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Various Mosquitoes Species and Control Efforts in Villages With Malaria Problem at Menoreh Hill Central Java

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Abstract— **Menoreh Hill is located in Central Java and divide two provinces and three districts namely Purworejo and Magelang District of Central Java Province and Kulonprogo District of Yogyakarta Province. The height of this area is about 1000 m asl. In this area, Malaria is one of problematic diseases. Nevertheless, Magelang district got the National Malaria Elimination Certificate in 2014, while Purworejo and Kulonprogo are still in malaria pre elimination phase. The aims of this research are to describe various species of mosquitoes and mosquitoes control efforts specially genus Anopheles. The Data were collected from entomological survey using a technique based on WHO guidelines. Catching the mosquitoes was done twice, each was done all night in two different villages–which both located in Menoreh and had malaria problem. The research was done in July-October 2018. The mosquitoes that had been caught were then identified and checked for their parousity to estimate the average age of the mosquitos. Focus Group Discussion was done to get the information about mosquitoes control that had been done in the community. The result of this research : genus of mosquitoes found in menoreh hill were Anopheles, with species *An. maculatus, An. balabacensis, An. aconitus, An. vagus, An. flavirostris, An. barbirostris, An,minimus, An. kochi, An.limosus*. genus Culex, Armigeres, Aedes and *Uranotaenia* . *Anopheles balabacensis* and *An. aconitus* in Kulonprogo have reached enough to transmit malaria. Impregnated Threatening Nets (ITN), Indoors Residual Spraying (IRS), lavaciding, household insecticides and community service were mosquitoes control that had been done. Towards malaria elimination and to maintain malaria elimination status in Menoreh Hill area Anopheles vector need to be monitored regularly. *Anopheles balabacensis* in dry season in Kulonprogo had reached enough age to transmit malaria. Combinations of several ways to control mosquitoes had been done by people in menoreh hill.**

Keywords: masquito, species, malaria, Menoreh Hill

I. INTRODUCTION

Menoreh Hills is located in Central Java which divide two province and three district namely Purworejo and Magelang District of Central Java Province and Kulonprogo District of Yogyakarta Province. The height of this area reached about 1000 m asl. Malaria is one of problematic diseases in this area. Magelang district had been got National Malaria Elimination Certificate in 2014 while Purworejo and Kulonprogo are in pra malaria elimination phase. The number of malaria cases at first December 2018 in Magelang was 5 malaria import cases, while in Kulonprogo was 28 malaria cases (14.29% indigenous) and in Purworejo was 190 malaria cases. Those were dominated by indigenous case. Malaria transmission influenced by the host, agent and environment. Mosquitoes are the definitive host for malaria, human is the intermediate host, and Plasmodium is the agent of malaria. Suitable environment for the life-cycle of Anopheles vector would affect the malaria transmission [1]. Identification and elimination of malaria foci combined with targeted vector control must be done to eliminate malaria [2]. Research in endemic area in Purworejo show shows that humidity, precipitation, migration and previous malaria cases had have a significant relationship with malaria problems [3]. Analysis spacial Special analysis from a research in 3 village in Menoreh Hills (i.e. Kaligesing, Bagelen Subdistrict Purworejo District and Kokap Subdistrict Kulonprogo District) found out that malaria cases were more common in a low density population, as malaria patients were living near the mosquitoes breeding places like river, spring and puddle [4]. The result of malaria vector survey in Kaliwader Village, Bener Subdistrict, Purworejo s District at Menoreh Hills, in 2000 found various species such as *An. maculatus, An.balabacensis, An. vagus,*

An. barbirostris, An. aconitus, An. kochi and *An. flavirostris*, in Sidomulyo Village. A survey in Bener Subdistrict, Purworejo District, found *An. balabacensis, An. vagus* and *An. kochi*. All species were found indoor and outdoor and had both exofagic and exofilic tendency [5]. To eliminate malaria, one of the things needed is surveilans vector. Surveilans vector could be done by larval survey and mosquitoes survey. Larval survey is easier, cheaper and do not need more resources, therefore larval survey is possible to be done by health worker in Public Health Centre or District Health Office. Mosquitoes data is needed to complete malaria vector data. Vector control of malaria that has been done by community would affect the vector malaria existence and chance of malaria transmission. The aims of this research are to describe various species of mosquitoes and mosquitoes control efforts specially genus Anopheles in Menoreh Hills.

