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Identification and Spatial Mapping of Termite Species Distribution in Oil Palm Plantations in Timpeh Subdistrict, Dharmasraya Regency, Indonesia

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ABSTRACT

Termites are one of the organisms that have the potential to reduce oil palm productivity, so it is necessary to identify the species and map their distribution to support more effective and sustainable management. This study was conducted to identify termite species and map their distribution in oil palm plantations in Timpeh District, Dharmasraya Regency, Indonesia. This study used a survey method with purposive sampling based on several criteria, including the presence of plant attack symptoms, air humidity ≥ 60%, the presence of rotten wood, the presence of termite nests, and the sampling location was selected in oil palm plantation areas located on the edge of local roads at a distance of about 0-15 meters. The termite samples obtained were identified morphologically using a microscope and identification keys. Termite distribution mapping was performed using ArcGIS 10.8 software, while the relationship between termite presence and environmental factors (temperature, light intensity, and humidity) was analyzed using Redundancy Analysis (RDA). The results showed that there were six termite species in Timpeh Subdistrict, namely *Macrotermes gilvus, Coptotermes curvignathus, Pericapritermes mohri, Dicuspiditermes nemorosus, Nasutitermes longinasus,* and *Termes propinquus.* The species *M. gilvus* has the widest distribution throughout the subdistrict and is not significantly influenced by environmental factors, but rather by its high adaptability. Meanwhile, the other species have a more limited distribution and tend to be influenced by factors such as humidity, light intensity, and the availability of organic material. The mapping results provide a crucial basis for determining priority areas for control and termite management strategies in oil palm plantations, enabling more effective and efficient approaches to be implemented.

Keywords: *C. curvignathus*, environmental, *M. gillvus*, morphologically.

INTRODUCTION

Palm oil is a leading agricultural commodity in Indonesia, with significant potential to produce a wide range of products, including cooking oil, margarine, candles, soap, body and beauty care products, and vehicle fuel. Timpeh Subdistrict has the largest plantation area and the highest palm oil production in Dharmasraya Regency. Based on data from the Badan Pusat Statistik Kabupaten Dharmasraya, 2022, in 2021, Timpeh District had the largest area of palm oil plantations, namely 7,303 ha, followed by Koto Besar District with 6,410 ha and Pulau Punjung District with 3,552 ha. In addition, Timpeh

Subdistrict had the highest palm oil production at 36,290 tons, followed by Koto Besar Subdistrict at 12,290 tons and Sitiung Subdistrict at 10,510 tons.

Timpeh District has the potential for oil palm plantation development, but one of the obstacles is termite infestation. Yulis et al. (2011) stated that termites infest up to 10.8% of oil palm plants. Nandika (2014) also reports that the frequency of termite attacks on oil palm plants, especially on peatlands, can reach 5%, or around 7-8 trees per hectare. Reports indicating that termites can damage oil palm plants underscore the importance of termite control.

Termite control efforts must begin with identification, as each species has different biological characteristics, behaviors, and levels of damage to oil palm trees. For example, *Coptotermes curvignathus* is recognized as the primary pest damaging oil palm plants (Nandika, 2014). With proper identification, it is possible to determine the species that genuinely have the potential to be major pests, allowing control measures to be more targeted and effective. Conversely, without accurate identification, control measures risk being ineffective and may disrupt the balance of the plantation ecosystem. Several termite species that have been successfully identified on oil palm plants include *Macrotermes gilvus, Coptotermes curvignathus* (Rafli et al., 2020; Savitri et al., 2016), *Dicuspiditermes nemorosus, Globitermes globosus, Heterotermes indicola, Pericapritermes mohri, Schedorhinotermes javanicus,* and *Schedorhinotermes longirostris* (Heriza, 2023).

In addition to termite identification, mapping their distribution is also important to identify palm oil plantation areas that are vulnerable to attack. Environmental factors such as temperature, humidity, and light intensity affect the distribution of termite colonies. With mapping, high-risk areas can be identified early, allowing management to plan accordingly. Mapping results provide a crucial basis for determining priority control areas, enabling more efficient use of labor, costs, and control materials. This information also helps palm oil farmers and companies in designing prevention and mitigation strategies, thereby reducing the potential for damage caused by termite attacks while maintaining the sustainability of plantation production.

