Colony Characterization of a Mound-Building Subterranean Termite, *Globitermes sulphureus* (Isoptera: Termitidae) Using Modified Single-Mark Recapture Technique

by

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ABSTRACT

Globitermes sulphureus (Haviland) is one of the most important mound-building subterranean termite species in the Southeast Asia region. It is also a major pest in oil-palm and coconut plantations. In this study, we characterized two field colonies (A & B) of *G. sulphureus* on a university campus. Population estimation using modified single-mark recapture technique revealed that the foraging colonies had 4.02 x 10^6 termites for colony A and 1.24 x 10^6 termites for colony B, respectively. Colony A has a foraging distance of approximately 15.0 m, covering a foraging area of 61.9 m^2, while the latter occupied an area of 25.8 m^2 with the foraging distance of 3.5 m. Foraging biomasses were 14.4 and 4.6 kg, respectively. Wood consumption rates were estimated at 57.6 ± 10.5 g/month/station and 36.2 ± 2.0 g/month/station, respectively.

Key words: subterranean termites, *Globitermes sulphureus*, foraging populations, foraging territory, wood consumption rate, single-mark recapture, Malaysia.

INTRODUCTION

Termites are an important group of insect pests to Malaysia and neighboring Southeast Asian countries. This group contributed approximately 50% of business turnover of the pest control industry in Malaysia in 2000 (Lee 2002a). More than 175 species of termites have been described from Malaysia (Tho 1992). However, termites belonging to the genus *Coptotermes* are considered the most important structural pest in the urban environment (Lee 2002a, 2002b).

Globitermes sulphureus (Haviland), is a mound-building termite species of the family Termitidae, restricted to the Indo-Malayan region (Noirot 1959; Howse 1970; Harris 1971; Tho 1992). One main distinct characteristic of this species is the bright yellow-colored abdomen of the

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soldier termite, which has a salivary gland that extends to the end of the abdomen (Noirot 1969). This species is commonly found in coconut and oil-palm plantations in Malaysia and Java (Harris 1971). With the rapid urbanization in Malaysia and the neigboring Southeast Asian countries, many plantations have been cleared and developed to become residential premises and complexes. This species is now readily found along the perimeters of buildings and structures in Malaysia (Lee 2002b). In many instances, it was found infesting door and window frames of dwellings.

Despite the potential of *G. sulphureus* as a structural pest in the Indo-Malayan region, limited information is available on this pest species. Information on its biology, ecology and foraging behavior are essential for better management strategies against this species to be developed. In this study, we report our findings on the characterization of two colonies of *G. sulphureus* on a university campus using a modified single-mark-recapture protocol.

MATERIALS AND METHODS

Two field colonies of *Globitermes sulphureus* (A & B) on the Universiti Sains Malaysia Minden campus, located in Penang Island, Malaysia, were selected for this study. Oven dried rubber (*Hevea brasiliensis* Mueller) wooden stakes (4 x 2.5 x 30 cm) were driven into the ground within the vicinity of *G. sulphureus* mounds, leaving about 5 cm of the stake exposed above ground. Survey stakes were checked monthly and a cylindrical-shaped polyethylene container (11 cm diam. x 17 cm height) was installed when termite activity was detected, to serve as a monitoring station. A wooden block consisted of four rubber wood stakes (2.2 x 2.2 x 17 cm) that were tied together, was placed into the monitoring station to act as food bait. All monitoring stations were then covered with soil to avoid possible vandalism.

The monitoring station with the highest termite activity (based on wood consumption rate) was chosen and termites in the station were brought back to the laboratory to be dyed. Our unpublished laboratory study indicated that Nile blue A at concentration of 1% w/w in impregnated rubber wood sawdust was the most suitable lipid-soluble dye for marking this species. After separating them from wood and soil debris using a method described by Tamashiro *et al.* (1973), the termites were fed on the dyed sawdust for three days (first staining). The numbers of dyed termites were recorded before they were released back into the same trap where they were collected earlier. Approximately a month after the release, first recapture was conducted where termites from all monitoring stations were collected and brought back to the laboratory. Monitoring stations with dyed termites were considered to be interconnected to the former dyed termites. Termites were separated, dyed and then released back to the stations where they were collected. This procedure was repeated again (second recapture) after another month period.

