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Termite Identification Attacks on Buildings

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Abstract. House construction continues from time to time, the frequency of termite attacks on buildings in the area is also very high due to the disturbance of the termite's natural habitat. Termites target the structural wood of buildings and objects derived from cellulose. This study aims to analyze the diversity of termite, house component damage, the relationship between the age and condition of building in Jakarta, Indonesia. This study used a purposive sampling method from 134 houses in Jakarta, Indonesia with a cross-sectional approach. The research procedures included taking and identifying specimens, analyze the intensity percentage of building damage, analyze the relationship between the age of the building and the condition of the building, and environmental factors. Based on the results of research conducted on 134 houses in Jakarta, it is concluded that there are four types of termites in the study sites: *C. curvignathus* (61.14%), *M. gilvus* (18.65%), *M. inspiratus* (10.88%), and *C. cynocephaus* (9.33%). The worst damage to residential components is found in the sills. Based on statistical tests, there is a correlation between age and the condition of the building. It indicates that the age of the building is significantly related to its condition.

Keywords: Damage; House; Economic Damage; Termite

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INTRODUCTION

In the last ten years since 2010, Jakarta's population has increased by around 954,000, or an average of 88,000 annually (BPS, 2021). This population growth rate urges the conversion of land into residential areas. The housing development progresses, the frequency of termite attacks on buildings in the area is also very high due to the disturbance of the termite's natural habitat. Termites target the structural wood of buildings (roofs, windowsills, doors, and its kind) and objects derived from cellulose in buildings, such as furniture, clothing, and books (Subekti et al., 2018).

Termites are social insects that live in colonies and belong to the order Isoptera because the size of both pairs of wings is the same. In Indonesia, three species of subterranean termites (*Coptotermes curvignathus* Holmgren, *Macrotermes gilvus* Hagen, and *Schedorhinotermes javanicus* Kemner) and one species of dry wood termite (*Cryptotermes cynocephalus* Light) (Aflah et al., 2021), are very detrimental economically.

Factors that influence termite attacks on buildings are wooden building components and furniture, areas around buildings with high humidity, parts of wooden buildings in direct contact with the ground, piles of wood, and cellulose materials (Subekti et al., 2018). The risks of termite attacks on buildings increase the value of damage losses due to termite attacks yearly. Termite attacks on residential buildings are worrying because their intensity can cause significant losses.

In Nebraska, USA, termites are estimated to infect 17-20% of homes (Govorushko, 2018). In the Azores, the maintenance cost of all buildings currently infested with termites is €51 million, while the reconstruction of buildings is estimated at €175 million (Guerreiro et al., 2014). In Indonesia, economic losses due to termite attacks on residential buildings are reported to reach IDR 1.67 trillion (Savitri et al., 2016). According to research by the Life Sciences Research Center of Institut Pertanian Bogor (IPB), the average annual loss caused by termites in public buildings in Indonesia is around IDR 2.8 trillion per year (Nurrachmania et al., 2022).

Based on research by Savitri et al (2016) the calculation of termite damage to residential houses is only limited to the age of the building and the durability of the construction. The older the building, the durability of the wooden construction inside tends to decrease and the potential for termite attack will increase. However, research by Hasman et al (2019) states that it is not certain that houses with a younger age

will not have major damage, depending on the maintenance and maintenance carried out on the building.

Damage and impact from termite attacks on Jakarta's residential buildings have not been studied and reported much. Therefore, this study aims to analyze the type of termites and the damage level to buildings in Jakarta, Indonesia. This field of research includes identifying the diversity of termites, the damage level to residential components, the relationship between the age of the building and the condition of the building. The results of this study can be used as basic information in further scientific studies on effective termite control in residential buildings for communities and pest control companies. This research can be used as a reference for termite diversity data in Jakarta, Indonesia for researchers.

