TEMPERATURE VARIABILITY AND BIONOMICS OF *ANOPHELES* IN ENDEMIC MALARIA AREA OF DISTRICT PURWOREJO CENTRAL JAVA PROVINCE INDONESIA

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Abstract

Introduction : The annualy of temperature variete by weather. The gowth of organism depend on annual weather. The special behavior of life for energi consumtion. Bionomics was important matter as base on mosquito protectif.

Method : The descriptive analitical reserach with longitudinal survey. The observation going on four period, wet season, intermediate, dry season and intermediate. Temperature and vector densities were sampled 34 villages covering settings available, on 12 hour researh. Base on Manual on Practical Entomology In Malaria, WHO Division of Malaria and Other Parasitic Diseases, Part I,II for vector identification.

Results and Discussion : Nine species was found as : *An.balabacensis; An.aconitus; An.barbirostris; An.vagus; An.anullaris; An.kochi; An.maculatus; An.indifinitus; An.subpictus*, disperse on 82.35% research area, 2 of them *An.maculatus* and *An.balabasencis* are identified as a vector. The temperature variated on 20-29ºC. The behavior of blood consumtion as bionomics of Anopheles as follow: 1. *An. Balabacencis* on 20.00-02.00 pm; 2.*An.aconitus (18.00-06.00 pm continyu); 3.An.barbirostris (19.00-05.00 pm discontinyu); 4. An.vagus (18.00-06.00 pm continyu);5.An.anullaris (22.00-05.00pm); 6.An.kochi (21.00-05.00 pm discontinyu); 7. An.maculatus (19.00-22.00); 8. An.indifinitus (19.00-21.00); 9.An.subpictus(19.00-20.00 and 04.00-05.00 pm).*

Conclusion : There are four vectors that live throughout the year, namely *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus and Anopheles kochi*. There are three species of the behaviors in searching for the blood that lasted all night. All three species are *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus.*

Keywords : Temperature, bionomics, *Anopheles*, Purworejo

Introduction

The annualy of temperature variete by weather. There are three factors that influence the weather in each region, namely topography, inter-tropical convergen zone (ITCZ), and monsoonal (Oke, 1997). Global climate change on extreme conditions, giving effect to the micro climate (Mursid, 2015). Global climate change continues to this day. Extreme weather with high air temperature, and low air temperatures up to blizzard felt in many parts of the world (Easterbrook, 2014; Dixon, 2010). Climate change impact on various aspects of life (Gratz, 1999; Partz JA, 2000). Direct influence on climate change in each region. Indonesia is among countries affected by climate change. Extreme weather increases the risk of the spread of infectious diseases including diarrhea, vector-based disease (vector-borne diseases), including non-communicable diseases malaria, floods (IPCC, 2001; IPCC, 2013).

Purworejo potentially affected by global climate change (Mursid, 2012; Ayala, 2009). In 2010 the average flawed rainfall occurs throughout the year, with the average temperature is lower than the annual average temperature. Substitution season has changed from October to April to the next month (Meteorology, 2011). Purworejo also fluctuated duration of wet and dry months, which is one of climatic factors (Dept of irrigation, 2013)

Land units used as the basis for the analysis. Land units resulting from the conduct overlaying various environmental characteristic parameters produces land units. Environmental characteristic parameters used may be altitude region, classification of cases of malaria, land use, and other environmental parameters. Land units have characteristic as the habitat of oraginsm. In these habitats will be found a life of mutual interaction and interdependence (Odum, 1988). The existence of an organism in an area influenced by: 1. The dispers of organisms in a region; 2. The influence of the limiting factors that do not allow the organisms to live and develop according to the tolerance range of living organisms; 3. The changes in the environment that causes the organism is not capable of adaptation or mutation (Brewer, 1993; Odum, 1988).

