caught using an aspirator. During the next 10 minutes, the volunteers caught the resting mosquitoes (resting collection). The arrests were performed on the walls, mosquito nets, curtains, and hanging clothes (inside the house) as well as on the outside walls of the house, the walls of cages, and leaves (outside the house). The last ten minutes were a chance to take a break, and some glasses were replaced with new glasses for the next hour.

Mosquito identification was carried out based on the guidelines in Rampa Rattanirithikul Mosquito Identification Key Book, *et al.* [10] - [16]. Surgery was performed on female mosquitoes. Identification of mosquito breeding places was done by observing the surroundings of the mosquito catching area. Larvae were picked up from the puddles found.

The parameters analyzed were mosquito density stated as Man Hour Density (MHD) and relative abundance (RA). MHD is the number of mosquitoes that bite people per hour at a specific time of the day. MHD is determined by the number of mosquitoes, which land on a feeder's limb and are successfully captured, divided by the number of catchers multiplied by the time of capture in hours. Relative abundance is the ratio between the number of mosquitoes of a particular species and the total types of mosquitoes of various species caught in percent.

This research has received ethical approval from the Ethics Commission of the Faculty of Medicine, Public Health, and Nursing of Universitas Gadjah Mada.

3. RESULTS

Demak is located at 6043 "26" – 7009 "43" South Latitude and 110027 "58" – 110048 "47" East Longitude with an altitude of 0 to 100m above sea level.

The number of mosquitoes caught in 2 locations, namely Katonsari, Demak sub-district and Jungsemi, Wedung sub-district, for 12 hours from 18.00 to 06.00 was 957 adult mosquitoes, consisting of 851 female and 106 male mosquitoes. The mosquitoes were then identified using the guidelines [10] - [16], and the female mosquitoes were dissected to examine whether there were any filarial worm larvae. The surgery was carried out through a pool method, and the results showed that all female mosquitoes were negative. The identification of the captured mosquitoes resulted in six (6) species of mosquitoes from 3 genera, namely *Culex quinquefasciatus, Cx. vishnui, Cx. tritaeniorhynchus, Cx. sitiens, Aedes aegypti,* and *Mansonia indiana.*

The relative abundance of each species is shown in Figure 1. The density of mosquitoes that bite humans every hour (Man Hour Density/MHD) is shown in Figure 2 and 3 in both Katonsari and Jungsemi regions.

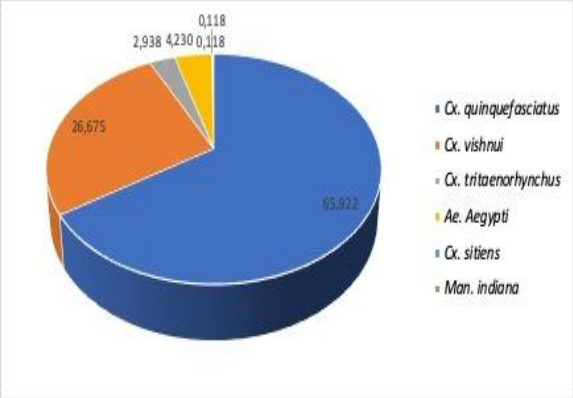

Figure 1. Relative abundance of the mosquitoes caught in Demak in April 2019

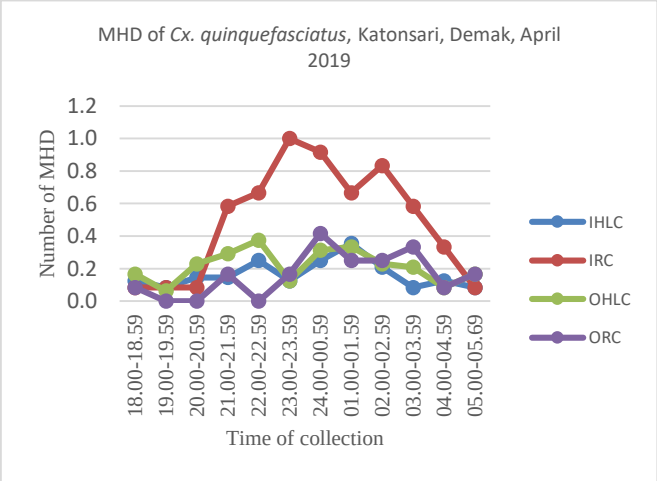

Figure 2. *Hourly Man Hour Density of the mosquitoes caught in Katonsari, Demak in April 2019.*

Note: ORC: Outdoor Resting Collection; OHLC: Outdoor Human Landing Collection; IRC: Indoor Resting Collection; IHLC: Indoor Human Landing Collection

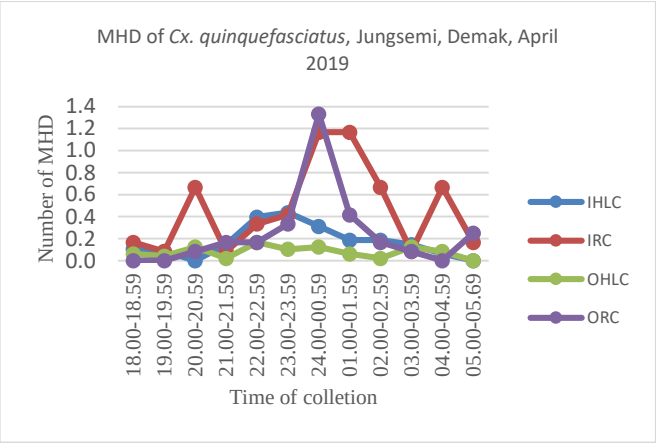

Figure 3. Hourly Man Hour Density of the mosquitoes caught in Jungsemi, Demak in April 2019.