To date, no research has specifically identified termite species and mapped their distribution in Timpeh Subdistrict. This information is crucial in supporting the management of productive and sustainable oil palm plantations. Therefore, this study was conducted to identify termite species and determine their spatial distribution and relationship with environmental factors in oil palm plantations in Timpeh District, Dharmasraya Regency.

METHODS

This research took the form of a survey with research procedures including preliminary surveys, sample point determination, sampling, sample identification, termite distribution mapping, and correlation analysis. The procedures are described in detail below.

Preliminary Survey

The preliminary survey aimed to gather information about the field conditions prior to the research. Information from the preliminary survey served as the basis for determining the methods to be employed. The preliminary survey was conducted by visiting the research location, namely Timpeh Subdistrict.

Sample Point Determination

The sampling points were determined using purposive sampling based on the following criteria: (1) symptoms of attack on oil palm plants; (2) locations with air humidity ≥ 60%; (3) presence of decayed wood; (4) discovery of termite nests; and (5) sampling locations were selected in oil palm plantations located on the edge of local roads at a distance of approximately 0-15 meters. The coordinates of sampling points that met the criteria were recorded in the Avenza application.

Sampling

The coordinates of the termite nests were recorded using Avenza and documented with a camera. Next, the termite nests were carefully dismantled with a small shovel or hoe so that the termites would not die. The samples taken were soldier termites and worker termites. The soldier caste was chosen for identification because it has the most distinct morphological characteristics that differentiate between termite species, as does the worker caste. The termites were then placed in collection bottles that had been previously filled with 70% alcohol. A total of 10 individuals were selected as backups in case of damage to the samples. The reproductive caste was not collected because the king and queen are located in a special chamber deep inside the central nest, making them very difficult to find. Another reason for not collecting the reproductive caste is that alates, which are also part of the reproductive caste, emerge only during the mating season and for a short period after rain and at night. Therefore, it is unlikely that alates will always be available at the sampling site.

Temperature, humidity, and light intensity also need to be recorded using a thermohygrometer and a luxmeter. These instruments are placed near the termite nest, ensuring that the sensors are not obstructed by grass, leaves, or other objects, thereby ensuring more accurate results. The instruments are left until the results appear on the panel screen. The data is collected before dismantling the termite nest.

Sample Identification

Termite samples from the field were identified at the Integrated Pest Management Laboratory of Andalas University, using a microscope. Termites were identified using several termite identification keys, including Ahmad (1958), Syaukani (2006), and Kallehwaraswamy et al. (2013). Termites were identified and grouped by species based on their morphological characteristics, including the head, mandibles, and entire body.

Worker termites have milky white bodies, no eyes, and no wings. Their bodies are soft, but they have hard mouthparts, which are adapted for chewing food. Soldier termites are characterized by their milky white bodies, soft bodies, and blindness. Soldier termites have larger heads and are darker in color. On the head of soldier termites are large, strong mandibles that function as fighting tools.

Termite Distribution Mapping

The identification data were used to compile a map of termite distribution at the research site. The map was created based on predetermined sampling points. The mapping was done using ArcGIS 10.8 software. The data used included attribute data such as termite species and the coordinates where termites were found. In addition to attribute data, spatial data such as subdistrict boundaries, village/neighborhood boundaries, and roads were also used and displayed in ArcGIS software, following the steps shown in Figure 1.

