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Entomological Assessment in Tangerang, Indonesia: Post Transmission Assessment Survey of Lymphatic Filariasis Endemic Villages

Heni Prasetyowati
Pangandaran Unit for Health Research and Development
National Institute of Health Research and Development
Pangandaran, Indonesia
https://orcid.org/0000-0002-9418-6082

Muhammad Umar Riandi
Pangandaran Unit for Health Research and Development
National Institute of Health Research and Development
Pangandaran, Indonesia
https://orcid.org/00000002-9800-934X

Joni Hendri
Pangandaran Unit for Health Research and Development
National Institute of Health Research and Development
Pangandaran, Indonesia
https://orcid.org/0000-0001-9563-1312

Mara Ipa
Pangandaran Unit for Health Research and Development
National Institute of Health Research and Development
Pangandaran, Indonesia
https://orcid.org/0000-0002-48316536

***Abstract*— A transmission assessment survey (TAS) has been conducted in 2014 following five years mass drug administration (MDA) of anti-filarial medication in Tangerang district. To assess vector density and transmission dynamic of lymphatic filariasis (LF) after the MDA implementation, entomological surveys were carried out in 2017 from August to September at Rajeg and Kemiri subdistrict. Adult filarial mosquito vectors were collected using double net-trapped human bait method. In addition, habitat characteristics were recorded. Abundance, frequency, and species dominance were analyzed. A total of 4462 mosquitoes from five genera Anopheles, Aedes, Armigeres, Culex and Mansonia were captured at both sites of which Culex quinquefasciatus has the highest relative abundance (n= 3510/4462, 78.75%) resulted in species dominance index of 0.62. The most common Cx. quinquefasciatus breeding site was drainage ditch (n=20/44, 45.5%). Excessive breeding sites may likely preserve the abundance of filarial vector Cx quinquefasciatus in these areas, highlighting the potential risk for the re-emergence of LF transmission. Routine vector control and surveillance is required to continuously monitor the filarial vector density and their habitats.**

Keywords:* *Cx quinquefasciatus, filariasis, Tangerang District, transmission assessment survey, Indonesia, vector

I. Introduction

Lymphatic filariasis (LF) is among the neglected arthropod-borne diseases of public health significance caused by filarial nematodes (Wuchereria bancrofti (Wb), Brugia malayi (Bm) or Brugia timori (Bt)). It is estimated that 67.88 million people from 73 countries are disproportionately affected by LF [1] with communities living in tropical and subtropical countries are at highest risk. LF causes progressive and irreversible lymphatic dysfunction resulting in the swelling of limbs and genitals. This leads to significant and permanent disability worldwide [2,3].

Filarial worm is transmitted by various mosquito species from genus of Anopheles, Aedes, Culex, Mansonia, and Ochlerotatus. Among these types, Culex quinquefasciatus (which belong to the genus Culex) is the main vector of Wuchereria bancrofti that plays a major role in bancroftian filariasis transmission in many urban areas [4,5]. Cx. quinquefasciatus has strong endophilic and anthropophilic behaviour. Their breeding sites are mostly inside or around human settlements area. This species can adapt to artificial man-made habitats including ponds, open water containers, and shallow drainages [6,7].

LF is among the nine infectious diseases targeted for elimination globally. To eliminate LF, mass drug administration (MDA) of albendazole combined with diethylcarbamazine (DEC) is administered annually in endemic regions. The MDA is administered to the entire population residing in the area where the prevalence of LF is 1% or above. To support LF elimination program, local health authorities carried out regular vector control to monitor mosquito vector [8].

LF is an important public health problem in Tangerang district, Banten Province, Indonesia. A survey conducted in 2005-2007 demonstrated high microfilaria (MF) rate (>1%) in four subdistricts of Tangerang including Cikupa, Rajeg, Sepatan Timur and Tiga Raksa. Following this survey, in 2009, health authorities had performed MDA towards population living in the region. Since then, Tangerang was declared as LF endemic area until the Transmission Assessment Survey (TAS) has reached MF rate <1% [9]. The TAS is a standard method used to stop MDA. When TAS reaches Mf rate of <1%, this means that there is no new LF transmission, and the region is allowed to stop MDA [10].

