Temporal and Spatial Variation in Caste Proportions in a Northern *Reticulitermes flavipes* Colony (Isoptera: Rhinotermitidae)

by

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ABSTRACT

Reticulitermes flavipes (Kollar) foragers were collected at 2-4 week intervals during spring and fall 1988 from traps placed upon a tree stump and below the soil surface throughout a field site in the City of Scarborough, Ontario. Caste proportions were determined from all collections. Nymphs represented approximately 2% of foragers collected from the tree stump in May and early June, but 31-47% of the foragers collected in this trap from late June through early August. During this same period of June and August, nymphs represented 2-8% of the foragers within the traps placed in the surrounding soil. In late August, nymph proportions in the stump trap declined to the level of those in the soil. No alates were collected from any traps. These results indicate a preferential aggregation of nymphs in the vicinity of a large perennial resource, and support previous suggestions that neotenic reproductives arising from the numerous nymphs that develop in the spring are the major reproductive forms in *R. flavipes* colonies in the northern portion of the geographic distribution of this species.

INTRODUCTION

The eastern subterranean termite, *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae), enjoys a broad geographic distribution in North America from the state of Florida in the south to the Canadian province of Ontario in the North (Weesner 1970, Kirby 1965). The most complete published study of caste proportions in *R. flavipes* field colonies has been that of Howard & Haverty (1980, 1981) in the southern portion of this range (Mississippi). Esenther (1969) summarized his studies of *R. flavipes* demographics in a northern habitat (Wisconsin), emphasizing the rare occurrence of the alate stage in comparison to southern termite populations, but provided few details on other caste proportions. To date, the most detailed study of *R. flavipes* colony demographics and caste development and proportions in a northern climate was probably the unpublished M. Sc. research of

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Husby (1980) in southern Ontario.

Both Esenther (1969) and Husby (1980) destructively sampled different *R. flavipes* colonies at various times of the year, collecting from termite-infested wood debris and the surrounding soil in order to obtain as large a sample as possible from each location. Howard & Haverty (1981), on the other hand, followed the demographics of a set of *R. flavipes* field colonies over time by collecting from pine bolts placed as baits around infested logs, although different colonies were sampled at different times over the course of their two-year study.

In this paper, I report the seasonal pattern of caste proportions within foraging groups collected using a baiting technique from an *R. flavipes* field colony in Metropolitan Toronto, Ontario. Mark-release-recapture methods were employed to determine that this colony extended over an area of at least 1091-m^2 and contained a foraging population of approximately 3.2 million (Grace *et al.* 1989). Collection traps were located both in the soil within this foraging territory, and on top of a termite-infested tree stump in order to determine whether caste proportions might vary in proximity to a large perennial resource. This is not an unusual expectation, since aggregation of certain castes is known to occur in *R. flavipes* (Howard & Haverty 1980, Zimet 1980) as in other social insects; and in a northern climate it is likely that trees and stumps might serve as a refuge from cold weather and thus more centralized nesting locations than the network of galleries extending through the soil.

MATERIALS AND METHODS

Reticulitermes flavipes foragers were collected at 2-4 week intervals during 1988 from traps placed at a field site in the City of Scarborough, in the Metropolitan Toronto region, on the bluffs overlooking Lake Ontario (43°44'N, 79°16'W). Traps buried just beneath the soil surface have been described in detail by Grace (1989a), and consisted of 15cm lengths of plastic (ABS) pipe containing rolled corrugated cardboard. During the survey period, 44 soil traps were installed at the site, at minimum 2m distances from each other. All traps were monitored at each collection period, with from 1 to 22 traps found to contain termites. In addition to the collection traps in the soil, a 15cm length of 10cm diameter plastic pipe, containing rolled corrugated paper and capped with a plastic pipe cap, was secured by brackets and screws to the top of a maple (*Acer negundo* L.) stump near the north end of the field site.