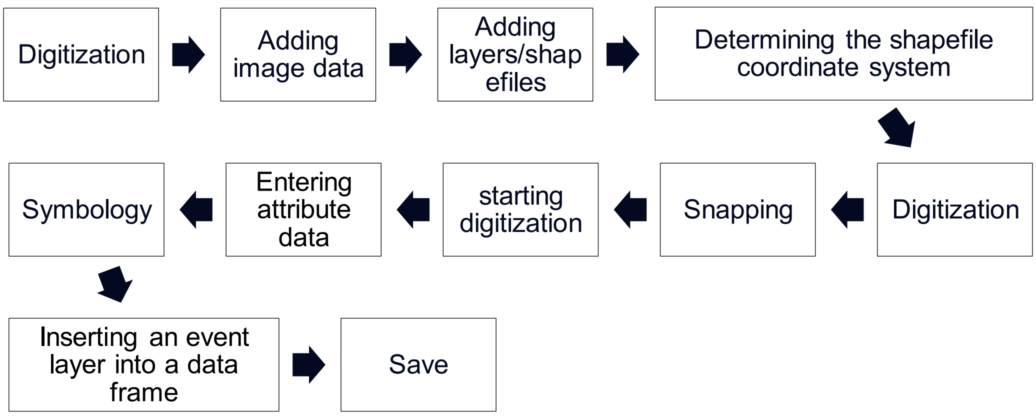

Figure 1. Steps for running the ArcGIS 10.8 program

Correlation Analysis

A correlation analysis was performed between the presence of termite species and environmental factors using Redundancy Analysis (RDA). This analysis aimed to describe the correlation between species distribution and environmental variables, including temperature, light intensity, and humidity. Species number data were used as the response variable, while temperature, light intensity, and humidity were used as explanatory variables. This analysis was performed using R software.

The RDA results were visualized in the form of a biplot. In the biplot, termite species were displayed as points, while environmental factors were represented by vectors (arrows). The position of species points relative to the direction of the vectors represented their level of correlation with environmental factors.

RESULTS AND DISCUSSION

Termite Species in Timpeh Subdistrict

The results of morphological identification of termite species show that there are six species of termites found, namely *Macrotermes gilvus, Pericaptitermes mohri, Nasutitermes longinasus, Termes propinquus, Coptotermes curvignathus,* and *Dicuspiditermes nemorosus.*

Macrotermes gilvus has a soldier caste with a reddish-brown head, sparse hair, a distinct fontanel located at the front of the head; antennae with 17 segments, the third segment one and a half times as long as the second segment; head length with mandibles 4.70–5.35 mm, without mandibles 3.30–3.50 mm; head width 2.66–3.00 mm; mesonotal and metanotal angles rounded and broad; pronotum length 1.15–1.20 mm, width 2.20–2.55 mm; mesonotum width 2.10–2.30 mm, metanotum width 2.20–2.40 mm. Workers have a reddish-brown head; oval-shaped ocelli; antennae with 19 segments, the third segment slightly longer than the second and fourth segments; head length to labrum tip 2.40-2.60 mm, without mandibles 1.87 mm, head width 2.00-2.44 mm; pronotum crescent-shaped, slightly concave at the rear; pronotum length 1.33-1.56 mm, width 2.36-2.60 mm.

Figure 2. Soldier caste of *Macrotermes gilvus*

Pericapritermes mohri has a soldier caste with a head bearing scattered hairs; antennae with 14 segments, the third segment nearly half as long as the fourth; the antero-lateral angle of the labrum is indistinct, does not form a narrow process, and is very short; the anterior margin of the labrum is slightly convex; the left mandible has a pointed tip; head length with mandibles 3.10–3.40 mm, without mandibles 1.80–2.00 mm, head width 1.10–1.25 mm; left mandible length 1.45 mm; pronotum length 0.30 mm, width 0.75–0.77 mm. Workers have the following characteristics: Head almost parallel behind the antennae; ocelli separated from the eyes; posterior margin of the postclypeus slightly convex; fontanel exceeding the posterior level of the eyes; head length 1.10–1.35 mm, head width 0.70–1.15 mm; pronotum length 0.40 mm, pronotum width 0.65–0.80 mm.