The organism is controlled by the environment (habitat) in two ways: the threshold in the number of organisms required by all organisms to survive, and the limits of tolerance in which the organism is able to survive and thrive (Black's Law Mann About the limiting factor, in Beroya, 2000) . The reaction of the organism in response to environmental changes can be various stages include migration, adaptation or mutation (Odum, 1988).

Population growth over the carrying capacity will provide the load carrying capacity and will happen concept of homeostasis, where the total population will be at a fixed amount, in accordance with the carrying capacity of the existing environment (Cape, 1995). Environmental characteristics resulting from the reaction of various environmental changes make a habitat for living beings. At the habitat of living beings will grow and evolve organisms. Anopheles are always experiencing dynamic organism, which behaves to grow and thrive. Aim of the research was identify and analysis of bionomics of *Anopheles.* Bionomics information is essential for best knowledge as a basis for malaria control.

Method

The study was conducted with longitudinal survey covers four seasons, include dry- rainy (May), dry season (July), rainy-dry (October) and rainy season (December). The study was conducted in a malaria endemic area. Malaria endemic area grouped as low case Incidence (LCI), Middle Case Incidence (MCI), and high case incidence (HCI). The study sample intervals determined by multistage sampling method . The samples were selected by classified proportional random sampling.

The population is a village with malaria cases as much as 224 villages. Overall sample calculation result class number 4, bound Of error at 95% confidence level, is taken as 1, (Nasir, 1983; Lapao, 2012). The formula used to determine the number of samples is: n = (L Σ Ni2. Σi2) / (N2D + Σ Ni. Σi2), D = B2 / 4, with 95% confidence. The number of samples so that the number of samples rounded 33.44 34 locations.

Air temperature was measured every hour at each location of the observations from 6 p.m. to 6:00 hours by portable thermometer. The type and density vector arrests every hour, on 12 hours. Research of mosquito density is done by using the guidelines of the "Manual on Practical Entomology In Malaria, WHO Division of Malaria and Other Parasitic Diseases, Part I, II) (WHO, 1995; WHO, 1975). Identification of species carried in Parasitology Laboratory UGM.

Results and Discussion

1. Daily Air Temperature

The results of air temperature measurements at 34 locations with variability of air temperature. At transition dry rainy (May) maximum temperature 31°C, minimum temperature of 23.5°C, with an average of 28.32°C. The temperature in the dry season (July) has been changed into a maximum temperature of 32 °C, the minimum temperature of 23 ºC with average 26.98 ºC. In the transition season (October) air temperature changed to a maximum of 33 °C, a temperature of 26.5 ° C and average of 29.01 °C. In the rainy season (December) air temperature changed to a maximum of 30.5 °C, a minimum of 22.5 ° C, with an average amounting to 26.29 ºC.

