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ARTIKEL

DIVERSITY AND DENSITY OF VECTOR FOR LYMPHATIC FILARIASIS IN BUTON DISTRICT, SOUTH EAST SULAWESI PROVINCE, INDONESIA

[*Keanekaragaman dan Kepadatan Vektor Filariasis Limfatik di Kabupaten Buton Provinsi Sulawesi Tenggara, Indonesia*]

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ABSTRACT

A study was conducted in Buton District, Southeast Sulawesi, to ascertain the diversity and density of mosquito species and to determine the potential for transmission, prevention, and control of filariasis. The findings of this study serve as a baseline for the assessment and monitoring of the risk of filariasis disease, which may contribute to the prevention of future transmission. The collection methods employed involved the use of landing collection techniques, with several modifications to standard procedures. The identification of mosquitoes was conducted using a dissecting microscope and a mosquito identification key book. The collection yielded a total of 1,100 mosquitoes, classified into seven genera: *Aedes*, *Anopheles*, *Armigeres*, *Coquilettidia*, *Culex*, *Mansonia*, and *Uranotaenia*. The composition of the collection included 1,035 *Culex*, 27 *Armigeres*, 22 *Anopheles*, 11 *Aedes*, 2 *Mansonia*, 2 *Uranotaenia*, and 1 *Coquilettidia*. These numbers represented 94.09%, 2.45%, 2.00%, 1.00%, 0.18%, 0.18%, and 0.09%, respectively. The 23 distinct species of mosquito identified based on their morphological characteristics included nine species of *Culex*, six species of *Anopheles*, three species of *Aedes*, two species of *Armigeres*, and one species belonging to *Coquilettidia*, *Mansonia*, and *Uranotaenia*. Of particular note are the two species, *Cx. quinquefasciatus* and *Cx. vishnui*, which exhibited a high density. These species were found to be dominant in both outdoor and indoor human dwellings. Notably, *Cx. quinquefasciatus* and *Cx. vishnui* have been identified as potential risk factors for filariasis transmission, highlighting the need for continued surveillance and monitoring in filariasis-endemic regions.

Keywords: diversity, density, vector, lymphatic filariasis, Buton

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ABSTRAK

Penelitian telah dilakukan di Kabupaten Buton, Sulawesi Tenggara, untuk mengetahui keanekaragaman dan kepadatan spesies nyamuk serta potensi penularan, pencegahan, dan pengendalian filariasis. Hasil penelitian ini menjadi dasar penilaian dan pemantauan risiko penyakit filariasis yang dapat memberikan kontribusi terhadap pencegahan penularan di masa mendatang. Metode pengumpulan yang digunakan adalah teknik pengumpulan koleksi nyamuk hinggap dengan beberapa modifikasi terhadap prosedur standar. Identifikasi nyamuk dilakukan dengan menggunakan mikroskop bedah dan buku kunci identifikasi nyamuk. Hasil pengumpulan nyamuk sebanyak 1.100 ekor nyamuk yang diklasifikasikan menjadi tujuh genus; Aedes, Anopheles, Armigeres, Coquilettidia, Culex, Mansonia, dan Uranotaenia. Komposisi nyamuk yang terkumpul meliputi; 1.035 ekor Culex, 27 ekor Armigeres, 22 ekor Anopheles, 11 ekor Aedes, 2 ekor Mansonia, 2 ekor Uranotaenia, dan 1 ekor Coquilettidia, masing-masing secara berurutan sebesar; 94,09%, 2,45%, 2%, 1%, 0,18%, 0,18%, dan 0,09%. Dua puluh tiga spesies nyamuk berbeda yang dapat diidentifikasi berdasarkan karakteristik morfologinya, terdiri dari 9 spesies Culex, 6 spesies Anopheles, 3 spesies Aedes, 2 spesies Armigeres, dan satu spesies Coquilettidia, Mansonia, Uranotaenia. Yang menjadi perhatian khusus adalah spesies, Cx. quinquefasciatus dan Cx. vishnui, menunjukkan kepadatan tinggi. Kedua spesies ini ditemukan dominan di luar dan dalam rumah. Oleh karenanya, Cx. quinquefasciatus dan Cx. vishnui diidentifikasi sebagai faktor risiko potensial penularan filariasis, sehingga perlu adanya pengawasan dan pemantauan berkelanjutan di wilayah endemis filariasis.

