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Ecological Factors Determining Abundance of Parasitic Mites on *Aedes* spp. Larvae

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Abstract

Ability to infestation and abundance of parasitic mites in *Aedes* spp. larvae cannot be separated from the influence of various factors. Ecological factors have been suggested to play a role determine the presence of parasitic mites that under certain conditions become a key factor in determining the abundance of parasitic mites on *Aedes* spp. larvae. The aim of this study to determine the ecological factors affect the abundance of parasitic mites on *Aedes* spp. larvae in Bogor Regency. Capturing of *Aedes* spp. larvae was performed directly on the habitats found in indoor and outdoor. Capturing mites in the body of *Aedes* spp. larvae was performed using insect forceps. Ecological factors measured were dissolved oxygen (DO), pH, temperature, and total dissolved solid (TDS). The influence of ecological factors was analyzed using regression and correlation analysis. The result of mite identification has been obtained three species of mites that are *Halacarus* sp., *Histiostoma* sp., and *Hydrozetes* sp. The result indicated that total dissolved solid (TDS) and temperature was the factors that determined the abundance of mites. The factors of pH, and dissolved oxygen (DO) did not determine the abundance of parasitic mites of *Aedes* spp. larvae. The research result can be further developed as a new alternative to Dengue Hemorraghic Fever control and provide information on parasitic mites that infest *Aedes* spp. larvae. In addition, this results become an early step in controlling of *Aedes* spp. strategy platform by the parasitic mites.

How to Cite

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) became one of the endemic diseases and causes of a health problem in Indonesia. It is indicated by the higher incidence rate and the spread of DHF is increasing (Sungkar, 2007). Up to 2015, there are 436 regencies in Indonesia with DHF cases (Departemen Kesehatan RI, 2016). One of regency with DHF case is Bogor Regency, West Java. In 2015, there were 1,201 DHF patients scattered in almost all districts (Dinas Kesehatan Bogor, 2015).

DHF vectors in Indonesia are *Aedes aegypti* and *Ae. albopictus* (Departemen Kesehatan RI, 2016). Currently, the control of DHF still focuses on *Aedes* spp. as vector DHF to decreasing case of DHF. One of the parts in control of *Aedes* spp. is controlling of *Aedes* spp larvae. Controlling for *Aedes* spp. larvae is an effective strategy including the termination of the DHF transmission cycle. It is an effective method to control larvae because the larvae are prone to death than controlling the adult mosquitoes (WHO, 2011). Other control programs such as the physical control that are *Menutup*, *Mengubur, Menguras* (3M), use of insecticides and other control programs are considered less than the maximum in suppressing the *Aedes* spp. population. as well as the incidence of DHF.

Budianto & Widiastuti (2012) suggested that the parasitic mites on *Aedes* spp. larvae provide a new alternative in the control of *Aedes* spp. The parasitic mites may affect to the growth of mosquitoes from instar to instar. The effect can be demonstrated by the reduced number of mite host diversity, the population of adult mosquitoes is reduced and the age of the adult mosquito that comes from the larvae infected pathogens or parasites are usually shorter (Smith, 1988; Atwa *et al.,* 2017). A study by Budianto (2016) found parasitic mites from the family Pionidae and Hydryphantidae attached to the abdominal *Aedes* spp. larvae whereas the family Hydrachnidae was attached to the *Aedes* spp. thorax in Karanganyar Regency.

Ability to infestation and abundance of parasitic mites in *Aedes* spp. larvae cannot be separated from the influence of various factors. Di Sabatino *et al.* (2004) suggests that abiotic and biotic factors such as pH, temperature fluctuations, ionic content of water, and seasons also influence the distribution pattern and abundance of parasitic mites. Another influence was shown by altitude factors, velocity and habitat types (Goldschmidt, 2004). Ecological factors have been suggested to play a role determine the presence of parasitic mites that under certain conditions become a key factor in determining the abundance of parasitic mites on *Aedes* spp. larvae. As far as it is not yet known what aspects of the ecological factors determining the abundance of parasitic mites on *Aedes* spp. larvae. This study aim to determine the ecological factors affect the abundance of parasitic mites on *Aedes* spp. larvae in Bogor Regency. This research results can be further developed as a new alternative to DHF control and provide information on parasitic mites that infest *Aedes* spp. larvae in Bogor Regency. In addition, this results become an early step in controlling of *Aedes* spp. strategy platform by the parasitic mites.