Based on the number of collected and dyed termites, colony size was estimated using the modified Lincoln Index (Begon 1979): $N = (n_0 + n_1)n_2 / m$, where, n_0 = total number of dyed termite on first release; n_1 = total number of dyed termite on second release; n_2 = total number of termites in on second recapture; m = total number of dyed termites n_2. Standard error, SE, was also calculated according to Bailey (1951): $SE = [(n_0 + n_1)^2 (n_2 + 1)(n_2 - m) / (m + 1)^2 (m + 2)]$.

RESULTS AND DISCUSSION

Results from the first recapture indicated that for colony A (Fig. 1), monitoring stations number 2, 3, 4, 6, 9, 10, 11, 32, 33, and 34 were interconnected, while colony B had monitoring station number 2, 3, 5, 6, and 10 that belonged to the same colony (Fig. 2). Colony A had a foraging area of 61.9 m^2, while the latter occupied an area of 25.8 m^2 (Table 1). Estimation of foraging population using single-mark recapture technique recorded a foraging population of 4.02×10^6 for colony A and 1.24×10^6 for colony B, respectively (Table 1). Colony A showed a much higher mean wood consumption rate than colony B with 57.6 ± 10.5 g/month/station, compared to 36.2 ± 2.0 g/month/station in the latter.

Foraging populations and territories of *G. sulphureus* estimated in this study are readily distinguishable from other termite species. For example, colony size for *Heterotermes aureus* (Snyder) was estimated at 2.3×10^5 with a foraging territory of 12.5 m^2 (Haverty *et al.* 1976), *Macrotermes subhyalinus* (Rambur) – 1.4×10^6 (Darlington 1984), *Coptotermes formosanus* Shiraki – $(1.8 - 4.4) \times 10^6$ (Su *et al.* 1984), *Coptotermes acinaciformis* (Froggat) – $(0.4 - 19.1) \times 10^6$, 266 m^2 (Grace *et al.* 1989), *Reticulitermes flavipes* (Kollar) – $(2.1 - 3.2) \times 10^6$, 266 - 1091 m^2 (Su *et al.* 1993), *Reticulitermes hesperus* Banks – $(7.9 - 8.3) \times 10^5$ (Haagsma *et al.* 1995), *Coptotermes gestroi* Wasmann – $(1.13 - 2.75) \times 10^6$ (Sornnuwat *et al.* 1996), *Reticulitermes speratus* (Kolbe) – $(1.1 - 4.7) \times 10^5$, 6.0-56.6 m^2 (Tsunoda *et al.* 1999), *Coptotermes curvignathus* – $(1.7 - 7.1) \times 10^5$ (Sajap *et al.* 2000) and, *Coptotermes travians* (Haviland) – $(0.3 - 1.3) \times 10^6$, 125-384 m^2 (Lee 2002a).

Foraging biomass for colony A and colony B is 14.4 kg and 4.6 kg, respectively (Table 1). These figures fall into the range of *Coptotermes formosanus* Shiraki (4 - 34 kg) as reported by Su & Scheffrahn (1988).

