BIODIVERSITAS
Volume 25, Number 12, December 2024
Pages: 4886-4893

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d251225

Survey of mosquitoes species in Henda Village, Pulang Pisau District, Central Kalimantan, Indonesia in filariasis case area

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Manuscript received: 8 March 2023. Revision accepted: 14 December 2024.

Abstract. *Augustina I, Kurniawan MYI, Triawan N, Manta MF, Riyadi NR, Syahridho MA, Ratnasari A, Karmila M, Jabal AR. 2024. Survey of mosquitoes species in Henda Village, Pulang Pisau District, Central Kalimantan, Indonesia in filariasis case area. Biodiversitas 25: 4886-4893.* Filariasis is a zoonotic disease found in tropical regions. One of the filariasis endemic areas is Henda Village, Pulang Pisau District, Central Kalimantan Province, Indonesia. Three cases of filariasis cases were identified in Henda Village. This study aimed to identify mosquito species that act as vectors in Henda Village. Mosquito samples were collected using human landing collection, resting collection, animal-baited traps, animal barrier screens, and light traps. A total of 650 mosquitoes were collected, including *Culex quinquefasciatus* (n=361), *Mansonia bonneae* (n=134), *Mansonia uniformis* (n=90), *Aedes aegypti* (n=46), *Aedes albopictus* (n=13), *Coquillettidia crassipes* (n=5), and *Anopheles barbirostris* (n=1). The human landing collection method caught the highest number of mosquitoes at 438 mosquitoes. Overall, the total number of mosquitoes obtained, the highest number of mosquitoes obtained was the species of *Culex* sp. was *Cx. quinquefasciatus*.

Keywords: Distribution, filariasis, Henda Village, mosquito

INTRODUCTION

Filariasis continues to be a global health concern, including in Indonesia. This disease is caused by mosquito-transmitted filarial worms (Lourens and Ferrell 2019). These worms inhabit the ducts and lymph nodes, causing fever, lymph duct, and lymph node inflammation (Yamin 2019). Without adequate care, chronic disease can cause permanent disability, limiting activity, and productivity (Zeldenryk et al. 2012; Yamin 2019). Filariasis rarely causes death but suffers socio-economic losses and decreases productivity.

Filariasis is a zoonotic disease caused by filarial worms *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori* that can be transmitted by a variety of mosquito species (Bockarie et al. 2009; Ministry of Health 2014). Five mosquito genera have been reported as filariasis vectors, i.e., *Mansonia, Anopheles, Culex, Aedes*, and *Armigeres* (Ministry of Health 2014). The species of *Anopheles* that have been identified as vectors of *B. malayi*, *B. timori*, and *W. bancrofti* are *An. aconitus, An. barbirostris, An. flavirostris, An. maculatus, An. minimus, An. nigerrimus, An. subpictus*, and *An. vagus* (Ministry of Health 2014; B2P2VRP 2017). *Culex* sp. species recorded as being able to act as filariasis vectors are *Cx. fuscocephala, Cx. sitiens, Cx. whitmorei, Cx. annulirostris*, and *Cx. quinquefasciatus* (Ministry of Health 2014; B2P2VRP 2017; Lupenza et al. 2021). Meanwhile, from *Mansonia* species is *Ma. bonneae, Ma. indiana, Ma. uniformis, Ma. dives*, which act as filariasis vectors (Ughasi et al. 2012; Ministry of Health 2014; B2P2VRP 2017). Currently, *Ma. uniformis* is a confirmed filariasis vector in Central Kalimantan, Indonesia (B2P2VRP 2017; Ridha 2018; Ridha et al. 2020). Additionally, cases of filariasis have also been reported in cats, dogs, and *Macaca fascicularis* in Central Kalimantan (Rahayu et al. 2020).

In 2018, 51 million cases of filariasis were found worldwide with the highest prevalence of filariasis is found in West Africa, Central Africa, and Papua New Guinea (Cromwell et al. 2020). In 2021, Indonesia reported 9,354 cases of chronic filariasis, making it still common on the country (Ministry of Health 2021). A total of 236 regencies or cities in 28 Provinces of Indonesia are recorded as filariasis endemic areas. Central Kalimantan is one of the provinces with endemic filariasis. In 2021, Central Kalimantan was ranked 22 out of 34 provinces, with 49 chronic cases of filariasis (Ministry of Health 2021). Based on data from the Central Kalimantan Health Office in 2021, 49 chronic cases of filariasis were found in Central Kalimantan consists of 14 districts or cities, with eight areas being classified as endemic areas (Central Kalimantan Health Service 2021). Furthermore, according to the Central Kalimantan Health Office (2021), there were 34 cases in East Kotawaringin, three cases in Pulang Pisau, three cases in Lamandau, two cases in Kapuas, two cases of Murung Raya, two cases in Seruyan, two cases in West Kotawaringin, and one case in Katingan.

