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Assessment of Termite Infestation in Academic Infrastructure at Central Mindanao University (CMU)

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ABSTRACT

Knowing the pest species first is necessary for the formulation of pest control method. In this study an assessment of termite infestation in the academic buildings was conducted. All wooden materials both furniture and structural member were inspected for signs of termite infestation. Soldiers of termites found infesting wooden structures were collected for identification. The data gathered during actual inspections include moisture content of infested wood, coatings (painted or not), type of wood in service (furniture or structural member) and materials used (lumber or plywood). A regression analysis was run to determine if the mentioned factors or combination thereof can best explain the rate of infestation. A total of 28 buildings were inspected. All of the buildings showed signs of termite infestation. Pieces of furniture were mostly infested with drywood termites while structural member were infested mostly by subterranean termite. However, most of the buildings have empty tunnels with no active termite population. There were only 3 species of subterranean termites collected and identified viz., Macrotermes gilvus Hagen, Coptotermes gestroi Wasmann and Microcerotermes losbañosensis Oshima. Regression analysis showed that none of the factors or combinations thereof can explain the variation in the extent of damage caused by termites.
Keywords: edible ferns, phenolics, flavonoids, antioxidant activity.

Keywords: drywood termites, subterranean termites, termite infestation

INTRODUCTION

Wood as a basic structural material is susceptible to wood destroying insect attack such as termites (Indrayani et al. 2014). The attack may result to significant structural damages leading to early replacement and reduction of service life wooden structure (Acda, 2004a). The world-wide economic impact figure of termites is uncertain, but the control cost for termite pests in the United States was estimated at $1.5 billion annually in 1994 (Su & Scheffrahn, 2000). In the Philippines, no data were available on total financial losses however Yudin (2002) estimated the annual damage cost to about 8 to 10 million dollars.

There are more than 2,600 described termite species in the world (Kambhampati & Eggleton, 2000). A total of 54 species were known to occur in the Philippine encompassing 18 genera (Snyder & Francia, 1960). Within these genera, only three families are with economic importance and associated with damage to wood products and timber structures, viz., Rhinotermitidae, Termitidae and Kalotermitidae. Six species are considered serious structural pests, viz., Coptotermes gestroi, Nasutitermes luzonicus, Macrotermes gilvus, Microcerotermes losbañosensis, Cryptotermes cynocephalus and C. dudleyi (Snyder & Francia, 1960; Valino, 1967; Acda, 2004a).

Central Mindanao University (CMU) in Maramag, Bukidnon is located at the heart of Mindanao Island, Philippines where the climate is generally warm with significant amount of rainfall throughout the year. The campus is surrounded with diverse species of trees (ornamental and timber producing) and aside from its plantation forest the university was also able to preserve a substantial area of natural forest. This environment is suitable for termite colonies to thrive. Thus, a survey of termite infestation is important since wooden material is common component in buildings especially classroom and office furniture. This study provides information on the economically important species infesting academic buildings and the extent of damage.

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Table 1. *Termite's damage rating modified from Rojo (2017)*

Rating	Definition	Qualitative rating
0	There is the presence of signs (fecal pellets, tunnels) but no apparent termite damage	With signs
1	<20% of the wooded structure were damaged	Low
2	20 - <40% of the furniture were damaged	Moderate
3	>40% of the furniture were damaged	Heavy

METHODOLOGY

Survey and Termite Collection

The methods used by Indrayani et al. (2014) were followed in this study with some modifications. 100 percent survey were conducted which involved visual inspection in all academic buildings, offices, and dormitories within the campus. Infestation was determined by the presence of damaged wooden parts, fecal pellets, tunnels, and termites. The damage was classified following the procedure described by Rojo (2017) (Table 1). Ratings of damage were based on actual inspection on furniture, structural members and other wooden materials in all buildings. Termites especially soldier caste were collected and placed in a vial with 90% ethanol for identification. The head of the soldier termite were compared to available pictures and keys in the internet for identification. The moisture content of the wood was determined using a handheld digital wood moisture meter (FA507) developed by the Forest Products Research and Development Institute (FPRDI).

Data analysis

A linear regression analysis was employed to determine which factors or combination of factors (types of wood in service either furniture or structural member, material used either pure lumber or with plywood, coatings and wood moisture content) can best explain the variation in damage intensity.