Figure 3. Soldier caste of *Pericapritermes mohri*

Nasutitermes longinasus has a soldier caste with a yellowish-brown head, covered with microscopic hairs; a long, cylindrical nose with many small hairs; antennae consisting of 13 segments, the third segment twice as long as the second segment, the fourth segment slightly shorter than the second segment; head length including nasus 1.80-2.10 mm, without nasus 1.20 mm, head width 0.70-1.05 mm. The worker caste exhibits the following characteristics: the head is yellowish-brown, with microscopic hairs; the antennae consist of 13 segments, with the second segment being twice as long as the third segment; the head length ranges from 1.10 to 1.40 mm; the pronotum length is 0.30-0.50 mm, and its width is 0.50-0.60 mm.

Figure 4. Soldier caste of *Nasutitermes longinasus*

Termes propinquus has a soldier caste. The head is cylindrical, light yellow in color; the antennae consist of 14 segments, the second segment twice as long as the third; the fourth is the shortest; head length with mandibles 1.90-2.00 mm, without mandibles 1.20 mm, head width 0.70 mm; the pronotum is 0.20 mm long and 0.40 mm wide. In the worker caste, the head is light yellow; the antennae consist of 14 segments, with the second segment being twice as long as the third segment. The head measures 0.60-0.80 mm in length and 0.60-0.70 mm in width.

Figure 5. Soldier caste of *Termes propinquus*

Coptotermes curvignathus has a brown soldier caste with a broad, flat oval head; antennae with 16 segments, the second segment slightly longer than the third; the labrum reaches the middle of the mandibles; head length with mandibles 2.10-2.40 mm, without mandibles 1.20-1.50 mm, head width 1.30-1.40 mm; pronotum clearly indented at the front and rear; pronotum length 0.40-0.50 mm, width 0.80-1.00 mm. In the worker caste, the head is pale yellow; the eyes are round; the ocelli are broad oval; the antennae have 22 segments; the head is 1.30-1.60 mm long, 1.50-1.60 mm wide; the pronotum length is 0.70–0.80 mm, the width is 0.90–1.20 mm.

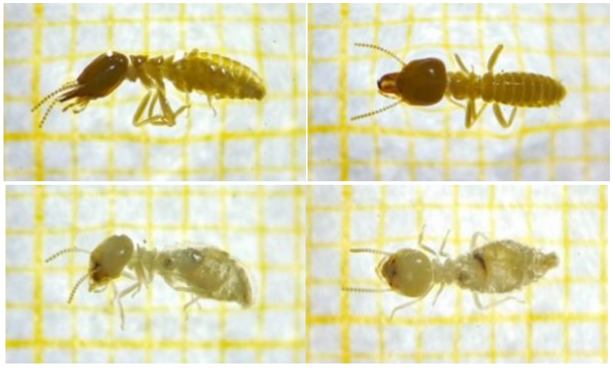

Figure 6. Soldier caste of *Coptotermes curvignathus*

Dicuspiditermes nemorosus has the following characteristics: the antero-lateral angle of the head is protruding; the right mandible is strongly curved at the base; head width 1.00-1.10 mm; antennae 13-14 segments; head length with mandibles 3.00-3.20 mm; head length without mandibles 1.50-1.70 mm. In the worker caste, the head is slightly oval in shape; the antennae consist of 14 segments; the second segment is twice as long as the third segment; head length 0.90–1.10 mm, head width 0.80–1.00 mm.

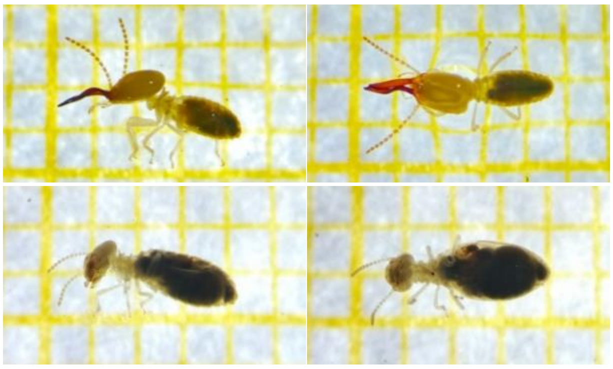

Figure 7. Soldier caste of *Dicuspiditermes nemorosus*

Mapping the Distribution of Termite Species in Timpeh Subdistrict

The mapping results, generated using the ArcGIS application, display the visual distribution of termites. Each termite sample point is marked with a pin symbol in different colors. Macrotermes gilvus is marked in purple, Coptotermes curvignathus in red, Pericapritermes mohri in green, Dicuspiditermes nemorosus in pink, Nasutitermes longinasus in blue, and Termes propinquus in orange (Figure 8).

