

Diversity, density and distribution of termites in housing complexes in Purwokerto, Central Java, Indonesia

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Abstract. Pratikno H, Haryanto T, Apriyanto DN. 2020. Diversity, density, and distribution of termites in housing complexes in Purwokerto City, Central Java Indonesia. *Biodiversitas* 21: 5729-5735. Termite attacks have detrimental effects on buildings and incur considerable costs. The rapid development of housing complex in Purwokerto City, Central Java Province, Indonesia urges an investigation on the occurrence of termite attacks. This research aimed to identify the diversity of termite species, its spatial distribution and its density on a variety of wood on housing complexes in Purwokerto City and the surrounding areas. The context of this study focused on wood species commonly used by the developers, namely albasia (*Paraserianthes falcataria*), which is commonly used for the upper ceiling, bangkirai (*Shorea laevifolia*) for poles and door/window frames, and teak (*Tectona grandis*) which is often used for door and window boards. We used bait techniques with the rationale that it is cheap and environmentally friendly as well as accurate. Four housing complexes in four subdistricts were randomly selected stratified based on four altitude ranges (<100 m, 100 m, 200 m, and 300 m). In each selected housing complex wood baits of three durability types (i.e. albasia, bangkirai and teak) were installed, each measuring 30 cm x 2 cm x 2 cm with five replications. Data of termite species, spatial distribution of termite species, and individual density in each housing complex were recorded after three months since the wood baits were stockpiled. Microclimate variables during the study were also recorded. The differences in density across housing complexes and the three types of wood were tested using ANOVA and continued with Duncan's test. The results showed three species of termites attacked wood baits, namely *Microtermes insperatus*, *Macrotermes gilvus*, and *Odontotermes javanicus*, all belong subterranean termite group. *M. insperatus* and *O. javanicus* had specific spatial distribution without overlapping zone among the two, while *M. gilvus* was the most adaptable and widely distributed in all housing complexes (<100-300 m asl.) regardless of the durable quality of the wood. There was significant difference in termite attacks across housing complexes with Ketapang housing complex in Sokaraja Subdistrict (<100 m asl.) was most frequently attacked. Conversely, there were no significant differences in termite attacks across the three types of wood (i.e. albasia, bangkirai, and teak).

Keywords: Altitude, settlement, termites, wood durable quality

INTRODUCTION

Termites are a group of insects that cause significant harm by destroying buildings. Drywood and subterranean termites are the most destructive insect pests of wood causing more than US\$ 1.7 million damage each year in the United States (Aludairo et al. 2016) and Japan are around 800 million US\$ a year, respectively (Verma et al. 2009). In Europe, the losses caused by termites are estimated at 313 million US\$ per year (Eggleton 2000). Economic losses due to termite in India have been estimated at around 35.12 million US\$ (Joshi et al. 2005). The global economic impact of termite pests is estimated to be at least US\$40 billion (Rust and Su 2012). In Southeast Asia region, the damages caused by termite attacks on various facilities reach US\$ 10 million per year. Such as in Malaysia 8 million US\$ is spent toward termite treatment every year (Lee 2002). In Indonesia itself, the damage to buildings caused by termite attacks in year 2000 was up to US\$ 2.67 million. Particularly in housing development sector in Indonesia, losses due to termite infestation contribute to 12.5% of the total housing development costs each year (Rachmawati, 2016). For example, in Banyumas District, Central Java Province, the number of public housing in

rural areas suffering damage from termite attacks reached 86.25% (Wahyuni et al. 2000). Such problem causes a heavy burden for the rural communities, most of whom still use wooden houses and semi-permanent houses with the primary construction material dominated by wood.

As social insects, termites have a division of caste and work. The castes work together to accomplish specific and complementary tasks within a colony. Division of labor among castes is the key to efficient colony development, survival, and reproduction (Haifig et al. 2016). The higher the number of worker castes that attack a location, the greater the size of the termite colony of that species. Instinctively, each termite colony is bound and held together by a social pheromone produced by the termite queen and propagated by and to members of the working caste through the behavior of feeding each other (trophallaxis) (Nandika et al. 2003). Based on this social pheromone odor, a colony of termites within one species recognizes each other and physically develops a separate colony from other territories of different species. Then separately, termite communities from various species attack wood material to obtain cellulose and obtain the right conditions to grow the termitomycetes group of fungi as a protein source.