Kata kunci: *keanekaragaman, kepadatan, vektor, filariasis limfatik, Buton*

INTRODUCTION

Lymphatic filariasis (LF) is one of the oldest neglected tropical diseases (NTDs), caused by three species of parasitic worms, *Wuchereria bancrofti*, *Brugia malayi,* and *B. timori*, and transmitted to humans by mosquitoes (WHO, 2013).

Mosquitoes are an important group of arthropods that inhabit freshwater habitats (Rueda IM, 2008). Mosquitoes are vectors that should be monitored and evaluated because of their potential to transmit the disease. The presence of mosquitoes is generally undesirable as they may transmit pathogens, especially to humans, causing diseases such as filariasis (Kauffman *et al*., 2017). Members of the genus mosquitoes, such as *Anopheles*, *Culex*, *Aedes*, *Mansonia*, and *Ochlerotatus,* transmitted filarial parasites depending on the geographical location and biological peculiarities of each species (WHO, 2013)

Monitoring and evaluation could be conducted by assessing the presence of prevalent mosquito vectors, including their species diversity and composition (Beerntsen *et al*., 2000). The diversity and density of mosquitoes have never been reported comprehensively despite the fundamental role of such data in informing the potential risk and impact of the transmission of infectious diseases and the plausible preventive actions to control the transmission (Vourc'h *et al*., 2012); Chaves *et al*., 2011). The lack of information on the species diversity of mosquitoes hampers the understanding of the distribution and occurrence of vectors that potentially initiate the infectious disease. A diversity and density of mosquito species is studied for the first time in two villages in Buton District, Southeast Sulawesi, to know the potential of transmission, vector prevention, and control of filariasis that could be supported by environmental conditions, which are dominated by beaches, hills, lowlands, and rice fields, which provide habitats for vector mosquitoes to breed. Important parameters of disease transmission, such as mosquito species composition, person-hour density, density per man day and hourly density, are unknown. A diversity and density of mosquitoes are potentially/risk factor for the possibility of pathogen transmission of filariasis (Roche *et al*., 2013; WHO, 2013).

The choice of the study area was based on chronic filariasis cases. The results study could be used as baseline data for assessing and monitoring the risk of filariasis disease, which may help to prevent a disease transmission in the future.

MATERIALS AND METHODS

Study sites

Buton was one of the Malayan filariasis endemic areas, caused by *Brugia malayi*. Buton, however, microfilariae (mf) prevalence in human populations becomes low due to the MDA (mass drug administration) lymphatic filariasis program. But there were still 4-6 cases of chronic filariasis as an old case, according to case data for chronic filariasis/elephantiasis (Dinas Kesehatan Provinsi Sulawesi Tenggara, 2017). Buton, the climate is marked by high temperatures and humidity. Rainfall is moderate. Mosquito collections were undertaken twice a month in September and October 2017. The location of the study was conducted in 2 filariasis endemic villages, namely Bonelalo Village, Lasalimu Subdistrict, and Mabulugo Village, Kapontori Sub-District, Buton. The location for the mosquito catching station was chosen based on 2 criteria, namely ecological conditions that support the existence of vectors and the houses of positive patients with filariasis.

