Foraging Populations and Territories of a Mound-Building Subterranean Termite, *Microtermes pakistanicus* (Isoptera: Macrotermitinae)

by

Chow-Yang Lee[1], Peng-Soon Ngee[1] & Leng-Choy Lee[1,2]

ABSTRACT

A study was conducted in a university campus setting to characterize foraging populations and territories of a mound-building higher subterranean termite, *Microtermes pakistanicus* Ahmad. The triple-mark recapture technique revealed that the foraging populations of four *Microtermes pakistanicus* colonies (A, B, C and D) were (1.25 ± 0.03) x 10^5, (4.47 ± 0.13) x 10^5, (1.07 ± 0.04) x 10^5 and (5.59 ± 0.17) x 10^5, respectively. Termite foragers occupied an area of 30.5 – 54.2 m^2, while foraging biomasses ranged between 0.33 – 1.99 kg. The maximum foraging distance was registered at 10.5 m. Mean wood consumption rate per month ranged between 397.4 – 795.2 g $month^{-1}$.

Key words: *Microtermes pakistanicus*, foraging territory, foraging distance, wood consumption rate, mound-building termite.

INTRODUCTION

Termite infestation is a major problem in many tropical countries including Malaysia (Lee *et al.* 1999). In addition to several *Coptotermes* species that cause widespread and serious damage to forests, agricultural crops (rubber and oil-palm) and urban buildings, other species such as *Globitermes sulphureus*, *Microtermes pakistanicus*, *Macrotermes gilvus* and *Microcerotermes* spp. are also regularly found along the perimeter of urban buildings (Lee *et al.* 1999; Lee 2002a).

Fungus-growing termites (Macrotermitinae) such as *Macrotermes* spp. and *Microtermes* spp. are considered important pests of crops (Cowie *et al.* 1989; Harris 1971) in Africa and Malaysia. Cowie *et al.* (1989) reported that in Africa and India, the most serious losses (up to 100%) were due predominantly to macrotermitini such as *Microtermes* spp.

Of the 58 *Microtermes* species that have been described, only 14 of them are oriental species (West Pakistan, India, Eastern Bengal,

[1]Urban Entomology Laboratory, Vector Control Research Unit, School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, MALAYSIA. Email: chowyang@usm.my

[2]Current address: Dow AgroSciences Asia Sdn Bhd, Level 6, CP Tower, No. 11, Section 16/11, Jalan Damansara, 46350 Petaling Jaya, Selangor, MALAYSIA.

Ceylon, Burma, Thailand, Malaysia and Indonesia) (Roonwal 1969; Tho 1992). In Malaysia, *M. pakistanicus* is a small mound-building termite that has dimorphic soldiers. They sometimes also occur in the mounds or nests of other termite species, especially *M. carbonarius* and *M. gilvus*. Based on our field observation, one characteristic that can easily distinguish this termite species from the other peridomestic species is that its major soldiers release a fluid with a lemon-like odor when disturbed.

M. pakistanicus is widespread and common throughout Malaysia and especially in the agriculture sector, mainly rubber, oil palm and sugar cane plantations (Tho 1992). This termite species is also a serious pest of tea plantation in Peninsular Malaysia (Lee 2002a; Roonwal 1969). Mora *et al.* (1996) reported that termites belonging to the genus *Microtermes* occasionally attack living plants; however, in natural ecosystems, they forage more regularly on dead plants. Despite its pest status in forested and agricultural sectors, and its potential as a structural pest, basic biology and ecology of this species is seriously lacking, and urgently needed. In this paper, we present our findings on foraging populations and territories of *M. pakistanicus* from a university campus setting.