Each year, the coverage of MDA at Tangerang has reached its target both epidemiologically and geographically although the percentage was relatively low compared to the coverage in the initial year. The MDA program has been completed on May 2013 and continued with pre-TAS implementation on November 2013 (Mf rate = 0.3%). To evaluate MDA, TAS was performed in 2014 and 2016, and it showed a satisfactory result, suggesting that Tangerang has achieved their target on eliminating LF transmission [9].

Although the TAS has been passed, the potential of re-emergence of LF transmission in Tangerang should be anticipated. Tangerang is an industrial zone where people from all around the country come to work in this area. Thus it is possible that some people that come from LF endemic area cause a new local transmission. A community-based survey in American Samoa has identified the existence of LF residual transmission where a number of people has higher number of positive antigen than expected. Sheel et al (2016) mentioned that school-based TAS was logistically simpler, and it is possible to acquire samples from a larger proportion than the target population. However, the result is not going to provide better indication than the total prevalence of CFA on the age beyond school age [11]. This study aimed to describe the post-TAS entomological condition of selected LF endemic sub-districts in Tangerang. This study will provide recent entomological information after TAS which could help local health authorities in improving vector control and surveillance to prevent the re-emergence of LF transmission in Tangerang.

II. METHOD

This study was conducted to further analyze the data obtained from the multicenter study for Filariasis Elimination [12]. The LF multicenter study was conducted by National Institute of Health Research and Development, Ministry of Health of Indonesia from August to September (2017) in 14 Provinces, 24 Districts across Indonesia.

In Tangerang, an observational study was conducted in Rajeg subdistrict ('Kecamatan') and Kemiri subdistrict from August to September 2017. The former was assigned as sentinel area while the latter was assigned as the spot area. Sentinel area is an area with LF patients whereas spot area is geographically similar with sentinel area but without any LF patients. In both areas, adult mosquito was captured, and potential habitats were mapped. In both sites, two entomological surveys with an interval of one month were administered. Mosquitoes were caught using modified Human bait Double Net (HDNs). A large untreated bed was hung over smaller net and raised 30 cm above the ground. Participants rested on mattress with fabric inlay and were fully protected from mosquitoes by polyester bed net. Mosquitoes were caught in the 30 cm gap between the two nets for 10 minutes every hour. The captured mosquitoes were extracted and put into different paper cups by participant who was in-charge at each trap. Mosquito collection was conducted from 6 PM to 6 AM and repeated the next day using the same method.

The mosquitoes were separated based on species and sex using stereo-microscopes to identify its species complex, and morphological traits. Survey for potential mosquito habitat was conducted within radius of 1-km where mosquitoes were captured. Relative abundance, frequency, and dominance of each captured mosquito species was calculated. Relative abundance is the proportion of a specific species to the total number of the captured mosquito (all species). It is stated as percent unit.

$$\text{Relative abundance} = \frac{\text{Number of specific species x 100}}{\text{Total number of caught specimens}}$$

Frequency is determined by comparing the number of species found in the collection with the total hours of capture.

$$\text{Frequency} = \frac{\text{Number of specific species caught}}{\text{Total number of caught with the same method}}$$

Dominance is calculated by multiplying the relative abundance with the frequency of specific mosquito species.

$$\text{Dominance index} = \text{Relative abundance x Frequency of capture}$$

III. RESULTS

A total of 4.462 mosquitoes (Rajeg subdistrict: 1.558 (35 %); Kemiri subdistrict: 2.904(65 %)) from six genera including Anopheles, Aedes, Armigeres, Culex, Lutzia and Mansonia were captured. 11 species were identified with Culex as the most dominant genus (4 species). Among these four identified Culex species, Cx. quinquefasciatus was the most dominant (n=3510) with 78,6% of the total number of mosquitoes collected during the survey (Table 1).

