# Mark-Recapture Studies with Reticulitermes flavipes (Isoptera: Rhinotermitidae)

by

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## ABSTRACT

Mark-release-recapture studies were conducted at four locations in southern Ontario in summer 1989, with *Reticulitermes flavipes* foragers marked with the dietary dye Sudan (Fat) Red 7B. Although cool weather depressed termite foraging activity at two sites previously surveyed in 1988, the distances travelled by foragers agreed with the results previously reported from these locations. Foraging populations at the two additional sites were estimated (Lincoln index) at 0.72 and 0.94 million termites. At the latter location (Kincardine), marked foragers were recaptured over an area of approximately 285-$m^2$, with a maximum linear foraging distance of 41-m.

## INTRODUCTION

Eastern subterranean termite, *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae), colonies occupy extensive networks of underground galleries. Grace *et al.* (1989) released dye-marked workers at two sites in metropolitan Toronto and, by subsequent recaptures, delimited *R. flavipes* foraging territories and estimated foraging populations at these sites. Dye-marked *R. flavipes* workers moved over areas as large as 1,091-$m^2$ and were recaptured up to 75-m from their release point. The estimated foraging populations of 2.1 and 3.2 million agreed with previous mark-recapture estimates by Esenther (1980), but greatly exceeded the mean *Reticulitermes* colony population of 244,445 derived by Howard *et al.* (1982) from destructive sampling of

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termite colonies. Here, I report the results of additional mark-release-recapture studies at these two sites and at two other locations in southern Ontario. The large foraging distances observed in these studies and new population estimates agree with those previously reported by Grace *et al.* (1989).

## MATERIALS AND METHODS

Eastern subterranean termite, *R. flavipes*, populations were monitored at four sites in southern Ontario. Initially, small (1.5 X 4 X 15-cm) white pine stakes were installed at each site in various grid patterns, dependent upon the configuration and topography of the site. These stakes were checked for termite feeding periodically, and infested stakes replaced with collection units described by Grace (1989). This collection unit (or trap) consists of two short lengths of plastic (ABS) pipe (15 X 4-cm ID) containing rolled corrugated cardboard, placed within a larger (15 X 10-cm ID) pipe buried slightly below the soil surface. By removing the small pipes and capping both ends, foraging aggregations can be transferred intact to the laboratory.

Mark-release-recapture studies in summer 1988 were conducted at two sites in the metropolitan Toronto area, labelled as Scarborough and Toronto (Grace *et al.* 1989). In summer 1989, additional surveys were conducted at these two sites and at two additional locations: Warden and Kincardine.

The Warden site is also located in the City of Scarborough on the bluffs overlooking Lake Ontario, a short distance from the Scarborough site. This site is a narrow public access strip (ca. 20 X 130-m) between a fenced private yard and a golf course. Prior to this study, *R. flavipes* was collected in fallen wood here and shelter tubing was observed on a wooden post supporting a traffic barrier at one end of the site. Approximately 400 stakes were installed at this site, around trees and posts and at 1-m intervals along either side of the strip. This was followed by the installation of ten collection traps.

The Kincardine site is less urbanized than the other three sites, and is situated near a cemetery and an out-of-service railway line at the edge of the Town of Kincardine. Termites were first collected at this location in 1954 (Kirby 1967), and Kincardine (44°11'N, 81°38'W) currently represents the northernmost site

of known *R. flavipes* establishment in Ontario. Stakes (220) were installed in 4 X 4-m and 2 X 2-m grids at this site, followed by the installation of 32 collection traps (Fig. 1).

Termites collected from a single trap at each site were marked by feeding for five days on Whatman No. 1 filter paper impregnated with a 2% (weight/weight) concentration of the oil-soluble dye Fat (= Sudan) Red 7B (Sigma Chemical Co., St. Louis, MO) (Grace & Abdallay 1989; Su *et al.* 1988). These dye-marked termites were counted, and released back into the trap from which they had been originally collected. Termites were then collected from the other traps at each site at 3-6 day intervals over the next three weeks.