RESULTS AND DISCUSSION

Termite Infestation

Out of 262 wooden structures in 28 buildings inspected 170 were structural member, and the rest were furniture. Signs of both subterranean and drywood termites were observed which includes presence of dead termites, damaged wood with galleries lined with mud, and presence of mud tubes (tunnels). During actual inspection, mud tubes were observed on walls and flooring. However, when inspected some tunnels were already empty. An empty tunnel may simply mean that they may have abandoned this particular tunnel to move to other sections of the building to find accessible food. Unless chemical control was applied however in this study information about application of such control method is not available.

Mud tubes are made of "carton material," a mixture of fecal matter and partially digested wood (Woodrow et al., 1999), this protects termite from dry weather, direct sun light, low humidity and predation (Manzoor & Mir, 2010). For drywood termites, the noticeable sign of infestation is the presence of a pile of fecal pellets. Locally this group of termites is called "unos" in Tagalog or "agay-ay" in Visaya. These pellets are expelled from the gallery system through small holes in the infested wood surface (Grace, 2009).

Termite Species that Invaded Buildings and Furniture

There were 3 species of subterranean termites found infesting wooden structures in CMU buildings i.e. the mound building termite *Macrotermes gilvus* Hagen, Los Baños termite *Microcerotermes losbañosensis* Oshima and the Asian subterranean termite *Coptotermes gestroi* Wasmann. These species were classified as economically important termites in the Philippines considering the degree of damage it brought to wooden structures (Snyder & Francia, 1960; Valino, 1967; Acda, 2004a).

M. *gilvus* was found to be abundant in CMU. It is the most common termites observed infesting wooden walls and other structural member, and according to Acda (2003), it is a menace to farming operation. Tunnels were observed mostly from the flooring then on the walls. It is also the dominant termite observed foraging on plant debris in the open fields. This dominance was due to its aggressive agonistic behavior (Rojo & Acda, 2016). In addition, the species is relatively bigger with an average length and width of head of major soldier 3.43mm and 3.17 mm respectively (Neoh & Lee, 2009) perhaps the biggest among the destructive termites in the country. This species was ranked by Acda (2004a) as the second most destructive termites in the Philippines, however, in this study since it is the frequently encountered termite in academic buildings it can be ranked as no. 1. The estimated foraging populations ranged from .25 to .46 million per colony which can cover an area of *124 - 350* m^2 (Acda 2004b). M. gilvus is a voracious feeder capable of 1.32 to 2.36 kg per month wood consumption rate (Acda, 2004b). However, most of the feeding occurred at lower portion of the building (1st floor). Aside from its size the species can be identified easily by observing the morphological feature of the soldier caste as describe by Dahlan *et al*. (2014) Dorsal head shape is almost rectangular, the ratio between the length and width of the head capsule is greater than 1.50 with thick sword like mandible without teeth.

C. gestroi was only observed in one building, specifically at the CMU hospital attacking medicine cabinets, paper-based medicine containers, ceilings and other structural members. The low occurrence of this species can be attributed to the aggressive agonistic behavior of the bigger M. *gilvus* as discussed in Rojo and Acda (2016). Unlike *M. gilvus* which is usually confined in the lower part of the building, *C. gestroi* was found nesting (satellite nest) in the roof frame. The genus *Coptotermes* is a large group of subterranean termites (Li et al., 2010). However out of the estimated 69 named species, only 21 taxa have solid evidence, 44 names have uncertain status and the remaining should be synonymized (Chouvenc et al., 2016). In the Philippines, C *gestroi* is previously known as C. vastator Light or Philippine milk termite until the recent molecular study showed that C. vastator is a junior synonym of C. *gestroi* (Yeap *et al*., 2014). This termite is an important structural pest reported from Asia, Pacific Islands, North America, Caribbean islands, South America, and Indian Ocean islands (Li *et al*., 2013). In the Philippines, Acda (2003) classified this species as the most destructive subterranean termite. The termite can take advantage of cracks on cement floors, foundations or splits in treated or naturally durable timber to reach softer or untreated wood (Valino 1967; Acda 2004a). A feeding rate test showed that C. *gestroi* wood consumption rate range from .24 mg to .55 mg per termite for 21 days in jWPA-test, and 0.63--0.73 mg in MWBT-test (Sornnuwat *et al*., 1995). C. *gestroi* can easily be distinguished from other destructive termites in the Philippines by observing the tear-drop shaped soldier's head as described by Scheffrahn & Su (2000).

