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The rubber sap bowl from plastic bottle waste as breeding site mosquito

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Abstract. This study examines the use of the sap bowl from plastic bottle waste as an alternative breeding site for various species of mosquitoes. This study used a purposive random sampling method by selecting the location of rubber plantation that no tapped and the sap bowl filled with water. Observations included the type of plastic bottle as a sap bowl, mosquito larvae, pH and volume of water. Samples were taken by plot method and data were analyzed by correlation analysis. Types of plastic waste used as sap bowls from lubricant bottles, beverage bottles, liquid fertilizer bottles, and food jars. Mosquito larvae were found in a sap bowl of 6 species namely *Ae. albopictus*, *Ae. butleri*, *Armigeres* sp., *Tx. splendens*, *Tripteroides* sp., and *Cx. phangngae*. Correlation between the number of mosquito larvae with a bowl, the plastic type, volume and pH of water shows a range of values of 0.96-1. This indicates that mosquitoes in determining breeding sites do not pay attention to specific factors that are in the bowl but based on the number of bowls or more dominant environmental factors.

1. Introduction

Rubber sap contains 93% hydrocarbon compounds in the form of polyisoprene macromelecules (-(CH=CH-C(CH3)=CH)$_n$-). Besides hydrocarbons, it also contains protein, fat carbohydrates, and minerals. These compounds can be broken down by bacteria and fungi [1,2,3]. Rubber sap submerged in water will make it easier for bacteria and fungi to decompose/ferment. This fermentation result becomes a signal for the mosquitoes that will lay eggs in searching for suitable waters as the place to lay their eggs. These fermented nutrient elements become a source of nutrition for mosquito larvae [4,5]. The higher fermentation process becomes a strong signal for mosquitoes to come and lay eggs [6,7].

One of the special tools for rubber farmers is a rubber sap container. Rubber sap bowls have been produced by industry using materials made of clay, plastic, aluminum, and coconut shell [8], and rubber composites [9]. A large plantation area will require a relatively large cost in the procurement of the sap bowl. This makes farmers look for alternatives to the use of used bottles as sap bowls.

Many rubber trees are not tapped and the bowl is left sticking to the tree for a relatively long time. These bowls in the rainy season will fill with water and have the potential to become

breeding sites for mosquitoes. Mosquito breeding sites will cause an increase in the number of mosquito populations in a fast time.

Therefore, in this study, we will explain the used bottles that have been used as the sap bowls and the side effects of the use of the bottles as breeding sites for mosquitoes in rubber plantations around Banjarbaru.

2. Materials and methods

This research was conducted at existing plantations around Banjarbaru, South Kalimantan, Indonesia, from March to May 2020. This study used a purposive random sampling method with regard to rubber trees that had not been tapped for a long time with the sap bowl still attached to the tree. Table 1 explains the locations chosen as the places of sampling.

Table 1. Sampling locations.

No	Location	longitude of the earth		Specific environmental profile sampling location
1.	GK1	-3.4827524	114.8691732	there are several houses, far from water sources (rivers, lakes, ponds)
2.	GK2	-3.4886562	114.8892642	adjacent to a poultry farm
3.	GK3	-3.488188	114.883477	adjacent people's homes and rice fields
4.	GK4	-3.49011	114.8767416	adjacent to water sources (natural pond)
5.	GK5	-3,49011	114.876741	adjacent to a river
6.	MA	-3.46446	114.906883	adjacent to swampy rice fields
7.	PP1	-3.46433	114.914174	adjacent to swampy rice fields
8.	PP2	-3.46607	114.9117217	adjacent to a water source (natural pond)
9.	PP3	-3.457512	114.913265	adjacent to people's homes, poultry farm, and rice fields
10.	PP4	-3.457512	114.913265	adjacent highway

Sampling used quota method, that was, 20 sap bowls containing mosquito larvae were taken from each location. The profile of the sap bowl was recorded, namely: the type of used goods that were used as sap bowls, the number of mosquito larvae, the volume, and the pH of the water in the sap bowls. Mosquito larvae were taken with a dropper and put in a bottle. Mosquito larvae were brought to the laboratory to be identified by the identification key of mosquito larvae [10,11]. Field data retrieval was done 2 times with an interval of 14 days. Data analysis of mosquito larvae populations includes relative frequency, Shannon-Wiener diversity and evenness index and Simpson's dominance index. The relationship of the number of larvae with the type of container and other environmental factors were analyzed by Pearson's correlation analysis.

3. Results and discussion

Sampling was carried out in 10 locations where the condition of rubber trees in productive age, but no tapping was done. The rubber plantations were partially maintained (figure 1 a, b, and c) and partly under-maintained. This could be seen by the amount of grass growing around rubber trees and several bowls strewn on the ground (figure 1d, e, and f).