TABLE I. LF VECTORS COLLECTED FROM THE SURVEYS IN RAJEG AND KEMIRI, TANGERANG, 2017

No	Genus	Type of Vector	Number (Mosquitoes)		
		Species	*Rajeg (N=1.558)*	*Kemiri (N=2.904)*	*Total*
1	*Mansonia*	*Mansonia uniformis*	0	2 (0.07%)	2
2	*Culex*	*Culex uinquefasciatus*	1.173 (75,3%)	2.33 (80,5%)	3.510
3	*Culex*	*Culex tritaeniorrhync hus*	13 (0,83%)	29 (1%)	42
4	*Culex*	*Culex vishnui*	365 (23,4%)	529 (18,2%)	896
5	*Culex*	*Culex fuscocephalus*	1 (0,06%)	0	1
6	*Lutzia*	*Lutzia vorax*	0	1 (0,03%)	1
7	*Anopheles*	*Anopheles barbirostris*	0	1 (0,03%)	1
8	*Anopheles*	*Anopheles vagus*	0	1 (0,03%)	1
9	*Aedes*	*Aedes aegypti*	2 (0,1%)	0	2
10	*Armigeres*	*Armigeres kasseli*	3 (0,2%)	2 (0,07%)	5
11	*Armigeres*	*Armigeres malayi*	1 (0,06%)	0	1
		Total	100 %	100 %	4.462

Table 2. shows the density of mosquitoes captured during the survey. Density is presented by relative abundance, frequency, and dominance. Cx. quinquifasciatus has the highest relative abundance (78.75%), and these mosquitoes were collected every hour until 6 AM (frequency = 1). Figure 1 shows the fluctuation of collected mosquitoes during the survey. The number of

TABLE II. RELATIVE ABUDANCE, FREQUENCY, AND DOMINANCE OF LF VECTORES CAPTURED IN RAJEG AND KEMIRI, TANGERANG, 2017

Species	**Relative Abundance**	**Frequency**	Dominant Species
Ae. Aegypti	0,08%	0,08	0,000001
An. Barbirostris	0,04%	0,08	0,000000
An. Vagus	0,04%	0,08	0,000000
Ar. Kesseli	0,15%	0,08	0,000002
Ar. Malayi	0,04%	0,08	0,000000
Cx. fuscocephalus	0,04%	0,08	0,000000
Cx. quinquifasciatus	78,75%	1,00	0,620156
Cx. tritaeniorhynchus	1,17%	0,58	0,000138
Cx. Vishnui	19,58%	1,00	0,038351
Lutzia vorax	0,04%	0,08	0,000000
Ma. Uniformis	0,08%	0,17	0,000001