Macrotermes gilvus is distributed throughout the Timpeh District. Its nests are shaped like mounds of soil or attached to oil palm trees. The nests of *M. gilvus* that have been found are tough to dismantle. According to Nandika (2014), *M. gilvus* constructs dome-shaped nests or small mounds above ground level. These nests have a strong structure because they are composed of a mixture of clay, sand, and dust.

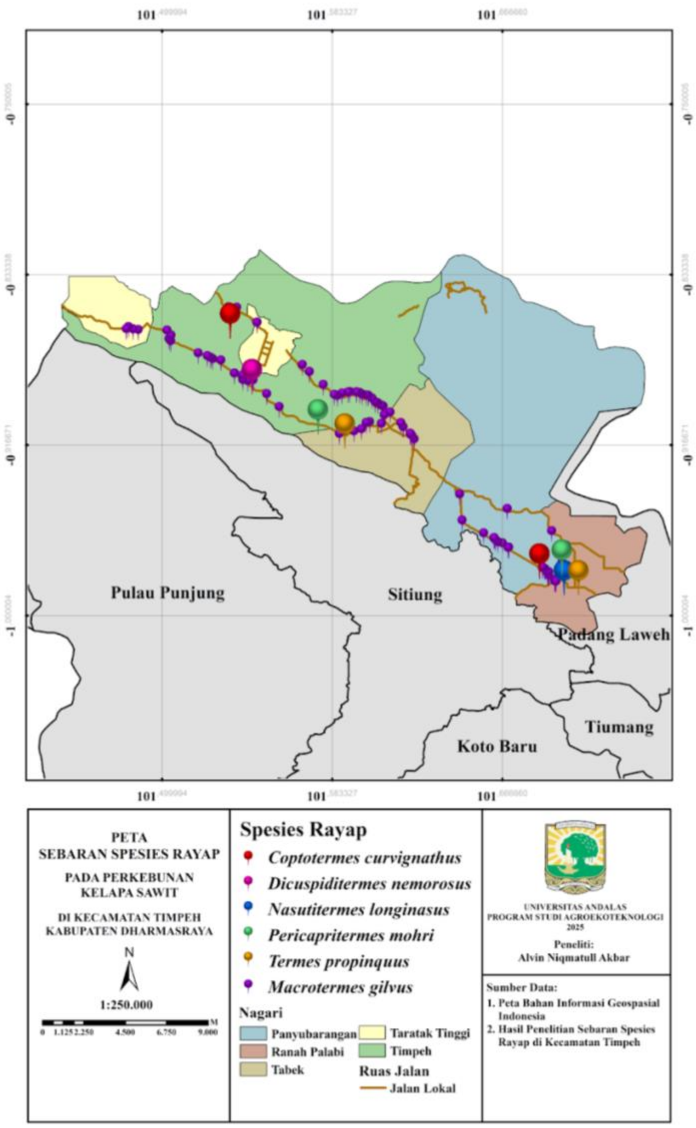

Figure 8. Map of termite species distribution in Timpeh Subdistrict, Indonesia

Nests of *Coptotermes curvignathus* were found inside oil palm plants, creating twin tunnels in the trunks, which caused damage to the plants. One of the two sampling points found oil palm plants with holes and nests of *C. curvignathus* termites inside. The discovery of termites on oil palm trunks was also reported by Toni et al. (2015), who found *C. curvignathus* termites on the trunks, fronds, apical growth, and fruit bunches of oil palms.