According to the Central Bureau of Statistics, Pulang Pisau District cover a total area of 1,323 km^2 and has a population of 8,286. Henda Village is one of eight villages in Jabiren Raya Sub-district, Pulang Pisau District (BPS Kabupaten Pulang Pisau 2020). It spans an area of approximately 25,000 hectares and is home to 686 people with the majority of the people work as farmers (Tim Pemetaan Desa Henda 2018). Those working as farmers have an 8.4 times higher risk of contracting filariasis compared to those in other occupations. Additionally, residence near rice fields and plantations are significantly linked to the incidence of filariasis (Irfan et al. 2018). The village predominantly comprises of plantations and forests, some of which contain peat swamps, increasing the chances of mosquito breeding. This study aimed to identify the mosquito species acting as filariasis vectors in Henda Village, Pulang Pisau District, Central Kalimantan Province, Indonesia.

MATERIALS AND METHODS

Study area

Henda Village is one of 8 villages in the Jabiren Raya Sub-district, Pulang Pisau District, Central Kalimantan, Indonesia. It is located at coordinates 2°36'13.3" N and 114°12'35.5" E, consisting of plains, lowlands, swamps and peatlands with an area of 18,750 ha (Tim Pemetaan Desa Henda). The village is strategically positioned on the banks of the Kahayan River and is passed by the main road between the provinces of Central Kalimantan and South Kalimantan. Henda Village has a tropical and humid climate, with temperatures ranging from 23-30°C and an average annual rainfall of 6 mm. The air temperature reaches a maximum of 32.5°C and a minimum of 22.9°C. The relative humidity is consistently high, averaging above 80%, with more than 50% sunlight. The rainy season in Henda Village occurs between 7 to 9 months, with a monthly rainfall of 20 mm, while the dry season occurs for less than 2 months. Rain is spread throughout the year, with the highest rainfall falling in November to December and January to March.

A study on mosquitoes was conducted for one month, starting in July 2022 in the Henda Village, Pulang Pisau District, Central Kalimantan, Indonesia. with twelve sampling locations that chosen based on location variation, outskirts location with easy access, and the highest number of dengue cases (Figure 1, Table 1).

Table 1. Latitudes and longitudes of the study locations in the Henda Village, Pulang Pisau District, Indonesia

Collection methods	Site
Human landing collection	a. 2°36'13.4"S 114°12'48.5"E b. 2°36'11.7"S 114°12'48.7"E c. 2°36'08.7"S 114°12'48.5"E d. 2°36'05.1"S 114°12'49.0"E
Resting collection	a. 2°36'05.1"S 114°12'49.0"E b. 2°36'08.7"S 114°12'48.5"E
Animal barrier screen	2°36'08.7"S 114°12'48.5"E
Animal baited trap	2°36'11.5"S 114°12'47.4"E
Light trap	a. 2°36'27.9"S 114°12'52.5"E b. 2°36'13.0"S 114°12'47.2"E c. 2°36'09.4"S 114°12'48.6"E d. 2°36'08.0"S 114°12'49.0"E