METHODS

This research used survey method with random sampling technique. The locations of this research were in four locations in DHF endemic area in Bogor Regency that are Cibinong District (Cirimekar, Ciriung, Cibinong and Pabuaran Village). This research was conducted in January-April, 2016.

Collection of *Aedes* spp. Larvae and Mites

Capturing *Aedes* spp. larvae was performed on objects with a pool of water that is a potential breeding habitat for *Aedes* spp. larvae. *Aedes* spp. larvae habitat search was conducted in indoor and outdoor. *Aedes* spp. larvae were taken using a pipette and placed in a sample bottle. The mites on the body of *Aedes* spp. larvae were captured using insect forceps. The mites found were put in 70% alcohol.

Mites Preservation

Preservation was performed using 70% alcohol. Maceration was carried out using 10% KOH solution for 1-2 days. Mounting was carried out using Hoyer's solution. After that, mites were placed on an object glass identification process. Identification of mites referred to Krantz & Walter (2009).

Measurement of Ecological Factors

Measurement of ecological factors was performed in situ on the habitats of *Aedes* spp. larvae. Ecological factors measured were Dissolved Oxygen (DO), pH, temperature, and Total Dissolved Solid (TDS). The measurement of DO value was performed using DO meter, pH value using pH meter, temperature value using a thermometer, and TDS value using TDS meter.

Data Analysis

Regression and correlation analysis was used to see the relationship between ecological factors that have been measured and the abundance of mites with significance level α = 20%. Regression and correlation analysis was calculated by using SPSS software version 16.

RESULT AND DISCUSSION

A total of 2,260 individuals *Aedes* spp. larvae were examined and found as many as 80 individuals of parasitic mites (Table 1). The 80 individual of parasitic mites have been identified as *Halacarus* sp. (Figure 1), *Histiostoma* sp. (Figure 2), and *Hydrozetes* sp (Figure 3). *Halacarus* sp. was found in the sampling area of Cibinong and Cirimekar village with the relative abundance of 3.75%. *Histiostoma* sp. with relative abundance value of 5% found only in Ciriung village. *Hydrozetes* sp. found on larvae of *Aedes* spp. was obtained from Cibinong, Ciriung, Pabuaran, and Cirimekar village. *Hydrozetes* sp. had the highest relative abundance with a value of 91.25%. The high value of abundance obtained was suspected because *Hydrozetes* sp. has modified claws to attached strongly to the host's body, resulting in the number of *Hydrozetes* sp. which is obtained more than *Halacarus* sp. and *Histiostoma* sp. According to Seniczak and Seniczak (2008) mites of family Hydrozetidae have a pointed claw to attached to the host surface. A'yunin (2015) found 3 individual mites from the family Hydrozetidae on the *Aedes* spp. larvae which was obtained from a water reservoir in Semarang City, Central Java.

Table 1. The abundance of parasitic mites on *Aedes* spp. larvae

No	Village	Host	Parasitic Mites		
		Aedes spp.	*Hydrozetes* sp.	*Halacarus* sp.	*Histiostoma* sp.
1	Cibinong	522	17	2	-
2	Cirimekar	502	26	1	-
3	Ciriung	569	12	-	4
4	Pabuaran	667	18	-	-
Total		2,260	73	3	4
Relative abundance			91.25%	3.75%	5%

Halacarus sp. is a member of family Halacaridae. Family Halacaridae belongs to the order Prostigmata which has 17,170 species divided into 1,348 genera and 131 families. Prostigmata is a very diverse order with widebody wide variation (100-1600 μm). Stigmata are located in front on the anterior edge of the propodosoma or between the base of chelicerae. Order prostigmata found in a variety of habitats as predators, parasites, fitofag and fungivores (Evans 1992). According to Krantz and Walter (2009) family Halacaridae has a body length of less than 800 μm. The shape of the body resembles a diamond (hexagon). There are 5-10 pairs of setae in the idiosoma. There is a claw on the foot to I-IV. Adult stage of family Halacaridae mites have 2 prominent genital pairs covered by genital valves. Family Halacaridae are scattered throughout the world and the highest abundance is found in the tropics. Family Halacaridae consists of 68 genera and 1,118 species that live in salt water (sea) and freshwater habitat. Pepato and Da Silveira (2013) stated that the genus Halacarus has a longer genu than the tibia and telofemur. Palpus with 4 segments and setae on dorsal 6 pairs. Female mites have 2 - 15 pairs of setae on the perigenital and there is no setae on the anal. According to Bartsch (2009) that specifically, there have been no reports on the patterns of migration, dissemination and life cycle of the Halacaridae parasitic mite.