II METHOD

A. Adult Mosquitoes Survey

This paper uses part of research data from "*Development Role of Cross Program, Cross Sectors and Communities in Supporting Malaria Elimination at District in Menoreh Hill Area*". Ethical approval from the Health Research Ethics Committee of the National Institute of Health Research and Development Number LB. 02.01/2/KE.056/2018 Jakarta was obtained on February 15th , 2018. The Data collected from entomological survey using a technique based on WHO guidelines and Ministry of Health Republic of Indonesia [6][7] Catching the mosquitoes was done twice, each was done all night in two different villages which both located in Menoreh and had malaria problem The research was done in July-October 201**8**. There were six mosquitoes collector who collected mosquitoes using manual aspirator from 06.00 pm until 06.00 am. Each mosquitos collector caught mosquitoes in the house~~s~~. Three of six collectors caught mosquitoes indoor with human landing technique in 40 minutes. After that they caught mosquitoes resting ~~in~~ on the wall in 10 minutes every hours. The others collected mosquitoes outdoor with human landing technique in 40 minutes and caught mosquitoes resting in the cattle for~~—~~around 10 minutes. Each collector had 10 minutes break. Number of mosquitoes that had been caught every hour were sent to post and then were identified based on the identification key [8], and calculated the relative mosquitoes density by using a formula[7] :

Man Hour Density (number of mosquitoes/person/hour)=

number of mosquitoes caught/(number of collector x catching time)by using dissecting microscope with 40x objective lens and check for parousity by dissecting abdomen and observed in compound microscoupe with 100x magnification. Parousity number use to estimate the average of mosquitoes' age by using formula [9].

Age of mosquitoes in population (days) =1/-log e^p

While e= natural logaritma

p= opportunities daily life of mosquitoes, with formula

$$P = \sqrt[A]{B}$$

A= gonotrophyc cycle (use estimated in three days)[10].

B= parousity (percent of number of parous mosquitoes per number of mosquitoes examinated).

B. Focus Group Discussion[11]

Focus Group Discussion was done to get information about mosquitoes control that had been done in the community. There were 3 to 4 group FGD in each villages whose members were health cadre, village officials, village malaria community health workers*("Juru Malaria Desa"*), public figure, youth group. The Focus Group Discussion was about malaria and one of the question that will be discussed in this paper is about malaria control especially mosquitoes control.

II. RESULTS

Mosquitoes that were found in this survey can be seen in Table 1-3.

TABLE I. THE VARIETY OF MOSQUITOES SPECIES FROM BITING INDOOR, BITING OUTDOOR, RESTING INDOOR AND RESTING IN THE CATTLE IN KULONPROGO

Species	Man Hour Density/MHD (/people/hour)	% parous	Opportunities daily life	Age of mosquitoes in population (days)*
biting indoor				
An. maculatus	0.005	0	0	<0,2
An. balabacensis	0.01	0	0	<0,2
An. aconitus	0.005	100	1	~ (more than 28 days)
An. barbirostris	0.005	0	0	<0,2
Cx vishnui	0.01	0	0	<0,2
Cx. quenquefasciatus	0.005	0	0	<0,2
Ar. subalbatus	0.005	0	0	<0,2
biting outdoor				
An. balabacensis	0.026	80	0.93	13.44
An. maculatus	0.031	50	0.79	4,3
An. vagus	0.115	0	0	<0,2
An. limosus	0.005	0	0	<0,2
An. barbirostris	0.025	0	0	<0,2
An. flavirostris	0.015	0	0	<0.2
Cx. bitaeniorhyncus	0.005	0	0	<0,2
Cx vishnui	0.01	0	0	<0,2
Ar. subalbatus	0.026	0	0	<0,2
Ar. aureolineatus	0.005	0	0	<0.2
Resting indoor				
An. vagus	0.084	0	0	<0.2
An. flavirostris	0.021	0	0	<0.2
An. barbirostris	0.021	0	0	<0.2
Cx quenquefasciatus	0.146	14.29	0.52	1.5
Cx vishnui	0.209	0	0	<0.2
Resting in the cattle				
An. maculatus	0.771	54.05	0.81	4.87
An. vagus	12.91	16.94	0.55	1.69
An. minimus	0.063	0	0	<0.2
An. barbirostris	0.229	9.09	0.45	1.25
An. balabacensis	0.041	100	1	~ (more than 28 days)
An. kochi	0.229	18.18	0.56	1.75
An. aconitus	0.146	42.86	0.75	3.55
Cx quenquefasciatus	0.125	0	0	<0.2
Cx vishnui	1.334	0	0	<0.2
Cx. bitaeniorhyncus	0.084	0	0	<0.2
Ar. subalbatus	0.229	0	0	<0.2
Ar. theobald	0.021	0	0	<0.2
Ar. Kesseli	0.041	0	0	<0.2
An. Flavirostris	0.104	0	0	<0.2
Ar. Aureolienatus	0.063	0	0	<0.2