Figure 4. Sewerage serving as a breeding place in Katonsari, Demak, April 2019

4. DISCUSSION

In the 12-hour observation in Katonsari, Demak sub-district and Jungsemi, Wedung district, it was found that *Cx quinquefasciatus* had the highest MHD compared to the other mosquitoes. This shows that the possibility of humans being bitten by *Cx. quinquefasciatus* is higher than by the other mosquitoes, namely *Cx. vishnui*, *Cx. tritaeniorhynchus*, *Cx. sitiens*, *Ae. Aegypti*, and *Man. Indiana*. Previous studies also found the highest percentage of *Cx. quinquefasciatus* in Demak [7], [9]. The presence of *Cx. quinquefasciatus* with high MHD increases the risk of filariasis transmission. Although the surgery on female mosquitoes in this study did not produce positive results, the microfilaria rate in Demak remained above 1% [7]. This shows that the transmission in this area continues. In fact, the theory of filariasis transmission is complicated. According to Hairston and de Meilon, 15,000 infective bites are required for an infection to occur [17]. Consequently, a high number of infected mosquitoes are needed to transmit the disease. In this study, it was found that the density of Cx quinquefasciatus in a house was 3,000-4,563 bites per person per hour, while outside the home it was 7,833-8,667 bites per person per hour. This finding is far below the Hairston and de Meilon statistical figures, but in fact transmission is found [7].

Research in other Java regions also obtained corresponding results, in which the mosquito species with the highest density was *Cx. quinquefasciatus*, in among others Pekalongan [18], Tasikmalaya [19], and Bandung [20]. Likewise, although Mojokerto [21] is not an endemic area of filariasis, high density of *Cx. quinquefasciatus* was found in this area with the potential for filariasis transmission.

The activity of mosquitoes inside and outside the home is related to the transmission pattern of filariasis. In both collection areas, the MHD of *Cx quinquefasciatus* shows a higher figure outside the house than in the house. This finding is consistent with the results of research in Pekalongan [18] and Bandung [20]. This indicates that the risk of individuals coming into contact with mosquitoes outside the home is higher than inside the house, resulting in correspondingly higher risk of contracting filariasis from outside. Filariasis preventive measures can be taken by avoiding outdoor activities at night or wearing closed clothes outside the home. Figure 2 and Figure 3 indicate that the peak density of *Cx quinquefasciatus* mosquito is at 00.00-01.00 at night, in both cities and villages. This condition is consistent with the periodicity of microfilaria bancrofti, which is periodic nocturnal. In this type, the density of microfilariae in the peripheral blood reaches the highest at night. According to research by Ramadhani, the bancrofti filariasis in Pekalongan mediated by Cx quinquefasciatus experienced a peak density of microfilariae at 22.6'36 "- 03.56'24" [22]. In addition, the residents have a habit of staying outside the house at night often without wearing tops, particularly done by men, because of hot weather. Also, many houses are densely occupied by mosquitoes, making filariasis transmission easy to occur.

Geographically, Demak district is located in the northern part of Central Java province. Bordering the Java Sea on the north side, this area is at an altitude of 0-100 above sea level. At certain times, tidal water rises towards the land which then creates a pool of water. Stagnant water that persists for several weeks is a breeding ground for mosquitoes. The existence of vector mosquitoes allows transmission of filariasis in the area. This is consistent with a study by [23] which revealed that filariasis cases were mostly found in the northern regions with post-tidal inundation characteristics. Stagnant water is one of the larval habitats suitable for *Cx. quinquefasciatus* in addition to other habitat types, such as shallow wells and obstructed channels [24], [25]. *Cx. quinquefasciatus* is an urban type bancrofti filariasis vector [26]. This type of filariasis is also found in Java region, with the discovery of L3 larvae in the thorax of *Cx. quinquefasciatus* [27].

Mosquito breeding sites in the form of sewerage or sewers are also found in Katonsari. The mosquito larvae found in the sewers (Figure 4) were reared in the laboratory until they were adults and identified as *Cx quinquefasciatus*. This shows that the mosquito breeding cycle continues and has the potential for the spread of filariasis. Sewage in a household waste disposal channel contains a number of organic and inorganic substances. The fluid is a suitable medium for mosquito breeding. This is in accordance with the laboratory test results of several media, including rice washing water, screen printing water, rice field water, and sewage water which all showed that they could be the breeding media for *Cx. quinquefasciatus* [28].

5. CONCLUSION

Although no filarial larvae were found in the study, the high MHD of *Cx. quinquefasciatus* indicated the considerable potential of *Cx quinquefasciatus* to be a filariasis vector in Demak, Central Java, Indonesia.

AUTHORS' CONTRIBUTIONS

Data gathering and idea owner of this study: Istianah, S., Mulyaningsih, B., Umniyati SR. Study design: Istianah, S., Mulyaningsih, B., Umniyati SR. Data gathering: Istianah, S. Manuscript writing and submission: Istianah, S., Mulyaningsih, B., Umniyati, SR. Editing and approval of final draft: Istianah, S

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