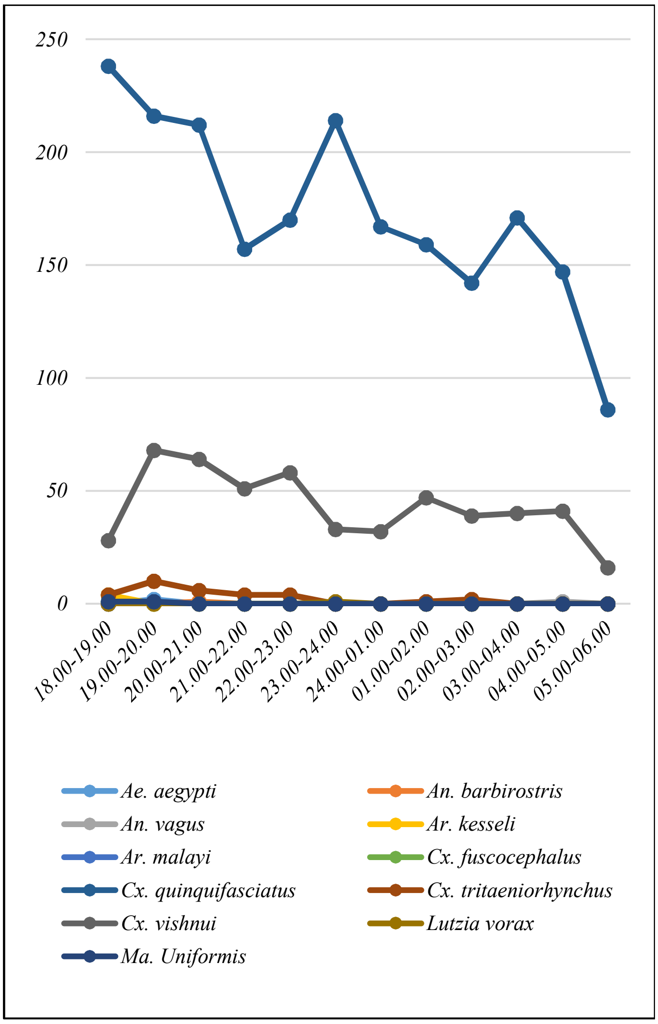

Fig 1. Collected Mosquitoes Fluctuation at The Region of Tangerang

mosquitoes collected fluctuated depend on the species. Figure 1 shows that Cx. quinquefasciatus was always caught every hour for 12 hours collection time.

TABLE III. DISTRIBUTION OF POTENTIAL HABITATS TYPES AT THE RESEARCH LOCATION IN TANGERANG, 2017

Table 3 presents the potential habitats of LF mosquito vectors identified in both sites. Six types of mosquito habitat were identified including ditch, pond, swamp, irrigation canal, rice field, and digging hole. Forty-four habitats that contained larvae were identified (Rajeg, n = 27(61.3 %); Kemiri, n = 17 (38,7%) of which the most abundant was ditch (45,5%). Ditch is a narrow channel that is used for drainage around residential area.

No.	**Types of Habitat**	**Number of potential habitas**		
		Rajeg (N= 27)	**Kemiri (N = 17)**	**Total**
1	Ditch	13 (48.15%)	7 (41.18%)	20 (45.5%)
2	Pond	2 (7.14%)	1 (5.88%)	3 (6.8%)
3	Digging hole	2 (7.14%)	0	2 (4.5%)
4	Swamp	0	3 (17.65%)	3 (6.8%)
5	Irrigation channel	2 (7.41%)	1 (5.88%)	3 (6.8%)
6	Rice fields	8 (29.63%)	5 (29,41%)	13 (29.5%)
	Total	27 (100%)	17 (100%)	44 (100%)

IV. DISCUSSION

Tangerang has a relatively flat topography with an average slope of 0.8% downward towards the north. It lies at the altitude of 0-85 m above sea level. The northern part of Tangerang consists of coastal and urbanized areas while the eastern part is more rural and consist of settlement areas. The west part is dominated by industrial area and developing city. Our study was conducted in low-land and densely populated human settlement areas. The survey was conducted in September and October with average temperature ranged from 28.4-28.50C. Rainfall was about 93.4 mm with 7 rainy days (September) and 124.8 mm with 12 rainy days (October) and the humidity ranged from 77.6 to 80.2% [13].

Based on the climate during the survey, the rainfall at the study sites was considered low. It might partly explain an increase in mosquito density at the study sites. Sitohang and Shidqon (2016) suggested that rainfall level of an area may influence the development of mosquito. Rainfall facilitates the development of mosquitoes as it increases the level of humidity and provides plenty of water containers and favourable conditions to breed. A high rainfall may not be beneficial for mosquito's development. Meanwhile, longer period of medium rainfall may increase the probability of mosquitoes to breed [14]. In addition to rainfall, the weather condition that influences mosquito development is air temperature, air humidity, and wind speed; all of which may play a role on the dynamic of mosquito density in the environment. It has been shown that these climatic conditions have been an important drive for the dynamics of JE mosquito vectors including Cx. quinquefasciatus at the region of OKI. High temperature and low humidity likely increase the number of captured mosquitoes. Wind speed is also a major factor that correlates with the density of mosquito; the higher the wind speed, the more mosquitoes are captured [15].