Dicuspiditermes nemorosus is found on dead and decaying tree stumps and in the surrounding dense weed vegetation. The nest of *D. nemorosus* is characterized by its dark color and hollow exterior. This indicates that *D. nemorosus* is found in places with high organic content. This is consistent with the report by Tuma et al. (2022), which indicates that *Dicuspiditermes* selects its food from soil layers rich in organic matter, specifically plant material. The blackish-brown color of the nest indicates that it has a high organic content.

Termes propinquus and *Pericapritermes mohri* are found above ground and also have tunnels in oil palm trunks. Both termites tend to live in the shade, especially on oil palm trees. This finding was also reported by Muarrif et al. (2022), who discovered that *T. propinquus* nests are attached to living trees, felled trees, and dead trees. Trianto et al. (2020) also explained that the species *C. mohri* and *T. propinquus* are found in large numbers in high to very high shade.

The termite species *Nasutitermes longinasus* can also be found on oil palm plants, creating tunnels in the trunks. This was also reported by Johari et al. (2022) in their research, which found *N. longinasus* in oil palm plantations, where it formed tunnels.

Correlation Analysis between the Presence of Termite Species and Environmental Factors

The results of the Redundancy Analysis (RDA) show that the total inertia is 0.1803, with constrained inertia of 0.1046 (58.0%) explained by environmental factors. The remaining 0.0757 (41.9%) represents unconstrained inertia, which is variation not explained by environmental variables. The permutation test (999 randomizations) yielded an F value of 0.8581 with a p-value of 0.646, indicating that the model is not statistically significant. This suggests that temperature, light intensity, and humidity explain only a small portion of the variation in termite species distribution (Table 1).

Table 1. Correlation Analysis Results

Component(s)	Value	Explanation
Total inertia	0,1803	Total species data diversity
Constrained inertia	0,1046 (58%)	Variations are explained by environmental factors
Unconstrained inertia	0,0757 (41,9%)	Variation is not explained by environmental factors
Permutation test (F)	0,8581	F value of the RDA model
p-value	0,646	Not significant

The RDA biplot indicates that the environmental vector tends to align with other species, whereas M. gilvus is oriented in the opposite direction (Figure 9). This condition indicates that the presence of *M. gilvus* is not directly influenced by variations in temperature, light intensity, or humidity, but is instead determined by its high adaptability in the Timpeh District. *M. gilvus* shows better adaptability because it builds nests with complex structures, consisting of nest walls, nest centers, ventilation channels or air holes, wandering tunnels, and nest bases. Pratama et al. (2023) explain that the complexity of the *M. gilvus* nest structure enables this species to adapt, maintain the nest's microclimate, and provide protection against predators.

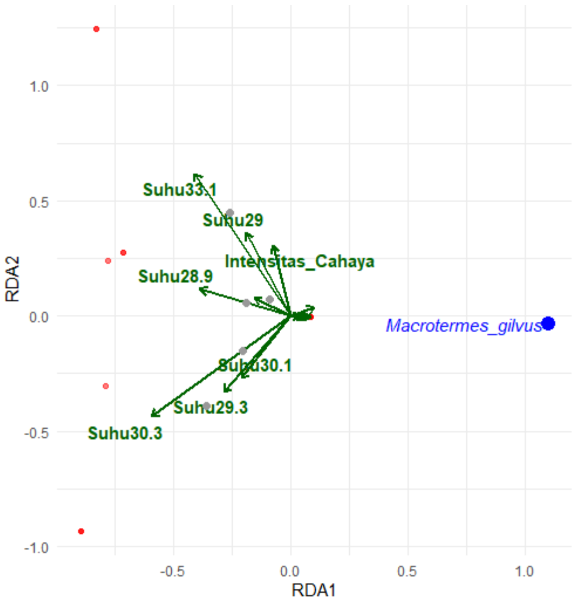

Figure 9. Biplot of termite species with environmental variables

The results indicate that termites are more frequently found in locations with temperatures between 26°C and 32°C (Figure 10). This temperature is optimal for the metabolism and activity of termite colonies, especially subterranean termites. Termites found in the field within this temperature range were also reported by Ardiansyah et al. (2025), who stated that the optimal temperature for termites to thrive and reproduce is between 25°C and 30°C. Termite activity is affected by extreme temperatures, causing them to be more active underground.