Mosquito trapping

In order to monitor the effectiveness of the control programme, mosquito abundance and composition before and after intervention deployment can be determined by undertaking entomological surveys. The survey was conducted for 2 nights respectively. The method used was a modification of the human landing collection in a mosquito net. *Human Landing Catches* (HLCs)/*Human Landing Collections* are the gold standard method for collecting human-biting mosquito species (Service, 1993). HLCs collect anthropophilic, host-seeking mosquito species. Mosquitoes were collected every 12 hours. Landing mosquitoes were collected outdoors from 18:00 to 06:00 using manual aspirators in teams of 6 volunteers. Catching mosquitoes was carried out by 3 catchers in a mosquito net inside the house and 3 catchers in a mosquito net outside the house. Mosquito nets installed consist of 2 mosquito nets, where the outer mosquito net is open and the inside mosquito net is smaller than the outer mosquito net. The human was inside a mosquito net as bait. Every 10 minutes, a mosquito catcher comes out of the mosquito net to catch mosquitoes that are between the 2 mosquito nets.

The identification of mosquitoes and data analysis

Mosquitoes collected from HLCs were morphologically identified using keys by Stojanovich {Formatting Citation} and Rampa (Rattanarithikul, 1982). Mosquito species, number of mosquitoes caught, time of mosquitoes' activity, also habitat characteristics were recorded. Species diversity and density were then analyzed based on the following parameters, including indexes of density, frequency, and dominance.

Parameters of mosquitoes are determined by the formula:

$$\text{Density} = \frac{A\ number\ of\ mosquitoes-caught\ per\ species\ by\ certain\ methods}{A\ number\ of\ mosquitoes-caught\ with\ certain\ methods}\ x\ 100\%$$

$$\text{Frequency} = \frac{A\ number\ of\ Mosquitoes-caught\ containing\ certain\ species}{A\ number\ of\ certain\ mosquitoes-caught\ in\ the\ same\ way}$$

Dominance rate = *frequency x density*

RESULTS

Diversity and density of mosquito species collection in Buton

A total of 1100 mosquitoes were collected in Buton. It consisted of seven genera from the human landing catches method, examined in two villages. The seven genera of mosquitoes were *Aedes*, *Anopheles*, *Armigeres*, *Coquilettidia*, *Culex*, *Mansonia,* and *Uranotaenia*. The majority of the mosquitoes collected across this study belonged to the genera *Culex*, *Armigeres,* and *Anopheles*. Others, *Aedes*, *Mansonia*, *Uranotaenia,* and *Coquiletidia,* respectively. The mosquitoes were collected in the field: 1035 *Culex* sp, 27 *Armigeres* sp, 22 *Anopheles* sp, 11 *Aedes* sp, 2 *Mansonia* sp, 2 *Uranotaenia* sp, and 1 *Coquiletidia* sp individual. Morphological identification of collected mosquitoes showed that 94,09% were *Culex* sp, 2,45% were *Armigeres* sp, 2% were *Anopheles* sp, 1% were *Aedes* sp, 0,18% were *Mansonia* sp, 0,18% were *Uranotaenia* sp, and 0,09% were *Coquiletidia* sp, respectively (Table 1).

Table 1. The Genera of Mosquitoes in Two Study Areas, Bonelalo and Mabulugo Village,Southeast Sulawesi, Indonesia (*Genus nyamuk di dua daerah studi, Desa Bonelalo dan Mabulugo, Sulawesi Tenggara, Indonesia*).

No	Genera	Bonelalo		Mabulugo		Number and Percentage (*Jumlah dan Persentase*)
		∑	%	∑	%	
1	*Aedes*	10	3,32	1	0,12	11 (1)
2	*Anopheles*	3	0,99	19	2,38	22 (2)
3	*Armigeres*	27	8,97	0	0,00	27 (2,45)
4	*Coquilettidia*	0	0,00	1	0,12	1 (0,09)
5	*Culex*	259	86,05	776	97,12	1035 (94,09)
6	*Mansonia*	0	0,00	2	0,25	2 (0,18)
7	*Uranotaenia*	2	0,66	0	0,00	2 (0,18)
	Total	**301**	**27,36**	**799**	**72,64**	**1100 (100)**

Twenty-three species of mosquitoes from two villages were only identified using morphological features, consisting of 9 *Culex* sp, 6 *Anopheles* sp, 3 *Aedes* sp, 2 *Armigeres* sp, and one species belongs to *Coquilettidia*, *Mansonia, Uranotaenia* (Table 2). In terms of abundance, *Culex quinquefasciatus* (570) had the highest number of mosquitoes collected, followed by *Culex vishnui* (438).