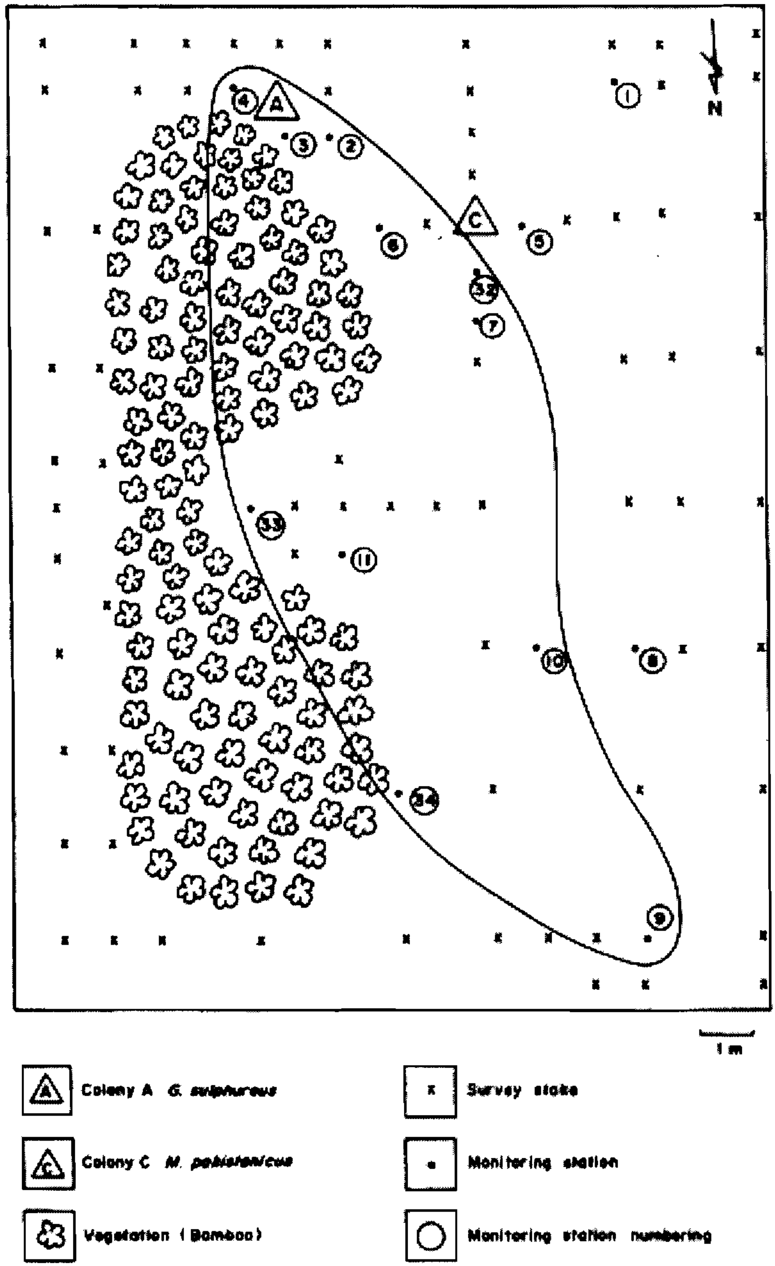

Fig. 1. Foraging territory of mound-building subterranean termite, *Globitermes sulphureus* (Colony A).