The sap bowls used by rubber farmers can be classified into 2 types of bowls, namely a special bowl for collecting sap and bowls made from used goods. Used goods used as sap bowls all come from waste plastic bottles. Sap bowls are from lubricating bottles, liquid fertilizer bottles, plastic bottles and cups of beverage and food jars (figure 2). The percentage of bowls of used goods is higher than that of special bowls, which is 71% (table 2).

The types of plastic bowls are classified as follows: High Density Polyethylene (HDPE) (48%), Polyethylene terephthalate (PETE) (29%), Polypropylene (PP) (20%), and Polycarbonate (O) (5%) (table 4). The use of basic material for making the bowl of sap will affect the quality of the sap produced [9].

The sap bowls attached to the rubber trees in the rainy season has the potential to fill with rainwater. The size of the sap bowl determines the volume of water it holds. The sap bowl made from liquid fertilizer bottles, lubricant bottles, food jars, and large beverage bottles will hold more rainwater than special bowls and plastic cups. The volume of water in the sap bowl ranges from 100ml to 600ml. The highest percentage of water volume is in the range of 200ml-300ml (figure 3). The volume of water in the bowl will guarantee the development of the mosquito larvae becoming imago [12,13].

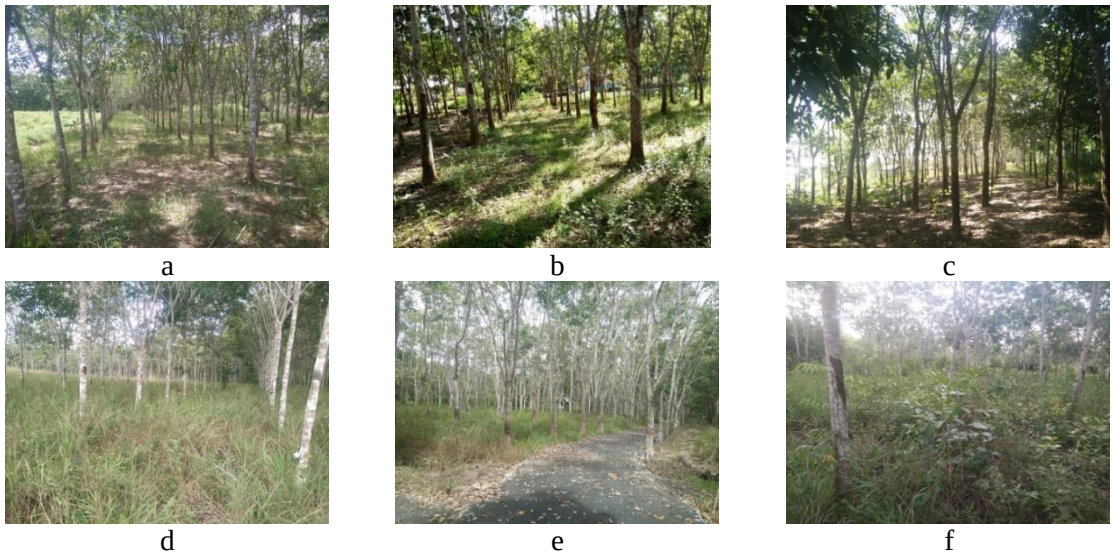

Figure 1. The conditions of the plantations when doing sampling. Pictures a, b, and c show that the plantations were still maintained; Pictures d, e, and f show that the ground was overgrown with various types of grass.