*) counting with assumption of gonotrophic cycle in three days

Table 1 showed that various species of mosquitoes found were biting indoor and outdoor, resting indoor and resting in the cattle in Kulonprogo. Species Anopheles vector–found biting indoor were *An. maculatus* MHD 0.05/people/hour, *An. balabacensis* MHD 0.01 people/hour and *An. aconitus* MHD 0.05/people/hour. While Anopheles found biting outdoor were *An. balabacensis* MHD 0.026 people/hour, *An. vagus* MHD 0.115/people/hour and *An. maculatus* MHD 0.031/people/hour. Anopheles vector found resting indoor were *An. vagus* MHD 0.084/people/hour. Anopheles vector found in the cattle were *An. maculatus* MHD 0.771 /people/hour, *An. vagus* MHD *12.91/*people.hour, *An. balabacensis* MHD 0.041 /people/hour ,*An. aconitus* MHD 0.146 /people/hour. Based on the parousity and assumption of gonotrophic cycle, *Anopheles balabacensis* that were found outdoor had estimated age in population–which were about 13-14 days, *An. aconitus* that were found biting indoor and *An. balabacensis* that were found resting in cattle had estimated age in population which were more than 28 days.

TABLE II. THE VARIETY OF MOSQUITOES SPECIES FROM BITING INDOOR, BITING OUTDOOR, RESTING INDOOR AND RESTING IN THE CATTLE IN PURWOREJO

Species	Man Hour Density/MHD (/people/hour)	% parous	Opportunities daily life	Age of mosquitoes in population*
biting indoor				
An. Balabacensis	0.015	0	0	<0.2
An. Vagus	0.005	0	0	<0.2
An. Flavirostris	0.016	0	0	<0.2
Cx. quenquefasciatus	0.105	10	0.46	1.30
Cx vishnui	0.083	0	0	<0.2
Ar. Kesseli	0.005	0	0	<0.2
biting outdoor				
An. Balabacensis	0.058	18.18	0.56	1.75
An. Barbirostris	0.005	0	0	<0.2
An. Minimus	0.005	0	0	<0.2
An. Vagus	0.051	20	0.58	1.86
An. Maculatus	0.015	0	0	<0.2
Cx. quenquefasciatus	0.068	13.33	2.37	1.47
Cx vishnui	0.306	0	0	<0.2
Cx. Citiens	0.01	0	0	<0.2
Cx. Gelidus	0.01	0	0	<.2
Ar. Subalbatus	0.021	0	0	<0.2
Ae. Poicillus	0.005	0	0	<0.2
Resting indoor				
An. Maculatus	0.041	0	0	<0.2
Cx quenquefasciatus	0.146	0	0	<0.2
Cx vishnui	0.105	0	0	<0.2
Cx. Fuscocephala	0.021	0	0	<0.2
An. Vagus	0.063	0	0	<0.2
Resting in the cattle				
An. Barbirostris	0.041	0	0	<0.2
An. Minimus	0.291	0	0	<0.2
An. Vagus	0.584	21.43	0.60	1.92
An. Maculatus	0.146	0	0	<0.2
An. Flavirostris	0.041	40	0.74	3.27
Cx quenquefasciatus	0.271	15.38	0.54	1.58
Cx vishnui	0.605	3.45	0.33	0.85
Cx. Gelidus	0.396	5.26	0.37	1.00
Cx. tritaeniorhyncus	0.021	0	0	<0.2
Ar. subalbatus	0.209	0	0	<0.2
Ar. malayi	0.021	0	0	<0.2
Ar. kesseli	0.084	0	0	<0.2
Uranotaenia campestris	0.041	0	0	<0.2