Purwokerto City, as the center of government for Banyumas District, Central Java Province, Indonesia and the surrounding areas have very rapid development of residential housing complexes. Such complexes have mostly developed on previously irrigated rice fields that were converted into human settlements, expanding from Baturaden Subdistrict on the southern slope of Mount Slamet (300 m asl.) to Banyumas old town area (<100 m asl.). Various models and sizes of housing complex have been developed, from cluster model consisting of only a few housing units to a large housing complex such as Perumnas (a project run by government). In general, the building construction utilizes a mixture of low, medium, and high quality wood, including albasia (*Paraserianthes falcataria* syn. *Albizia falcataria*), bangkirai (*Shorea laevifolia*), and teak (*Tectona grandis*). Despite the rapid development of human settlements in Purwokerto City and Banyumas District, a study suggested that 20% of such housing development were attacked by termite's infestations (Wahyuni et al. 2000).

The high level of termite infestation in Purwokerto City and the surroundings is likely caused by several factors, including climate, wood quality and environmental sanitation. The climate of Purwokerto City and the surroundings is classified as B2-C2, which is characterized by very high rainfall (2456-3895 mm per year), and average daily temperature of 25.4°C, and average relative humidity of 75% (Oldeman 1978). These climate conditions are very suitable to support termite life. Cao and Su (2015) stated that temperatures of 20-34°C and air humidity of 80-95% are the optimal climates for the development of termites colony. Rao et al. (2012) found significant correlation between air temperature and the occurrence of two genera from Termitinae sub-family, one of them is the genus of Macrotermes that relatively more dominant at higher temperature. This fact indicates that stable air temperature and humidity on certain range is potential to support Macrotermitinae subfamily of Termitidae Family (Grieco et al. 2009).

The quality of wood used in the construction of housing complexes also plays an essential role in the emergence of termite attack. There are three grades of wood durability against termite attack: i.e. low, medium, and high. Group of wood with high cellulose content and low lignin extractive substances, such as *P. falcataria* is more preferable for termite attacks. On the other hand, group of wood with a balanced content of cellulose and lignin, such as *S. laevifolia* has moderate durability, while high durable wood is characterized by low cellulose content but very high lignin, such as *T. grandis*. Albasia wood is classified as low durable grade (class 5) with a specific gravity of 0.33. Its wood is easily weathered, so termites and fungi quickly attack it due to high content of cellulose with very low lignin and pentosan content. The preference for greater cellulose concentrations could be adaptive for termites and their symbionts. Food with higher concentrations of cellulose is probably more digestible for termites (Judd and Corbin, 2009). This type of wood is classified as sapwood and it has lower durability than terrace wood (Tobing, 1977). *S. laevifolia* wood is medium durable grade with a

specific gravity of 0.91 with high content of lignin compounds. Its terrace wood is darker due to its high extractive lignin concentration and is more resistant to termite attack (Haygreen and Bowyer 1996). Conversely, wood with higher concentration of lignin is not easily digested by termites (Waller and La Fage 1990). The high durable grade wood, such as *T. grandis*, has high strength since it is composed of 47.5% cellulose, 30% lignin, 14.5% pentosan, and tectoquinone (2-methyl anthraquinone) and terpenes (Fengel and Wegener 1984).

Environmental sanitation factors when developing housing complexes are also crucial in influencing termites occurrence. The application of termiticide treatment on the soil during the pre-construction period can reduce the risk of termites infestation (Nandika et al. (2003). In addition, wood wastes piled around the building can invite termites, suggesting that proper management of wood materials and wastes is important to avoid termites' emergence.

So far, research on the damages caused by termite attacks, specifically in the housing sector built by developers in Purwokerto and Banyumas region, has never been carried out. This research aimed to identify the species of termite, its spatial distribution, and its density on a variety of wood on housing complexes in Purwokerto City and the surroundings.