Table 2. The Diversity of Mosquito Species Collected in Bonelalo and Mabulugo, Southeast Sulawesi, Indonesia, 2017 (*Keanekaragaman Spesies Nyamuk yang Dikumpulkan di Bonelalo dan Mabulugo, Sulawesi Tenggara, Indonesia, 2017*).

No	Species (*Species*)	Bonelalo		Mabulugo		Number of (*Jumlah*)
		∑	%	∑	%	
1	*Aedes aegypti*	9	100,00	0	0,00	9
2	*Aedes albopictus*	1	100,00	0	0,00	1
3	*Aedes amesii*	0	0,00	1	100,00	1
4	*Anopheles barbirostris*	0	0,00	14	100,00	14
5	*Anopheles flavirostris*	3	100,00	0	0,00	3
6	*Anopheles kochi*	0	0,00	1	100,00	1
7	*Anopheles subpictus*	0	0,00	1	100,00	1
8	*Anopheles tesselatus*	0	0,00	1	100,00	1
9	*Anopheles vagus*	0	0,00	2	100,00	2
10	*Armigeres malayi*	1	100,00	0	0,00	1
11	*Armigeres subalbatus*	26	100,00	0	0,00	26
12	*Coquilettidia crassipes*	0	0,00	1	100,00	1
13	*Culex bitaeniorhynchus*	1	100,00	0	0,00	1
14	*Culex mammilifer*	2	100,00	0	0,00	2
15	*Culex mimulus*	1	100,00	0	0,00	1

No	Species (*Species*)	Bonelalo		Mabulugo		Number of (*Jumlah*)
		∑	%	∑	%	
16	*Culex nigropunctatus*	4	66,67	2	33,33	6
17	*Culex pallidothorax*	1	100,00	0	0,00	1
18	*Culex quinquefasciatus*	247	43,33	323	56,67	570
19	*Culex sitiens*	1	33,33	2	66,67	3
20	*Culex tritaeniorhynchus*	0	0,00	13	100,00	13
21	*Culex vishnui*	2	0,46	436	99,54	438
22	*Mansonia uniformis*	0	0,00	2	100,00	2
23	*Uranotaenia lateralis*	2	100,00	0	0,00	2
	Total	**301**		**799**		**1100**

Table 2 showed the diversity of mosquitoes species that were caught during data collection. *Culex quinquefasciatus* was a dominant species, accompany by *Culex vishnui* respectively. Of the 1100 mosquitoes collected, the species of mosquitoes that were caught at study area of two villages as many as 301 mosquitoes (27,36%) in Bonelalo and 799 mosquitoes (72,63%) in Mabulugo.

Regarding the composition of collected mosquitoes, there were 5 genera consisting of 10 species of mosquitoes collected in Bonelalo Village, while in Mabulugo Village, the genera were 5 with 9 species. There were 4 species collected in both study area, which were *Culex sitiens, Cx. quinquefasciatus, Cx. vishnui* and *Cx. nigropunctatus*. Figure 1 explained an occurrence of mosquitoes species in Bonelalo and Mabulugo Village. Besides the diversity of mosquitoes is different between two villages, several species are found in both areas, there are four species are in both places, such as *Cx. sitiens*, *Cx. vishnui*, *Cx. quenquefasciatus*, *Cx. nigropunctatus*. The presence of those species in two villages suggested that mosquitoes could breed and adapt to wide range of environmental characterization. Otherwise, the absence of some species indicated that environmental characterization of each villages could not support the breeding of such mosquitoes. There was no significant difference in the species composition across the two villages.