*) counting with assumption of gonothropic cycle in three days

Table 2 showed that various species of mosquitoes were found biting indoor and outdoor, resting indoor and resting in the cattle in Purworejo. Species Anopheles vector found biting indoor were *An. balabacensis* MHD 0.01 people/hour and *An. vagus* MHD 0.05/people/hour. While Anopheles found biting outdoor were *An. balabacensis* MHD 0.058 /people/hour, *An. vagus* MHD 0.051 /people/hour and *An. maculatus* MHD 0.015/people/hour. Anopheles vector found resting indoor were *An. maculatus* MHD 0.041/people/hour, *An. vagus* MHD 0.063/people/hour. Anopheles vector found in the cattle were *An. vagus* MHD 0.584 /people/hour, *An. maculatus* MHD 0.146 /people/hour. Estimated age of mosquitoes in population was not more than 4 days.

TABLE III. THE VARIETY OF MOSQUITOES SPECIES FROM BITING INDOOR, BITING OUTDOOR, RESTING INDOOR AND RESTING IN THE CATTLE IN MAGELANG

Species	Man Hour Density/MHD (/people/hour)	% parous		Age of mosquitoes in population*
biting indoor				
Cx. quenquefasciatus	0.719	4.348	0.35	0.93
biting outdoor				
An. barbirostris	0.005	0	0	<0.2
An. kochi	0.005	0	0	<0.2
An. minimus	0.005	0	0	<0.2
An. vagus	0.125	8.333	0.44	1.19
An. maculatus	0.005	0	0	<0,2
Cx. quenquefasciatus	1.313	2.098	0.28	0.76
Cx vishnui	0.02	0	0	<0,2
Ar. subalbatus	0.005	0	0	<0,2
Ar. malayi	0.005	0	0	<0,2
Resting indoor				
An. maculatus	0.021	0	0	<0,2
Cx quenquefasciatus	4.929	3.086	0.31	0,85
Cx vishnui	0.166	0	0	<0,2
Resting in the cattle				
An. barbirostris	0.168	12.5	0.50	1.41
An. minimus	0.188	22.222	0.61	1.98
An. vagus	15.561	3.867	0.34	0.92
An. maculatus	0.395	31.579	0.68	2.6
An. kochi	0.208	30	0.67	2.5
An. aconitus	1.271	24.590	0.63	2.13
An. flavirostris	3.105	11.409	0.48	1.36
An. limosus	0.041	0	0	<0.2
Cx quenquefasciatus	13.168	5.538	0.38	1.00
Cx vishnui	1.314	6.349	0.40	1.06
Cx. gelidus	0.438	4.762	0.36	0.98
Cx. hutchinsoni	0.021	0	0	<0.2
Cx. tritaerhyncus	0.041	0	0	<0.2
Ar. subalbatus	0.021	0	0	<0.2
Ar. kucingensis	0.021	0	0	<0.2
Ar. malayi	0.043	11.538	0.49	1.38
Ae. albopictus	0.021	0	0	<0.2
Ae. aegypti	0.021	0	0	<0.2

*) counting with assumption of gonotrophic cycle in three days

Table 3 showed that mosquitoes biting indoor was only *Cx quenquefasciatus*, various other species of mosquitoes found biting outdoor, resting indoor and resting in the cattle in Magelang. Anopheles vector species that was found biting outdoor was *An.vagus* MHD 0.125 /people/hour, *An. maculatus* MHD 0.005/people/hour. Anopheles vector found resting indoor were *An. maculatus* MHD 0.021/people/hour. Anopheles vector found in the cattle were *An. vagus* MHD 15.561 /people/hour, *An. maculatus* MHD 0.395 /people/hour, *An. aconitus* MHD 1.271/people/hour. The estimated age of mosquitoes in population was not more than 3 days.