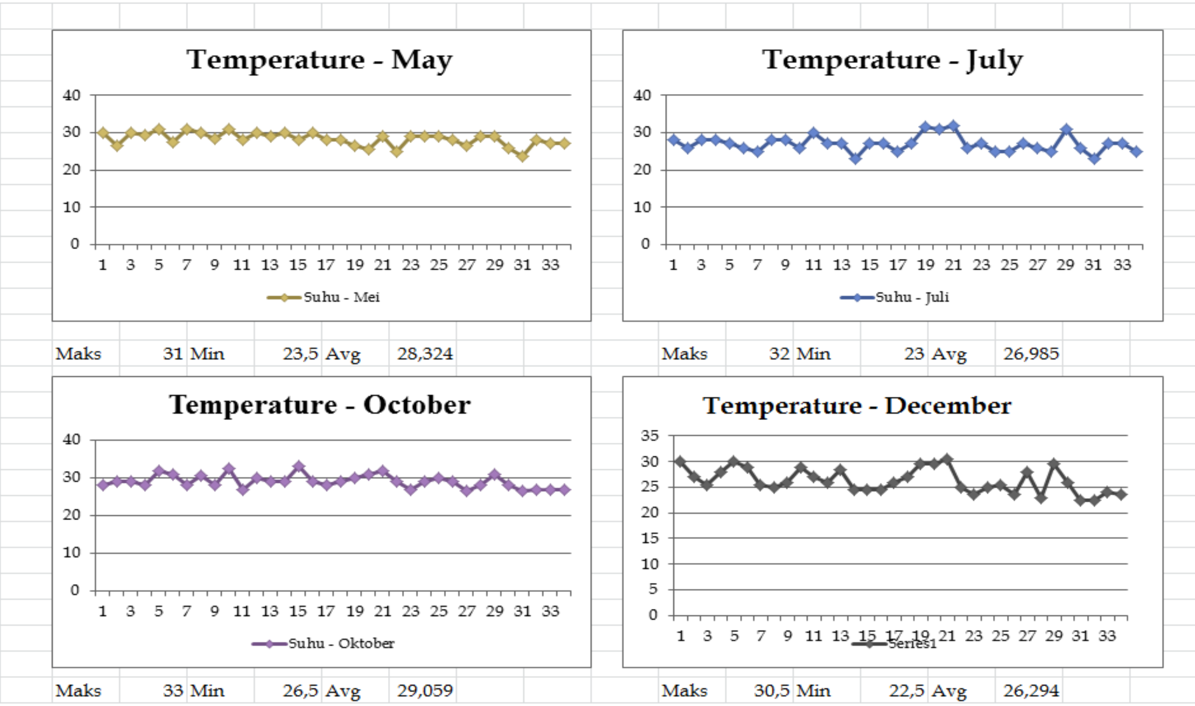


Figure 1. Variability of air temperature on endemic area

2. Type and Density Malaria Vectors

The results of field research conducted by the mosquito trapping of Anopheles species at 34 sites in a longitudinal study that is in May, July, October and December. Anopheles species for each season are presented in the following discussion. Mosquito trap in May represent a state of transition rainy season to dry season. Catches in the transition period discovered 9 (nine) species distributed in 28 (82%) the location of the observation. Nine species found are as follows: *An.balabacensis; An.aconitus; An.barbirostres; An.vagus; An.anularis; An.kochi; An.maculatus;*

An.indifinitus; An.subpictus. The number of species caught dominant Anopheles vagus (209 in number) followed by Anopheles barbirostres (84 animals) and Anopheles aconitus many as 49 tails. Vector density from 0.38 to 3.85 sp/man/hr.

An. vagus found in a wide range of territory, covering 17 villages with a height range of <100 to> 700 m msl. Other species that have a wide distribution is *An.aconitus* and *An.balanecenci*s. *An.barbirostres*, scattered in 11 (eleven) observations village. Anopheles aconitus found at an altitude of 200-300 m and 400-600 m above sea level. Species of *An.barbirostres* species found in the area with an altitude range <100-600 m above sea level. Other species were found with low populations are Anopheles indifinitus, found only region of the height of 300-500 m above sea level. *An.subpictus* are found at low densities in areas with an altitude of 100-400 m above sea level.