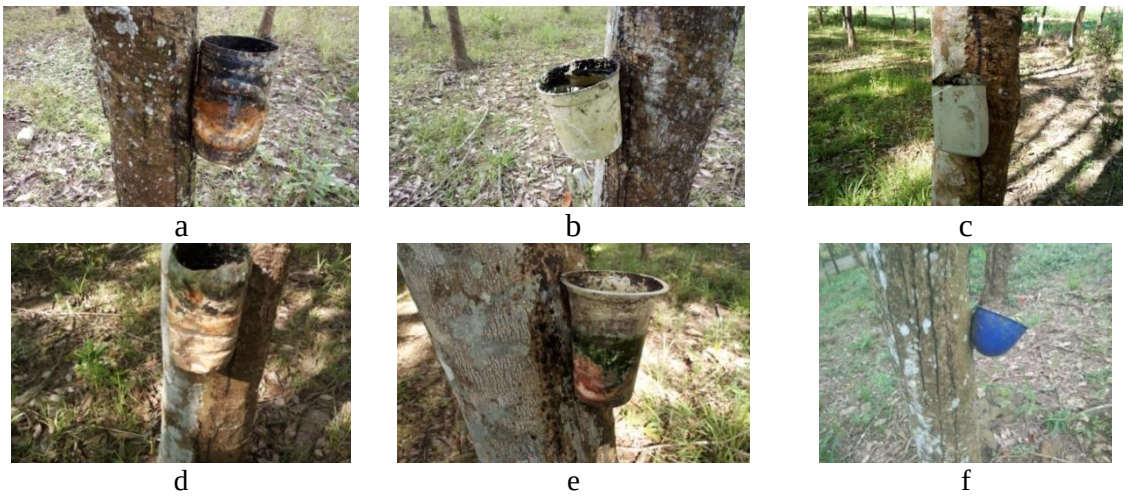

Figure 2. Various rubber sap bowls. In picture a and b, the sap bowls used were dry food jars. In picture c, the sap bowl used was a lubricant bottle, in the pictures d and e the sap bowls were beverage bottles; and in the picture f the bowl used was a special bowl of rubber sap.

On the surface of the inner wall of the bowl there is a sap crust that has been blackened. This sap crust indicates that the bowl is often used and rarely cleaned. The elongated shape of the bowl makes it difficult to get the sap (figure 4). This sap will be fermented by bacteria and fungi which

causes the walls to turn black and produce odors. The blackish color and odor from the fermentation results in attractiveness for mosquitoes to lay eggs [5,14,15].

The results of identification of mosquito larvae show there are 6 species, namely: *Ae. albopictus, Tx. splendens, Ae. butleri, Cx. phangngae, Tripteroides* sp. and *Amigeres* sp. (table 3). Calculation of the diversity of mosquito species in rubber plantations is quite low with a Shannon-Wiener (H) index value of 1.56 compared to a Hmax of 2.56. This causes the species evenness index is also low at 0.45 (range 0-1). The level of species dominance according to Simpson's dominance index is 0.62 (range 0-1). The dominance index of this species is relatively high with one of the dominant species being *Ae. albopictus* and *Ae. butleri*. There are two species that have a high relative frequency of 0.26, namely *Ae. albopictus and Tx. splendens* (table 3).

Table 2. Used bottles, plastic types, and the number of bowls used by rubber farmers as rubber sap bowls with mosquito larvae.

No.	Location	*HDPE*		PP		*O*	PETE	
		Lubricant bottle	liquid fertilizer bottle	Beverage bottle	plastic cup	Food jar	Sap bowl	∑
1.	GK1	28	12	0	0	0	0	40
2.	GK2	25	4	0	5	0	6	40
3.	GK3	7	0	12	0	21	0	40
4.	GK4	7	0	0	0	0	39	40
5.	GK5	25	0	15	0	0	0	40
6.	MA	18	8	12	2	0	0	40
7.	PP1	0	0	0	0	0	40	40
8.	PP2	18	0	8	12	0	2	40
9.	PP3	21	18	1	0	0	0	40
10.	PP4	0	0	7	4	0	29	40
∑		149	42	55	23	21	116	400
%		37	11	14	6	5	29	

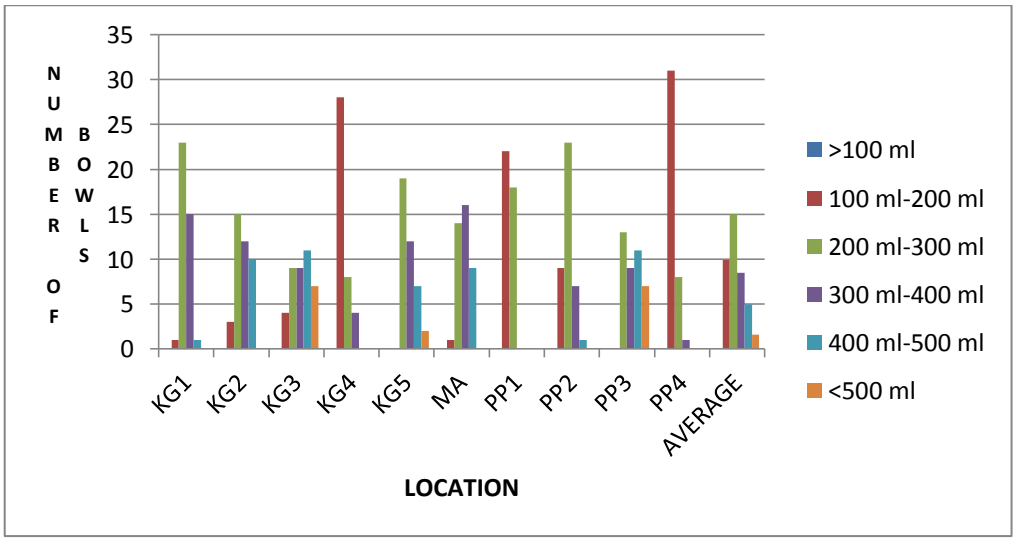

Figure 3. The classification of the sap bowls based on the volume of rainwater that is collected.