Focus Discussion one of the points in discussion were about vector control. The group of Focus Group Discussion (FGD) in Kulonprogo consisted of health cadre group , village malaria community health workers (*Juru Malaria Desa*), and village officials group. Group of FGD in Purworejo were health cadre group, village officials group, public figure and youth group. Meanwhile, the group of FGD in Magelang consisted of village officials group, health cadre group, public figure, and village malaria community health workers (*Juru Malaria Desa*). The results of FGD which emphasize on the vector control were shown in Table 4.

TABLE IV. RESUME OF FOCUS GROUP DISCUSSION ABOUT VECTOR CONTROL OF MALARIA IN KULONPROGO, PURWOREJO AND MAGELANG

Kulonprogo	Purworejo	Magelang
a. cleaning environment individually or together b. Malaria control socialization c. Distribution of temephos d. using Impregnated Insecticide Thretening Bed Nets (ITN) e. Indoor Residual Spraying f. Repelen distribution g. Training of village malaria community health workers (JMD) h. Involvement of health cadre i. The existence of the village malaria prevention post	a. The existence of a village health forum b. The existence of village malaria community health workers (JMD) c. cleaning environment individually or together. d. Indoor Residual Spraying e. Impregnated Insecticide Thretening Bed Nets (ITN) f. Distribution of temephos	a. cleaning environment individually or together. b. Indoor Residual Spraying c. Impregnated Insecticide Thretening Bed Nets (ITN) d. The existence of village malaria community health workers (JMD) e. Malaria control socialization f. Giving larvae-eating fish

Table 4 showed that Impregnated Threatening Nets (ITN), Indoors Residual Spraying (IRS), lavaciding, household insecticides, using larvae-eating fish in Kulonprogo and community service were the mosquitoes control that been done.

IV. DISCUSSION

Malaria in Menoreh Hills could be eliminated by cross district collaboration. Survey in three district in Menoreh Hills found various mosquitoes species, namely *An. maculatus, An.balabacensis, An. aconitus, An. vagus, An.flavirostris, An.limosus, An. barbirostris,An,minimus, An. kochi, An.limosus;* Culex with species *Cx vishnui, Cx. quenquefasciatus, Cx. bitaeniorhyncus, Cx. citiens, Cx. gelidus, Cx. fuscocephala, Cx. hutchinsoni*; Armigeres with species *Ar. subalbatus, Ar. kesseli, Ar. aureolineatus, Ar. theobald, Ar. aureolienatus, Ar. malayi, Ar. kucingensis* and Aedes with species : *Ae. aegypti, Ae. albopictus* and *Uranotaenia campestris*.The variety of mosquitoes species that had been caught indicated that the survey areas have a risk for another disease transmission such as Dengue Haemorrhagic Fever, Chikungunya, Japanese Encephalitis or lymphatic filariasis [12].

Species of Anopheles that were examined as vector of malaria were *An. balabacensis*, *An. maculatus* and *An. aconitus* [7]. *Anopheles vagus* was potential as a malaria vector in Kokap by ELISA Test [13]. In this survey, *An. balabacensis, An. maculatus, An. aconitus* and *Anopheles vagus* were found in all survey location except *An. aconitus* which was found only in Purworejo District. From this survey, it can be concluded that ~~in~~ the survey location ~~is~~ was receptive for malaria. *Anopheles balabacensis* in Kulonprogo have reached enough age to transmit malaria. The process from plasmodium in gametocyte phase from human ~~that~~ who was suffering from malaria entered mosquitoes body until it became sporozoit of plasmodium phase (the sporogony process) which needed about 8-15 days according the species type of plasmodium and temperature [14][15]. In this survey the paraousity of *An. aconitus* biting indoor and *An. balabacensis* resting in the cattle were 100% parous. When calculating the age of mosquitoes in population we did not find any, so we estimated using 99% parous and the result can be used to estimate a mosquito in population which is 298 days more than 9 months. Literatures show that in nature mosquitoes can survive for longer than 3 weeks and in the laboratory they can live for more than 4 weeksb [16]. The longevity of mosquitoes was affected by environment factor like temperature, relative humidity wind, vegetation and host [9].