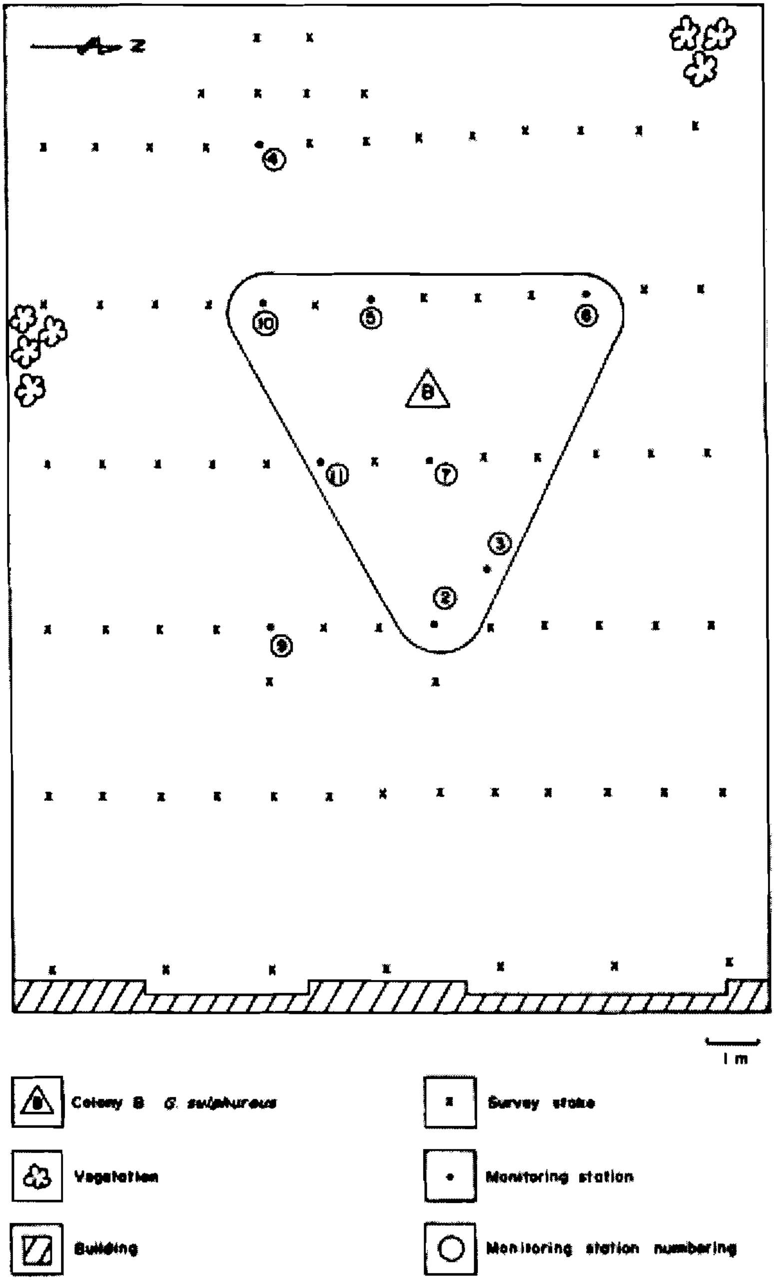

Fig. 2. Foraging territory of mound-building subterranean termite, *Globitermes sulphureus* (Colony B).

Table 1. Characteristics of two colonies of mound-building subterranean termite, *Globitermes sulphureus* (Haviland) in a university campus.

Colony	$[n_o]^1$	$[n_1]^2$	$[n_2]^3$	$[m]^4$	N^5	SE^6	L^7 (m^2)	B^8 (kg)	D^9 (m)
A	2680	11993	23810	87	4.02×10^6	0.42×10^6	61.9	14.4	15.0
B	2839	1399	2045	7	1.24×10^6	0.36×10^6	25.8	4.6	3.5

[1]numbers of stained termite released to mark the foraging area (1st release)
[2]total numbers of stained termite released (2nd release)
[3]total number of termites recapture (2nd recapture)
[4]total number of stained termites in $[n_2]$.
[5]population estimation using Lincoln Index (Begon 1979), $N = (n_o + n_1) n_2 / m$
[6]standard error (Bailey, 1951 in Begon 1979),
$SE = [(n_o + n_1)^2 (n_2 + 1)(n_2 - m) / (m + 1)^2 (m + 2)]$
[7]foraging area
[8]foraging biomass
[9]foraging distance

G. sulphureus could forage up to a distance of 15.0 m from the mound. However, Lai (1977) had reported that foraging distance for *Coptotermes formosanus* Shiraki is about 100 m.

Several environmental factors that might have an effect on the estimation of colony size were observed near the study sites. A shaded area caused by vegetation and the coexistance of other termite colonies (termite mound labeled C)(Fig. 1) could restrict or increase the foraging area of *G. sulphureus* (Sornnuwat *et al.* 1996, Su & Scheffrahn 1988, Polizzi & Forschler 1998). Besides that, displacement of *G. sulphureus* in monitoring stations by *Coptotermes havilandi* Holmgren occurred after the mark-recapture study for colony B. This phenomena was observed earlier by Su & Scheffrahn (1988) where *R. flavipes* (Kollar) was displaced by *C. formosanus* Shiraki.

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