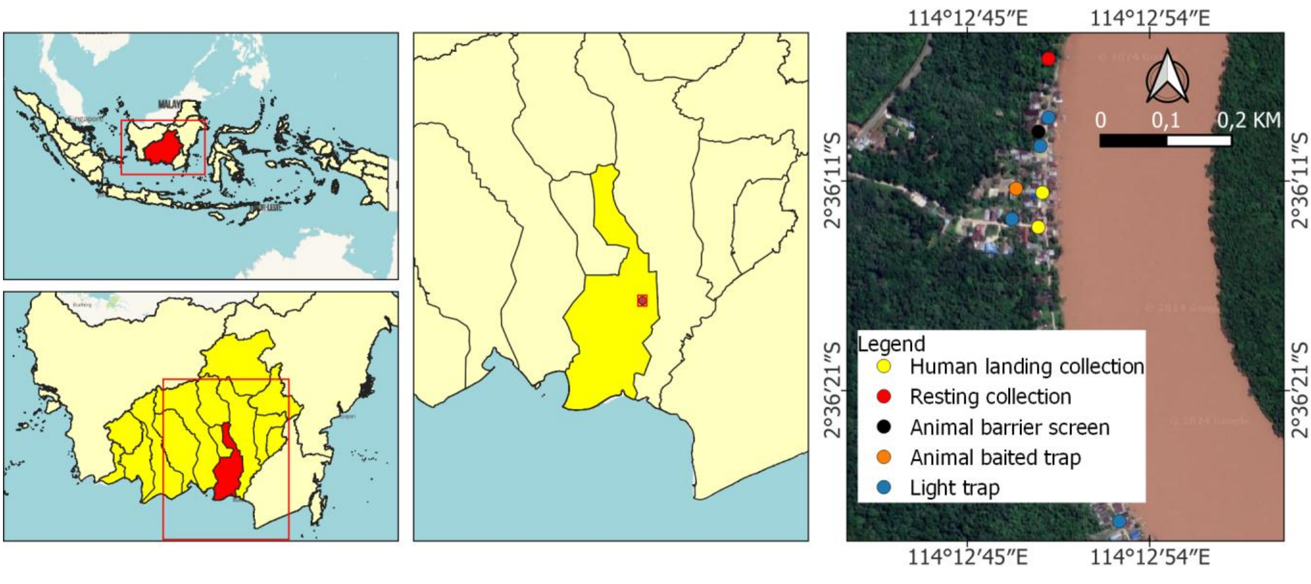

Figure 1. Location of Henda Village, Pulang Pisau District, Central Kalimantan Province, Indonesia with the survey sites

Procedure

This study is a descriptive observational study with a simple random sampling design. Sampling was conducted for fourteen days in July 2022 in Henda Village, Pulang Pisau District, Central Kalimantan Province, Indonesia. The limited time for sampling was due to limited permits and only a few houses from the community were willing to be sample. This research has been approved by the Health Research Ethics Committee of the University of Palangka Raya Medical Faculty number 99/UN24.9/LL/2022. This study used five methods of catching mosquitoes, i.e., animal-baited traps (ABT), animal barrier screens (ABS), light traps (LT), human landing collections (HLC), and resting collections (RC). The five methods used to collect mosquitoes are from 18:00-06:00 (Ministry of Health 2017). The collected adult mosquitoes were grouped and counted based on the sampling location. Mosquitoes were placed on a glass object using insect dissection. Mosquito identification was done using an Olympus stereo microscope with a using a taxonomic identification key of mosquito by Rueda (2004), O'Connor and Soepanto (1999) and Ministry of Health Indonesia (2017). Sample mapping using Garmin GPS and visually displayed using the ArcGIS application version 10.5.

Animal-baited trap (ABT)

Animal-baited traps are installed on poles or trees. The animal-baited trap is adjusted according to the livestock size and the catcher's height. The trap will be opened every 45 minutes and then given 15 minutes to catch mosquitoes using an aspirator (Ministry of Health 2017).

Animal barrier screen (ABS)

The animal barrier screen method was applied around the livestock pen using a 2 m high mosquito net tied to a wooden pole with a distance of 2 m and a length of 10 m, so that it can function to prevent mosquitoes from entering through the mosquito net (Davidson et al. 2019). The barrier screen was installed in an open space with a parallel position and a distance (10-15 m) from vegetation and community settlements in the village. The barrier screen was installed in the same position throughout the study. Mosquito collection was carried out by researchers by walking on each side of the trap for 15-20 minutes using a flashlight to see mosquitoes that were resting and collecting mosquitoes using an aspirator (Burkot et al. 2013). Furthermore, the mosquitoes were put into paper cups that were given gauze and rubber bands as adhesive (Davidson et al. 2019; Rahma et al. 2020).

Light trap (LT)

The light trap method works by placing a light trap inside the house and near animal cages. Mosquitoes trapped in the light trap will be transferred to a paper cup using an aspirator (Ministry of Health 2017; Mwanga et al. 2019).