In 1989, 1,800 dye-marked termites were released at the Toronto site, 5,000 at Scarborough, 5,824 at Warden, and 3,280 at Kincardine. Four to six sequential collections were then made from the traps at each site. The Toronto and Scarborough studies were conducted in June when cool weather still limited *R. flavipes* foraging activity at the soil surface, and the small number of active traps and relatively small collections from those traps precluded population estimation. The Warden and Kincardine sites were surveyed in August and September, when termite activity was greater, and foraging populations were estimated from recapture proportions by the Lincoln index method (cf. Grace *et al.* 1989). Six collections were made at these sites, and populations estimated for each of the last five collection dates from the proportions of marked and unmarked workers collected in traps containing marked individuals, adjusting for marked termites removed in earlier collections.

## RESULTS AND DISCUSSION

Results of the 1989 studies at the four sites are presented in Table 1. Termite activity was restricted to too few traps at the Scarborough, Toronto, and Warden sites (1-2 traps at each site) to define foraging territories. However, although the release points at both Scarborough and Toronto were outside of the territories defined at these two sites in 1988 (Grace *et al.* 1989), in both cases the recaptures were made from traps located within the previously-defined territories. Marked workers were recaptured at a maximum distance of 46-m from their release point at

the Scarborough site, with comparable distances recorded at Toronto (33-m) and Kincardine (41-m). The strip-like shape of the Warden site restricted the maximum distance travelled by marked workers between traps to 16-m. These linear distances should be considered conservative measurements since, as was observed in 1988, termite activity extended to traps placed at the margins of all sites.

Table 1. Results of 1989 mark-release-recapture studies with *Reticulitermes flavipes* at four sites in southern Ontario.

| Site | Number of Traps[a] | Maximum Foraging Distance(m)[b] | Foraging Area ($m^2$)[b] | Foraging Population (Mean ± SE)[c] |
|---|---|---|---|---|
| Kincardine | 4-9 | 41 | 285 | 943,237± 14,133 |
| Warden | 1-2 | 16 | - | 722,679±189,729 |
| Scarborough | 1-2 | 46 | - | - |
| Toronto | 1-2 | 33 | - | - |

[a]Range of traps containing dye-marked termites.
[b]Maximum linear distance between traps from which dye-marked termites were recovered, and area delimited by trap positions.
[c]Mean of Lincoln index estimates, n=5 collections.

In Kincardine (Fig. 1), marked foragers were recovered from traps located over an area of approximately 285-$m^2$, comparable to the territory of 266-$m^2$delimited in 1988 at the Toronto site. Again, termite activity extended to the margin of the survey plot. Unlike the more urbanized sites, where trap placement is constrained by buildings, streets, etc., it may be possible in Kincardine to enlarge the survey plot beyond its current margins in order to completely delimit *R. flavipes* foraging territories.

Based upon the proportions of marked workers recaptured at Kincardine and Warden, the *R. flavipes* foraging populations were estimated respectively as 943,237±14,133 and 722,679±189,729. Although less than the 1989 estimates of 3.2 and 2.1 million foragers at the Scarborough and Toronto sites, these estimates still fall within Esenther's (1980) Wisconsin mark-recapture estimates of 0.3-9.5 million and exceed the 0.05-0.4 million colony population estimates of Howard *et al.* (1982) from destructive sampling in Mississippi.

Mark-release-recapture methods provide an accurate measure

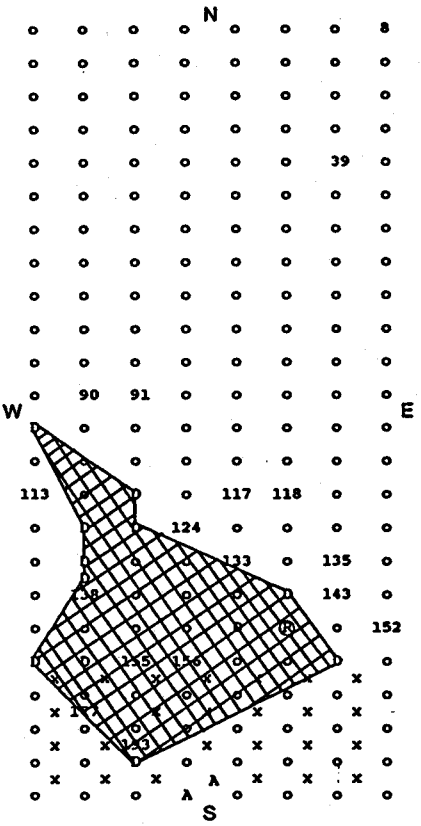


Figure 1. Diagrammatic representation of Kincardine survey plot with *Reticulitermes flavipes* foraging territory (shaded). Stakes placed on 4 X 4-m squares are indicated by "o", and stakes placed in the center of 4 X 4-m squares by "x". Numbers indicate inactive traps, "A" - active traps from which no dyed termites were recaptured, "D" - traps from which dyed termites were recaptured, "R" - release site of dye-marked termites.