MATERIALS AND METHODS

Four colonies of *M. pakistanicus* were chosen in this study. All colonies occurred at the Universiti Sains Malaysia campus, located in Penang Island, Malaysia. Oven dried rubber (*Hevea brasiliensis* Mueller) stakes (4.0 x 2.5 x 30 cm) were driven into the ground, exposing about 5 cm of the stake to allow easy detection. When termite activity was detected, a cylindrical plastic container (11 cm diam. x 17 cm. height) was installed, and this served as underground monitoring station. A total of 5, 7, 4 and 4 monitoring stations were set up for colony A, B, C and D, respectively. Pre-weighed and dried wooden blocks consisting of four rubber wood stakes (2.2 x 2.2 x 17 cm) tied together, were placed into the monitoring station to serve as food source for foraging termites. All monitoring stations were checked monthly and wooden blocks were removed and replaced. The wooden blocks that were partially consumed were brought back to the laboratory, cleaned and oven-dried to determined total wood consumption per month. Foraging termites were returned to the stations after they were dyed (see below).

Population size was determined with the triple-mark-recapture method (Su & Scheffrahn 1988; Su *et al.* 1993). Termites collected from the traps were brought back to the laboratory and separated using method described by Tamashiro *et al.* (1973). They were then force-fed

filter paper that was dyed with 0.5% (w/w) Nile Blue A for three days, then released back to the traps where they were previously collected. The mark-recapture procedures were repeated for three cycles. The number of foraging workers was estimated based on weighted mean model by Begon (1979): $N = (\Sigma M_i n_i)/(\Sigma m_i) + 1$, where, for each i th cycle, n_i = the number of termites captured; m_i = number of marked individuals among captured termites; and M_i = total number of marked individuals up to the i th cycle. $SE = N \{[1/(\Sigma m_i + 1)] + [2/(\Sigma m_i + 1)^2] + [6/(\Sigma m_i + 1)^3]\}^{1/2}$.

RESULTS AND DISCUSSION

Based on the results obtained from the triple mark-recapture study, foraging populations of four *M. pakistanicus* colonies (A, B, C and D) were 1.25×10^5, 4.47×10^5, 1.07×10^5 and 5.59×10^5, respectively and the S.E. ranged between 2.5 – 3.4% (Table 1). This study used triple mark-recapture to provide an estimation of population sizes. This is in contrast with previous studies that provided limited information on foraging area only or, where population sizes were derived from numbers of termite per area or object (Badawi *et al.* 1984a; Badawi *et al.* 1984b; Pearce *et al.* 1990; Mora *et al.* 1996). Mark-recapture population size estimation is considered a more feasible method than direct excavation. Darlington (1984) found that counts of live or dead *Macrotermes* spp. in excavated mounds can underestimate the population by up to an order of magnitude. Furthermore, Mora *et al.* (1996)

Table 1. Foraging populations of four colonies of *Microtermes pakistanicus* Ahmad based on triple mark-recapture technique.

Colony (traps)	First collection & marking	Cycle	r_i	n_i	m_i	N	SE
A (5)	3694	1	3475	4711	235		
		2	4489	6382	547	1.25×10^5	3178
		3	6153	8924	768		
B (7)	7925	1	7639	8812	273		
		2	8562	10915	384	4.47×10^5	13393
		3	9981	9732	459		
C (4)	4570	1	4221	3983	115		
		2	3802	4119	272	1.07×10^5	3655
		3	3967	3483	471		
D (4)	10,762	1	10,017	12,355	225		
		2	11,988	10,314	393	5.59×10^5	17186
		3	9976	7549	441		

Table 2. Characteristics of the four colonies of *M. pakistanicus* in this study.