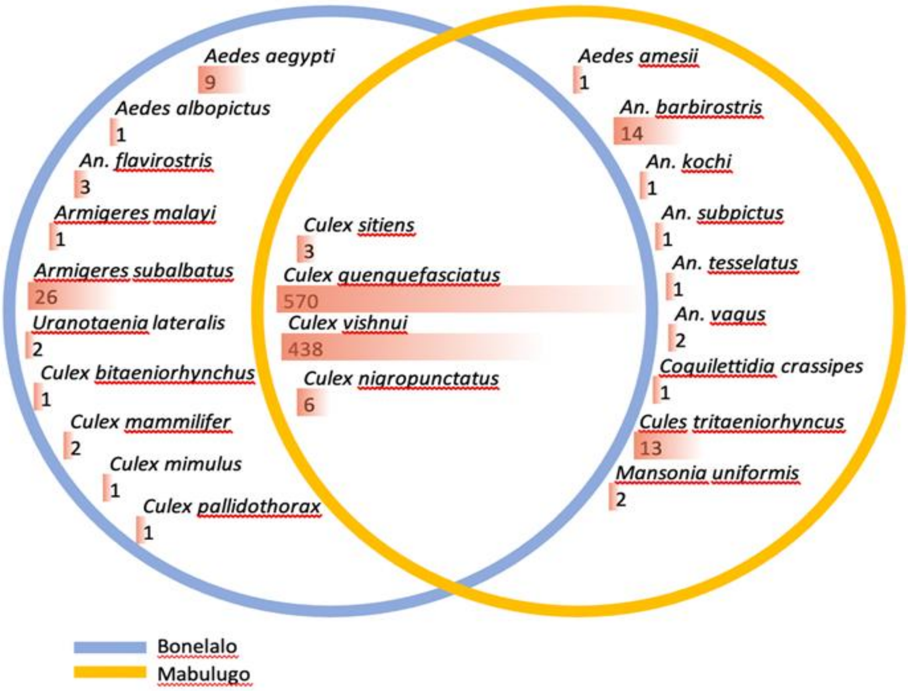

Figure 1. The composition of Mosquitoes collection in Bonelalo and Mabulugo village, Buton, Southeast Sulawesi, Indonesia (*Komposisi koleksi Nyamuk di Desa Bonelalo dan Mabulugo, Buton, Sulawesi Tenggara, Indonesia*).

Biting behaviour of mosquitoes collection in Buton

Biting behaviour were conducted on September and October in Bonelalo and Mabulugo villages, by two trapping methods of mosquitoes collection, which were Indoor Human Bait and Outdoor Human Bait.

In Bonelalo village, the outdoor and indoor biting behaviour of collected mosquitoes is dominated by *Culex quinquefasciatus* with 82,06% for both Indoor and Outdoor Human Bait respectively, followed by *Armigeres subalbatus* was 8,64%, *Aedes aegypti* was 2,99%. Subsequently, in Mabulugo village, the outdoor and indoor biting behaviour of collected mosquitoes is dominated by *Culex vishnui* was 54,57% for both Indoor and Outdoor Human Bait respectively, followed by *Culex quinquefasciatus* was 40,43%, *Anopheles barbirostris* was 1,75%.

In term of dominance rate of collected mosquitoes, *Cx. quinquefasciatus* had the highest dominant rate by having 67,29 of biting activities in indoor and outdoor condition, followed by *Armigeres subalbatus* 0,74, and *Aedes aegypti* 0,09. In term of frequency of biting activities, *Cx. quinquefasciatus* has the highest frequency with 0,82 for both indoor and outdoor respectively, followed by *Armigeres subalbatus* 0,086 was presented on Table 3.

Tabel 3. Number of Mosquitoes Collected in Bonelalo, Lasalimu, 2017 (*Jumlah Nyamuk yang Dikumpulkan di Bonelalo, Lasalimu, 2017*).