of the distances over which subterranean termite populations forage. When collections are made from traps distributed over a relatively large area, recovery of dye-marked termites can also accurately delimit at least the minimum foraging territory of the population, and be used to monitor changes in that territory (cf. Su & Scheffrahn 1988b). For these purposes, cellulosic materials impregnated with a less persistent non-deterrent dye (cf. Grace & Abdallay 1990) might also be placed directly into collection traps in the field to facilitate distribution of the dye through a large portion of the foraging population.

Population estimation by mark-recapture is more problematic than area measurement, primarily due to the assumption of random distribution of marked individuals in the foraging population. Other possible sources of error are (1) passage of the dye by trophalaxis or cannibalism, and (2) differential mortality of dye-marked workers. Of these latter two possibilities, only differential mortality could lead to an overestimate of the true population, and both potential problems can be excluded by prior laboratory evaluation of the dye marker. These studies attempted to minimize problems associated with possible nonrandom distribution by placement of a large number of collection traps over a large area around the release site, since avoidance of traps by marked workers would lead to overestimation of the field population. Overestimation was also avoided by only including foragers collected from traps simultaneously containing marked workers, and by summing the collections from all such traps on each collection date. Thus, the large foraging populations reported here, and by Grace *et al.* (1989) are likely to be conservative estimates. When termite foraging activity at the soil surface is reduced by disturbance or cool weather, as at Toronto and Scarborough in this study, and very few foragers are collected on one or more of the collection dates, reliable population estimation is not possible. Despite these difficulties, mark-recapture currently offers the only practical method of censusing subterranean termite foraging populations over the large territories occupied by *Coptotermes* (Su & Scheffrahn 1989a) and *Reticulitermes species*.

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## REFERENCES

Esenther, G.R. 1980. Estimating the size of subterranean termite colonies by a release-recapture technique. Inter. Res. Group on Wood Preserv., Doc. No. IRG/WP/1112. 5 pp.

Grace, J.K. 1989. A modified collection trap technique for monitoring *Reticulitermes* subterranean termite populations (Isoptera: Rhinotermitidae). Pan-Pac. Entomol. 65: 381-384.

Grace, J.K., & A. Abdallay. 1990. A short-term dye for marking eastern subterranean termites (*Reticulitermes flavipes* Koll., Isoptera, Rhinotermitidae). J. Appl. Entomol. *in press*.

Grace, J.K., & A. Abdallay. 1989. Evaluation of the dye marker Sudan Red 7B with *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). Sociobiology 15: 71-77.

Grace, J.K., A. Abdallay, & K.R. Farr. 1989. Eastern subterranean termite (Isoptera: Rhinotermitidae) foraging territories and populations in Toronto. Can. Entomol. 121: 551-556.

Howard, R.W., S.C. Jones, J.K. Mauldin, & R.H. Beal. 1982. Abundance, distribution and colony size estimates for *Reticulitermes* spp. (Isoptera: Rhinotermitidae) in southern Mississippi. Environ. Entomol. 11: 1290-1293.

Kirby, C.S. 1967. Termites in Ontario, with particular reference to the Toronto region. Can. Dept. Forestry and Rural Develop., For. Res. Lab. Info. Rep. O-X-56. 30 pp.

Su, N.-Y., & R.H. Scheffrahn. 1988a. Foraging population and territory of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in an urban environment. Sociobiology 14: 353-359.

Su, N.-Y., & R.H. Scheffrahn. 1988b. Intra- and interspecific competition of the Formosan and eastern subterranean termite: evidence from field observations (Isoptera: Rhinotermitidae). Sociobiology 14: 157-164.

Su, N.-Y., R.H. Scheffrahn & P. Ban. 1988. Retention time and toxicity of a dye marker, Sudan Red 7B, on Formosan and eastern subterranean termites (Isoptera: Rhinotermitidae). J. Entomol. Sci. 23: 235-239.