Colony	Total foraging area (m^2)	Maximum foraging distance (m)	Total wood consumption/mo (g)	Mean worker weight (mg)	Foraging biomass (kg)
A	32.8	7.3	546.8	3.05 ± 0.2	0.38
B	54.2	10.5	795.2	3.43 ± 0.3	1.53
C	30.5	5.7	397.4	3.14 ± 0.2	0.33
D	39.7	7.9	591.7	3.56 ± 0.2	1.99

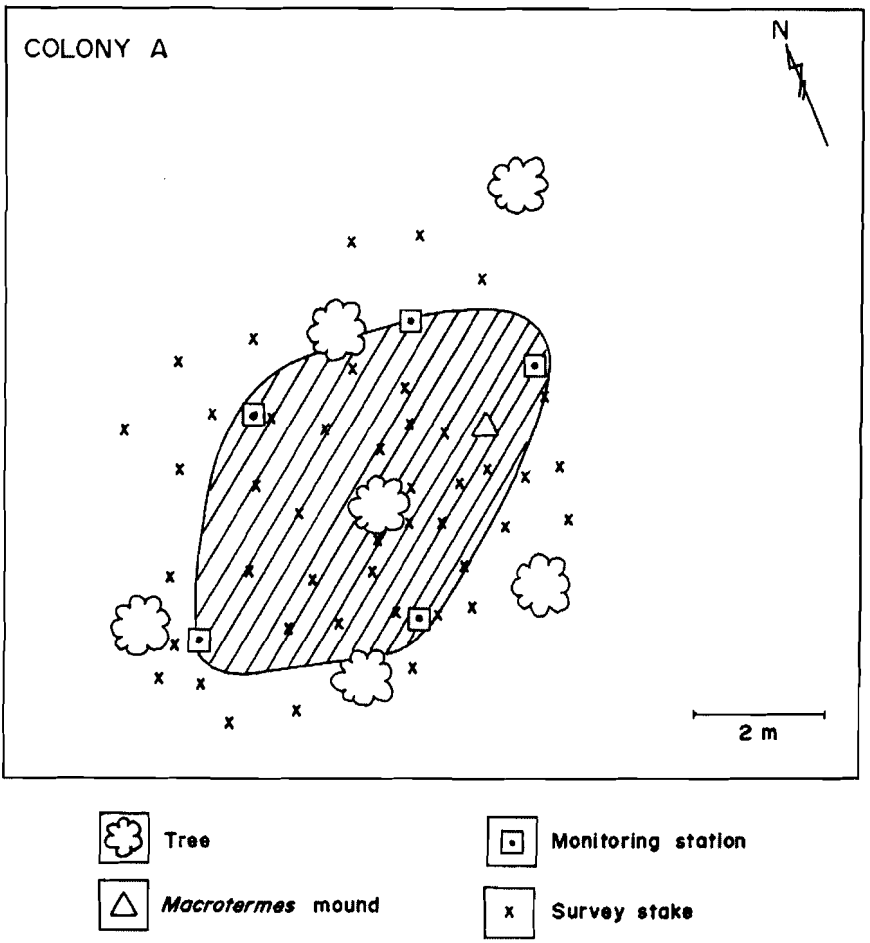

Fig. 1. Foraging territory of colony A, *Microtermes pakistanicus*.