Table 1. Malaria species distribution base on elevation of four survey periods

Part - 1

No	sampling location	densities (sp/m/hr)	Number of Species Anopheles															
			balabasensis				aconitus				barbirostres				vagus			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	0-100 mdpal	number	1	2	2	9	1	69	8	14	42	198	2	4	14	14	17	26
		densities	0,02	0,04	0,04	0,19	0,02	1,44	0,17	0,29	0,88	4,13	0,04	0,08	0,29	0,29	0,35	0,54
2	100-200 mdpal	number	1	3	4	5	5	58	14	25	1	2	5	9	28	9	100	58
		densities	0,02	0,06	0,08	0,10	0,10	1,21	0,29	0,52	0,02	0,04	0,10	0,19	0,58	0,19	2,08	1,21
3	200 - 300 mdpal	number	2	3	1	15	2	58	1	9	1	16	1	0	32	9	143	79
		densities	0,04	0,06	0,02	0,31	0,04	1,21	0,02	0,19	0,02	0,33	0,02	0,00	0,67	0,19	2,98	1,65
4	300 - 400 mdpal	number	0	6	1	1	0	5	10	4	14	19	0	0	4	11	11	3
		densities	0,00	0,13	0,02	0,02	0,00	0,10	0,21	0,08	0,29	0,40	0,00	0,00	0,08	0,23	0,23	0,06
5	400 - 500 mdpal	number	3	0	0	10	29	11	3	3	15	35	1	1	118	12	57	18
		densities	0,06	0,00	0,00	0,21	0,60	0,23	0,06	0,06	0,31	0,73	0,02	0,02	2,46	0,25	1,19	0,38
6	500 - 600 mdpal	number	2	1	1	6	11	3	15	22	11	92	44	18	11	0	21	11
		densities	0,04	0,02	0,02	0,13	0,23	0,06	0,31	0,46	0,23	1,92	0,92	0,38	0,23	0,00	0,44	0,23
7	600 - > 700 mdpal	number	3	4	3	14	1	12	12	0	0	0	0	0	2	1	4	1
		densities	0,06	0,08	0,06	0,29	0,02	0,25	0,25	0,00	0,00	0,00	0,00	0,00	0,04	0,02	0,08	0,02
	number of species (sp)		11	14	9	55	49	166	52	55	84	355	52	25	209	48	255	129
	densities		0,23	0,29	0,19	1,15	1,02	3,46	1,08	1,15	1,75	7,40	1,08	0,52	4,35	1,00	5,31	2,69

part-2

No	sampling location	densities (sp/m/hr)	Number of Species Anopheles																			
			anularis				kochi				maculatus				indifinitus				subpictus			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	0-100 mdpal	number	0	0	0	0	3	9	0	1	0	10	1	7	0	0	0	0	0	1	0	0
		densities	-	-	-	-	0,06	0,19	-	0,02	-	0,21	0,02	0,15	-	-	-	-	-	0,02	-	-
2	100-200 mdpal	number	0	0	2	0	2	0	0	0	5	13	8	30	1	0	0	0	5	0	0	0
		densities	0,00	0,00	0,04	0,00	0,04	0,00	0,00	0,00	0,10	0,27	0,17	0,63	0,02	0,00	0,00	0,00	0,10	0,00	0,00	0,00
3	200 - 300 mdpal	number	0	0	0	1	1	0	0	0	0	7	3	3	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,02	0,02	0,00	0,00	0,00	0,00	0,15	0,06	0,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	300 - 400 mdpal	number	0	0	0	1	0	1	0	0	0	0	0	2	1	0	1	0	0	0	0	0
		densities	0,00	0,00	0,00	0,02	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,04	0,02	0,00	0,02	0,00	0,00	0,00	0,00	0,00
5	400 - 500 mdpal	number	18	14	0	0	15	10	1	2	6	1	9	5	0	0	0	0	0	0	0	0
		densities	0,38	0,29	0,00	0,00	0,31	0,21	0,02	0,04	0,13	0,02	0,19	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	500 - 600 mdpal	number	0	0	0	0	2	1	3	4	1	1	10	0	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,00	0,04	0,02	0,06	0,08	0,02	0,02	0,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	600 - > 700 mdpal	number	0	0	0	0	0	0	0	0	1	2	2	1	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02	0,04	0,04	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	number of species (sp)		18	14	0	2	23	21	4	7	13	30	29	45	2	0	0	0	5	0		
	densities		0,38	0,29	0,00	0,04	0,48	0,44	0,08	0,15	0,27	0,63	0,60	0,94	0,04	0,00	0,00	0,00	0,10	0,00	0,00	0,00