The context of this study focused on wood species commonly used by the developers, namely *P. falcataria* (albasia), which is commonly used for the upper ceiling, *S. laevifolia* (bangkirai) for poles and door/window frames, and *T. grandis* (teak) which is often used for door and window boards.

MATERIALS AND METHODS

Study period and area

The research was conducted from February 2020 to May 2020, in Purwokerto City and the surrounding areas of Banyumas District, Central Java Province, Indonesia (Figure 1). It is located at E 90°17'20"-90°18'40" and S 7°10' and 7° 30' and altitude between <100 m-300 m asl. The air temperature is 24.4-32.9°C with relative humidity of 60-85%, annual rainfall of 2000-4000 mm per year. The soil type is gray alluvial with brown latosol-regosol association.

Data collection

The research used a survey method with stratified random sampling technique. The study areas (Purwokerto City and surroundings) were stratified into four subdistricts based on altitude (<100 m, 100 m, 200 m, and 300 m). In each subdistrict, one housing complex was selected randomly. Each selected housing complex, was randomized five locations were then selected as replications. Sampling area is shown in Table 1.

Data analysis

The differences in termite density attacked the logs and housing complexes were analyzed using ANOVA model II at confidence level of 95% and 99%. If there was significant or very significant difference, the Duncan test was then conducted to determine where the difference. SPSS program was used for the statistical tests.