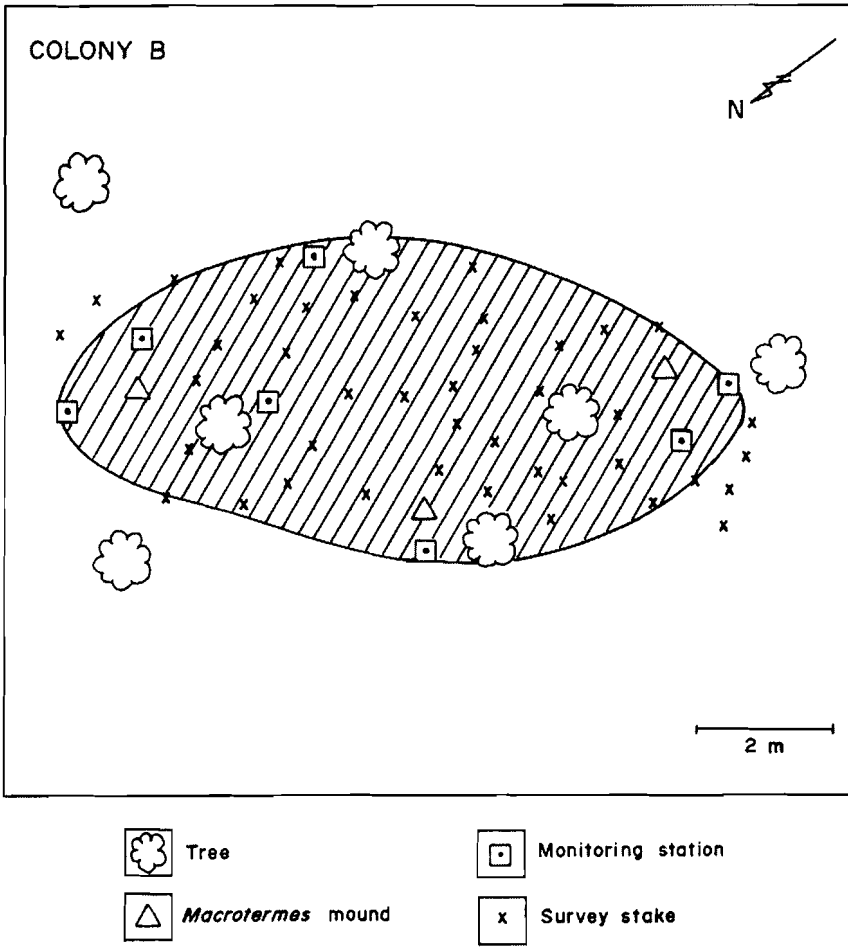

Fig. 2. Foraging territory of colony B, *Microtermes pakistanicus*.

reported on changes of nest structure of *Microtermes subhyalinus* under different seasons especially the fungus comb, and there appeared to be a positive correlation between fungus comb densities and foraging activity.

Regardless of estimation methods used, foraging populations estimated in this study (Table 1) were 2 – 11 fold larger than *Microtermes* sp. populations reported by Badawi *et al.* (1984b), and approximately 5 times larger than *Macrotermes carbonarius* (Matsumoto 1976) from the subfamily Macrotermitinae. However, compared to other mound-building termite species in the region such as *G. sulphureus*, *M. pakistanicus* has smaller populations, where the former has population sizes esti-