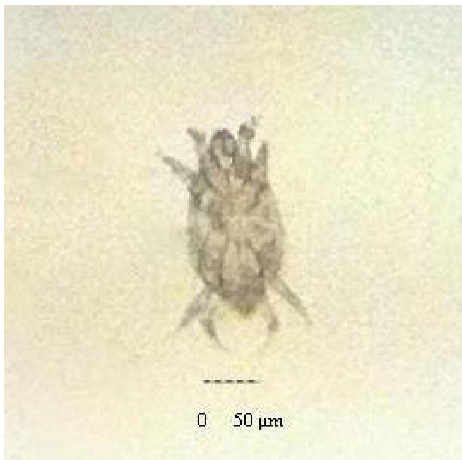

Figure 1. *Halacarus* sp.

Histiostoma sp. is a mite of the family Histiostomatidae belonging to the order Astigmata. This order has about 4,500 species divided into 627 genera and 70 families. The species of the order Astigmata are usually weakly cloned, medium-sized (200-1200μm), have no stigmata and are found in many habitats (Evans 1992). According to Krantz and Walter (2009) family Histiostomatidae has 58 genera and more than 500 species. The highest diversity can be found in natural habitat containers such as tree holes distributed by species of order Diptera and Hemiptera. Family Histiostomatidae lived cosmopolitan with relatively large body size and dorsoventral flat. Legs III and IV curved toward the gnathosoma. In the ventral area, there is a circular sucker plate. Tibia I-II has 0-2 ventral setae. Family Histiostomatidae do not have the empodium on the claws. Asbfaq *et al.* (2000) state *Histiostoma* sp. has a soft body, there are 13 pairs of setae on the dorsal. The second leg tibia with 2 setae, the third leg tibia and leg tarsus with 8 setae, tibia and tarsus of the fourth leg with 7 setae. Pedipalpus is smaller than the genu and tibia of the first leg.

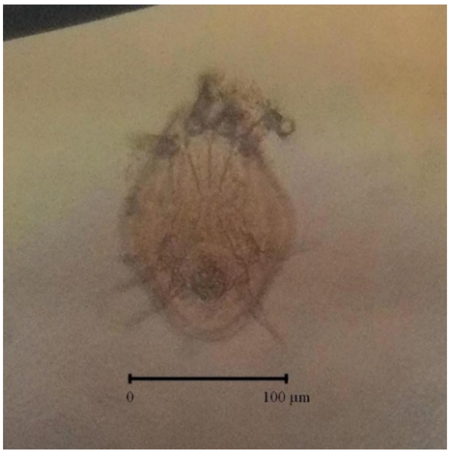

Figure 2. *Histiostoma* sp.

Hydrozetes sp. is a mite from family Hydrozetidae. Family Hydrozetidae belongs to the order Oribatida which has about 11,000 species divided into 1,100 genera and 150 families. Medium-sized Oribatida mites (200-1200 μm) and very thickly cloned idiosoma (Evans 1992). According to Krantz and Walter (2009) family Hydrozetidae has a circular lenticulus, body length up to 700 μm. There are 13 or 15-17 pairs of setae in the notogastral section. Family Hydrozetidae has a large genital opening and wide opening. Ermilov (2006) states the genus Hydrozetes has a body length up to 488 μm and body width up to 299 μm. Brown body color with the oval body shape in hysterosoma and there are 13 pairs of setae in hysterosoma. In the ventral, around the genital opening, there are 6 pairs of setae and 2 pairs of setae on the anal. A'yunin's study (2015) found three individual mites from the family Hydrozetidae in *Aedes* spp. larvae which are obtained from a water reservoir in Semarang City, Central Java.