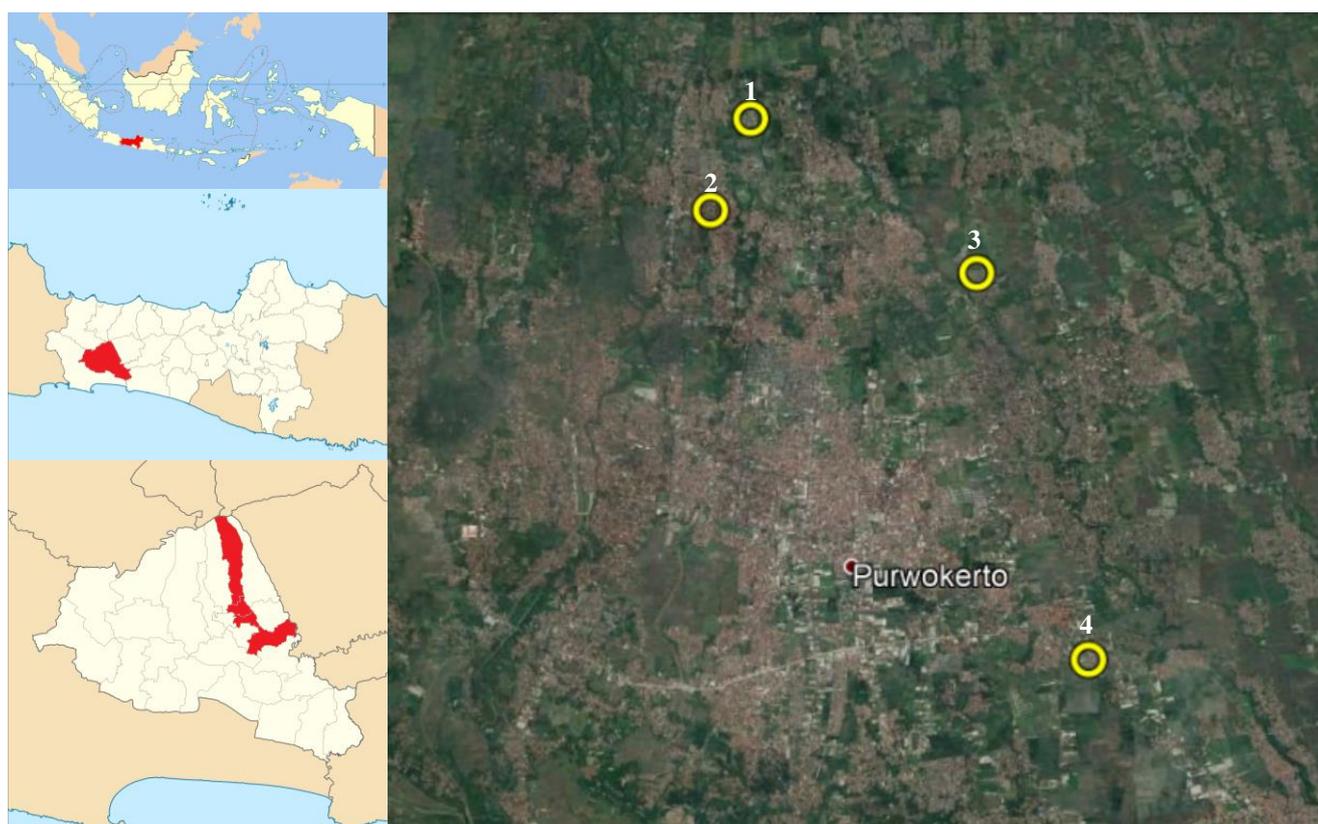


Figure 1. Area sampling of termites in Purwokerto City and surrounding areas, Central Java, Indonesia. No. of location refer to Table 1.

Table 1. Area sampling of housing complexes and the characteristic

No.	Name of housing complex	Subdistrict-distance from Mount Slamet crater	Area Size	Altitudes	Year of built	Typical size of house (m ²)	Daily average of abiotic variable
1	Langen Estate	Baturaden; 3 km	20 ha	300 m asl.	2005	36; 45, 54 and 70	30°C; 80%; 13 lux
2	Sumampir Indah	North Purwokerto; 5km	25 ha	200 m asl.	2000	36; 45, 54 and 70	31°C; 75%; 14 lux
3	Shapphire Estate	East Purwokerto; 6 km	30 ha	100 m asl.	2003	36; 45, 54 and 70	32°C; 70%; 15 lux
4	Ketapang Indah	Sokaraja; 20 km	25 ha	75 m asl.	1999	36; 45, 54 and 70	33°C; 65%; 16 lux

RESULTS AND DISCUSSION

This study found three subterranean termites in the studied area, namely *Odontotermes javanicus*, *Microtermes insperatus*, and *Macrotermes gilvus* (Figure 2). These three species belong to the subfamily Macrotermitinae of the Termitidae family. Species *M. gilvus* and *O. javanicus* were found et all (four) housing complexes, while *M. insperatus* was found in two housing complexes. The main characteristic of these three species is that they build a wandering canal that connects the nest location with the attacked site. The wandering canal is made with the substrate around the attacked site. In soil habitats, the protective walls of the wandering canal are made of soil, but in the karst habitats, the protective walls are built from karst material (Pratiknyo and Setyowati 2020). Nandika et al. (2003) stated that living subterranean termites are always in contact with the soil, although their attacked site is above the ground (arboreal).

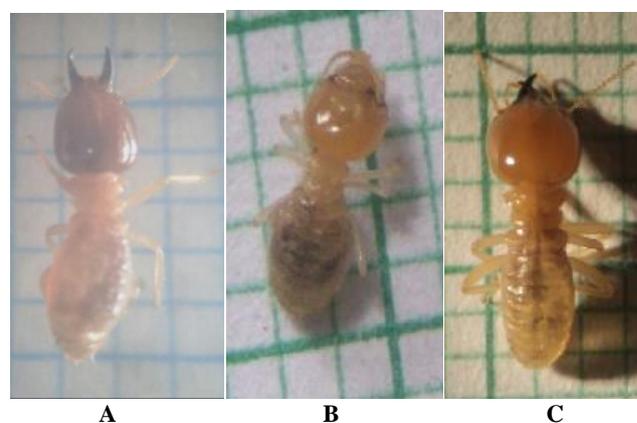


Figure 2. A. *Odontotermes javanicus*, B. *Microtermes insperatus*, C. *Macrotermes gilvus*

The presence of termites from the Termitidae family is not surprising because the Termitidae family has an extensive distribution, even reaching an altitude of 3000 m. According to Nandika et al. (2003), the Termitidae is family with the highest number of members, and about 85% of the termite species identified belongs to the Termitidae family. In the tropics, termites are found from the coast to an altitude of 3000 m asl. with a narrow spatial distribution between latitudinal 5° N and 5° S. These three species of subterranean termites are high-level groups. Apart from consuming wood, they also consume Termitomycetes fungi as a source of protein. Bignel and Eggleton (2011) state that there are four categories of termites, namely wood-eating or low-level, fungi-eating or high levels, eating rotten organic substances, and eating pure soil.