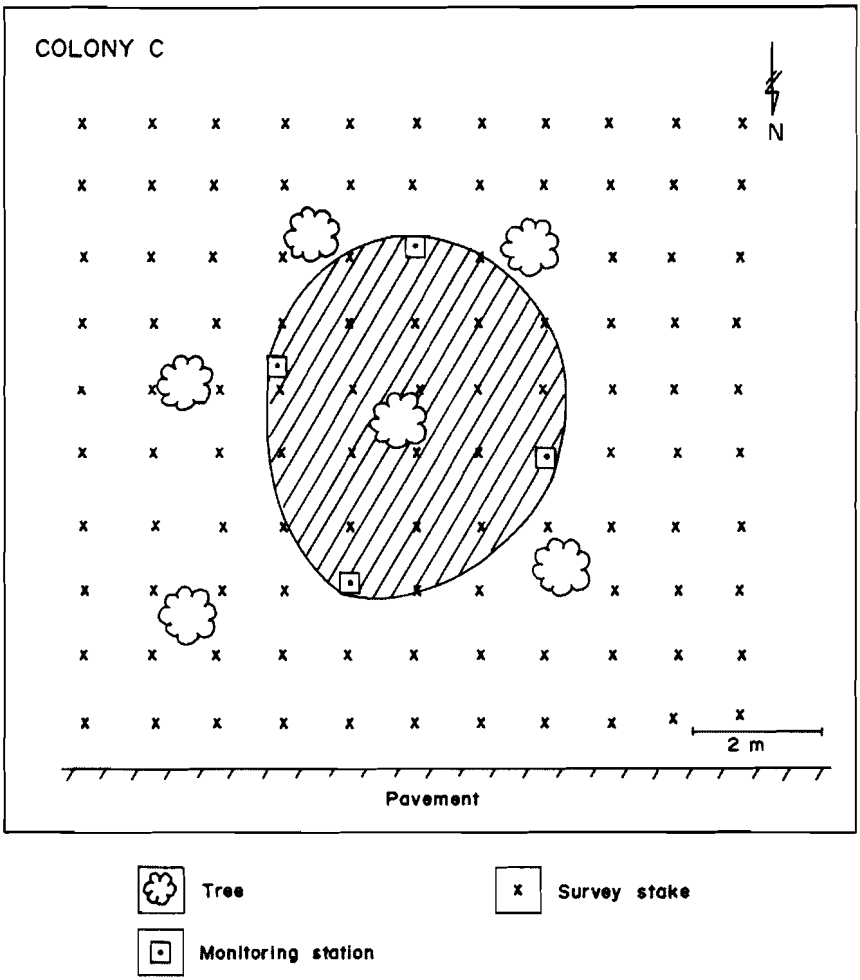

Fig. 3. Foraging territory of colony C, *Microtermes pakistanicus*.

mated at 1.24 – 4.02 x 10^6 foragers (based on single mark-recapture technique [Ngee & Lee 2002]). On the other hand, an above-ground foraging termite species, *Hospitalitermes umbrinus* was estimated to have 5 x 10^5 individuals (Collins 1979).

Generally, larger population sizes and longer foraging distances occur in lower termites belonging to family Rhinotermitidae (such as *Coptotermes* spp. and *Reticulitermes* spp.) (King & Spink 1969; Lai 1977; Spragg & Paton 1980; Su & Scheffrahn 1988; Grace *et al.* 1989; Su *et al.* 1993; Su 1994; Haagsma & Rust 1995; Forschler & Townsend 1996; Sornnuwat *et al.* 1996; Evans *et al.* 1998; Evans *et al.* 1999; Sajap