No	Species (*Spesies*)	Mosquitoes collected (*Nyamuk dikumpulkan*)							
		UOD	**%**	**UOL**	**%**	**∑**	**%**	**Frq**	**DR**
1	*Aedes aegypti*	3	2,22	6	3,61	9	2,99	0,03	0,09
2	*Aedes albopictus*	0	0	1	0,60	1	0,33	0,003	0,0009
3	*Anopheles flavirostris*	0	0	3	1,81	3	0,99	0,009	0,0089
4	*Armigeres malayi*	0	0	1	0,60	1	0,33	0,003	0,0009
5	*Armigeres subalbatus*	9	6,67	17	10,24	26	8,64	0,086	0,74
6	*Culex bitaeniorhynchus*	0	0	1	0,60	1	0,33	0,003	0,0009
7	*Culex mammilifer*	1	0,74	1	0,60	2	0,66	0,007	0,0046
8	*Culex mimulus*	0	0	1	0,60	1	0,33	0,003	0,0009
9	*Culex nigropunctatus*	0	0	4	2,41	4	1,33	0,013	0,0173
10	*Culex pallidothorax*	0	0	1	0,60	1	0,33	0,003	0,0009
11	*Culex quinquefasciatus*	120	88,89	127	76,51	247	82,06	0,82	67,29
12	*Culex sitiens*	1	0,74	0	0,0	1	0,33	0,003	0,0009
13	*Culex vishnui*	0	0	2	1,21	2	0,66	0,007	0,0046
14	*Uranotaenia lateralis*	1	0,74	1	0,60	2	0,66	0,007	0,0046
	Total	**135**		**166**		**301**			

In Mabulugo village, *Culex* dominated of collected mosquitoes with 436 and 323 mosquitoes-caught in indoor and outdoor, respectively. To be more specific, *Cx. vishnui* and *Cx. quinquefasciatus* were the most abundant mosquitoes-caught species for both indoor and outdoor (Table 4).

Tabel 4. Number of Mosquitoes Collected in Mabulugo, Kapontori, 2017 (*Jumlah Nyamuk yang Dikumpulkan di Mabulugo, Kapontori, 2017*)

No	Species (*Spesies*)	Mosquitoes collected (*Nyamuk dikumpulkan*)							
		UOD	%	UOL	%	∑	%	Frq	DR
1	*Aedes amesii*	0	0	1	0,19	1	0,125	0,0012	0,00015
2	*Anopheles barbirostris*	10	3,66	4	0,76	14	1,75	0,017	0,03
3	*Anopheles kochi*	0	0	1	0,19	1	0,125	0,0012	0,00015
4	*Anopheles subpictus*	1	0,37	0	0	1	0,125	0,0012	0,00015
5	*Anopheles tesselatus*	1	0,37	0	0	1	0,125	0,0012	0,00015
6	*Anopheles vagus*	1	0,37	1	0,19	2	0,25	0,0025	0,0006
7	*Coquilettidia crassipes*	1	0,37	0	0	1	0,125	0,0012	0,00015
8	*Culex nigropunctatus*	2	0,73	0	0	2	0,25	0,0025	0,0006
9	*Culex quinquefasciatus*	141	51,65	182	34,60	323	40,43	0,404	16,33
10	*Culex sitiens*	1	0,37	1	0,19	2	0,25	0,0025	0,0006
11	*Culex tritaeniorhynchus*	3	1,1	10	1,90	13	1,63	0,016	0,03
12	*Culex vishnui*	111	40,66	325	61,79	436	54,57	0,546	29,79
13	*Mansonia uniformis*	1	0,37	1	0,19	2	0,25	0,0025	0,0006
	Total	**273**		**526**		**799**			

Cx.vishnui had the highest frequency of biting activity both indoor and outdoor with frequency rate was 0,55 in which *Cx.quinquefasciatus* had frequency of 0,40 for both indoor and outdoor. The frequency index indicated that *Cx. vishnui* had higher intensity of encounter compared to *Cx. quinquefasciatus* during the study period. The other species of mosquitoes-caught which had lower frequency were *Anopheles barbirostris* and *Culex tritaeniorhynchus* with 0,017 and 0,016, respectively, indicated a lower intensity of presences of those species compared to *Cx. vishnui* and *Cx. quinquefasciatus*. *Mansonia uniformis* was only mosquito-caught in Mabulugo village, which had percentage of collecting for both indoor and outdoor was 0,25 percent.