METHODS

This research was located in five municipalities of Jakarta: West Jakarta, North Jakarta, South Jakarta, East Jakarta, and Central Jakarta. The areas surveyed are elite residential areas in the five municipalities of Jakarta, Indonesia. Area surveyed 2.894,4 m^2. The houses surveyed include residential houses with wooden foundations, a building age of one year to more than ten years. The research was conducted for two months, including taking samples in the field and identification at the Termite Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang.

The tools used in this study were specimen tubes, questionnaires, lux meters, thermos-hygrometer, labels, microscopes, a book of key determinants by Tho (1992), stationery, cameras, and the Global Positioning System (GPS). The materials used were 70% alcohol and termite specimens.

This study used a purposive sampling method from 134 houses in Jakarta with a cross-sectional approach. The research procedures included taking and identifying specimens, analyzing the percentage of intensity of damage to buildings, estimating economic losses caused by termites that were converted into Indonesian Rupiah (IDR), and measurements of temperature, humidity, and light intensity.

All field data obtained were analyzed descriptively. Termite damage distribution data was presented in a diagram to analyze the number of termites found. Processing data on the relationship between the age of the building and the condition of the building used SPSS with Crosstabs (Cross Tabulation) and Chi-Square.

Specimen Collection and Identification

Termite samples found during the building survey were taken using a brush, put into a vial containing 70% alcohol, labeled, and observed using a microscope. The sample was identified concerning the book *Termite of Semenanjung Malaysia* by Tho (1992).

Building Damage Percentage

The percentage of building damage was found through interviews and building surveys with a sample of 134 residences in Jakarta. This inspection was carried out on the main parts of the building, such as roofs, sills, foundations, wall frames, walls, floors, yard drainage, ceilings, and utilities. The score of the building damage level is presented in Table 1.

Table 1. Percentage of Building Damage**.** Source: Subekti et al. (2018).

Building Condition	Score	Description
Light Damage	1	Building components are still functioning, but <10% are experiencing signs of damage due to termite attack
Moderate Damage (10g/100mL)	2	Building components are still functioning, but 10%-40% are experiencing signs of damage due to termite attack
Heavy Damage	3	>40% of the building is experiencing signs of damage due to termite attack

RESULTS AND DiSCUSSIONS

Diversity of Termite

Termite identification finds four species: *Coptotermes curvignathus* (61.14%), *Macrotermes gilvus* (18.65%), *Microtermes inspiratus* (10.88%), and *Cryptotermes cynocephaus* Light (9.33%). The termite species consist of three families: Rhinotermitidae, Termitidae, and Kalotermitidae. The percentages of the Termitidae attacking are Rhinotermitidae 61.14%, Termitidae 29.53%, and Kalotermitidae 9.33%. *Coptotermes curvignathus* from the

Rhinotermitidae family attacks many housing areas in Jakarta.

Figure 1. a. Damaged wooden door due to attack by *C. curvignathus* b. Door frame damage due to attack by *M. gilvus* c. Damage to the painting frame due to attack by *C. cynocephalus* c. M. in-spiratus nests are an indication of termite attack activity

These results follow the theory that the Rhinotermitidae family is known to have a type of termite that destroys buildings (Arif et al., 2020). According to Subekti et al. (2018), the Rhinotermitidae family attack buildings in several big cities in Indonesia.