The abundance of *M. gilvus* was the highest with 1100 individuals followed by *O. javanicus* with 234 individuals and *M. insperatus* with 174 individuals (Table 2). The exciting thing about this finding was the individual abundance of *M. gilvus* was inversely proportional to the increase in the housing complex's altitudes, where the abundance of *M. gilvus* getting lower with the increasing altitude. This is in line with Inoue et al. (2006) that stated the Macrotermitinae sub-family decreases in abundance with the increasing altitudinal elevation. In this case, Gathorny-Hardy et al. (2001) explained that every 100 m increase, air temperature will reduce about 1°C, thus affecting the metabolic activity of termites as poikilothermic fauna. This fact suggests that *M. gilvus* species is not adaptive to air temperature changes, humidity, and light intensity due to altitude elevation.

Our study found that termites' attacks varied across housing complexes, positions and types of logs (Table 3). In addition, the spatial distribution of termite attacks in each log showed no overlapping distribution, suggesting that each log was attacked by one termite species (Table 4).

The spatial distribution of *M. insperatus* was broader, which were found in two housing complexes, while *O. javanicus* was only found in one housing complex.

The species *O. javanicus* only attacked in Ketapang-4 in subdistrict Sokaraja, which geographically is the lowest elevation (<100 m asl.), and attacked all three wood species. It was supposed that *O. javanicus* developed well in Ketapang-4 because the temperature of 33°C was ideal for the development of their colony. This activity suggests that *O. javanicus* is an opportunistic social insect. The colony did not distinguish the wood grade, either the low grade (*P. falcataria*) and the high grade (*T. grandis*). This ability is supported by the strong-giant mandible and big size of the body they have. On the other hand, *M. insperatus* attacks were found in Langen housing complex 1 (Langen 1) and Sumampir housing complex 2 (Sumampir-2) with the higher altitude (200 and 300 m asl.), and only attacked the low and medium qualities wood. The small body size supports the habits of consuming low and medium durable quality wood. Taxonomically, these three species belong to the Subfamily Termitinae but they have different optimal temperatures and humidity according to their metabolic needs.

The local microclimate (air temperature, relative humidity and sunlight intensity) in Ketapang housing complex 4 (Ketapang-4) (33°C/65%/16 lux, alt < 100 m) was different to Langen-1 (30°C/80%/13 lux, alt = 300 m asl.), Sumampir-2 (31°C/75%/14 lux, alt =200 m asl.) and Shapphore housing complex 3 (Shapphore-3) (32°C/70%/15 lux alt = 100 m asl.). This means that *O. javanicus* prefers local microclimate with higher temperature, lower humidity, and brighter sunlight. Likely *M. gilvus* is the most adaptable on various conditions, their colony developed better at higher temperature and lower relative humidity, similar to *O. javanicus*. But, the colony of *M. gilvus* also developed well in lower temperature and higher humidity and less sunlight of Ketapang-4.

Table 2. The individual abundance of species across housing complexes

Species	Langen-1	Sumampir-2	Shapphore-3	Ketapang-4	Total abundance
<i>M. gilvus</i>	167	242	264	427	1100
<i>M. insperatus</i>	86	88	0	0	174
<i>O. javanicus</i>	0	0	0	234	234

Table 3. The density of termites across housing complexes, positions and type of log

Site	Langen-1			Sumampir-2			Shapphore-3			Ketapang-4		
	A	B	C	A	B	C	A	B	C	A	B	C
Location 1	0	0	0	65	0	0	0	0	0	130	0	60
Location 2	0	0	0	72	0	0	126	15	27	97	15	34
Location 3	97	0	0	0	16	0	96	0	0	115	10	40
Location 4	0	25	0	0	31	26	0	0	0	139	21	0
Location 5	86	0	45	81	0	39	0	0	0	0	0	0
Density per logs (individu)	183	25	45	218	47	65	222	15	27	481	46	134
Density (individu)	253			330			264			661		