The dominance rates of mosquitoes species in Mabulugo village showed that *Cx.vishnui* was the predominant species by having 29,79 of biting activities indoor and outdoor condition, followed by *Cx. quinquefasciatus* 16,33, *An. barbirostris* 0,03 and *Cx. tritaeniorhynchus* 0,03 respectively, was presented on Table 4.

Abundance of mosquitoes collection in Buton

The abundance of mosquitoes captured during the night was significantly higher than the day collection, since some of the most abundant mosquitoes of the collection, such as *Cx.quinquefasciatus* are night biters. The highly abundant *Cx.sitiens* were also mostly collected at night, indicating similar behaviour to *Cx.sitiens* which are known night biters (Biosecure Entomology Laboratory, 2006). Some day-biting mosquitoes, like *Ae.aegypti*, may have been found in the night collection, as well as some night biters.

Figure 2. Abundance cluster estimate of mosquitoes species collected in Bonelalo and Mabulugo village, 2017 (*Perkiraan gugus kelimpahan spesies nyamuk yang dikumpulkan di desa Bonelalo dan Mabulugo, 2017*).

Figure 2 showed that there were two major species of both area and trapping methods with a very high number of capture when compared to a number of other species. A number of species caught in two regions had insignificant ranges in numbers for both indoor and outdoor human landing catches. However, each region explained whether two mosquito species were caught in huge numbers as outliers, namely *Cx.quinquefasciatus* and *Armigeres subalbatus* in Bonelalo village then *Cx.quinquefasciatus* and *Cx.vishnui* in Mabulugo village.

DISCUSSION

The findings of diversity from different two villages provide baseline data on distribution of mosquitoes in Buton District. Therefore, diversity of mosquito populations captured takes into account richness (number of different species) and evenness (comparison of population size of each species). The high diversity of mosquito reveal potential risk associated with the occurrence and transmission of vector-borne diseases. Many factors affecting a diversity of mosquitoes, the most important are quality and characteristic of environment, especially the water (Lawal *et al*., 2012). The water quality and characteristics of environment determine species diversity and community composition of mosquitoes (Bashar*et al*., 2016). On this study, *Culex quenquefasciatus* was the numerous and dominant mosquito captured in Buton. Previous research explained that *Cx.quenquefasciatus* found in many parts of area, such as Aceh, West Java, East Java and Papua (Directorate General of Disease Control and Environmental Health, 2008). A high density of mosquitoes vectors increases the risk of disease transmission (Sukendra *et al.*, 2020). Therefore, *Cx.quenquefasciatus* has a chance to be a vector in research area.

Other findings of study showed that *Cx.quenquefasciatus* was the most dominant mosquito captured by outdoor human landing catches. Human landing catches are gold standard method for measuring exposure of humans to mosquito bites (Silver, 2008). However, this method is labour-intensive and faces ethical considerations (WHO, 2017), human landing catches are one of trap method to anthropophilic *Anopheles* species. Therefore, this method would still be recommended for targeting species with this behaviour.

The most dominant species obviously are also mosquitoes with the most biting activities. Host feeding behaviour of mosquitoes has important implications to human since biting activities of mosquitoes could be as detecting disease transmission and baseline information for assessing and monitoring of mosquito-based pathogen diseases. *Culex* sp are the most dominant species found in two villages which potentially transmit disease such as filariasis (Kauffman *et al.*, 2017). *Culex* mosquitoes are used routinely for the surveillance of lymphatic filariasis diseases (Hapairai *et al.*, 2015).

According to the number of trapped mosquitoes, it is obvious that the more natural habitat creates better conditions for mosquito biology (Ferraguti *et al.*, 2016). The density of

Cx.quenquefasciatus has been related to suburban and agricultural land use. These factors more closely to larval habitat in tropical habitats (Cardo *et al.*, 2018).

