Preference of Termites to Habitat under The Trees along Altitudinal Gradient in Western Slope of Mount Slamet Central Java

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Abstract. The western slope of the production forest of Mount Slamet locating in 700-1300 m asl, dominated by trees of *Recinus damara* and *Pinus mercusii*. The dominant trees create specific character habitat and be prefered of termites to inhabited under them. The aims of this research to differ the preference of termites to habitat under the tree on western Slope. The method used was a survey with sampling based on belt transect.(L=100m, W=2m) layed under both habitats for 600 m length. Each transect for 100 m length divided into 20 sections, then the termites sampled on a living tree, branch, bark, litter, and soil in each section. Diversity, equality, and domination of termites were analyzed by Shannon-Wienner index (H′), Shannon-Evenness index (E), and Simpson's Domination index and correlation test. The result, six species of termites *Schedorhinotermes javanicus*, *Odontotermes javanicus*, *Nasutitermes matangensis*, *Capritermes semarangi*, *Procapritermes stiger,* and *Microtermes insperatus* were found under both of the trees. The pattern of abundance of each species termites on altitudes showed maximal on mid altitudes. The conclusion was the preference of termites to the dominant tree was significantly different, the termites diversity was categorized as low level, and the most dominant species was *Schedorhinotermes javanicus.*

1. Introduction

Termites are invertebrate fauna dominating the tropical land forest [1], and the role of the decomposition mediator process on the terrestrial ecosystem is vital ([2]; [3]; [4]). The carbon mineralization process and nitrogen fixation in this decomposition process depend on the diversity of the termites community [4] and how the role of termites community on their habitat usually expressed on their feeding habits. At present, at least 3-4 groups of feeding habits of termites consist of pure wood feeder, wood and fungi feeder, humic feeder, and soil feeder termites [4]. That is why the information of termite preference to a habitat be important. The preference of termites to a habitat reveals whats the roles of termites on the habitat [5].

Preference of termites to habitat under the tree was influenced by many environmental factors, such as canopy cover [6], altitudes [7], air temperature, and humidity [8]. [9] stated that local factors such as canopy cover and forest conversion are more attributable to the preference of termites. Canopy loose declines preference of termites to under trees habitat [6], and canopy dense affect optimal soil humidity termites colony development [8].

The altitudinal factor is essential on the preference of termites to specific habitat in the tropical land forest [7]. The altitudes enable the variation of air temperature and humidity. Usually, the air

temperature declines 1°C every uphill for 100 m high. This is one reason why termites were denser on low land than high land. Termites usually live on optimal air temperature of 15-38°C with air humidity of 75-90 %. The genera *Coptotermes, Macrotermes,* and *Odontermes* prefer to this interval air temperature than the lower. Correlation between air temperature and the presence of these genera is caused by the feasibility of air temperature for the growth of fungus the main diet beside wood [10].

The Western slope of the production forest of Mount Slamet is dominated by trees of damar (*Agathis damara*) and pinus (*Pinus merkusii*). The habitat under both of the trees is highly different. The leaf of Pinus has a noodle-like thin leaf, is coated by a thin wax layer, and these leaf are not degradable easily. This is why the waste of pinus leaf on the ground is much denser than dammar leaf waste, pH is also lower (6,5-7), the canopy is denser. On the other hand, the dammar leaf waste beside it is easier degradation, and the canopy is more opened. It produces gum, a secondary metabolism antifeedant of termites and fungi products [11]. The respon of termites on two kinds of habitat absolutely different. The soil feeder termites group is usually more susceptible than the wood feeder termites group, to that environmental factor of habitat.

2. Methods

This research was surveyed, and termites sampled followed a standardized belt transect (P= 100 m, W= 2 m) for 600 lengths, in Western Slope of Mount Slamet. Each belt transect for 100 lengths, was divided into 20 sections (P=5m, W:2m), then the termites were taken in the living trees, litter, bark, humic located in each section for 1 hour per man/section. The specimens were kept in alcohol 70%. The tools used were pinset, plastic vial bottle, altimeter, pH meter, thermohygrometer, and stereo microscope.