Note: A: *P. falcataria*, B: *S. laevifolia*, C: *T. grandis*

Table 4. Spatial distribution of termite attacks across species, types of log, and housing complexes

Site	Langen-1			Sumampir-2			Shapphire-3			Ketapang-4		
	A	B	C	A	B	C	A	B	C	A	B	C
Location 1	0	0	0	Mg	0	0	0	0	0	Mg	0	Mg
Location 2	0	0	0	Mg	0	0	Mg	Mg	Mg	Mg	Mg	Oj
Location 3	Mg	0	0	0	Mi	0	Mg	0	0	Mg	Mg	Oj
Location 4	0	Mg	0	0	Mg	0	0	0	0	Oj	Oj	0
Location 5	Mi	0	Mg	0	Mg	0	0	0	0	0	0	0

Note: A: *P. falcata*, B: *S. laevifolia*, C: *T. grandis*; Mg: *M. gilvus*, Mi: *M. insperatus*, Oj: *O. javanicus*, 0: no termites found

These results are in line with statement of Gathorny-Hardi et al. (2001) that stated the Macrothermitinae subfamily prefers to hotter air temperatures, and the abundance decreases with the increasing altitude. Another assumption that *M. gilvus* and *O. javanicus* prefer high air temperature with low humidity is these factors can support the growth of Termitomyces fungi group. According to Korb and Linsmeier et al. (1978), Termitomyces group grows well at high temperatures and low humidity. On the other hand, *M. insperatus* prefers microclimate with lower air temperature and higher relative humidity.

Another exciting thing was no low-level wood termites, *Schedorhinotermes javanicus*, found in the studied area. Pratiknyo et al. (2018) found *S. javanicus* as the dominant species on the south slope of production forest area of Mount Slamet, which is only 5 km from the location of Langen-1. It supposed, the differences in altitude (700 m-1300 m) with air temperature (18°C) and relative humidity (90%) is an ideal place for *S. javanicus* species, which were not found in housing complex conditions. Bignel and Eggleton (2011) stated that air temperature and humidity are the main limiting factors for termite life in tropical soil. These findings suggest that the termites attacked the housing complexes in Purwokerto City and the surroundings belong to the group of high-level subterranean termites.

In terms of spatial distribution, there was specificity in termite community where *M. insperatus* was distributed in two housing complexes in Baturaden and North Purwokerto Subdistrict with upper altitude (200 and 300 m asl.) or closer (5 km) to Mount Slamet. On the other hand, *O. javanicus* dominated Ketapang-4 in Sokaraja Subdistrict which has the lowest-altitude (<100 m) or away (20 km) from Mount Slamet. Between *M. insperatus* and *O. javanicus*, there was no spatial distribution similarity (housing complex) and never overlap in the single housing complex. It was suspected that the difference in spatial distribution was caused by the presence of social pheromones that bind worker caste termites in one colony. The social pheromones in termites have function to unite the worker caste into one colony (Borror et al. 2016). It was also stated by Nandika et al. (2003) that the behavior of feeding each other (trophallaxis) in the working caste is a social pheromone transfer medium aimed to unify the colony and renew the digestive bacteria that produce cellulase enzymes. The second cause is there were different microclimate requirements for developing colonies. This was in line with Palin et al. (2017) statement that in the tropic, the adaptation ability of several termite species to microclimate factors, especially altitude, is very narrow. In contrast, *M. gilvus* had the broadest spatial distribution,

occurring in all housing complexes studied in four subdistricts (Sokaraja, East Purwokerto, North Purwokerto, and Baturaden) with altitude from < 100 m asl. to 300 m asl. This indicates that *M. gilvus* has a relatively wider microclimate range requirement than the other two species.

