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Research Article

Decomposition of Wood by Termites in Different Types of Land Use

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ABSTRACT

Decomposition is an important process in nature, as it can break down organic matter into smaller particles and nutrients. Nutrients are returned to the environment and can be reused by other organisms. One important organism that plays a role in the decomposition process is termites because termites are able to decompose organic matter such as wood in all habitats. Different termite habitats can be seen in terms of different types of land use. Some types of land use, such as natural forests, secondary forests, palm oil plantations, and settlements, can be used as a test site for wood decomposition by termites. All types of land use can be found in Dharmasraya Regency, West Sumatra Province. The purpose of this study was to study the decomposition of wood by termites in several different types of land use. Four types of land use are selected from habitats with the least disturbed conditions to the extent of high habitat disturbances, namely natural forests, secondary forests, palm oil plantations, and settlements. The study was conducted in Dharmasraya Regency, West Sumatra Province. The research method uses pine wood bait (*Pinus merkusii*), measuring 1.9 cm x 1.9 cm x 25 cm. The wooden bait is winded for seven days, and the wood bait is weighed to gain its initial weight and measured moisture content. Furthermore, wood bait that has been installed is observed and re-weighed to gain final weight and measured water content. The results showed that deforestation in Dharmasraya, West Sumatra had an effect on reducing wood decomposition by termites. Five (5) termite species were found in wood bait, including *Pericapritermes* sp.1, *Microtermes* sp.1, *Schedorhinotermes* sp.1, *Macrotermes gilvus*, and *Coptotermes curvignathus.*

Keywords: decomposition; land use type; termites

INTRODUCTION

Different land-use types can affect structures and compositions of insects inside them (Gimenez *et al*., 2015). Several insect groups, such as ants, beetles, lepidopterans, and termites, are affected by the different land use (Sholih *et al.*, 2017), which showed that ant composition in the secondary forest had the most ant species compared to other land uses. Nazaretta (2017) and Rubiana (2014) stated the effect of land use on the structure and composition of ants. The same results were shown by beetle species (Carrión-Paladines *et al*., 2021), Lepidoptera (Sambhu, 2018), and termites (Heriza *et al.*, 2021). All reports supported the effects of land use on the structure and composition of insect groups.

Differences in land use may cause different ecosystem services of insects to their environment. An ecosystem service that can be observed is the function of termites as decomposers. Termites can decompose an average of 835.5 kg of wood/ha in a year, leaf litter by an average of 68.4 kg/ha each year, and fallen wood by an average of 3 kg/ha each year (Collins, 1981). This demonstrated the ecological services of termites to their environment to decompose organic matters, provide nutrients for the surrounding vegetation, and ensure regeneration. Results have shown that termites can decompose wood in several land use. However, results from those studies varied. Sholih (2017) demonstrated that termites as decomposers provided the highest ecosystem services in palm oil plantations compared to other land uses, such as secondary forests, rubber forests, and plantations. Meanwhile, other research has shown that there was no significant difference in wood decomposition by termites in five different land use, which were considered low (Schuurman, 2005). Another study stated that forest fragmentation in the dry subtropical forest in southwest Puerto Rico had significant wood decomposition by termites (Genet *et al*., 2001).

Wood decomposition by termites is related to different land use. Jones and Eggleton (2000) explained that termites demonstrated high sensitivity to environmental biotic and abiotic factors. Sudden change in environmental conditions due to changes in land use is believed to affect decomposers. This has been reported to occur in other decomposers, as shown by the research of Danang and Musyafa (2010), where decomposition rates by Coleoptera in teak environments were higher than in community forests or dry lands.

Different land uses are often related to vegetation structures that then determine abiotic factors, especially the microclimate under it (Donovan *et al*., 2001). Dense trees and canopies affect light intensity received and later air and soil temperature and high humidity. Microclimate conditions are an important factor affecting decomposer occurrence (Wang *et al*., 2010). The occurrence of decomposers is also affected by pH and water levels (Sulistiyanto *et al.*, 2005).