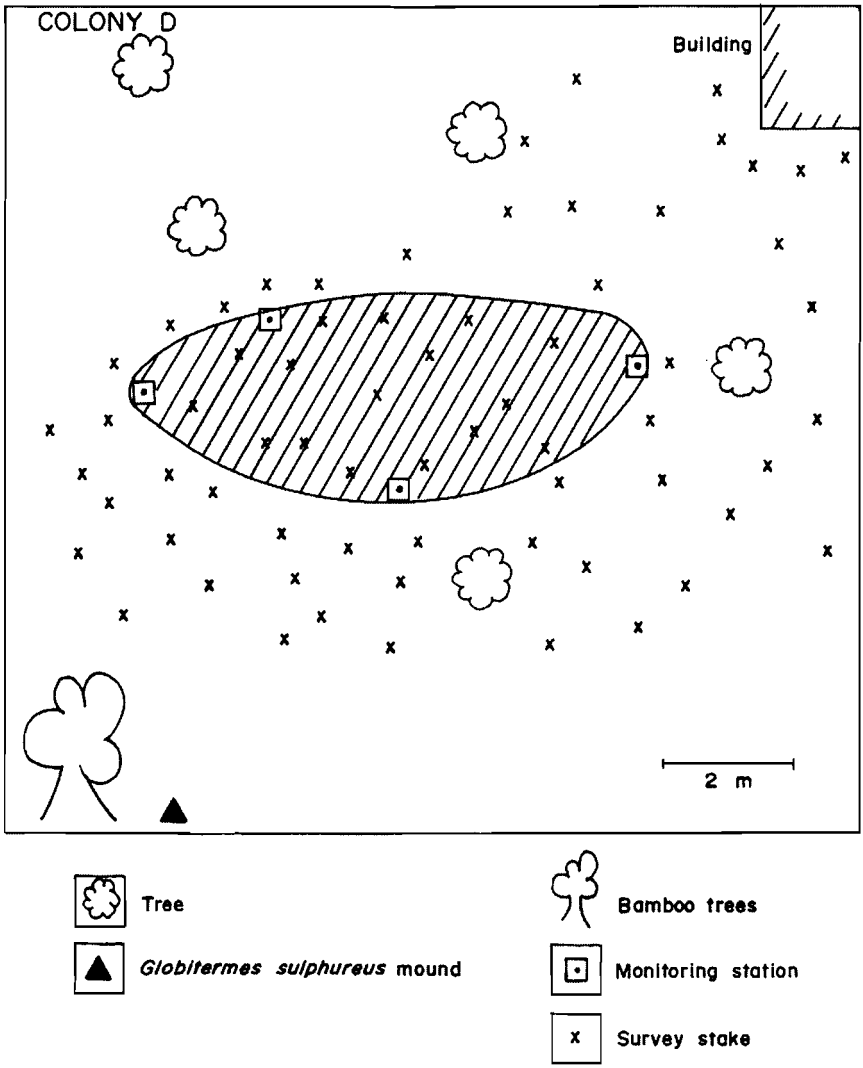

Fig. 4. Foraging territory of colony D, *Microtermes pakistanicus*.

et al. 2000; Lee 2002b). In this study, we found that foraging distances for *M. pakistanicus* (colony A, B, C and D) were 7.3, 10.5, 5.7 and 7.9 m, respectively (Table 2; Figure 1 - 4), and shorter than local rhinotermitids such as *Coptotermes travians* (17 – 32 m) (Lee 2002b). However, when compared with higher termites, *G. sulphureus* (3.5 – 15 m) (Ngee & Lee 2002), the results obtained were comparable. Pearce *et al.* (1990) reported the foraging distances of *Microtermes* sp. at 11.3 – 42.0 m. This

termite species however, showed relatively smaller foraging biomasses (0.38 – 1.99 kg) (Table 2) when compared to *G. sulphureus* (4.6 – 14.4 kg) (Ngee & Lee 2002).

In this study, the maximum foraging area was relatively small (54.2 m^2) (Table 2). This was 7-fold smaller than *C. travians* (384 m^2) as reported by Lee (2002b) and 64-fold smaller than *Coptotermes formonsanus* (3500 m^2) as reported by Su & Scheffrahn (1988).

All *Microtermes* colonies characterized in this study showed a larger foraging territory (Figure 1 – 4) when compared to *Microtermes* spp. (ca. 18.2 m^2) as reported by Badawi *et al.* (1984b), but smaller than those reported by Pearce *et al.* (1990) for *Microtermes najdensis* (1390 m^2). Foraging areas of several mound-building subterranean termite species such as *Microcerotermes* spp. (31.8 m^2) (Badawi *et al.* 1984b) and *G. sulphureus* (25.8 m^2) (Ngee & Lee 2002) were generally smaller than *M. pakistanicus* colonies in this study.

Based on the mean wood consumption rate data (Table 2), *M. pakistanicus* has a comparable feeding rate with *Coptotermes travians* (478.2 – 643.7 g $month^{-1}$) (Lee 2002b). Mean wood consumption rate data were 546.8, 795.2, 397.4 and 591.7 g $month^{-1}$ for colony A, B, C and D, respectively. In general, we hypothesize that higher feeding rate in *M. pakistanicus* is due to a more centralized feeding pattern and a smaller foraging territory, rather than a wider feeding pattern as noted for *Coptotermes* spp. (Su & Scheffrahn 1988; Lee 2002b). We also observed this species has the tendency to forage near to the nest or mound, and generally maximize utilization of nearer food sources.

The information reported here for *M. pakistanicus* has application in developing management strategies against this species and will assist current on-going studies on termite baiting in Malaysia and neighboring Southeast Asia region.

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