The results of spatial distribution of termites in this study are in line with several previous studies. According to Tarumengkeng et al. (1971), termites from the genera of Macrotermes and Microtermes are often found simultaneously in one attacked site. This is because the two genera share similar characteristics, often associated with growing fungi and attacking habits. Macrotermes eat fungi at the base, whereas Microtermes eat fungi on top (Krishna and Weesner et al. 1970). In terms of attacks on wooden objects, Microtermes act as pioneers by opening wandering tunnels, only then followed by Macrotermes (Inoue et al. 1998).

In terms of termite attacks on three types of wood, the individual density of termites was statistically not significant (F tab > 0.05) (Table 5). This means that the termites are opportunistic, meaning that they did not see the quality of the wood grade, and all of the three woods were attacked. This finding is different from Martawijaya et al. (1979) which stated that *S. laevifolia* wood has a durable quality up to 5 years (grade 2) and is not attacked by termites. Fengel and Wagener (1984) also said that grade 1-2 wood has high extractive substances, namely agrolesin and pterocarpin. It also contains eusiderin, catechin, and β sitosterol (Syafii et al. 1985). On the other hand, *P. falcata* is classified as grade 5, which is susceptible to termites. However, since the individual density termites attacked the wood did not differ significantly, it indicates that such termites did not prefer certain wood.

The rationales on the indifference in individual density of termites across the qualities of wood include: first, the extractive substance provided by the wood bait was relatively low and mostly water-soluble. Hoarding wood in the ground for one month allowed water to seep into the wood, making the extractive substance drop, consequently, termites' smell detection organ did not work well. Febriansyah et al. (2019) stated that the extractive substance of wood is one factor of repellent for attacking termites. Second, there are opportunistic habits of all termite colonies to utilize the limited cellulose immediately. Worker termites in a colony worked hard in finding cellulose sources and didn't care the distance of 1 m for the possibility of finding lower quality wood grade. As the main target for termite feed, cellulose will soon be isolated by the colony and immediately explore to benefit colony development.

Table 5. The Anova results on the individual density of termites across housing complexes and types of wood

Source of variance	Sum of square	df	Middle of square	Fcal	Signification
Housings	5.908	3	1.969	4.488	0.007**
Type of woods	0.703	2	0.351	0.801	0.455 ^{ns}
Replication	5.135	4	1.284	-	-
Error	21.904	50	0.439	-	-
Total	48.212	59	-	-	-

The significant difference in individual density of termite attacks across housing complexes ($F_{tab} \leq 0.05$) (Table 5) could be explained that there was a clear spatial distribution between the species. For example, *M. insperatus* prefers higher altitude, with lower temperature and higher humidity, while *O. javanicus* prefers lower altitude, with higher temperature and lower humidity. On the other hand, *M. gilvus* was very adaptive across varying altitudes, ranging from < 100 m asl. until 300 m asl. The accumulation of species density of *M. gilvus* and *O. javanicus* in Ketapang-4 makes the total density of the attacking termites was greater than both the accumulation between species density of *M. gilvus* and *M. insperatus* in Langen housing complexes 1 and Sumampir-2, or single species density of *M. gilvus* in Shapphire-3.

Duncan's continued test (Table 6) shows that Ketapang-4 in Sokaraja Subdistrict is the only housing denser of termites individual than the three others (Langen-1 in Baturaden Subdistrict, Sumampir-2 subdistrict of North Purwokerto and Shapphire-3) subdistrict of East Purwokerto. It is assumed that Ketapang-4 has more suitable microclimate factors for the needs of termites. Ketapang-4 has the longest distance (20 km) from the forest in Mount Slamet, which was blocked by the city of Purwokerto. The effect of Mount Slamet on the number of rainy days per month in the Banyumas Regency is very different. Areas at the foot of the mountain, such as Baturaden, North Purwokerto, and East Purwokerto Subdistricts, have 25-30 rainy days per month in the rainy season, which was higher than the areas in the lower altitude, such as South Purwokerto, West Purwokerto, and Sokaraja Subdistricts with 20-25 rainy days per month. As a result, the air temperature can reach > 33°C with the lowest relative humidity, about 65%, and the sunlight intensity of 16 lux. This condition is constant throughout the year, so it is very suitable for the Termitomycetes fungus to grow. Ketapang-4 is drier and hotter which is ideal for the *O. javanicus*. Even, this species filled out four parts of 15 locations of the three durable wood quality grades, two of which were of high-quality durable grades, implying that Ketapang-4 conditions were very suitable for *O. javanicus*. Sumarni and Ismanto (1988) stated that *O. javanicus* is able to adapt to dry soil by wandering over the surface of the soil looking for sources of cellulose. *O. javanicus* was known as a termite that eats wood, bark and dead trees. In Ketapang-4, with relatively dry soil conditions (soil moisture 51.37%), termites were found around the bait wood at a depth of 20 cm.