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Figure 4. The state of the surface in a sap bowl that is still left with sap soaked in rainwater.

Aedes albopictus is a mosquito species that is easily adaptable in rural and forest environments [16,17,18,19]. Good ability to adapt to the aquatic environment is made by humans [20]. Adaptation *Ae. albopictus* in the new environment is also supported by the ability to suck blood from both humans and animals [21,22].

Spread of *Tx. splendens* in the rubber plantations are very closely related to the spread of *Ae. albopictus*. This can be seen from the RF values which are both equal, 0.26 (table 2). The larval phase is one of the larval predators. Larvae *Tx. splendens* eat all types of mosquito larvae but the most preferred is the larvae of *Aedes* sp. [23,24,25]. Instar old larvae are found only 1 individual in a bowl of sap, this is because the larvae are cannibalistic. Cannibalism arises when other mosquito larvae are depleted depleted [26,27]. Larvae *Tx. splendens* control the population of other mosquito larvae so that there is a balance of mosquito populations in the rubber plantations environment.

Three species of mosquitoes namely *Ae. butleri*, *Cx. phangngae*, *Tripteroides* sp. and *Armigeres* sp. are generally found in forest areas or villages on the edge of the forest. The larval habitat is found in bamboo fragments and water-filled tree gaps [28,29,30]. These three forest mosquito larvae are able to adapt in the sap bowl microhabitat. There is one species of mosquito that has potential as a disease vector, *Ae. albopictus*. *Ae butleri*, *Cx. phangngae*, *Tripteroides* sp. and *Amigeres* sp. vector disease is unknown [31].

Table 3. Mosquito larvae found in the sap bowl and calculation of species diversity index.

No.	Species	∑	Frequency	Relative Frequency (RF)
1.	*Ae. albopictus*	8057	1	0,26
2.	*Tx. splendens*	249	1	0,26
3.	*Ae. butleri*	1368	0,7	0,18
4.	*Tripteroides* sp.	85	0,4	0,10
5.	*Armigeres* sp.	449	0,5	0,13
6.	*Cx. phangngae*	190	0,3	0,08
	∑	10398	3,9	
Shannon-Wiener Diversity Index (H) :				1.16
Maximum Diversity Index (Hmax):				2,58
equitibility (E) :				0,45
Simpson's dominance index:				0,62

Calculation of the correlation between the number of mosquito larvae and a bowl, the plastic type used as a sap bowl, the volume of water and the pH of the water in the bowl shows a range of values of 0.96-1 (table 2). This indicates that mosquitoes in determining breeding sites do not pay attention to specific factors that are in the bowl but based on the number of bowls or more dominant environmental factors.

Table 4. Correlation between the number of mosquito larvae and the number of bowls based on the type of used goods, the type of plastic, the volume of water and the pH of the water in the sap bowl.

Table 4a. Classifying bowls based on plastic type.

No.	Plastic type	Used goods	∑ bowl	∑ larvae
1.	HDPE	lubricating bottle	148	4011
		liquid fertilizer bottle	42	1221
2.	PP	beverage bottle	55	1573
		plastic cups	23	418
3.	O	Food jars	21	681
4.	PETE	Sap bowls	111	2125
correlation of the number of larvae with the number of types of used plastic				0,96
correlation of the number of larvae with the amount of used goods				0,97

Table 4b. Classifying bowls based on the volume of water in the bowl.

No.	Water volume (ml)	∑ bowl	∑ larvae
1.	0-200	93	1920
2.	200-300	149	3575
3.	300-400	91	2551
4.	400-500	51	1067
5.	>500	16	327
Correlation of the number of larvae with the volume of water in a bowl			0,98

Table 4c. Classifying bowls based on water pH in the bowl.

No.	Water pH	∑ bowl	∑ larvae
1.	4-4,5	23	676
2.	4,5-5	22	589
3.	5-5,5	135	3584
4.	5,5-6	108	2713
5.	6-6,5	74	1701
6.	6,5-7	21	462
7.	>7	17	304
Correlation of larvae number with pH of water in a bowl			1

4. Conclusions

The rubber bowls widely used by rubber farmers around Banjarbaru consists of plastic bottles from used lubricating bottles, liquid fertilizer bottles, beverage bottles and food jars. There are 6 species of mosquito larvae found in the bowl of sap, namely *Ae. albopictus, Ae. butleri, Tx. splendens, Cx. phangngae, Tripteroides* sp. and *Amigeres* sp.

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