2.1 Procedure

The west slope of Mount Slamet was divided into an area under pinus and dammar habitat, on 700-1300 m asl. On each habitat layed a belt transect (L: 100 m, W: 2 m) for 600 m length, each belt transect divided into 20 sections (L: 5 m, W: 2 m) as the sampling unit. The termites were taken from the living trees, branch, bark, litter, and soil in each section. The specimen termites found then kept in alcohol 70% in the plastic vial bottle. A sampling of termites was done for one hour per person every section, also tabulate the data of environmental parameters such as air temperature and humidity, light intensity, soil pH, and the canopy closed per 100 m length. Specimen termites identification is done based on [12].

2.2 Data analysis

Data analysis of preference to inhabited on both habitats were counted per section every transect 100 m length (range of altitude). Preference category of termites to habitat under the trees analyzed by Shannon-Wiener index, Shannon-Evenners for equability of sample and domination index of Simpson for domination [13]. The formula used is:

Shannon-Wiener index : $H = -\sum_{i=1}^{n} \quad Pi\ (lnPi) Pi = \frac{ni}{N}$

Notes :
H' = Diversity Index of Shannon-Wiener
Pi = Species sample proportion to i of species total
Ln = Normal Logarithm
ni = Number of individual of species to i
N = Total number of all species

Shannon-Evenness index : $E = \frac{H}{lnln\ S}$

Notes:
E = Equibility Shannon-Evenness index
H′= Diversity index of Shannon-Wiener
S = Number species

Domination index of Simson: $D = \sum_{i=1}^{n} \quad (Pi)^2$
Notes:
D = Domination index of Simson
Pi = Species sample proportion to i of species total

Correlation data between abundance with altitude was analyzed by the correlation test. The definition of abundance per species of termites was the accumulation of encounter every one species per section a species represented by soldier caste. So the maximum number for one species abundance per section was 20 hits. ([14]; [7]; [15]).

3. Results

Table 1. Termites species found under the pinus (P) and damar (D) habitat

Takson	700 m		800 m		900 m		1000 m		1100m		1200 m	
	P	D	P	D	P	D	P	D	P	D	P	D
F: Rhinotermitidae												
SF: Rhinotermitinae												
S: *S. javanicus*	1	1	5	3	7	0	1	1	1	1	1	1
F: Termitide												
SF: Macrotermitinae												
S: *O. javanicus*	1	1	1	1	2	0	1	0	1	0	1	0
S: *M. insperatus*	0	0	0	0	1	0	0	0	0	0	0	0
SF: Termitinae												
S: *C. semarangi*	0	1	1	0	2	2	1	0	0	0	0	0
S: P. stiger	0	1	2	2	3	1	0	0	0	0	0	0
SF: Nasutitermitinae												
S: *N. matangensis*	0	1	2	2	3	2	1	0	0	0	0	0
Spesies number	2	5	5	4	6	3	4	1	2	1	2	1
Abundance (hits)	2	5	11	8	18	5	4	1	2	1	2	1

Table 2. Shannon Diversity (H'), Equibility (E) and domination (D) index of termites