Most land use in Indonesia are shaped by conversion from natural forest. From 1990 to 2005, more than 40% of tropical rainforest in Sumatra and Kalimantan have experienced deforestation (Hansen *et al*., 2009), and only less than 30% of natural tropical rainforest in Sumatra (Margono *et al*., 2012). Indonesia had the highest deforestation level in 2012 (Margono *et al*., 2014). Deforestation di Sumatra occurred in Dharmasraya, West Sumatra. Deforestation was done to build palm oil plantation and settlement areas. Mutolib *et al.* (2017) demonstrated that forest conditions in Dharmasraya Production Forest Management Unit showed decrease of forest cover from 85% in 2000 to 18% in 2014 from a total of 32.000 ha. *Badan Pusat Statistik* (2018), land use changed from natural forest to palm oil plantation were high with an increase of 976.67 ha in 2017. Compared to event during 2014–2016, increases were still below 500 ha, respectively 214 ha; 408 ha; and 161.33 ha. Therefore, this research is important for the Regency of Dharmasraya to obtain decomposition rate and termites species in several land use area that experience deforestation.

MATERIALS AND METHODS

Research was conducted in the Regency of Dharmasraya, West Sumatra (0°47'07" S-1°41'56" S, 101°09'21'E'-101°54'27'E) with area coverage of 296.113 ha. Research was done at four land use types, natural forest, secondary forest, palm oil plantation, and settlement area. Four land use areas were chosen in different districts, namely Pulau Punjung, Koto Baru, Timpeh, and Sungai Rumbai. Each district was used as a replications and each replication was turned into 5 subplots. Each subplot was installed 3 wood baits resulting in a total of 240 wood baits.

Measurement of decomposition rates by termites were done in different land use types by following a wood bait approach as done by Kadarsah (2005) with modifications. Wood

bait were made of pines (*Pinus merkusii*) with the size 1.9 cm × 1.9 cm × 25 cm. Before installed, wood baits were air dried for seven days, weighted to obtain initial weight and oven at 80°C to obtain dry wood weight and water content.

Wood baits were buried 20 cm deep and maintained 5 cm of baits above soil. Distance between wood baits within each subplots were ±2 m. Observation of wood samples were done 4, 8, and 12 weeks after installment. Wood decomposition of termites can be observed based on the activity of worker and soldier termites on buried wood baits. All wood baits were collected to measure water content and weight. Besides measuring decomposition rate, quantitative measurement of the environment, such as temperature, cover, and pH surrounding word baits were done in each land use type.

Data analysis was done by calculating:

Decomposition rate of wood baits by termites in each land use types were done by following formulas from Dendy and Harris (1976) following the formula below with modification:

$$\text{Wood decomposition rate by termites(g/observation time)} = \frac{\Sigma\,(DW_0 - DW_t)}{\text{observation time}}$$

DW_0 = dry weight at the beginning

DW_t = dry weight at the end

Decomposition rates at each land use type were then compared using an ANOVA at $\alpha = 0.01$.

Ability of termite species to decompose wood baits at each land use type:

$$\text{Decomposition of wood bait by specific termite species} = \frac{\Sigma\,DWTo}{\Sigma\,DWTt}\ x\ 100\%$$

DWT_0 = Dry weight of wood decomposed by specific termite species at the beginning

DWT_t = Dry weight of wood decomposed by specific termite species at the end

Wood baits from this study were brought to the lab for termite identification. Termites were placed into vials with 70% alcohol and labelled and identified to morphospecies using determination keys of Ahmad (1958), Tho (1992), and Syaukani (2006).

RESULTS AND DISCUSSIONS

Results from the ANOVA showed no significant differences of termite decomposition between different land use types. The F-value and P-*value* were $F_{3,12}$ =1.132, P= 0.3754. Observation of consumption rates of wood baits at different periods are shown in Figure 1.

Figure 1 shows that the highest termite consumptions occurred in forest plantations followed by natural forests, settlement, and the lowest occurred at the palm oil plantation. Natural and secondary forest are both land use with canopies that covers soil surface creating a microhabitat with maintained humidity (Donovan *et al*. 2001); thus, increasing termite decomposing activities (Plowman, 2012).

Canopy covers, such as in natural and secondary forests, affect soil microhabitats. Stable soil microclimates increase micro fauna, such as termites, by supporting termites lives with providing food source and stable habitat conditions (Nandika *et al*., 2015). Figure 1 showed that wood decomposition did not occur in natural and secondary forest at week 4. This indicates that the forest habitat contained enough food and created a stable habitat. At week 8, an increase of average wood decomposition by termites was found on all land use types, except palm oil plantation that experience decrease of wood decomposition by termites.