Human landing collection (HLC)

The method of catching mosquitoes by perching on humans is conducted according to Ministry of Health Indonesia (2017). Mosquitoes were caught when they perch on the human body. This process involves four houses, each house is sampled by two people as bait who are on duty outside and inside the house who have agreed to be respondents. The mosquito catcher attaches the lower legs to the mosquito bait. Mosquitoes that perch on the open body are sucked using an aspirator and placed in a paper cup lined with gauze. Every hour, mosquitoes caught in different places are placed in paper cups lined with gauze and tied with rubber bands. The duration of catching each hour is 40 minutes, after which the next five minutes are used by the mosquito catcher to rest.

Resting collection (RC)

This method is carried out simultaneously with the human landing collection method. Mosquitoes that land on the walls or around them will be sucked up using an aspirator, and then when the session is over, they can be put in a paper cup covered with gauze (Ministry of Health 2017). The catching duration is 10 minutes every hour, after which catchers use the next five minutes to rest (Kusariana et al. 2021).

Data analysis

Data is presented with descriptive analysis to find out the percentage of distribution mosquitoe. Spatial distribution of mosquitoes was performed using IBM SPSS version 24. Distribution of mosquitoes was mapped by ArcGIS version 10.5 application.

RESULTS AND DISCUSSION

In Henda Village, Pulang Pisau District, Central Kalimantan Province, Indonesia, seven mosquito species were identified: *Cx. quinquefasciatus*, *Ma. bonneae*, *Ma. uniformis*, *Ae. aegypti*, *Ae. albopictus*, *Cq. crassipes*, and *An. barbirostris*. The morphological characteristics of each species are explicated as follows:

Anopheles barbirostris has dark scales all over the proboscis, and there are no black scales on the clypeus. The thorax has scales on the antepronotal lobes, and there are no pale spots on the R2 veins on the wings. The abdomen has a few white scales between the medial and lateral. Midtarsomers usually lack pale streaking (Rattanarithikul et al. 2006a) (Figure 2.A).

Mansonia bonneae has the pale and dark distribution of the proboscis that can be seen clearly and has supra-alar without or with curved white scales (Figure 2.B). *Mansonia uniformis* has part of the proboscis with visible pale and dark color, scutum on the thorax with a pair of pale green longitudinal lines, and the wings contain pale and dark scales in an asymmetrical distribution. Furthermore, the hind femur has five or more pale stripes (Darsie and Pradhan 1990; Rattanarithikul et al. 2006b) (Figure 2.C).

Ae. aegypti has the entire proboscis without a white line, and the clypeus has white spots. The scutum is black or brown with a pair of submedian white lines or a lyre-like appearance, and the mesepimeron has two separate white scales. In addition, the leg has a knee spot on the femur, the middle part is missing three white spots on the anterior surface, and the back of the fifth tarsomere is white (Figure 2.D). Meanwhile, *Ae. albopictus* has the proboscis without a white band in the submedian part, and the clypeus has no white spots. Instead, the scutum has a white line in the median, and the mesepimeron has a white spot forming a "v" shape. In addition, the middle femur has a long white line (Rueda 2004) (Figure 2.E).

Coquillettidia crassipes has bright yellow scutellum without scales, dark-brown wing scales, and wings without spots that are pale and dark. The pleural integument on the abdomen is yellow to orange-brown. Furthermore, there are no protruding scales on the distal femur (Yeo et al. 2019; Nugroho et al. 2020) (Figure 2.F).

Culex quinquefasciatus lacks a pale band pattern on the cephalic region of the proboscis. The mesokatepisternum and mesepimeron of this species do not have dark and pale patterns. The mesepimeral has one or two setae on the underside, and terga's abdomen has a pale band at its base. In addition, the tarsomeres are dark in color (Figure 2.G).

The total number of mosquitoes captured using five methods presents total of 650 female mosquitoes. The human landing collection method was the most effective, capturing 438 mosquitoes. The majority of the captured mosquito species found were *Cx. quinquefasciatus* with 361 individuals (Table 2).