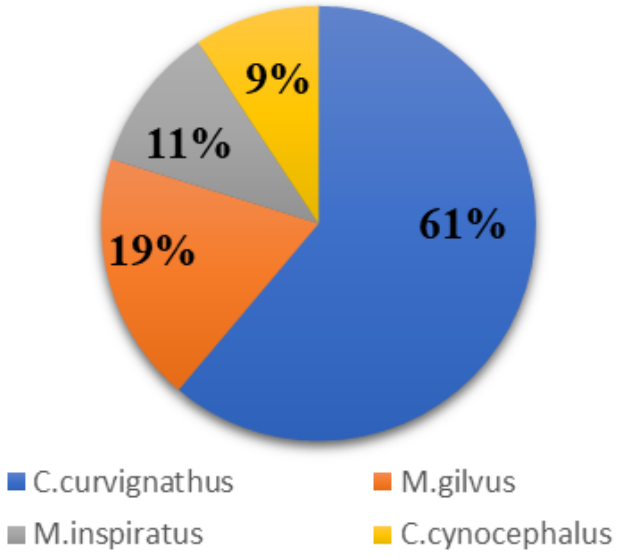

Figure 2. Percentage of termite species found during the study

Table 2. Parts of Buildings Attacked by Termites

Municipality	District	The number of houses surveyed	Damage percentage	Affected part of the house	The species of termite that attacks
Cental Jakarta	Cempaka Putih	7	40	Sills, wood panels, beds, kitchen sets	*C. curvignathus, M. gilvus, M. inspiratus*
	Menteng	9	80	Ceiling frame and cabinets	*C. curvignathus*
	Kemayoran	5	10	Wood panels	*C. curvignathus*
	Sawah Besar	4	30	Cabinet, kitchen sets	*C. curvignathus,*
East Jakarta	Cakung	5	10	Door frame	*M. gilvus* dan *M. inspiratus*
	Pulo Gadung	3	30	Ceiling frame and cabinets	*C. curvignathus*
	Pasar Rebo	6	50	Ceiling frame, kitchen sets and cabinets	*C. curvignathus*
West Jakarta	Palmerah	5	10	Cabinets	*C. curvignathus,*
	Kembangan	6	90	Ceiling frame and sills	*C. curvignathus, M. gilvus*
	Kebon Jeruk	5	20	Wood panels, kitchen sets and cabinets	*C. curvignathus, M. gilvus, C. cynocephaus*
	Grogol Petamburan	5	30	Ceiling frame	*C. curvignathus*
	Cengkareng	5	20	Cabinets and wood panel	*C. curvignathus*
	Tambora	3	30	Ceiling frame, sills and wood panels	*C. curvignathus*
	Kalideres	9	15	Sills and cabinet	*C. curvignathus, M. gilvus, C. cynocephaus*
North Jakarta	Kelapa Gading	5	80	Ceiling frame	*C. curvignathus*
	Tanjung Priok	9	30	Sills and kitchen sets	*C. curvignathus, M. gilvus,*
	Penjaringan	7	80	Ceiling frame and cabinets	*C. curvignathus,*
Douth Jakarta	Kebayoran Lama	5	40	Wood panel, sills	*C. curvignathus, M. gilvus*
	Kebayoran Baru	9	80	Sills, beds and cabinets	*C. curvignathus, M. inspiratus*
	Pasar Minggu	8	20	Ceiling frame, kitchen sets and cabinets	*C. curvignathus, M. inspiratus*
	Mampang	6	30	Ceiling frame and cabinets	*C. curvignathus*
	Jagaraksa	8	20	Warehouse contents and sills	*C. curvignathus*

According to Arina et al. (2016), Indonesia's subterranean termite *Coptotermes curvignathus* has a high attack intensity and can also build secondary nests on tall buildings. Nandika et al. (2015) report that subterranean termites can attack apartments and hotels up to the 33rd floor in Jakarta. Working termites of the genus *Coptotermes forage* underground and move to the roof through closed tunnels built on the vertical surface of the material (Subekti et al., 2018).

The results showed that *C. curvignathus* termites attacked many of the surveyed buildings, with an attack percentage of 61.14%. These termites eat a lot of sills and cabinets.In Taiwan, more than 90% of wooden buildings were heavily damaged by termites *Coptotermes* sp. These termites are responsible for >87% of termite infestation in urban Taiwan. Termite control costs in Taiwan are estimated at $4 million per year, and it is estimated that more than $3 million is the annual cost for controlling *Coptotermes* sp. (Li, 2014). In addition, examples of Termitidae species that most often attack buildings are *Macrotermes* sp and *Microtermes* sp.