Location	S	H'	E	D
Pinus	5	1,56	0,88	0,29
Damar	3	0,85	0,50	0,50

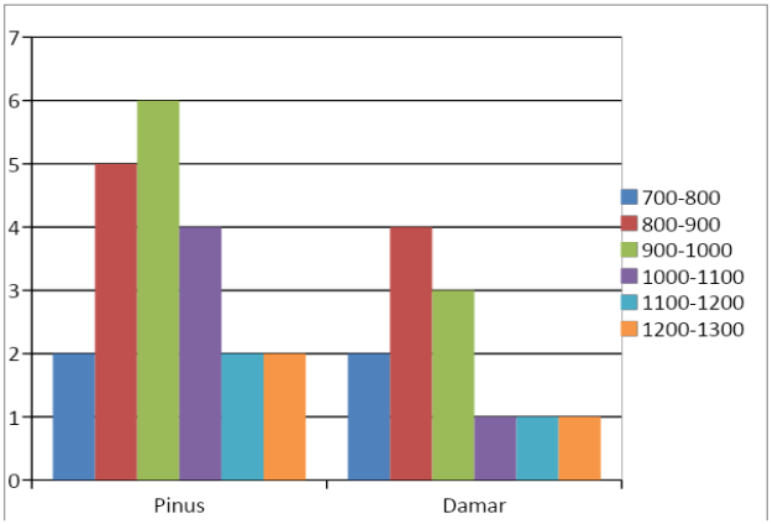

Figure 1. Species preference of termites to both habitat in each altitude

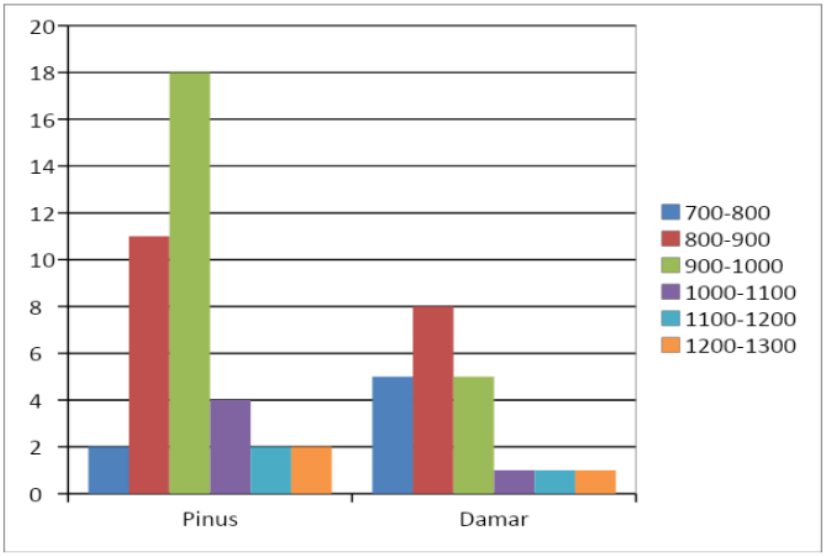

Figure 2. Abundance (hits) of termites in each of altitude

4. Discussion

The condition a long of altitudinal gradient 700-1300 m asl, both habitats under pinus and dammar trees are wet, with air temperature 24-27°C, air humidity 95%, mean of soil pH 6,6 (pinus) and 7 (dammar), canopy closing 100% on the transect, species of vegetation under pinus are *Clidemia hirta, Calliandra* sp, *Cyslosorus aridus,* then under dammar are *Axonopus compressus, Acmella paniculata,* and *Paspalum conjugate.*

The sampling in this western slope of Mount Slamet found six species. They are *Schedorhinotermes javanicus* belong to Family Rhinotermitidae, then *Odontotermes javanicus* and *Microtermes insperatus* belong to Subfamily Macrotermitinae. *Capritermes semarangi* and *Procapritermes stiger* belong to Subfamily Termitinae then *Nasutitermes matangensis* belong to Subfamily Nasutermitidae. That three subfamilies (Macrotermitinae. Termitinae and Nasutermitinae) belong to the Family of Termitidae. *Schedorhinotermes javanicus* is the one and only, belong to Family Rhinotermitidae found. *S. javanicus* (F:Rhinotermitidae) is the low level of wood feeder termites, with the number taxon is lower than high level wood feeder termites such as Termitidae. [16] stated that Family of Termitidae is the biggest family in Ordo of Isoptera and consists of 3/4 of species known. The species density in pinus ecosystem forest was 6 species, which is higher than the dammar ecosystem forest with three species (table 1). It means that the termites prefer to under pinus tree habitat than under tree dammar habitat.