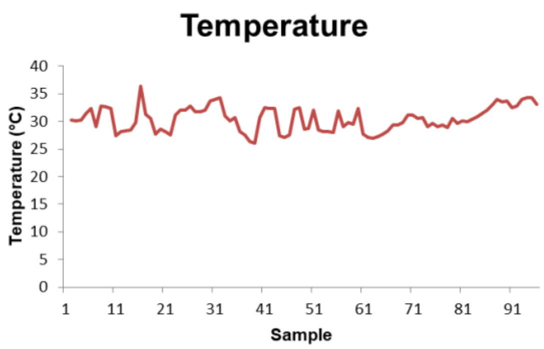

Figure 10. Temperature of the sample

The light intensity observed at the research site varied between 951 lux and 42,990 lux (Figure 11). Although they can be found in high light intensity, termites remain photophobic (avoid light), so they are more often found in areas protected from direct light, such as under the shade of oil palm fronds or thick litter. This is consistent with what Evans and Gleeson (2001) and Krishna and Wesner (1970) explained: termites are generally photophobic, and they avoid direct exposure to light because high light levels increase soil surface temperature and reduce humidity.

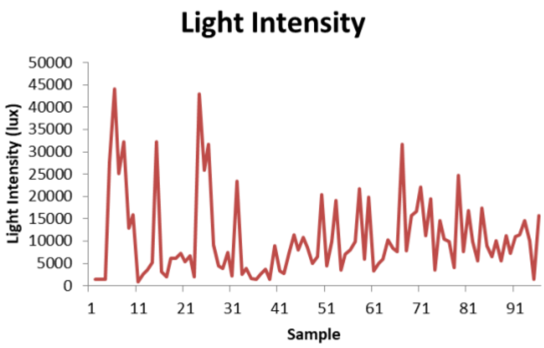

Figure 11. Light intensity of the sample

Termites are most commonly found in air humidity ranging from 60% to 65% (Figure 12). These conditions are quite humid and suitable for termites, which are susceptible to drought. This is related to the physiological characteristics of termites, which have soft bodies and easily lose water, so they tend to choose humid environments to survive. This finding aligns with several previous studies. Wiltz (2012) explained that soil termites have a much higher survival rate at humidity levels above 65%.

Additionally, Zukowski and Su (2017) reported that low humidity can drastically reduce termite activity. Meanwhile, Indrayani et al. (2007) found that humidity between 70% and 80% is the most optimal range for the feeding activity of drywood termites. Thus, the humidity at the study site supports and influences the high presence of termites.

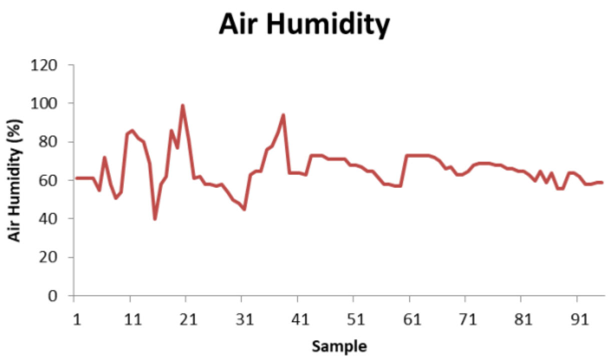

Figure 12. Air humidity of the sample

CONCLUSIONS

The termite species found in Timpeh District, Dharmasraya Regency are *Macrotermes gilvus, Coptotermes curvignathus, Pericapritermes mohri, Dicuspiditermes nemorosus, Nasutitermes longinasus,* and *Termes propinquus.*

M. gilvus has the widest distribution, covering almost the entire Timpeh District. Its presence is not directly influenced by variations in temperature, light intensity, or humidity. However, it is more determined by its ability to adapt to variations in microhabitats in oil palm plantations. In contrast, other species exhibit a more limited distribution. They are influenced by environmental factors and more specific habitat requirements, such as the need for humid environments, abundant organic matter, and adequate shade.

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