Cryptermes sp (drywood termites) have different characteristics from other species. They do not require high humidity conditions and are usually found in buildings and furniture, such as cabinets, tables, and chairs. The sign of termite-infested wood is small brown dirt around the wood. These termites are not related to the ground because their habitat is in dry places. Drywood termites attack the wood with a moisture content of 10-12% or less (Nurrachmania & Rozalina, 2021).

House Component Damage

The worst damage is found in the sills, with 84 attacks from the entire houses surveyed, then followed by damage to wooden cabinets with 68 attacks, ceiling frames with 44 attacks, kitchen sets consisting of cupboards or kitchen tables with 32 attacks, ceilings with 24 attacks, wooden trusses with 17 attacks, wood panels with 11 attacks, and others. Others include wooden furniture such as bed frames, pianos, and wooden pillars, with 17 attacks from the surveyed houses.

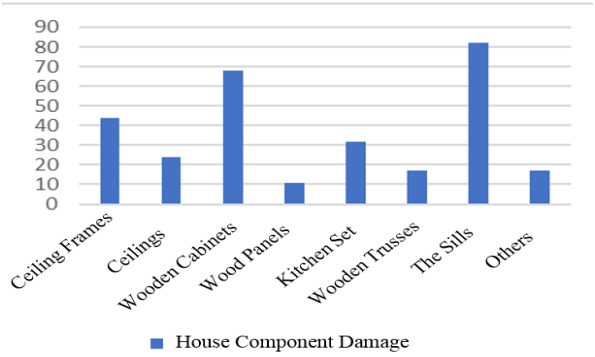

Figure 3. House Component Damage Due to Termite Attacks

In this study, many termites attacked the sills and cabinets. This is because the sills and cabinets are parts of the house that are close to the ground and contain a lot of cellulose as a food source for termites. According to Ugbomeh and Diboyesuku (2019), sills and roofs are the components most frequently attacked by termites. The sills and roof are closest to the ground, making it easier for termite attacks to enter the building. Termites usually attack the top of the building by passing

through narrow gaps (Sitepu et al., 2015). Sometimes termites also form tunnels or burrows (shelters) to link the foraging zone and humidity with their nests (Jordania, 2013). In addition to increasing their damage to buildings, termites often build nests to aid their mobility in infecting wooden structures (Savitri et al., 2016).

The Relationship between the Age and Condition of Building

The cross-tabulation analysis shows that the relationship between the age and the condition of the building is indicated by a Chi-Square value of 9.565a at DF 4 (p-value 0.048 <0.05).

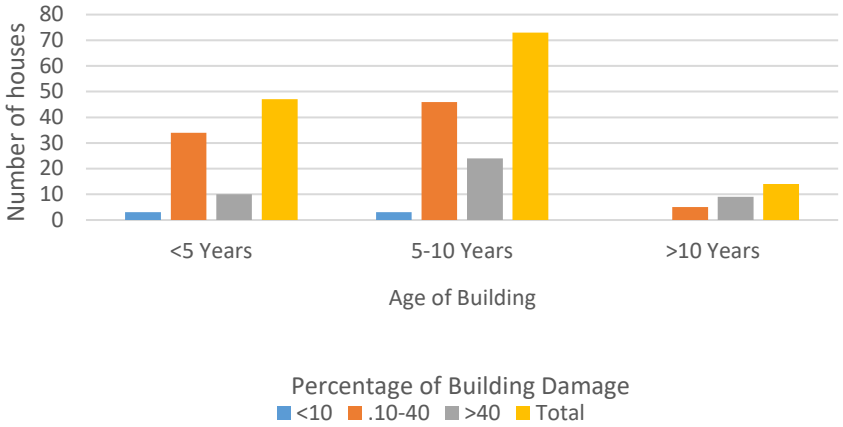

Figure 3. Calculation between Building Age and Building Damage Percentage

In general, older buildings suffer more damage. Because as the building ages, the durability of wooden structures usually decreases and termite attacks increase. However, it is not certain that older houses have more damage than new houses. It depends on the perseverance and maintenance of the house (Savitri et al., 2016).