Note :
A. PRE-DRY SEASON
B. DRY SEASON
C. PRE-WET SEASON
D. WET SEASON

3. Malaria Vector bionomics

Describe the behavior of the malaria vector bionomics daily, bitting on habits and look for blood as a source of life. Air temperature influence on the activity of mosquitoes. Nine species found in endemic areas have different behaviors. The results of observations of a species of Anopheles have appropriate habitat distribution. Results classification various species of *Anopheles* during 4 periods of the season and temperature observations are presented in the table following table. The table shows that each species has a different behavior. The behavior of each species are presented in the following description.

a. *An.balabaensis*

This species is found at an altitude of 100-about 700 meters above sea level. *An.balabacensis* living habitat with temperatures from 22.5 to 31 ° C, with humidity> 61%. Have a look for patterns of blood at 20:00 to 1:00. Found mainly in the dry transition towards the rainy (May-June).

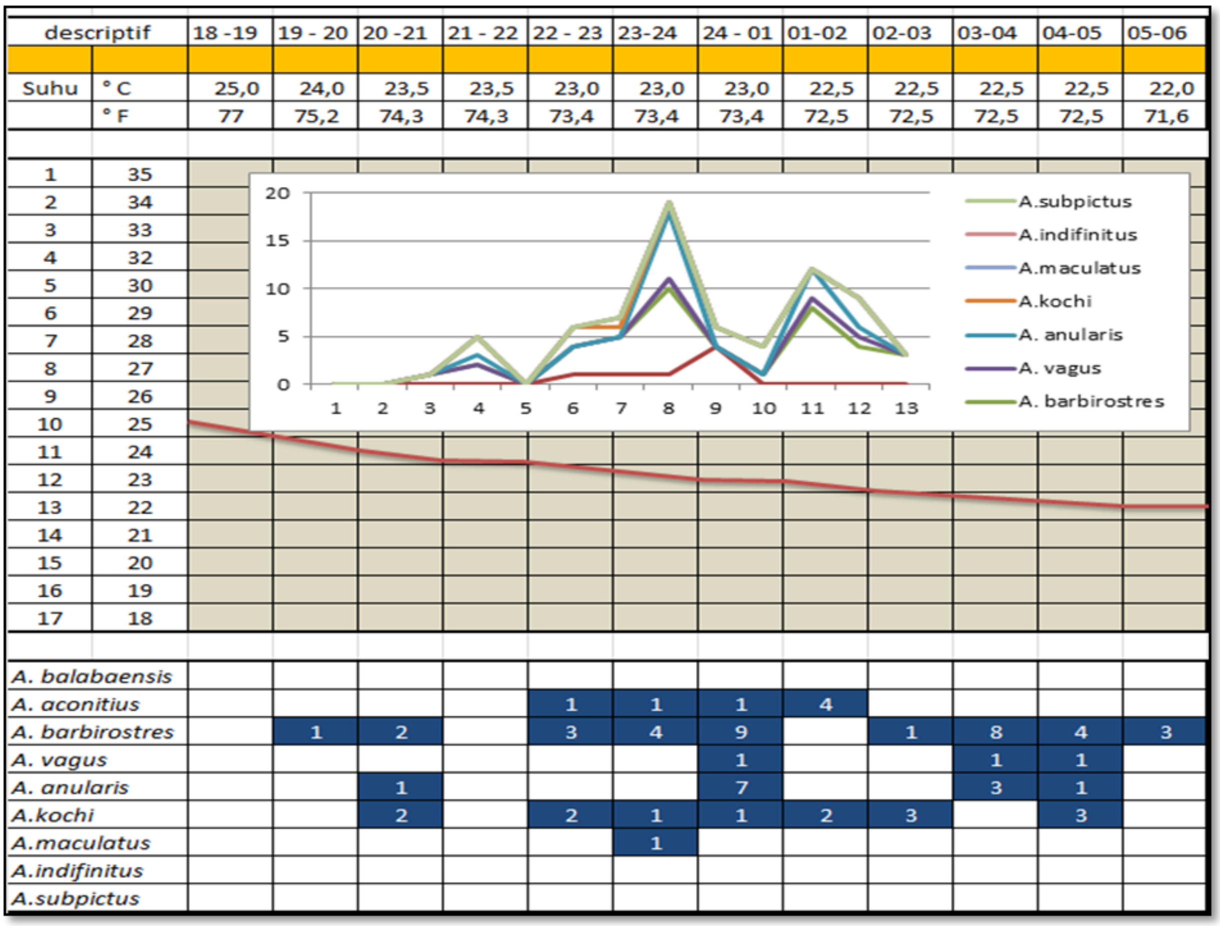


Figure 2. The bionomic of anopheles on dry seasons

b. *An.aconitus*

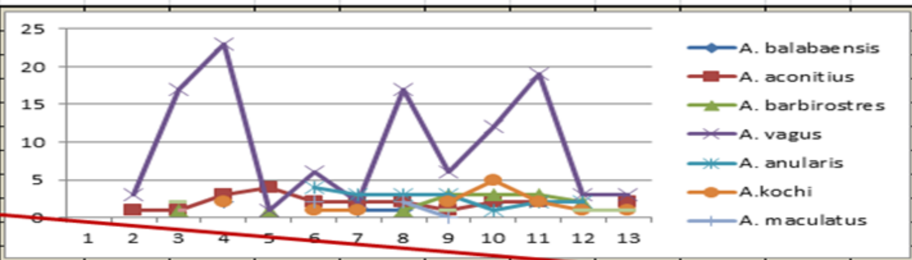
This species is found at an altitude of 100-about 600 meters above sea level. *An.aconitus* living habitat with temperatures from 22.5 to 33 ° C, with humidity> 52%. Almost all night activity in this species for blood. Found throughout the year, with the highest density in the dry rainy transition season (May-June).

c. *An.barbirostress*