Shapphire-3 is located in the eastern of Purwokerto City and was bordered by rice fields. There is a large river (Pelus river) in the western and located on the town's outskirts. It was geographically close (6 km) to Mount Slamet forest so that the air humidity was higher (70%) with air temperature of 32 °C and the sunlight intensity of 15 lux. In this microclimate, there were no *O. javanicus* or *M. insperatus* occurred, but *M. gilvus* showed a relatively high abundance, it could even occupy four parts of 15 positions without distinguishing the durable quality wood grade.

The phenomenon of the absence of *O. javanicus* and *M. insperatus* showed that the microclimate in the-3 was the limiting factor for these two species. Moist soil factor (soil moisture reaches 63%) and the absence of trees planted in Shapphire-3 were likely related to the absence of *O. javanicus*. However, further research is needed to prove it.

Sumampir-2 is located in the North Purwokerto Subdistrict (200 m asl.) with distance of 5 km from the forest of Mount Slamet and had a dense housing complex adjacent to other complexes. The number of rainy days reached 25-30 days per month in the rainy season, higher than that in Ketapang-4 in Sokaraja Subdistrict. It is located at an altitude of 200 m asl. and had an average daily temperature (30°C) and sunlight intensity (14 lux) lower than Ketapang-4. These microclimate conditions were favorable for *M. insperatus*. This species has wide distribution and is often found to attack wood together with *M. gilvus*. This species occupied one part of 15 positions. They selected only medium-durable wood grade, while *M. gilvus* still dominated, attacked 4 part of 15 positions of two durable quality wood grade although it decreased in abundance compared to housing complexes 3 and 4. As old housing complex (built in 2000), this complex had many trees with old age. Despite the potential to carry out joint attacks with *M. gilvus*, housing 2 did not find such an attack model, suggesting that there is no evidence of any association between termite species (interspecific competition).

Table 6. Duncan test of differences between housing complexes.

Housing complex	Number of samples	Subset	
		1	2
Ketapang-4	15	-0.0343	
Sumampir-2	15	0.542	
Shapphire-3	15	0.7141	
Langen-1	15	0.7472	

Langen-1 was a housing complex located at the highest altitude (300 m asl.), relatively young (built in 2013), surrounded by irrigated rice fields and not many large trees planted. Langen-1 is located on the northern edge of Purwokerto City, 5 km from the Mount Slamet Forest. The number of rainy days 25-30 days per month in the rainy season. In wet environment, the air relative humidity was 80%, and average daily temperature of 30°C, and a sunlight intensity of 13 lux. This microclimatic condition was a preference for *M. insperatus*.

Based on the spatial distribution and individual density, it can be stated that the most adaptive and highest species density of termites in housing complex in Purwokerto City and the surroundings was *M. gilvus*. Species *M. insperatus* had a lower individual density, but it was distributed wider than *O. javanicus*. Among the four housing complexes studied here, there was a significant difference in the individual density of termites attacks with the highest was occurred in Ketapang-4, in altitude < 100 m asl.

This research concludes that termite species that attacked housing complexes in the studied area belong to the group of subterranean termites. *M. insperatus* and *O. javanicus* have specific spatial distribution without overlapping zone among the two, while *M. gilvus* was the most adaptable and widely distributed in all housing complexes (<100-300 m asl.) without distinguishing the durable quality of the wood.

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