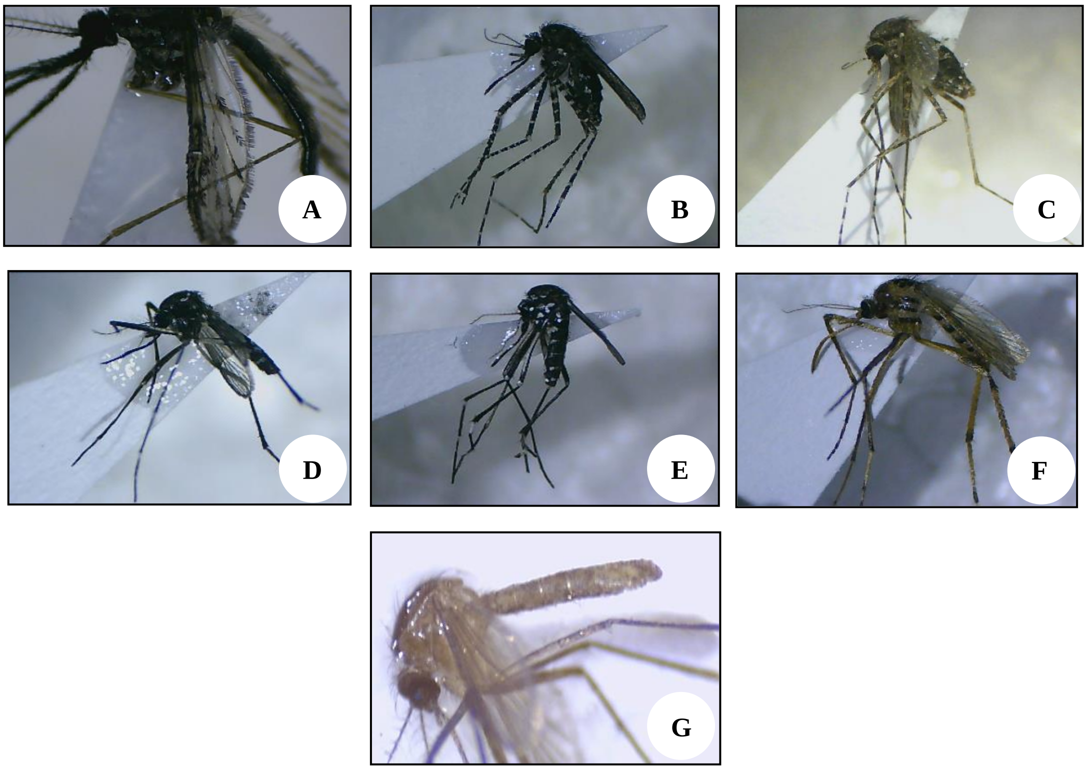

Figure 2. Adult mosquito species found in Henda Village Central Kalimantan Province, Indonesia. A. *Anopheles barbirostris*; B. *Mansonia bonneae*; C. *Mansonia uniformis*; D. *Aedes albopictus*; E. *Aedes aegypti*; F. *Coquillettidia crassipes*; G. *Culex quinquefasciatus*

Table 2. Number of mosquitoes with five collection methods in Henda Village, Pulang Pisau District Central Kalimantan Province, Indonesia

Species	**Methods**					**Total**
	LT	**RC**	**HLC**	**ABT**	**ABS**	
An. barbirostris	0	0	0	0	1	1
Ma. bonneae	0	5	74	0	55	134
Ma. uniformis	0	4	53	0	33	90
Ae. albopictus	0	0	7	2	4	13
Ae. aegypti	7	4	31	0	4	46
Cq. crassipes	0	0	0	0	5	5
Cx. quinquefasciatus	0	0	273	1	87	361
Total	7	13	438	3	189	650

Discussion

Filariasis is caused by filarial worms carried by vectors (Lourens and Ferrell 2019). Microfilariae are carried by *Aedes* spp., *Culex* spp., *Mansonia* spp., *Armigeres* spp., and *Anopheles* spp. (Ministry of Health 2014). Since 2018, 51 million people have been infected with filariasis parasites (Cromwell et al. 2020). According to the Ministry of Health (2021), there were 9,354 cases of filariasis, with the highest number occurring in Papua Province. According to the Health Office of Central Kalimantan, there were 49 cases of filariasis in Central Kalimantan, including four in Henda Village (Central Kalimantan Health Service 2021).

Culex quinquefasciatus can be found in South America, Central America, Africa, South Asia, Australia, New Zealand, and Southeast Asia (Nugroho and Mujiyono 2021; Samy et al. 2016). In addition, these mosquitoes are found in tropical and subtropical areas (Jones and Coleman 2005). *Culex* sp. is evenly distributed throughout Indonesia, especially in Sumatra, Java, Kalimantan, Sulawesi, East Nusa Tenggara, and Papua (O'Connor and Sopa 1981). According to Siwiendrayanti et al. (2021) and Chen et al. (2009), the breeding places of *Cx. quinquefasciatus* resides in puddles, gutters, and plastic containers. Breeding places found in Henda Village include pools of water and plastic containers. Stagnant water is often found because some houses dispose of household waste near their homes so that it can become a breeding place for mosquitoes.