Diversity Index of Shannon-Wienner (table 4.2) showed that pinus ecosystem forest is categorized to middle diversity. It revealed the $1,0<H'>3,0$, while dammar ecosystem forest is categorized to low diversity it revealed $H'<1,0$ [17]. Based on this data, it means that the pressure of pinus habitat to the termites life was middle, habitat under pinus trees balanced and enable to produce enough for the termites. On the contrary, habitat under dammar tress gave ecologically pressure very hard to the termites, ecosystem relatively not stable, and enable the termites very low productivity.

If compare partially between pinus and dammar habitat, it looks the termites species density in dammar is lower. Its supposed acidity soil (pH under pinus trees) is lower (6,5) than under dammar trees (7). Pinus leaf is more difficult to be decomposed than dammar leaf, and it potentially more acid [18]. The litter of pinus leaf is thinner (more than 20 cm thin) than dammar leaf. It means the source of cellulose is denser too [19]. pH 6,5 under pinus leaf is almost neutral (7); its preferred by termites. The other factor why the termites prefer the litter of pinus than dammar might be the litter of dammar produces a bioactive component of *monoterpen* and *sesquiterpene,* it was an anti termites and secondary antifungal metabolite. This compound is usually used as a wood protector in the wood industry [20].

The equability index of Shannon-Evennes (E) in dammar habitat was lower than pinus. This index was directly in line to the diversity index of Shanon-Wienner. This equability index showed that the species of termites spread more equally in every section of the pinus habitat. Based on the equability index, commonly, the pinus habitat was categorized to a high level while ini dammar is low [21]. Beside it was caused by the thinner factor of a litter of the pinus leaf, it was also caused by canopy closing in pinus habitat was denser than dammar habitat, even though both habitats had the equal (100 %) canopy closer to the belt transect. With monopodial character of pinus trees, where the leaf stands on all of the branches it possibly canopy closing be denser and decline the sunlight intensity is coming into the floor of the forest. [22] stated that closing canopy is one of the important factor that affects the species density of termites and abundance.

The domination of Simpson index was categorized to a high level (0,5) while in Pinus was categorized to moderate. [17] stated that if the domination index closer to 1,0 it means one species dominates the community, while if the domination index is closer to 0, it means no species domination. This research found that species *S. javanicus* dominate all of the altitudes, both in pinus and damar habitat. Genus Schedorhinotermes is the cosmopolitan genus in Java Island, and it could be found in the altitude of 200 m until 1000 m asl [23]. Furthermore, this genus Schedorhinotermes also has a high home range, up to 295 m, from the nest [24].

The correlation between species density and abundance with the altitude showed low correlation (R^2= 0,47) and (R^2=0,48). This was an interesting phenomenon. It differed with the result of the research by [7] in primer forest in Leuser Aceh Province, where the result showed that the correlation between species density and abundance with the altitudes were a closed correlation, with a monotonical pattern of increase of the altitudes with declining of the species density and abundance. In the explanation, [7] stated that in a tropical land forest, the altitudes is the main factor that was declining the species density and abundance of termites. It because every up hill 100 m caused declining of an air temperature of 1°C. In this research, the western slope of Mount Slamet showed that the highest density and abundance of termites occurred in mid altitudes of 800-1100 m asl (Fig. 1 and Fig.2). It was higher than 700-800 m

asl and 1200-1300 m asl. This result is in line with [25] and [26] that stated any other pattern of an altitudinal gradient effect to the species density and abundance. This phenomenon is called the mid-domain effect. [25] stated that the mid-domain effect phenomenon caused by natural resources is maximal in mid altitudes. [27] found in the national park of Khao Kitchagoot Thailand, the altitudes did not affect the species density and abundance of monotonical termites. Another researcher, [28] found that ordo of Lepidoptera and Hymenoptera showed the mid domain effect in Eastern Slope of Mount Slamet. This fact as an approach of location because the order of Lepidoptera and Hymenoptera are the insect with a poikilothermic system, as well of ordo Isoptera [29].