M. losbañosensis was also found infesting wooden structures although in one academic building only. Acda (2004a) considered the species as the least destructive among economically important subterranean termites in the Philippines. The same author further stressed that *M. losbañosensis* is relatively smaller and are often used by farmers as chicken feeds. Similar with C. gestroi secondary nest can also be built in beams or walls of houses. The species can easily be recognized by observing the Soldier's rectangular head and long horn like

mandibles (Valino 1967; Acda, 2004a). In addition, the tunnels were narrower compared to other termites.

Drywood termites

Signs of drywood termite infestation were observed on furniture, window jambs, door jambs, and other wooden materials. Unlike subterranean termites were tunnels (Figure 1A) are conspicuous in drywood termites the only sign of infestation is the presence of fecal pellets (Figure 1B). Moreover, the galleries in infested wood in subterranean termites were lined with muds (Figure 1C) and contrarily clean in drywood termites (Figure 1D).

Although no specimens were collected for identification, there are only two species of drywood termites in the Philippines i.e. Cryptotermes dudleyi Banks and Cryptotermes cyanocephalus Light (Valino 1967; Acda 2004a). Furthermore, the variation in shape and size of the fecal pellets collected showed a hint that there are two species of drywood termites infesting wooden structures in CMU academic buildings (Rojo, 2018).

Generally, damage severity was moderate, inflicting less than 40% damage to wooden structure. Heavy infestations were observed in the furniture found in CMU Hospital, College of Arts and Sciences (CAS) building, Psychological Testing and Guidance Center and in structural member like moldings and walls in the buildings of the College of Veterinary Medicine, Accountancy and Business Management, Agriculture and Catleya Ladies Dormitory. Although the infestation was only observed in few furniture and structural members but through time when left uncontrolled especially for subterranean termite the damage can increase significantly considering the habit of subterranean termite. As observed severe damage occurred in older buildings as enumerated above where wooden materials are common. However, the building that should be given priority for termite control program is the university hospital because of the presence of C. gestroi tagged as the most destructive termites in the Philippines (Valino 1967; Acda, 2004a).

A regression analysis was carried out to determine which factor or combination of factors (coatings, type of wood in service, wood MC) can best explain the rate of damage. As observed termite infestation occurred in both furniture and structural member wood, either painted or not and at wood MC ranging from 6 to 16% MC. As shown in Table 2, none of the variables can significantly explain the rate of infestation.

The use of paint (coating) as a barrier against termites is not thoroughly investigated (Lewis 2003). However, Oi et al. (2014) argued that paint may block the entry of termites but according to Lewis (2002) this can breach through time when the paint degrades. Rojo (2017) observed that among the classroom's furniture only the wooden stool was not infested with drywood termites, the author argued that the simple design of stool provides no entry point for the drywood termites.

Although subterranean termites prefer wood with high MC (> 100%) (Gautam & Henderson, 2011), in this study, actual survey showed subterranean termites were able to inflict more than 50% damage to a wooden structure with 12% MC. On the other hand, drywood termites prefer wood with 10% MC (Gouge et. al, 2009). This observation suggests that termite infestation can occur regardless of wood MC especially for subterranean termite, materials used (lumber or plywood), types of wood in service (furniture or structural member).

Furniture were mostly infested with drywood termites while subterranean termites were most commonly observed infesting structural member like walls. Drywood termites were also observed

Table 2
Four variable regression coefficients with standard errors and tests of significance

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	.792	5.812		.136	.892
types of wood in service	-.392	2.797	-.011	-.140	.889
Material used	-.218	2.712	-.006	-.081	.936
Wood MC	.812	.590	.590	.095	.169
Coating	6.790	3.557	3.557	.132	.057

Dependent variable: % Damage

infesting door and window jambs. The colony size of subterranean termites may reach to more than .5M (Acda 2004b, Acda 2007) thus causing severe damage in shorter period compared to drywood termites in which colony size only reaches a few hundred to a few thousand individuals (Grace, 2009).

CONCLUSION

All academic buildings in Central Mindanao University were infested with termites although the damage was generally moderate (ranged of % termite damage = 20% to 40%). Signs of termite infestation either drywood or subterranean termites were observed in furniture and structural members regardless of moisture content and coatings. There were three subterranean termites collected i.e. *M. gilvus*, *C. gestroi*, *M. losbañosensis*, and two species of drywood termites under the genera *Cryptotermes*. Statistical analysis showed that coatings (painted or not), materials used (plywood or pure lumber) and wood MC or combination thereof cannot explain the rate of infestation. Termite control program should prioritize the university hospital because of the presence of *C. gestroi*.

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