This species is found at an altitude of 100-about 600 meters above sea level. *An.barbirostres* live in habitats with a temperature of 24.5 - 33ºC, with a humidity of 52% -93%. Found throughout the year with the highest density in the wet-dry transition and the dry season (May to October). Activity for blood from 19:00 to 6:00 hours, with peak 21.00-24.00.

descriptif		18 -19	19 - 20	20 -21	21 - 22	22 - 23	23-24	24 - 01	01-02	02-03	03-04	04-05	05-06
temp	° C	26,0	25,5	25,0	24,5	24,5	24,5	24,0	23,5	23,5	23,0	23,0	23,0
	° F	78,8	77,9	77	76,1	76,1	76,1	75,2	74,3	74,3	73,4	73,4	73,4

1	35
2	34
3	33
4	32
5	30
6	29
7	28
8	27
9	26
10	25
11	24
12	23
13	22
14	21
15	20



	18 -19	19 - 20	20 -21	21 - 22	22 - 23	23-24	24 - 01	01-02	02-03	03-04	04-05	05-06
A. balabaensis			2			1	1					
A. aconitius	1	1	3	4	2	2	2	1	2	2		2
A. barbirostres		1		1			1	3	3	3	2	
A. vagus	3	17	23	1	6	2	17	6	12	19	3	3
A. anularis					4	3	3	3	1	2	2	
A.kochi			2		1	1		2	5	2	1	1
A. maculatus					2		2					
A.indifinitus		1										
A.subpictus		2						1			1	1

Figure 3. The bionomic of anopheles on pre-dry seasons

d. *An.Vagus*

This species is found at an altitude of 0-> 700 mean see level. *An.vagus* live in habitats with a temperature of 22.5 - 33ºC, with humidity> 52%. Is the most dominant species both of time and amount. Found throughout the year and not knowing the season, with the highest density in the transition rainy dry seasons, dry season and the transisition rainy dry seasons. Having a blood-seeking behavior throughout the night from 18:00 to 06:00.

