Control of Foraging Colonies of Subterranean Termites, *Coptotermes travians* (Isoptera: Rhinotermitidae) in Malaysia Using Hexaflumuron Baits

by

Chow-Yang Lee[1]

ABSTRACT

Coptotermes travians (Haviland) is one of the most important subterranean termite pest species attacking urban buildings and structures in Malaysia. Two colonies of *C. travians* infesting residential premises (Colony A & B), and another one in a natural habitat (Colony C) were characterized. Foraging territories ranged between 125 – 384 m^2, with maximum foraging distances of 17 – 32 m per colony. At pre-baiting, mean wood consumption were recorded at 526.4 g $month^{-1}$, 478.2 g $month^{-1}$ and 643.7 g $month^{-1}$ for colony A, B and C, respectively. Colony sizes for the three colonies were estimated using a triple mark-recapture method. Colony size ranged between 3.2×10^5 to 1.3×10^6 workers. Baiting against colony A and B was done using both in-ground and above-ground hexaflumuron baits, while only in-ground baiting was executed against colony C. The baits caused a substantial reduction in wood consumption rate in independent monitoring stations within 34 – 44 days post-baiting. At this stage, more soldiers were observed with a small number of workers. No termite activity was visible in the independent monitoring stations, as well as the bait stations at 49, 55 and 62 days post-baiting for colony C, A and B, respectively. Some challenges of baiting subterranean termites in Malaysia are discussed.

Key words: subterranean termites, *Coptotermes travians*, foraging colonies, baiting, hexaflumuron baits, Malaysia.

INTRODUCTION

Subterranean termites are a major group of insect pests in the urban environment in Malaysia (Lee *et al.* 1999; Lee & Robinson 2001). Its control accounted about US$8 – 10 million per year, which constitutes about 50% of the total business turnover for the pest control industry in the country for the year 2000 (Lee 2002). There are a total number of 175 species of termites in Malaysia (Tho 1992; Kirton & Wong 2001),

---

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

but only five species are common structural pests, namely *Coptotermes travians* (Haviland), *Coptotermes curvignathus* Holmgren, *Coptotermes havilandi* Holmgren, *Coptotermes kalshoveni* Kemner and *Coptotermes sepangensis* Krishna (Lee 2002). Based on a survey conducted with the help of pest control operators in central Peninsular Malaysia, *C. travians* is the predominant species (53%) attacking buildings and structures, followed by *C. curvignathus* (28%). More than 65% of the total pest control operations were done in residential premises, followed by 20% in industrial sectors (factories, warehouses, etc.) and 10% in commercial buildings (supermarkets, office complexes, etc.) (Lee 2002). Despite the importance of *C. travians* in Malaysia, limited information is available on the biology and control of this pest species. This study aimed to characterize foraging populations of *C. travians*, as well as to determine the performance of hexaflumuron baits (Sentricon®, Dow AgroScience, Indianapolis, IN) against these populations.

MATERIALS AND METHODS

Three colonies of *C. travians* were characterized. Two colonies (A and B) were infesting residential premises, namely in Gelugor and Sg Ara, respectively, while the other one was located in a natural habitat (Minden) [colony C]. All sites were located in Penang Island, Malaysia. Prior to colony characterization, oven-dried rubber (*Hevea brasiliensis* Mueller) wood stakes were driven into the ground along the perimeter of the structures, or open space, and replaced with monitoring stations containing pre-weighed dried rubber wood slates upon being attacked by termites (Su & Scheffrahn 1986). A total of 4, 5 and 4 monitoring stations were set up for colony A, B and C, respectively. The monthly wood consumption rate of each population was determined up to three months of feeding.

Population size was determined with triple mark-recapture method as described in Su & Scheffrahn (1988). Termites were collected, brought back to the laboratory, separated according to method described by Tamashiro *et al.* (1973), and forced-fed on filter paper pre-dyed with 0.1% Nile Blue A (Su *et al.* 1991) They were then released back into the traps where they were collected earlier and the mark-recapture process was repeated for three cycles. The colony sizes were estimated based on weighted mean model by Begon (1979). After colonies were characterized, they were left undisturbed for a month, before baiting started. Hexaflumuron-based baits (Recruit II®, Dow AgroScience, Indianapolis, IN) were placed in 2 – 3 selected monitoring stations (while wood-consumption measurement in other monitoring stations continued) and Recruit AG® (Dow AgroScience, Indianapolis, IN) were deployed onto mud-tubes inside structures. The bait matrix in all bait tubes were pre-weighed prior to use. The number of baits applied were as followed: colony A (2 in-ground bait tubes and 3 above-ground baits); colony B (3 in-ground bait tubes and 2 above-ground bait stations), and colony C (3 in-ground bait tubes). Baits were inspected weekly and replenished whenever 70 – 80% bait matrix was consumed. Digitized photographs were taken promptly on exposed wood slates collected from selected independent monitoring station at each inspection, so that the soldier-worker ratio could be determined. Whenever soldier number exceeded that of the workers, inspection was done every 3 – 4 days until termites were no longer seen in all monitoring stations. Bait tubes were then replaced with wood slates, and inspection continued up to 6 months post-elimination. The total amount of bait matrix consumed in all bait tubes were also determined.