Mansonia uniformis is present in countries such as Ethiopia, Tasmania, Melanesia, Micronesia, Polynesia, Australia, Japan, Korea, and Indonesia (Knight and Stone 1977; Nugroho et al. 2021). *Mansonia* spp. can be found on various islands in Indonesia, including Sumatra, Java, Kalimantan, Sulawesi, Maluku, and the Nusa Tenggara Islands (Nugroho et al. 2021). In addition, several species of *Mansonia* sp. that have been confirmed as filariasis vectors in Indonesia are *Ma. indiana, Ma. annulata, Ma. bonneae, Ma. annulifera*, and *Ma. dives* (B2P2VRP 2017). According to Wharton (1962) and Apiwathnasorn et al. (2006), the breeding place of *Ma. bonneae* is found in swamps or peat forest swamps. According to Pratiwi et al. (2018) and Wharton (1962), breeding places for *Ma. uniformis* in the form of swamps, rivers in forest areas, and rice fields with aquatic plants. *Mansonia* sp. larvae attached to the roots of aquatic plants. In Henda Village, various locations are covered with quite dense water plants (WHO 2013), which can serve as potential habitats for mosquito larvae as they provide protection from predators.

Aedes aegypti and *Ae. albopictus* are found in several countries, including Brazil, the United States, Mexico, Cuba, Argentina, Trinidad and Tobago, Venezuela, Colombia, Puerto Rico, Peru, Senegal, Cameroon, Kenya, Tanzania, Nigeria, Madagascar, Gabon, Mayotte, Sierra Leone, Taiwan, Indonesia, Thailand, India, Australia, Vietnam, Malaysia, Singapore, Philippines, and Cambodia (Kraemer et al. 2015). In Indonesia, *Aedes* present in all provinces (Heriawati et al. 2020). According to Ratnasari et al. (2020) and Augustina et al. (2021), breeding sites for *Ae. aegypti* and *Ae. albopictus* are in used tires, water drums, abandoned boats, pails, plant pots, and other containers. Since Henda Village is located on the banks of the Kahayan River, many residents' boats are placed on the riverbank. Abandoned boats increase the likelihood that they will serve as mosquito breeding places. There are also numerous water drums and buckets in residents' homes, which can serve as mosquito breeding spots. *Coquillettidia crassipes* are spread across several Indonesian islands, such as Sumatra, Java, Kalimantan, Nusa Tenggara, Sulawesi, Maluku, and Papua. The egg or larval stage of *Coquillettidia* sp. is attached to the roots of aquatic plants in ponds, lakes, swamps, ditches, ditches, and wells. Due to the river's tides, the Kahayan River's water level will decrease, causing several locations to become puddles and overgrown with aquatic plants to become breeding places for *Mansonia* sp. (Nugroho et al. 2020).

Anopheles barbirostris is widespread in India, Pakistan, Nepal, Sri Lanka, Vietnam, Thailand, Malaysia, Cambodia, China, Myanmar, Australia, and Indonesia (Reid 1962; Sinka et al. 2011). In Indonesia, *An. barbirostris* is present in provinces in Indonesia, such as Jambi, DKI Jakarta, Yogyakarta, Bali, Central Kalimantan, North Kalimantan, South Sulawesi, Riau Archipelago, and West Papua (Setiyaningsih et al. 2020). *Anopheles* mosquitoes inhabit various natural habitats, including swamps, calm rivers, and rice fields (Lestari et al. 2016). *An. barbirostris* are often found in plantations and forests with ditches and rivers with a calm flow. Clear streams in rivers and ditches can serve as potential breeding places for *Anopheles* sp.

The rainfall in Pulang Pisau District in July 2022 was 50-100 mm (BMKG 2022b) and increased in August 2022 to 100-150 mm (BMKG 2022a). According to Ridha et al. (2018) and Chandra and Mukherjee (2022), rainfall can affect the age of mosquitoes. Therefore, high rainfall can affect the mosquito population in the region. On the other hand, the low rainfall in Henda Village can increase the age of mosquitoes so that more mosquitoes will be obtained in the collection process.