e. *An.anularis*

This species is found at an altitude of 100-600 meters above sea level. *An.anularis* live in habitats with a temperature of 24.5 - 32,5ºC, with 60-90% humidity. Found on dry rainy transition season (May-June), until the dry season (July-September). The peaks density occur in the dry-rainy transition. Seeking behavior of blood preparations lasted from hours of 22:00 to 05:00.

f. ***An.kochi***

This species is found at an altitude of 0-600 meters above sea level. *An.kochi* live in habitats with a temperature of 23.5 - 32,5ºC, with 55-96% humidity. Found throughout the year, the peak density occurs at the transition dry-rainy seasons. Seeking behavior of blood preparations lasted from hours of 20:00 to 06:00.

g. An.maculatus

This species is found at an altitude of 0-700 meters above sea level. *An.maculatus* live in habitats with a temperature of 22.5 - 32,5ºC, with humidity> 55%. This species is not found in the rainy season, while the other 3 seasons found. The highest densities occur in the dry rainy transition season (October). The habit of looking for blood occur at 19.00-24.00.

descriptif		18 -19	19 - 20	20 -21	21 - 22	22 - 23	23-24	24 - 01	01-02	02-03	03-04	04-05	05-06
temp	° C	26,0	25,5	25,0	24,5	24,5	24,5	24,0	23,5	23,5	23,0	23,0	23,0
	° F	78,8	77,9	77	76,1	76,1	76,1	75,2	74,3	74,3	73,4	73,4	73,4
1	35												
2	34												
3	33												
4	32												
5	30												
6	29												
7	28												
8	27												
9	26												
10	25												
11	24												
12	23												
13	22												
14	21												
15	20												
A. balabaensis													
A. aconitius				2				1					
A. barbirostres					1								
A. vagus		12	3	7	4	9	3	7			2	5	
A. anularis													
A.kochi						1							
A. maculatus			2	3	2								
A.indifinitus													
A.subpictus													

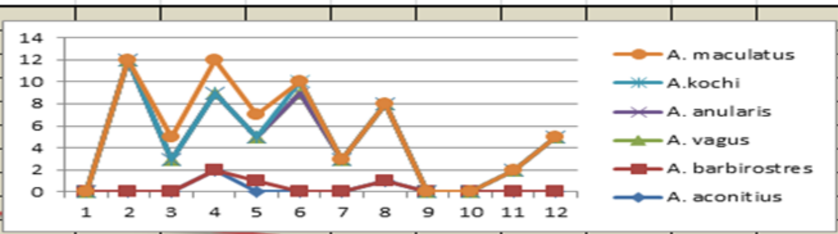


Figure 3. The bionomic of anopheles on pre-rainy seasons

h. ***An.indefinitus***

This species is found at an altitude of 330-400 meters above sea level. *An.indifinitus* live in habitats with a temperature of 25.5 - 32,0ºC, with 61-88% humidity. This species is very rare, found only in the wet-dry transition season (May). The habit of looking for blood take place from 19:00 to 20:00 hours.

i. *An.subpictus*

This species is found at an altitude of 100-400 meters above sea level. *An.subpictus* live in habitats with a temperature of 25.5 - 32,0ºC, with 61-88% humidity. This species is also found only in the wet-dry transition season (May). Seeking behavior of the blood occurs in the afternoon (19:00 to 8:00 p.m.), middle instead (1:00 a.m. to 02:00) and morning 04.00- 16.00).

descriptif		18 -19	19 - 20	20 -21	21 - 22	22 - 23	23-24	24 - 01	01-02	02-03	03-04	04-05	05-06
temp	° C	26,0	25,5	25,0	24,5	24,5	24,5	24,0	23,5	23,5	23,0	23,0	23,0
	° F	78,8	77,9	77	76,1	76,1	76,1	75,2	74,3	74,3	73,4	73,4	73,4
1	35												
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3	33												
4	32												
5	30												
6	29												
7	28												
8	27												
9	26												
10	25												
11	24												
12	23												
13	22												
14	21												
15	20												
A. balabaensis													
A. aconitius							1				1		
A. barbirostres										1			
A. vagus					8	2			2	1	1	4	
A. anularis													
A.kochi							1						
A. maculatus													
A.indifinitus													
A.subpictus													