RESULTS AND DISCUSSION

Foraging distance of the three *C. travians* colonies ranged between 17 – 32 m, and demonstrated foraging territories of 125.2 – 283.8 m^2 (Table 1). These findings were much larger than those reported for *C. curvignathus* (Sajap *et al.* 2000) where they demonstrated foraging territories of 15 – 50 m^2, but smaller than those reported for the Formosan subterranean termites, *Coptotermes formosanus* Shiraki, ranging between 160 – 3,500 m^2 (Su & Scheffrahn 1988; Su 1994). The Formosan subterranean termites also showed a longer foraging distance (30 – 185 m) compared to *C. travians*. The population sizes characterized for *C. travians* was bigger compared to *C. curvignathus* (0.2 – 0.7 x 10^6 individuals), but comparable to *C. gestroi* (1.1 – 2.8 x 10^6 individuals) in Thailand (Sornnuwat *et al.* 1998). Tho (1992) reported the difficulty to differentiate *C. travians* and *C. gestroi* (Wasmann), as they are morphologically very similar. The wood consumption rate ranged between 478.2 – 643.7 g/mo. (Table 1). This possibly suggested that the colony in natural habitat showed a much higher feeding activity which could likely due to a higher number of foragers, as estimated in this study.

Table 1: Characteristics of three colonies of *Coptotermes travians* in Malaysia

Colony	Foraging distance (m)	Foraging territory (m^2)	Colony size (x 10^5)	Wood consumption rate (g/mo)
A	17	125.2	3.2	526.4
B	19	149.5	4.6	478.2
C	32	383.8	13.0	643.7

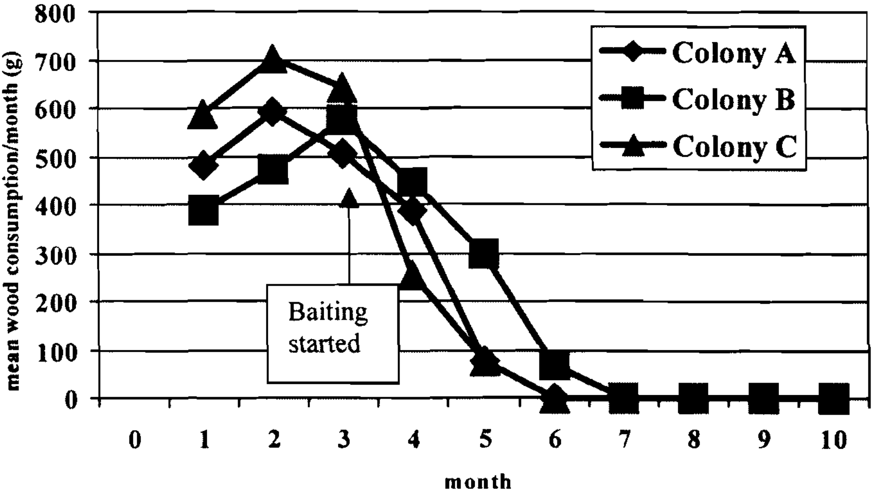

Fig. 1. Monthly wood consumption rate (g/month) of three populations of *Coptotermes travians* (before and after baiting)

Hexaflumuron baits performed very well against *C. travians* in all tested sites. Fig. 1 showed the monthly wood consumption rate of the three colonies in independent monitoring stations at pre- and post-baiting. It is evident that wood consumption rates were drastically reduced upon baiting. After 34 – 44 days post-baiting, more soldiers were found in the independent monitoring stations, compared to the workers (Table 2) This provided a positive indication that the workers' activities were likely to be affected by hexaflumuron at that stage, or they have been killed. I also observed poorer sanitary condition on the wooden slates, than those recorded prior to baiting. Small organisms such as diplurans and collembolans were spotted, as well as infesting fungi. This observation has also been previously reported by Su *et al.* (1998).

It took 49 – 62 days to achieve zero activity in independent stations (Table 2). This provided an indirect evidence that the termite colony has been eliminated. Furthermore, no termite activity were detected up to 6 months post-elimination. Su & Scheffrahn (1998) recently reviewed that a direct evidence to confirm the death of all termites in a subterranean colony maybe difficult to achieve, but the prolonged absence of termite activity in soil previously occupied by a foraging population presents strong evidence that the baited populations or colonies have been eliminated.