In Sulawesi, the vector of periodic *B.malayi* are *Anopheles* spp and three species of *Mansonia*. The primary vector is *An.barbirostris* and the mansonoids, *Ma.uniformis*, *Ma.indiana*, *Ma.bonneae/dives* are secondary vectors (Partono *et al.*, 1977).

Based on result study, *Aedes*, *Anopheles*, *Culex*, *Mansonia*, and *Armigeres* potentially as a vector of filariasis. Several species have been shown containing microfilaria worms in their bodies, among them *An. barbirostris*, *An. nigerrimus*, *Ar. subalbatus*, *Cx. bitaeniorhynchus*, *Cx. quinquefasciatus*, and *Ma. Uniformis* (Kementerian Kesehatan RI, 2015). Based on results of Filariasis Multicenter Study, *Cx. vishnui* contain microfilaria worms, which is potentially transmitting filariasis (Balitbangkes, 2017).

In this study, although mosquitoes captured were not found microfilaria based on PCR, but *Cx. quinquefasciatus* and *Cx.vishnui* were most abundant species, therefore it was still a potential risk for transmission of filariasis. Although *Cx.quinquefasciatus* was known as a vector for urban type of *Wuchereria bancrofti*, but it's could be as a vector of *Brugia malayi*, which was the same of previous study conducted by Safitri in Barito Kuala who discovered *Brugia malayi* in *Cx. quinquefasciatus* (Safitri A, 2011).

Brugia malayi rural type was transmitted by *Anopheles barbirostris*, which in Mabulugo as endofagic, cause it's caught more on indoor human bait. Mabulugo was bordered by rice field, forest and community plantation (Heriyanto *et al.*, 2011) stated that *An. barbirostris* breeds in stagnant water with leaves, shaded by vegetation such as ponds, swamps, ditches, rice fields. *An. kochi*, *An. subpictus*, *An. vagus*, *Ar. subalbatus*, *Cx.bitaeniorhynchus* and *Ma.uniformis* although caught in small numbers, but potential for transmission it remains. *Ma.uniformis* for example, is the main vector of *B. malayi* in Indonesia and Malaysia (Gunawan dan Marwoto, 1991; Narain*et al.*, 2010). So that, if breeding places was available, mosquitoes could increase and they might be rised for transmission of filariasis. Therefore, residents in endemic filariasis area must take a notice to mosquitoes biting and human activities when working outside a house both during a day or night. Behaviour of human activities at night must be along together with an effort for preventing mosquito bites.

The value of biting activities in indoor and outdoor condition was generally higher outside a house than in a house. It was explained that *Cx.quenquefasciatus* are mostly outdoor-captured mosquitoes. It was assumed that species of mosquitoes-caught more exofagic. In study area, density of mosquitoes-caught was higher outside a house than inside a house, because of it was closed to where mosquitoes larva breeding places were located around people's house.

The environment in Bonelalo and Mabulugo is densely populated and there are many mosquito breeding places, including household waste disposal, drain and canal of irrigation that's support *Cx. quinquefasciatus* to breed well. The results of numerous studies have confirmed the emergence of mosquito-borne infections as becoming especially associated with urban environments and anthropization (Ferraguti *et al.*, 2016); Kwon *et al.*, 2015). The effect of landscape anthropization on mosquito populations is a key factor in the spreading of vector-borne pathogens among the human communities (Ferraguti *et al.*, 2016).

CONCLUSION

Cx.quinquefasciatus and *Cx.vishnui* were the most abundant species; however, they both do not contain microfilaria based on PCR. It showed that there was still a potential risk for filariasis transmission, supported by their existence of breeding places. We have a recommendation: the information, such as vector abundance and diversity of mosquito vectors of lymphatic filariasis diseases, can help inform public health authorities on vector distribution and implications for the transmission, which can be a basis for deploying control measures.

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AUTHOR CONTRIBUTIONS

WIG: collecting research data, drafting the article, final revision of manuscript; DIC: revise manuscript, final revision of manuscript; DIA: revise manuscript, final revision of manuscript.

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