Our study demonstrated that the most dominant species captured in Tangerang was Cx. quinquefasciatus which accounted for 62% of the total capture mosquito. This suggests that the species has the ability to adapt with the environment at both sites. Potential habitats and sufficient environment enable the species to grow and develop rapidly. Culex quinquefasciatus is commonly found in urban areas [16]. Generally, the species breeds in water polluted with rich organic matters. Some studies also mentioned that the species is able to live and breed in artificial containers such as shallow water flow, well, and water stabilization pond [17,18]. A survey of Cx. quinquefasciatus habitat during wet season conducted by Okiwelu and Nautcha (2012) in Nigeria and found that Cx. quinquefasciatus could not only be found in urban areas but also has invaded rural areas, inhabiting diverse habitats such as containers (metal, plastic, clay), sites (pools and sewers), and holes on trees [19]. The distinction of Cx. quinquefasciatus is in their ability to use available containers as their breeding site, suggesting that this species has strong plasticity to breed both in clear or polluted water [20].

In this study, the identified potential habitat of Cx. quinquefasciatus around the study sites were water pools, ponds, digging holes, rice fields, swamps, and irrigation channels. The most common habitat was open water pool or ditch around residential areas that contain household wastewater. According to CABI (2018), the larva of Cx. quinquefasciatus prefers eutrophic water bodies with high organic composition. A very high larva density can be found in septic water connected with oxidized pool, sewerage line, and septic tank [21]. A similar finding was also found in Banyu Urip urban communities in Pekalongan. The breeding sites for Culex were commonly found at open pool of dirty water, open pool of clean water, open and calm water flows, open and heavy water flows, open water with high organic pollution, and also open water with low organic pollution [14].

Climatic factors combined with the community behaviour which tends to dispose household waste into ditches around their residential areas might have maintained the existence of mosquito habitats and the density of Cx. quinquefasciatus in the study site. Most of the habitats of Cx. quinquefasciatus are external and very endophilic and anthropophilic in nature. In tropical areas where the environmental factors support the abundance of breeding sites and allow faster biological development, high density of Cx. quinquefasciatus can be maintained for longer period of time. This can increase the risk of disease transmission especially LF. The dominance index can describe the real population density of an area compared to other density parameters [22]. CX. quinquefasciatus mosquito has the highest dominance number compared to other species. Studies have shown that Cx. quinquefasciatus is the main vector for urban filariasis [23,24]. The examination result of mosquito specimens captured in this research showed that W. bancrofti was found in the sample of Cx. quinquefasciatus [12]. This is critical as Tangerang has passed the TA,S but the risk of local LF transmission still exists. Moreover, Tangerang is known as industrial centre where a lot of people come in and out from and to other part of country. It is possible that people who migrated from an endemic LF areas play a role in creating new LF transmission in this area.

Developing a program or an effective vector control strategy for this species requires knowledge on some ecological aspects [25]. It is essential for the surrounding residents to be aware of the threat of transmission and improve the environment sanitation in order to minimize the breeding sites of Cx. quinquefasciatus. A recent study by Ipa et al (2018) demonstrated that some residents realized that filariasis is transmitted by mosquito. However, the knowledge regarding the type of mosquito vectors and its habitats were still lacking among the residents. Regardless the society's efforts to prevent mosquito bites using insect repellent or wearing jacket outdoor, the effort to eliminate the breeding sites of mosquito has not been fully conducted. This was shown by the number of habitats in the form of ditch that can still be found around residential area [12].

V. CONCLUSION

The Culex genus especially the Cx. quinquefasciatus species was the most dominant species found in Rajeg and Kemiri, Tangerang. The most commonly found habitat was ditch containing household wastewater in the surrounding residential area. Climatic factors may play a significant role in maintaining mosquito habitats and the dominance of Cx. quinquefasciatus in both sites. Public health intervention is required to improve community's awareness and sanitation to minimize the risk of the re-emergence of LF transmission.

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