The amount of hexaflumuron needed to eliminate a colony of *C. travians* was much larger (924 –1,456 mg) than that needed for *C. curvignathus* (137 – 395 mg) and *C. formosanus* (233 – 742 mg) (Sajap

Table 2: Effects of hexaflumuron baits on three colonies of *Coptotermes travians* in Malaysia

Colony	No. days taken to achieve		Total bait matrix consumed (g)	Total hexaflumuron taken (mg)
	Soldier > worker	Elimination		
A	39	55	184.9	924
B	44	62	244.3	1221
C	34	49	291.2	1456

et al. 2000; Su 1994). However, the amount of time taken to complete colony elimination of *C. travians* and *C. curvignathus* was relatively short, compared to that of *C. formosanus*; this clearly reflected the higher feeding activity of termites in the tropics than those from the subtropical and temperate regions (Su *et al.* 2001). Hexaflumuron baits have also been shown to provide good performance against other species of *Coptotermes* in Malaysia, such as *C. havilandi*, *C. kalshoveni* and *C. sepangensis* (Lee 2002). As most of these species have a smaller or comparable foraging territories and population sizes as *C. travians*, colony eliminations were usually achieved within 44 – 66 days utilizing 450 – 730 mg of hexaflumuron (C.Y. L., unpublished).

However, the biggest challenge of baiting subterranean termites in Malaysia was the ability to bait peridomestic species other than *Coptotermes* spp., such as *Macrotermes gilvus* (Hagen), *Microcerotermes* sp., *Schedorhinotermes* sp., and *Globitermes sulphureus* (Haviland). These species could be found inside structures as early as two months after *Coptotermes* spp. has been suppressed or eliminated (Lee 2002). It posed a major task to pest control operators in Malaysia because most of these species showed poor response to paper-based bait matrix, and they are also highly sensitive to disturbance made during bait inspection. To date, I have not had good success with most of these species due to limited feeding on baits, except for *Schedorhinotermes* spp. Another problem often faced when baiting *Coptotermes* is the displacement of the baited colony with another peridomestic species in the monitoring stations during the tenure of baiting (C.Y.L., unpublished).

ACKNOWLEDGMENTS

We thank L.C. Lee, S.Y. Lim, V. Somasundaram and A. Lazim for technical assistance, D.G. Ouimette and Dow Agrosciences Asia for many helpful discussions and partial funding of this project, respectively.

REFERENCES

Begon, M. 1979. Investigating animal abundance: capture-recapture for biologists. University Park Press, Baltimore, MD.

Kirton, L.G. & A.H. Wong. 2001. The economic importance and control of termite infestations in relation to plantation forestry and wood preservation in Peninsular Malaysia - An overview. Sociobiology 37: 325 - 349.

Lee, C.Y. 2002. Subterranean termite pests and their control in the urban environment in Malaysia. Sociobiology: In press.

Lee, C.Y. & W.H. Robinson. 2001. Handbook of Malaysian Household and Structural Pests. Pest Control Association of Malaysia, Kuala Lumpur, Malaysia. 96 pp.

Lee, C.Y., H.H. Yap, N.L. Chong & Z. Jaal. 1999. Urban Pest Control - A Malaysian Perspective. Universiti Sains Malaysia, Penang, Malaysia. 134 pp.

Sajap, A.S., S. Amit & J. Welker. 2000. Evaluation of hexaflumuron for controlling the subterranean termite *Coptotermes curvignathus* (Isoptera: Rhinotermitidae) in Malaysia. J. Econ. Entomol. 93: 429 - 433.

Sornnuwat, Y., K. Tsunoda, T. Yoshimura, M. Takahashi & C. Vongkaluang. 1996. Foraging populations of *Coptotermes gestroi* (Isoptera: Rhinotermitidae) in an urban area. J. Econ. Entomol. 89: 1485 - 1490.

Su, N.Y. 1994. Field evaluation of a hexaflumuron bait for population suppression of subterranean termites (Isoptera: Rhinotermitidae). J. Econ. Entomol. 87: 389 - 397.

Su, N.Y. & R.H. Scheffrahn. 1986. A method to access, trap, and monitor field populations of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in the urban environment. Sociobiology 12: 299 - 304.

Su, N.Y. & R.H. Scheffrahn. 1988. Foraging population and territory of Formosan subterranean termite (Isoptera: Rhinotermitidae) in an urban environment. Sociobiology 12: 299 - 304.

Su, N.Y. & R.H. Scheffrahn. 1998. A review of subterranean termite control practices and prospects for integrated pest management programs. Integ. Pest. Manag. Rev. 3: 1 - 13.

Su, N.Y., J.D. Thomas & R.H. Scheffrahn. 1998. Elimination of subterranean termite populations from the Statue of Liberty National Monument using a bait matrix containing an insect growth regulator, hexaflumuron. J. Am. Inst. Conserv. 37: 282 - 292.

Su, N.Y., P.M. Ban & R.H. Scheffrahn. 1991. Evaluation of twelve dye markers for population studies of the eastern and Formosan subterranean termites (Isoptera: Rhinotermitidae). Sociobiology 19: 349 - 362.

Su, N.Y., P.M. Ban & R.H. Scheffrahn. 2001. Control of subterranean termites (Isoptera: Rhinotermitidae) using commercial prototype aboveground stations and hexaflumuron baits. Sociobiology 37: 111 - 120.

Tamashiro, M., J. Fujii & P.Y. Lai. 1973. A simple method to observe, trap and prepare large numbers of subterranean termites for laboratory and field experiments. Environ. Entomol. 2: 721-722.

Tho, Y.P. 1992. Termites of Peninsular Malaysia. Malayan Forest Records No. 36: 1 - 224.