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SHORT COMMUNICATION

Termite Infestation Associated with Type of Soil in Pulau Pinang, Malaysia (Isoptera: Rhinotermitidae)

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Abstrak: Sembilan sampel tanah dari sembilan bangunan yang diserang oleh *Coptotermes gestroi* di Pulau Pinang, Malaysia, telah diuji untuk menentukan jenis tekstur tanah. Prosedur analisis tekstur tanah menggunakan kaedah hidrometer. Empat daripada sembilan bangunan (44%) dikenal pasti sebgai tanah jenis liat pasir. Manakala lima daripada sembilan bangunan (56%) telah dikenal pasti sebagai tanah jenis gembur berpasir.

Kata kunci: *Coptotermes gestroi,* Anai-anai*,* Tanah Liat Pasir, Tanah Gembur Berpasir, Kaedah Hidrometer

Abstract: Nine soil samples from nine buildings infested with *Coptotermes gestroi* in Pulau Pinang, Malaysia, were tested for the type of soil texture. The soil texture analysis procedures used the hydrometer method. Four of nine buildings (44%) yielded loamy sand-type soil, whereas five of nine buildings (56%) contained sandy loam-type soil.

Keywords: *Coptotermes gestroi,* Termites*,* Loamy Sand, Sandy Loam, Hydrometer Method

Subterranean termites, especially of the genus *Coptotermes*, are a widespread insect pest in Southeast Asia (Abdul Hafiz & Abu Hassan 2009). These termites were reported as the most destructive subterranean termite in Thailand and Malaysia (Abdul Hafiz & Abu Hassan 2009, 2008; Kirton & Brown 2003). The subterranean termite is a social insect with a mysterious life cycle. With cryptobiotic life and constant underground movement, subterranean termites can strike unexpectedly anywhere and can cause serious damage to buildings and products containing cellulose (Kamble & Davis 2005). Control of subterranean termites has always been an important concern of homeowners and the pest control industry. Lee (2002) reported that in 2000, a total of US$ 8–10 million were spent on termite control across Malaysia, which accounted for 50% of the business turnover of the pest control industry.

Soil termiticide treatment is one of the main strategies for protecting buildings and structures from subterranean termite attacks over the past 30 years. This treatment creates a chemical barrier underneath the premises or buildings. Termiticides are categorised as repellent, toxic and non-repellent. The

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effectiveness of these soil termiticides depends on the physical and chemistry properties of the termiticides and is also very dependent on the adsorption of the termiticides (Saran & Kamble 2009; Davis & Kamble 2008).

The adsorption of a termiticide in soil is the binding of a termiticide to the surface of soil particles, especially clay and organic matter (Davis & Kamble 2008). Depending on many factors in a soil profile, such as moisture, pH and temperature, a compound may adsorb to and desorb from soil particle surfaces while migrating through the soil. It is also important to consider the clay, sand and silt content of soils because insecticides generally do not migrate as readily in soils with high clay and organic matter content. The mineral content of soil is also an important factor in determining the persistence of termiticide by either catalysing decomposition or affecting the adsorption rate. Moreover, most of the chemical and physicochemical reactions in soils occur at the surface of the particles. Because smaller particles have a greater surface area than coarser particles, smaller particles have more influence on the soil (Saran & Kamble 2009; Davis & Kamble 2008).

In addition, soil is made up of four major components, namely, inorganic material, organic material, air and water. Inorganic soil particles occupy approximately one-half of the total volume of the soil surface. These soil particles are conveniently divided into size groups called separates. The three major soil separates are termed sand, silt and clay. The percentages of sand, silk and clay determine the texture of the soil (Davis & Kamble 2008; Bowman *et al.* 1965). Nevertheless, soil texture is important because it reveals the relative proportions of sand, silt and clay in soil because the physical and chemical properties of these separates differ greatly (Shirazi & Boersma 1982). Therefore, the purpose of this study was to determine the types of soils associated with termite infestation inside building structures, with the goal of developing better termite infestation prevention strategies utilising termiticide soil treatment or physical protection of building structures.

All of the soil samples from the study sites (Table 1) that were analysed for soil texture were from building structures that were highly infested with the subterranean termites *Coptotermes gestroi*. The soil samples were collected from a termite underground monitoring station and an above-ground monitoring station located inside and outside of the perimeter of the houses (Table 1). The soil sampling locations in the building structures are shown in Table 1. The termite monitoring stations consisted of cellulose bait inside the station that attracted termites to feed. The termites brought soil with them to cover the cellulose bait during their feeding activities inside the monitoring station. Soil texture analysis procedures used the hydrometer method (Ashworth *et al.* 2001). Hydrometers are instruments commonly used to measure the density of a solution. A soil hydrometer is calibrated in g/l to give the amount of material in suspension in a sedimentation cylinder. Large amounts of suspended particles impart a high density to a soil-water mixture, so the hydrometer floats at a comparatively high level. As the particles settle, the density decreases, and the hydrometer sinks. Several factors must be considered when performing this procedure, including temperature, soil clods, the aggregation of particles due to certain cations, the chemical (NaOH) and physical (stirrer) dispersion of soil particles and particle size analysis using a simplified experimental procedure.

Table 1: Building structures, termite species, levels of infestation and soil types of termite-infested structures in Pulau Pinang, Malaysia.