The average temperature in Henda Village from July to August is 26°C, and the wind speed at an altitude of 10 meters is 0.68 m/s (NASA 2022). According to Pratiwi et al. (2021) and Yahya et al. (2019), the optimum temperature for mosquitoes survival is between to live is around 25 and 27°C. Temperature is closely related to the survival and development of mosquitoes. Temperature below 10°C and above 40°C will halt their development (Yahya et al. 2019). During the study period, the temperature in Henda Village is conductive mosquitoes breeding. According to Endo and Eltahir (2018) and Adeleke et al. (2022), high wind speeds will reduce the activity of mosquitoes in flying to suck blood or nectar. Wind speeds above 0.9 m/s are the main inhibiting factor for mosquito activity in China (Wong and Jim 2017). Low wind speed will make it easier for mosquitoes to detect CO_2 emitted by humans and increase mosquito activity in sucking blood or nectar. The relatively low wind speed in Henda Village supports mosquitoes in detecting human scent.

The human landing collection method captured 438 mosquitoes, including *Cx. quinquefasciatus, Ma. bonneae, Ma. uniformis, Ae. aegypti*, and *Ae. albopictus*. Meanwhile, the animal barrier screen caught *Cx. quinquefasciatus* the most. According to Maksud et al. (2020), the most successful mosquitoes collections using the human landing collection method were *Cx. quinquefasciatus* and *Cx. vishnui*. *Cx. quinquefasciatus* can be found in Henda Village because many potential places can be used to lay their eggs. According to Dormont et al. (2021), each mosquito species has its attractant. Several attractants that can attract mosquitoes include CO_2, human body odor, and animal body odor. The high number of collections using the human landing collection method is associated with attractants released by humans, such as lactic acid, carboxylic acids, ammonia, ketones, alcohols, aldehydes, and CO_2 (Bello and Cardé 2022).

The animal barrier screen method captured a total of 189 mosquitoes, including *Cx quinquefasciatus*, *Ma. bonneae*, *Ma. uniformis*, *Ae. aegypti*, *Ae. albopictus*, *Cq. crassipes*, and *An. barbirostris*. *Culex quinquefasciatus* was the most commonly collected mosquito using this method. According to Rahma et al. (2020), this method can capture *Culex* sp., *Mansonia* sp., *Aedes* sp., *Coquillettidia* sp., and *Anopheles* sp. Burkot et al. (2013) also demonstrated that animal barrier screen method was most successful in capturing *Cx. quinquefasciatus*. In Henda Village, a potential breeding site for *Cx. quinquefasciatus* is a pool of water near the residents' settlements and a ditch near the residents' plantations.

The resting collection method captured a total of 13 mosquitoes, which included the species *Ma. bonneae*, *Ma. uniformis*, and *Ae. aegypti*. This finding is consistent with the results reported by Rohani et al. (2013). Among these, *Ma. bonneae* was the most frequently collected species using the resting collection method, as noted by both Supranelfy et al. (2012) and Rohani et al. (2013).

The light trap method caught seven individuals *Ae. aegypti*. This study aligns with the findings of Pimnon et al. (2022) where *Ae. aegypti* was also collected using a light trap. The low number of mosquitoes caught may be due to the light trap method being placed close to the human landing collection method, which makes mosquitoes more attracted to the attractants released by humans.

The animal-baited trap method caught three mosquitoes species, *Ae. albopictus*, *Cx. quinquefasciatus*, and *Ae. albopictus* with *Ae. albopictus* being the most frequently collected species. According to Boyer et al. (2021), *Ae. albopictus* was captured more often than other *Aedes* sp. when using the animal-baited trap, as it has a preference for human blood. After feeding, *Ae. albopictus* seek a resting place. Its flight range can extend up to 434 meters (Bonnet and Worcester 1946). The area surrounding the animal-baited trap consists of houses, providing potential resting sites for the mosquitoes after feeding.

In conclusion, this study offers valuable insights for prevention and control of filariasis vectors. These insights focus on lesser-known breeding sites in the community, effective methods for vector elimination, and the resting habits of filariasis vector mosquitoes.

ACKNOWLEDGEMENTS

The authors thank the Mr. Letus, Head of Henda Village Central Kalimantan Province for supporting this research.

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