A decrease in building quality can also be caused by the reluctance of building occupants to maintain their residences (Subekti et al., 2018). Termite attacks generally occur in buildings that are more than ten years. The attack is because old buildings contain lower water than new ones. Factors that support termite attacks on buildings include the amount of wood buried in the ground during construction, openings in the foundation walls, poor ventilation systems, wood in direct contact with the ground, the physical condition of the building, and the construction site that is favorable for termites (Yanti & Indrayani, 2013).

Analysis of Temperatire, Humidity and Light Intensity

Measurements were made at the time of the study. Environmental data is collected for each house survey. In the morning (07.30 WIB), the temperature is 27-30ºC, the humidity is 60-70%, and the light intensity is 8220 lux. In the afternoon (12.00 WIB), the temperature is 30-34ºC, the humidity is 69-73%, and the light intensity is 18.360 lux. In the evening (16:30 WIB), the temperature is 29-31ºC, the humidity is 79-82%, and the light intensity is 10.350 lux.

Table 5. Temperature, Humidity, and Light Intensity

Area	Time	Light Intensity (Lux)	Temperature (ºC)	Humidity (%)
Jakarta Barat	Morning (07.30 WIB)	8.220	27-30	60-70
	Afternoon (12.00 WIB)	18.360	30-34	69-73
	Evening (16:30 WIB)	10.350	29-31	79-82
Jakarta Timur	Morning (07.30 WIB)	8.220	24-29	60-65
	Afternoon (12.00 WIB)	17.140	29-30	70-75
	Evening (16:30 WIB)	10.550	25-29	60-75
Jakarta Pusat	Morning (07.30 WIB)	7.220	26-30	65-70
	Afternoon (12.00 WIB)	18.340	30-32	63-72
	Evening (16:30 WIB)	11.110	24-29	65-73
Jakarta Utara	Morning (07.30 WIB)	9.120	24-31	58-65
	Afternoon (12.00 WIB)	18.430	30-33	60-70
	Evening (16:30 WIB)	9.550	28-29	63-73
Jakarta Selatan	Morning (07.30 WIB)	8.140	28-29	65-70
	Afternoon (12.00 WIB)	19.430	25-31	63-72
	Evening (16:30 WIB)	10.030	27-30	65-73

The spread of termites is closely related to environmental conditions, such as humidity and temperature. Termites are insects with thin skin and easily dehydrated due to wind or dry air, so they need stable humidity (Subekti et al., 2018). The conditions at the time of the study were optimal for termites to grow and reproduce. According to Arif et al. (2019), the optimum temperature range for termite development is 15-38°C, and the optimum humidity is 95-98%, except for drywood termites, which require little moisture. Environmental conditions suitable for termite life lead to higher levels of building damage, because termites can grow optimally and reproduce.

The novelty of this study is to present data with several supporting factors such as the identification of termite diversity, the level of damage to residential components, the relationship between the age of buildings and the condition of existing buildings in Jakarta, Indonesia. The results of this study can be used as basic information in further scientific studies on effective termite control in residential buildings for communities and pest control companies.

CONCLUSION

Based on the results of research conducted on 134 houses in Jakarta, it is concluded that there are four types of termites in the study sites: *Coptotermes curvignathus* (61.14%), *Macrotermes gilvus* (18.65%), *Microtermes inspiratus* (10.88%), and *Cryptotermes cynocephaus* (9.33%). The worst damage to residential components was found in the sills, with 84 attacks from the entire houses surveyed. Based on statistical tests, there is a correlation between age and the condition of the building. It indicates that the age of the building is significantly related to its condition. Further research can discuss the damage to apartment buildings in DKI Jakarta

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