No.	Site	Building structure	Termite species	Level of infestation	Soil sampling location	Soil type
1	Bayan Baru	Terrace house	*C. gestroi*	High	AG (Living room)	Loamy sand
2	Bertam	Traditional Malay house	*C. gestroi*	High	AG (Living room)	Sandy loam
3	Guar Perahu	Bungalow house	*C. gestroi*	High	UG (Car garage)	Sandy loam
4	Mengkuang	Traditional Malay house	*C. gestroi*	High	UG (Car garage)	Loamy sand
5	Gelugor	Bungalow house	*C. gestroi*	High	AG (Bedroom)	Loamy sand
6	Kg.Guar Perahu	Traditional Malay house	*C. gestroi*	High	AG (Living room)	Loamy sand
7	Bayan Lepas	Musholla	*C. gestroi*	High	AG (Women's prayer hall)	Sandy loam
8	Taman Rupawan	Bungalow house	*C. gestroi*	High	UG (Car garage)	Sandy loam
9	Greenlane	Semi-detached house	*C. gestroi*	High	AG (Dining hall)	Loamy sand

Notes: *AG = Above-ground monitoring station
*UG = Underground monitoring station

The experimental procedures for the particle size analysis were divided into two categories: the calibration of each hydrometer and pretreatment to remove organic matter and disperse the soil particles.

For the calibration of each hydrometer (Zeal Ltd., England) 50 ml of dispersing agent (1 N NaOH) was added to a 1000 ml measuring cylinder, the volume was increased to 1000 ml with distilled water and mixed thoroughly, and the temperature was recorded. The scale reading on the hydrometer stem of the blank solution was read, and the temperature was recorded on the datasheet.

The first procedure for the second category was to place 50 g of 2 mm sieved soil samples and 100 ml of 6% H_2O_2 into a 600 ml beaker. The mixture was left at room temperature overnight. The beaker was then placed on a hot plate at 90°C for 10 minutes. The solution inside the beaker was placed on a stirrer and stirred thoroughly for 10 minutes. The suspension was later transferred to a 1000 ml measuring cylinder. Distilled water was added to the 1000 ml mark, time was allowed for the suspension to equilibrate thermally, and the temperature was recorded. The mouth of the measuring cylinder was covered with Parafilm, and the cylinder was inverted several times until the contents were thoroughly mixed and left in a cool, shaded place. The finishing time was set as T_0. Immediately, the hydrometer was lowered into the suspension and read after

40 seconds. The temperature was measured with a thermometer. The hydrometer was then removed and cleaned. After 2 hours, the hydrometer was again lowered into the suspension, and the data were recorded. The above methods were repeated for the rest of the soil samples collected from the termite-infested buildings. Appropriate values for all of the soil samples were recorded on the datasheet. After calculating the percentage of each particle, the United States Department of Agriculture (USDA) textural triangle was used to determine the texture class of the samples (Shirazi & Boersma 1982).

A total of 25 premises from 13 sites were surveyed for termite infestation. Of the 25 premises from 13 sites, only 14 premises from 9 sites were tested for soil types, as only these 9 sites underwent soil treatments and presented infestation by the economically important termite genus *Coptotermes*. The sites were Bayan Baru, Bertam, Guar Perahu, Mengkuang, Gelugor, Kampung (Kg.) Guar Perahu, Bayan Lepas, Taman Rupawan and Greenlane. The types of soil were either sandy loam or loamy sand (Tables 1 and 2). In Bayan Baru, Mengkuang, Gelugor and Greenlane, the soils were of the loamy sand type (44%), whereas in Bertam, Guar Perahu, Kg.Guar Perahu, Bayan Lepas and Taman Rupawan, the soils were of the sandy loam type (56%) (Tables 1 and 2).

Table 2: Percentage types of soil.

Soil types	Percentage (%)
Sandy loam	56
Loamy sand	44

Based on the soil analysis, most of the infested structures contained either loamy sand or sandy loam. Clay and organic matter content is an important characteristic influencing the termiticide adsorption mechanism. Clay and organic matter in soil can vary from less than 1% in sandy soils to well over 50% in heavy clay soils. The vertical and horizontal distribution of termiticides is dependent on the interaction with soil particles through processes called adsorption and desorption (Saran & Kamble 2009; Davis & Kamble 2008). Knowing the types of soil at the sites provides us with the density and hardness of the soil. Therefore, soil type will affect the drilling process throughout the foundation (Davis & Kamble 2008). Additionally, the type of soil will influence the adsorption of chemicals to the soil. Thus, during the process of sub-slab chemical injections, chemicals will spill from the hole because of the soil composition and structure underneath the foundation, which may not adsorb the chemicals very well when creating a continuous termiticide barrier around a building structure.

In this study, nine building structures infested with termites were identified as containing either the loamy sand or the sandy loam soil type. Therefore, we can conclude that termites from the genus *Coptotermes* will mainly infest a building structure if the structure was built upon either loamy sand or sandy loam. In addition, this research provides a procedure for housing developer contractors to test construction sites' types of soil. Therefore, a preventive measure could be applied, using soil termiticides or physical protection to prevent termites from penetrating through building structures. The future direction of this research is to test the "retention" of termiticides within each soil type. This research will lead to a better understanding of insecticide absorption and binding into soil particles.

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