The result of measurement of ecological factors can be seen in Table 2. The first ecological factor was dissolved oxygen (DO). DO did not have influence on the abundance of mites (P= 0.366 > α= 0.20). This means there is no significant correlation between DO and the abundance of mites. The measured DO range is 1.10 - 8.00 mg / l with an average of 3.59 ± 1.59 mg / l. Low DO levels in water samples measured showed too little-dissolved oxygen content. The parasitic mites do not absorb oxygen directly from the DO in the water. According to Marx & Messner (2012), *Hydrozetes lacustris* have a mechanism for conducting oxygen uptake of free air through the plastron found in the cerotegument. Rahmawati *et al.* (2017) stated that the DO factor in the waters is an abiotic factor and the diffusion of oxygen from the atmosphere into the water that occurs directly is a major factor in the formation of DO in the water.

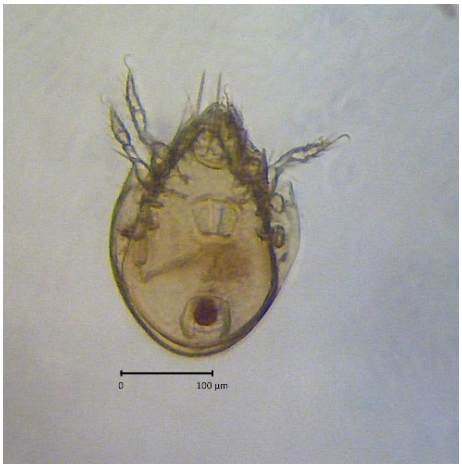

Figure 3. *Hydrozetes* sp.

Table 2. Ecological factors measured from all research locations

Parameters	Min.	Max.	Mean	*P value*
Dissolved Oxygen (DO) (mg/l)	1.1	8	3.59 ± 1.59	0.366
Temperature (°C)	26.5	31.8	29.33 ± 1.28	0.121*
pH	5	8.89	7.09 ± 0.75	0.856
Total Dissolved Solid (TDS) (mg/l)	16.4	186.9	62.49 ± 49.05	0.010*

*correlated

The relationship between pH and abundance of mites was not significant (P= 0.856 > α= 0.20). This means there is no significant correlation between PH and the abundance of mites.. The pH range measured was 5.00 - 8.89 with an average pH of 7.09 ± 0.75. The pH level measured indicates a varied value. This raises the notion that parasitic mites tend to be tolerant of acidic pH conditions <7 and base pH> 7. According to Ngodhe *et al.* (2014), pH is a logarithmic measure of acidity or basicity as well as a measure to determine the content of hydrogen ions in the water. pH affects the content of DO in water, aquatic organism photosynthesis (phytoplankton) and the sensitivity of the organism to pollution, parasites, and diseases. pH was associated with the diversity of water mites, but the effect of pH slightly contributed directly to mites life (Walter & Proctor, 2013). Edwards (2004) stated that in vitro, the *Unionicola foili* (Unionicolidae) parasitic mite survived up to 23.5 days at pH 5.2, 22 days at pH 7 and 32.5 days at pH 7.8

Temperature is related to the abundance of mites ($P = 0.121 < \alpha = 0.20$; $r^2 = 0.031$). This indicates that the temperature determines the abundance of mites. However, the relationship tends to be weak and the effect of temperature only contributes 3.1% ($r^2 = 0.031$), while other factors influence 96.9%. The measured temperature range is 26.5 - 31.8 ° C with an average of 29.33 ± 1.28 °C. The influence of temperature on the abundance of parasitic mites is suspected because mites do not have the ability to adapt to environmental temperature variations in order to survive. The graph of the relationship between temperature and abundance of mites tends to the inverse (Figure 4). It can be explained that the higher the temperature value the lower mite's abundance. The result of this research was same the result of Di Sabatino *et al.* (2004) research indicating that the temperature ranges from 4.2 - 16° C strongly correlated with the diversity of Hydrachnidia and Halacaridae mites found on Alpine Lake. Edwards (2004) adds that the *Unionicola foili* (Unionicolidae) parasitic mite survived for up to 16.5 days at 25°C, 11 days at 33°C and 4 days at 38°C. Wiecek *et al.* (2013) also added that temperature factor (*p-value*= 0.003) and conductivity (*p-value*= 0.001) affected the abundance of Hydrachnidia mites scattered on the waters in Poland.