Anopheles balabacensis in Kulonprogo and Purworejo found biting indoor and outdoor, and was also found in cattle in Kulonprogo, while in Magelang this species was not found. This species in Banjarnegara District was often found in malaria outbreak [17]. *Anopheles balabacensis* had a tendency to anthropophylic, breed in water like water springs, even found in footprint or vehicle foot print in plantation area with lush and uniform plants. Research from Umi Widyastuti, et all. in Tegiri and Gunungregi Village, Kokap Sub District, Kulonprogo District found that *An. maculatus* as dominant vector was succeptible to *P. vivax* with sporozoite rate 3.7% [18]. In this research we did not examine the sporozoit rate, *An. maculatus* in this survey was found in all survey location. *Anopheles aconitus* was found in Kulonprogo and Magelang because there ~~is~~ was no habitat for *An. Aconitus* which was terrace paddy fields in the survey location in Purworejo. From mosquitoes vector we get description that survey location had risk for malaria transmission especially in Kulonprogo.

The village communities in the survey locations in the three districts have made efforts to control mosquitoes ~~to~~ by cleaning environment individually or together. The weakness of this effort is that they cleaned the environment around houses which tend to be the breeding places of DHF vector, even though they consider such efforts to be a malaria vector control. This was because they did not have enough knowledge about where the breeding places of *Anopheles Sp* are. However, this kind of activity is good, it only needed to be expanded to clean the Anopheles mosquitoes breeding places like in along river, water springs, hoard puddles, hoard unused fish ponds, and to reduce twigs / midribs so that the sunlight could penetrate through those places . Research in Enugu Southeast Nigeria concluded that there is a need for audience- specific communication and attitudinal change to ensure the uptake improvement [19]. Malaria control socialization in Kulonprogo and Magelang were delivered as one of malaria vector control efforts. In Kulonprogo and Magelang. Socializations have always been done in every time and opportunity but they have never been mentioned as one of malaria vector control efforts.

Informant of FGD in Kulonprogo and Purworejo also said that distribution of temephos was also one of malaria vector control efforts. However in Magelang ITN was used in all three locations as one of malaria vector control efforts. All villages there even have received ITN from the government. The use of ITN is one way to combat malaria~~,~~. In Malawi the use of ITN on children under 5 years old has increased in the last five years [20]. A study in Haiti showed that there was no evidence that mass ITN campaigns reduce clinical malaria. This was caused by a kind of Anopheles vector behavior in this area.

Indoor Residual Spraying (IRS) was also one of malaria vector control efforts in survey location. They realized that the IRS was carried out under certain conditions. Additionally the informant suggested that coordination is needed whenever IRS was done in the border area, so IRS will be done by both districts including the adjacent area. According to their logic the mosquitoes will move to area that is not treated using IRS. Indoor Residual Spraying would reduce malaria incidence in unstable malaria setting, but some limited data from meta analysis research conclude that ITN give better protection in unstable malaria setting [21]. In research area IRS was conducted when there were indications of local malaria transmission. The distribution of repelen in Kulonprogo was used as a way to control malaria vector. Although as a program policy to control malaria, the

used of repelent is weak. Thus a deeper study regarding this matter is needed [22]. The existence of village malaria community health workers (JMD) in three location is considered as an attempt to control vectors. In Kulonprogo the involvement and existence of the village malaria prevention post play a role in controlling malaria vectors On the other hand the role in controlling malaria vectors in Purworejo is the existence of village health forum while in Magelang giving larvae eating fish especially in water springs. This research is in line with research from Solikhah in Kulonprogo that people play active role in malaria vector control effort even though they do not know well about vector of malaria [23]. Innovative control tool to ensure that vector control strategy are tailored to local circumstances [24]. This research conclude that towards malaria elimination and to maintain malaria elimination status in Menoreh Hill, A*nopheles balabacensis* in dry season in Kulonprogo has reached the age to transmit malaria. Impregnated Threatening Nets (ITN), Indoors Residual Spraying (IRS), larvaciding, household insecticides and community service were mosquitoes control that been done.

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