At week 12, average wood decomposition by termites in natural and secondary forest were still higher compared to palm oil plantation and settlement. Forest conditions had many living and dead tree that affect termites. As explained by Eggleton (2000), termites are able to explore even dead tree branches and live within them causing termites to have high decomposition ability.

Termite from wood baits placed in land use type were identified as five species, namely *Pericapritermes* sp.1, *Microtermes* sp.1, *Schedorhinotermes* sp.1, *Macrotermes gilvus,* and *Coptotermes curvignathus. Pericapritermes* sp.1 had the highest percentage of wood bait decomposition (Figure 2). *Pericapritermes* is a termite that feeds on humus, leftover rotten wood, and clay (Pribadi, 2009). Therefore, termites of this species are often found in natural and secondary forest due to the high content of humus and rotten wood.

Consumption of wood bait by *Schedorhinotermes* sp. is affected by physical and chemical characteristic of used pine wood. Results showed that weight loss and consumption of wood baits by *Schedorhinotermes* sp.1 was the highest. High wood bait consumption was caused by low natural durability of pine wood. This is caused of low extractive compound in this wood. Meanwhile, pine wood also has low density. This is supported that pine wood is a wood type with IV durability and III strength (Martawijaya *et al.*, 2005; Pandit & Kurniawan, 2008). *Schedorhinotermes* sp. have large population sizes (Kutana, 2021), and have high exploration area (Nandika *et al.*, 2015).

Termite decomposing activities are affected by environmental factors, such as temperature, cover, and pH. Results demonstrated that lower temperature at certain land use was supported by high canopy cover and low pH, causing higher decomposition rates by termites (Table 1). This was consistent with research by Jones *et al.* (2003), stating that change in land use from undisturbed to disturbed forests will increase soil pH levels and affect the decomposing activity of termites.

CONCLUSION

Deforestation in Dharmasraya West Sumatra affected the decrease of wood decomposition. Five termite species were identified: *Pericapritermes* sp.1, *Microtermes* sp.1, *Schedorhinotermes* sp.1, *Macrotermes gilvus*, and *Coptotermes curvignathus.*