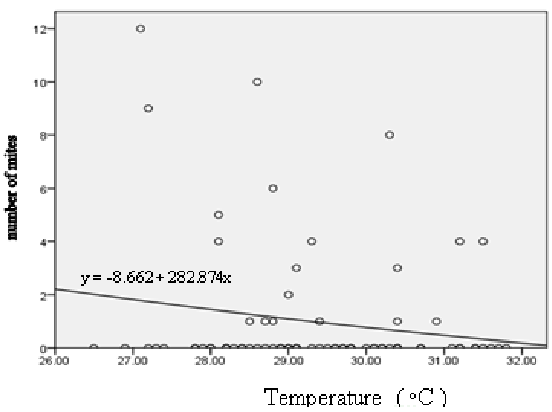

Figure 4. The graphic of relationship between temperature and the abundance of mites

Total Dissolved Solid (TDS) is associated with abundance of mites ($P = 0.010 < \alpha = 0.20$; $r^2 = 0.082$). The relationship is moderate and the effect of TDS only accounts for 8.2% ($r^2 = 0.082$), whereas 91.8% is influenced by other factors. The measured TDS values ranged from 16.40 - 186.90 mg / l with an average of 62.49 ± 49.05 mg / l. The graph of the relationship between abundance of mites and TDS tends to be linear (Figure 5).

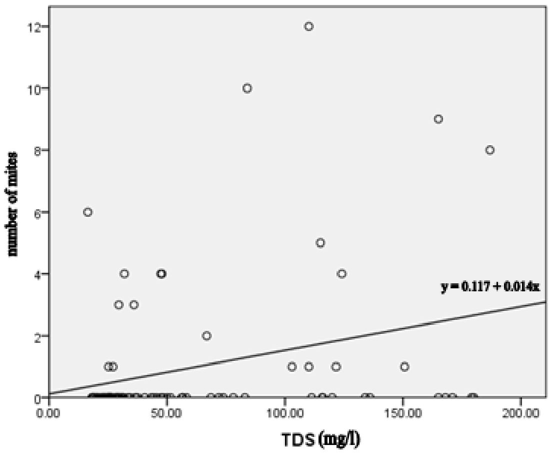

Figure 5. The graphic of relationship between Total Dissolved Solid (TDS) and the abundance of mites

According to Prommi and Payakka (2015), TDS is defined as total mineral salts (sodium ions, chlorides, magnesium, and calcium) contained in water. There were no reports of ions that affected the development of parasitic mites. It is suspected that if survival of mites is maintained, parasitic mites infestation of the host will persist and indirectly affect the abundance of parasitic mites on *Aedes* spp. larvae. Evans (1992) suggested that ions are essential to the survival of mites in the process of excretion and osmoregulation. Asci *et al.* (2015) stated that heavy metals (Al, Be, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, Li, Mg, Mn, Na, Ni, Pb, Se, Sr, Te, Tl, Zn, Bl) contained in Eber and Karamik Lakes reduced the abundance of water mites.

The discovery of three species of parasitic mites on *Aedes* spp. larvae in this study is a preliminary study in DHF endemic areas in Bogor Regency. The next step is to determine the mortality rate due to parasitation by parasitic mites to *Aedes* spp. larvae based on ecological factors. It is useful to explain the new alternative of *Aedes* spp. control as a DHF vector by parasitic mites. New alternatives to *Aedes* spp. control can also be selected and included in the DHF integrated control program implemented by the government.

From a scientific view, this results can explain what factors play a role in the abundance of parasitic mites and can be further investigated about the diversity of parasitic mites in other mosquito vectors and other contributing factors.

CONCLUSIONS

The parasitic mites that have been found were *Halacarus* sp., *Histiostoma* sp., and *Hydrozetes* sp. Ecological factors such as pH and Dissolved Oxygen (DO) did not correlate with the abundance of mites, while the Total Dissolved Solid (TDS) and the temperature were correlated with the abundance of mites.

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