Mark-release-recapture studies (Grace *et al.* 1989, Grace 1990) using a fat-soluble dye established that a single *R. flavipes* colony was

present at this field site, foraging over an area of at least 1091-m^2 and containing approximately 3.2 million foragers. Individual collections from the trap placed on the stump ranged from 776 to 13,286 termites, while the total number of termites collected in the soil traps on a single sampling date ranged from 553 to 56,737. All termites were returned to the laboratory, counted and individually examined to determine caste composition. A total of 185,922 termites were examined in the course of the 7 months of foraging activity at the site.

Caste determinations followed the terminology of Miller (1969), which was also used by Howard & Haverty (1981). Pseudergates were externally undifferentiated individuals of at least the third instar (as determined by size), larvae were undifferentiated individuals of less than the third instar, soldiers were recognized by their distinctive morphology, and nymphs were individuals of at least the third instar possessing external wing pads of any length. No apterous neotenic reproductives nor presoldiers were noted in the collections, although some such individuals could easily have been categorized as pseudergates in the first case, or as either pseudergates or soldiers in the second case (depending upon the degree of head capsule differentiation). Howard & Haverty (1981) noted that presoldiers, neotenic reproductives and alates never exceeded 0.4% of the sampled population in their *R. flavipes* field colonies. No alates were collected during the current study.

RESULTS AND DISCUSSION

During the 1988 calendar year, termites were first active in the trap placed on the stump on 24 May, and activity ceased after 16 November (Table 1). The traps in the soil were installed in June 1988 (following the installation of wooden stakes in the soil in a grid pattern in May 1988). Thus, the first termite activity in these traps on 22 July (Table 2) is likely more reflective of the installation date than of a delay in foraging activity in the soil.

Reticulitermes flavipes caste proportions within the groups collected from the stump were initially (May and early June) quite similar to those previously reported for *R. flavipes* in Mississippi (Howard & Haverty 1981), with approximately 97% pseudergates, 1% soldiers, 2% nymphs, and less than 1% larvae (Table 1, Fig. 1). However, the late June collection evidenced a dramatic increase in the nymphal population to 46%, with a concomitant decrease in pseudergate composition to 54%. The proportion of nymphs remained at this elevated level through early August, with an equally dramatic decrease to 6% by early September, and subsequently to less than 5% until the last collection

Table 1. Caste proportions in *Reticulitermes flavipes* foraging groups collected in a corrugated paper trap placed on a tree stump at a field site in Scarborough, Ontario.

Date	Total No. Termites	Pseudergates	% Nymphs	Soldiers	Larvae
May 24	5,946	97.16	1.73	1.06	0
June 2	6,438	96.26	2.19	0.59	0.95
June 28	8,949	53.87	45.92	0.11	0.09
July 14	9,088	55.20	44.50	0.21	0.08
July 27	7,914	52.64	47.14	0.21	0
Aug. 12	10,357	68.42	31.24	0.34	0
Aug. 25	13,286	87.34	11.94	0.49	0.23
Sept. 7	5,139	93.15	6.17	0.68	0
Sept. 21	12,009	92.12	6.31	1.57	0
Oct. 5	1,306	98.01	1.91	0.08	0
Oct. 20	776	98.58	1.03	0.39	0
Nov. 16	1,993	94.93	4.87	0.20	0

on 16 November.

Neither soldiers nor larvae ever exceeded 2% or 1%, respectively, of the sampled population in either collections from the stump (Table 1, Fig. 1) or the soil (Table 2). Although nymph proportions within the soil collection traps never approximated the high levels observed on the