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APPENDIX

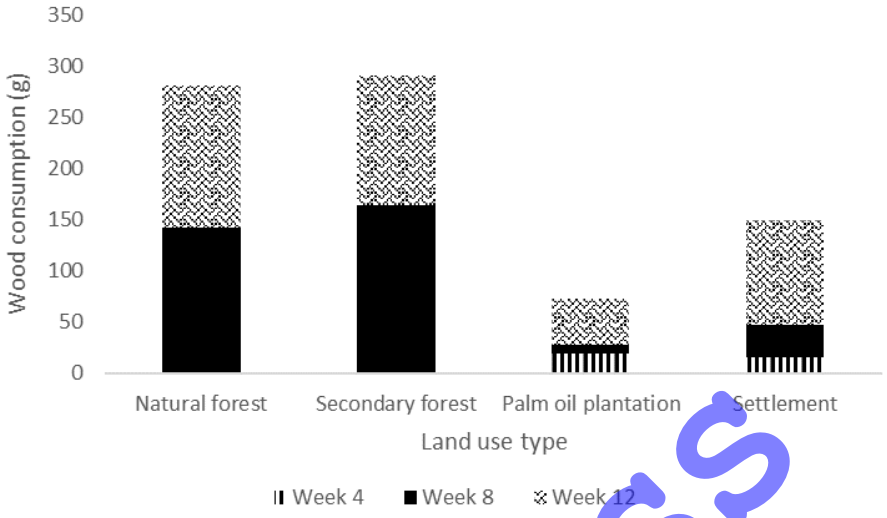

Figure 1. Wood consumption by termites at different observation periods

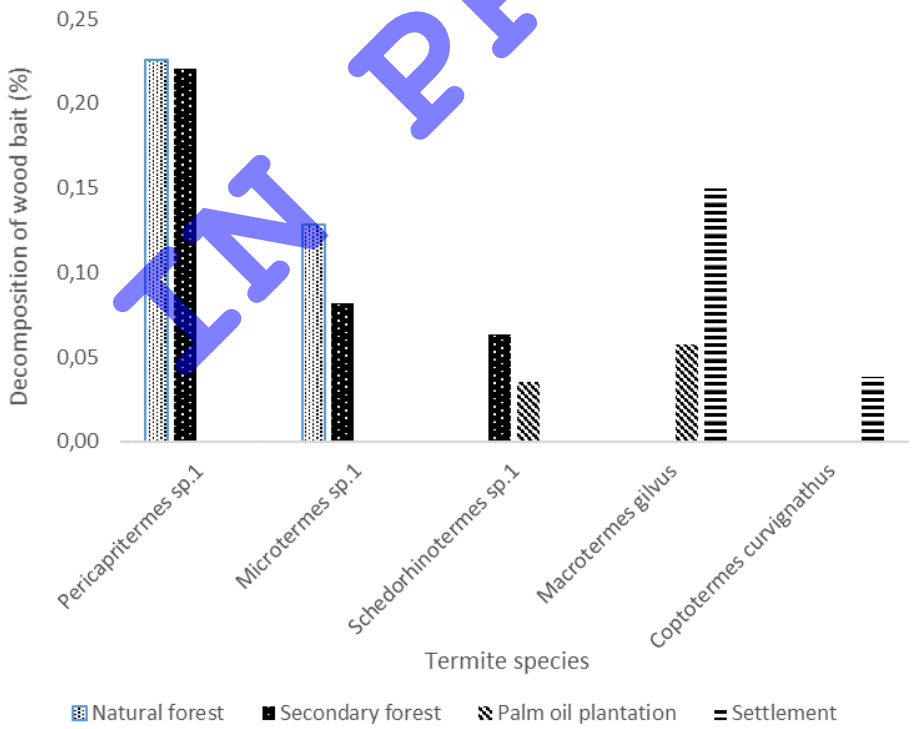

Figure 2. Percentage of decomposition on wood baits of termites in different land use

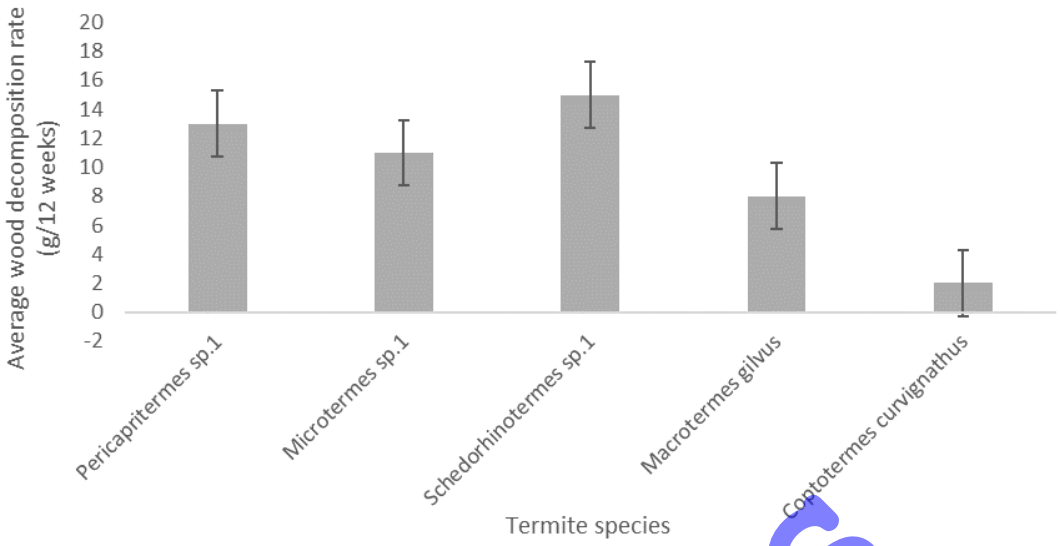

Figure 3. Mean decomposition rate of each termite species found on wood baits

Table 1. Mean of environmental parameters

Parameter	Natural forest	Secondary forest	Palm oil plantation	Settlement
Temperature (°C)	21.8	25.3	26.2	28.6
Cover (%)	95.2	90.7	73.3	47.11
pH	6.15	6.52	6.7	6.8