According to the maximal natural resources in mid altitudes, [30] stated that people's activities such as forest fragmentation and other activities affect termites species density and abundance. Why does on altitudes 700 m-800 m asl was lower, it supposed the location was disturbed by the people activities such as taking a dry wood branch and planting the vegetables. This possibly affects to the termites' life. Unlikely to the 700-800 m asl, why does on 1200-1300 m asl was lower of species density, it supposed the air temperature and humidity unfeasible to the life of termites.

Another interesting result of this research found that species *Odontotermes javanicus* on a higher altitude of 1000 m asl in pinus habitat. Usually, genera Macrotermitinae such species *Microtermes insperatus, Odontotermes javanicus,* and *Macrotermes gilvus* prefer to the warm temperature (24^{o}C-28^{o}C) with high humidity (90%) and an area close to people activities. This fact is supposed the species of *O. javanicus* migrate passively by joint in the wood or bamboo used by the farmer in vegetable planting or other activity in the tourism area of Kaligoa cave, a Japanese Cave was established in Japan colonialism era last 80 years ago.

Species *Nasutitermes matangensis* also found in western slope, even though only in pinus ecosystem forest. [31], released that this species of *N. matangensis* might be possible life in all of the habitat, and the limiting factor for this species is food resources. But in western slope of Mount Slamet that food resources available along the time, such as lichens, a litter of the leaf and of course wood. The lichens, life mutualism and dense in the trees of pinus, probably caused by canopy closing in all of area of pinus was full. The closing canopy area makes conditions in the forest wet and possibly for optimal for developing of lichens. [32] stated that under the closing canopy that protecting of sunlight and wet possibly for optimal development of lichens.

Based on feeding habits, the group of termites found in the western of Mount Slamet consist of (i) the group of pure *wood feeders* (deadwood feeder) represented by *S.javanicus.* This is inline to the stated of [33], that genus of *Schedorhintermes* is low-level termites that consume the deadwood material, usually called as group I. (ii) the group of *fungus growing wood feeders* (wood, litter, grass and microepypit feeder) are represented by *O. javanicus* and *M. insperatus.* [31] stated that some species of termites belong to subfamili Macrotermitinae such as *O. javanicus* and *M. insperatus* showed preference to the fungi. This fungi is an important factor in the food of the chain for subfamilia Macrotermitinae. (iii) group of *humic feeders* (litter feeder, namely the material soil-like contain organic material from the plant) is represented by species of *Nasutitermes matangensis.* [31], stayed that food resources for *Nasutitermes* were wood, lichens, and humic from plant. (iv) group of *soil feeders* was represented by spesies of *Procapritermes. stiger dan Capritermes. semarangi.* [33], stated that that genera of Pericapritermes and Capritermes are the members of Family of Termitidae consumes of pure soil.

Even though the diversity of termites in western slope of Mount Slamet consist of four categories feeding habits, the diversity could be categorized in low species density, if compared with similar research in Leuser ecosystem where it found 115 species with 15 species are new for the research world. The reasons why these two research differ extremely. First, Leuser ecosystem is the national park consist of primer forest, while western slope of Mount Slamet is production forest, conversion result since 1943. Second, the range of altitudinal research in Leuser ecosystem is wider (250 m asl-1800 m asl), while research in western Mount Slamet research done in 700 m asl-1300 m asl. Third, Leuser ecosystem is a closer area to the equator than Western Slope of Mount Slamet. [34] stated that the ecosystem closer to the equator possibly has a higher diversity of organisms than the ecosystem remote of the equator.

5. Conclusion

The conclusions based on the discussion are (i) the termites prefer habitat under the pinus trees to the damar trees. Also the termite diversity of western slope of Mount Slamet was categorized low, with dominant species found was *Schedorhinotermes javanicus* (ii) correlation pattern between species density and abundance with altitudinal gradient was not monotonically but *mid-domain effect.*

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