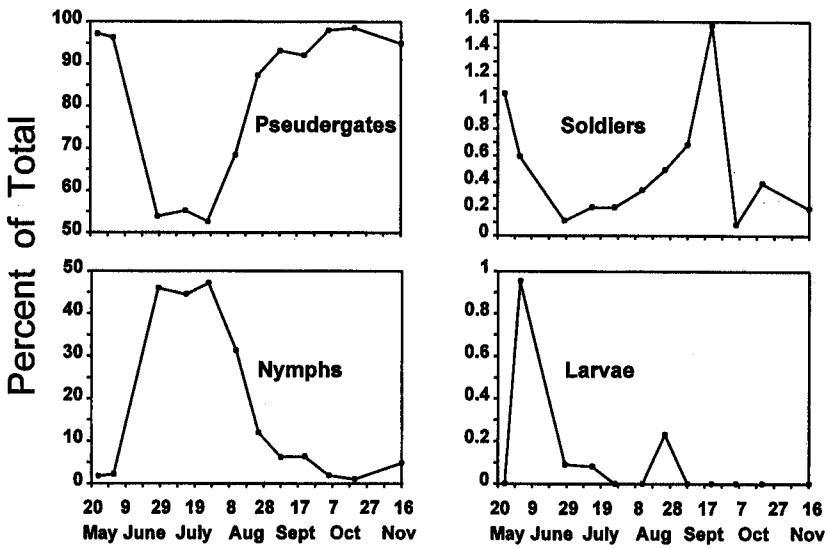

Fig. 1. Seasonal variation in caste proportions within a trap placed on a tree stump at a *Reticulitermes flavipes* colony in Scarborough, Ontario.

Table 2. Caste proportions (means) in *Reticulitermes flavipes* foraging groups collected in corrugated paper traps inserted into the soil at a field site in Scarborough, Ontario.

Date	No. Active Traps	Total No. Termites	Mean No. per Trap (SD)	Mean % per Trap Pseudergates	Nymphs	Soldiers	Larvae
July 22	2	8,904	4,452 (1,887)	91.75	7.53	0.18	0.60
Aug. 2	22	25,767	1,171 (1,660)	95.15	2.33	2.24	0.23
Aug. 12	4	2,432	608 (607)	93.39	4.39	2.23	0
Aug. 20	20	56,737	2,837 (1,181)	97.11	1.87	0.68	0.37
Sept. 7	1	5,269	5,269	98.77	0.61	0.63	0
Oct. 20	3	3,059	1,020 (898)	99.01	0.20	0.79	0
Nov. 18	2	553	276 (98)	100.00	0	0	0

stump, they reached a high of 7.53% on 22 July, generally declining thereafter to less than 1% in early September (Table 2).

In general, Husby (1980) recorded a similar flush of nymphs to very high proportions in the early part of summer in his collections from *R. flavipes* colonies in southern Ontario. Neither my observations nor Husby's (1980) provide evidence for a second flush of nymphs in early fall, as documented in southern populations (Howard & Haverty 1981), and it may be that this bimodal distribution is compressed to a single peak in the north as a result of the short interval of warm weather. On the other hand, a fall fluctuation in caste proportions might be difficult to observe due to the decline in termite activity at or above the soil/stump surface and subsequent difficulty in collecting a representative sample of foragers with the onset of cold weather in late October.

The preferential occurrence of nymphs in the stump (Table 1), rather than in the smaller food resources scattered throughout the surrounding soil (Table 2) supports the concept of differential aggregation of some individuals and/or castes (Zimet 1980) at discrete locations within the overall territory of the colony. A stump represents a fairly large and well-insulated perennial resource, and such resources may serve as refugia in which termites aggregate in response to cold weather and choose to locate colony nesting and nursery chambers, or at least a high proportion of the colony's reproductive and nursery activities. This has implications for the use of baits and groomable toxicants (Myles & Grace 1991, Myles *et al.* 1994) for subterranean termite control, since multiple points of bait introduction to the colony would certainly be required to reach all colony members unless passage of the toxicant via trophallaxis or mutual grooming behavior was extremely effective.

From this study, as well as the earlier observations of Snyder (1934), Esenther (1969) and Husby (1980), it is clear that large number of

nymphs develop annually in northern *R. flavipes* colonies, but that further development to the alate stage is relatively rare. Snyder (1934) speculated that these nymphs disperse through the soil to found new colonies. However, the very large size of some northern *R. flavipes* colonies (Esenther 1980, Grace 1989b, Grace *et al.* 1989) suggests that development of numerous active neotenic reproductives within the colony is more the rule, with "new" colonies forming at some later date via budding off of the more distant (or otherwise physically isolated) groups of individuals surrounding one of these active reproductives (Esenther 1969, Thorne 1996). Recently, Myles (1996) discussed preliminary results from a larger-scale study of termite colonies in Ontario than that presented here. When published, those results should add to the present study and the few other published reports to increase our understanding of the population dynamics of this widespread temperate termite species.

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