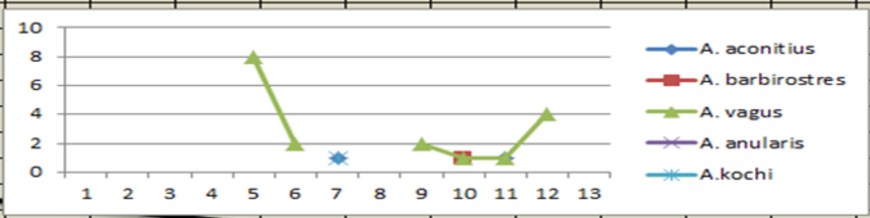

Figure 4. The bionomic of anopheles on rainy seasons

The results showed that each species of *Anopheles* have a different lifestyle in finding blood for its life cycle. Abundance of each species is strongly influenced by the availability of a suitable culture to grow and develop each species. There are four species that is always growing and evolving throughout the year, namely: *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus* and *Anopheles kochi*.

There are three species of the behaviors in searching for the blood that lasted all night. All three species are *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus*. The availability of suitable water source as a culture, is one of the supporters of the dominance of the four species of Anopheles.

In Purworejo there are sources of water that always has the potential inundation throughout the year. In the rainy season puddles found in yards and gardens population. In the dry season when there is no rain, the rivers have laminar flow, with puddles in some parts of the river, which is the primary breeding. This study was in accordance with (Ayala D, 2009; Mursid R, 2012) which suggested a stable habitat that allows the Anopheles cycle throughout the year. In line with this research is research (Adlaoui E, 2011; Sukowati S, 2011), which states where the main culture is a river that flows throughout the year.

Other Anopheles species dominance due to the tolerance factor of the four species in facing environmental changes between seasons. Factor in accordance with the laws of tolerance tolerance Shelford (Beroya, 2000; Odum T, 1988, Brewer, 1993), which states that a living creature has a range of tolerance to environmental changes. This is consistent with studies of (Gillian H, 2009; Li Li 2008), which states the influence of a culture of quality, which guarantees living things to grow and flourish.

The existence of the species throughout the year will be a major influence on the rate of entomologists (*Entomological Innoculation Rate, EIR*). Increased rate of EIR will increase the potential for transmission of malaria (Mardihusodo, 1999; Tellal 2009; Stainly, 2008). Anopheles species *An.aconitus* been indicated as a vector (Sukowati, 2010), although the results of the analysis in 2013 is not indicated as a vector (Mursid, 2013). Bionomics results which indicate four species able to survive throughout the year by biting through the night is a high hazard potential. Imported cases in endemic areas with a very dominant presence of the vector into a high threat for malaria transmission. The region has a Malaria Vulnerability Index (MVI) is high (Mursid, 2011; Sousa, 2010; IPCC, 2013).

The results of the analysis of the vector bionomics used as a basis for malaria vector control. There are 4 species throughout the year is vigilance in vector control should be followed up with control. Control especially in a culture dilkukan (brreding place), a rest (resting place) and changes in people's behavior. Malaria control is integrated with case finding, treatment, education, vector control, and ecological systems.

Conclusion

Results of research on the malaria vector bionomics endemic areas can be summarized as follows:

1. There are four vectors that live throughout the year, namely *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus and Anopheles kochi*.
2. There are three species of the behaviors in searching for the blood that lasted all night. All three species are *Anopheles barbirostres, Anopheles aconitus, Anopehes vagus.*
3. The bionomics of *Anopheles* very useful for grounding in malaria control

Recommendation:

1. Keep high vigilance for Purworejo region because it has species that live throughout the year.
2. Keep strengthening ecological approach in malaria control.

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