SEASONAL FORAGING BEHAVIOR OF *RETICULITERMES* SPP. (ISOPTERA: RHINOTERMITIDAE) IN NORTHERN CALIFORNIA, USA

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Abstract - Monitoring stations of were used to observe foraging and feeding behavior of *Reticulitermes* at the Institute of Forest Genetics (IFG) near Placerville, and at a site in Novato. At IFG 53 monitoring stations were used by cuticular hydrocarbon phenotype A, 10 by phenotype B, and 5 by phenotype C. At Novato 14 stations were occupied by phenotype A' and 12 by phenotype D. Monitoring stations were examined monthly for 3 yr at IFG and 2 yr at Novato. The percentage of stations occupied by termites ranged from 76.7-89.3% at IFG and 81.2-93.5% at Novato. Foraging at IFG was low in the late fall through early spring and high from June to October. At Novato foraging was highest from June to November or December. An estimated 188,750 foragers were collected from all monitoring station at IFG in October 1995, and an estimated 46,550 foragers from all station at Novato in August 1995 and June 1996.
Key words - Subterranean termites, foraging behavior, feeding behavior, wood consumption

INTRODUCTION

The foraging ecology of subterranean termites in North America, and particularly *Reticulitermes* species, has largely been ignored due to the success of termiticides applied as a soil drench. *Reticulitermes flavipes* (Kollar), *R. virginicus* (Banks), *R. hesperus* Banks, and *R. tibialis* Banks have all been reported to be economically important pests of structures in the mainland United States (Su and Scheffrahn, 1990), however, studies of the foraging and feeding behavior of *Reticulitermes* species has been sparse. With emerging bait technology an improved understanding of the foraging and feeding dynamics of *Reticulitermes* will be necessary to provide a basis for assessment of baits for termite control.

The research reported here provides important information on the foraging and feeding behavior of *Reticulitermes* spp. in northern California. We will describe the patterns of activity of foragers and the seasonal cycles of feeding. This information will be critical for the development and deployment of a bait-toxicant system.

MATERIALS AND METHODS

The Eddy Arboretum at the Institute of Forest Genetics (IFG) near Placerville, California was utilized to study the ecology and behavior of colonies of *Reticulitermes* in a "natural" setting without the interference of structures. IFG is at an elevation of 775 m (*ca.* 2,500 ft) and is comprised of 50-year-old plantation of mixed *Pinus* species. Trees are planted on 4-m intervals with a partially closed canopy. Tree mortality from root disease or unsuitable habitat has left numerous open patches amongst the trees.

A residential site in Novato, California, was selected to study *Reticulitermes* where elimination or suppression of colonies is ultimately desirable. The Novato site is approximately 40 km north of San Francisco, California, and consists of 3 buildings that are being utilized as a church, rectory, and nursery school, and are surrounded by extensive gardens, walks, and large trees on a 1-ha lot. Other than a sand barrier under the church rectory, no remedial control with soil termiticides have been used to control the attack of *Reticulitermes* on the structure prior to, or during, the course of our research (Lewis *et al.*, 1996).

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Pinus ponderosa Dougl. ex Laws stakes were driven into the soil in a 2x2-m grid at IFG or at approximately 1-m intervals around the Novato site. When termite activity was detected at a stake a monitoring station (Lewis *et al.*, 1998) containing aged ponderosa pine was installed. Monitoring stations were examined approximately every 28 days. Sixty-five monitoring stations were initially installed at IFG and 39 at the Novato site.

Current biogeographical information states that only *R. hesperus* should occur at our two sites (Nutting, 1990; Weesner, 1970). Using the abundant worker caste, cuticular hydrocarbon analysis has allowed us to separate *Reticulitermes* foraging groups into different taxa or cuticular hydrocarbon phenotypes (Haverty and Nelson, 1997). Each month, at the time of inspection, the percentage of monitoring stations occupied by each phenotype and the total number of termites foraging were calculated. The total number of termites foraging was estimated using a procedure similar to that used by Haverty *et al.* (1974) and La Fage *et al.* (1976).

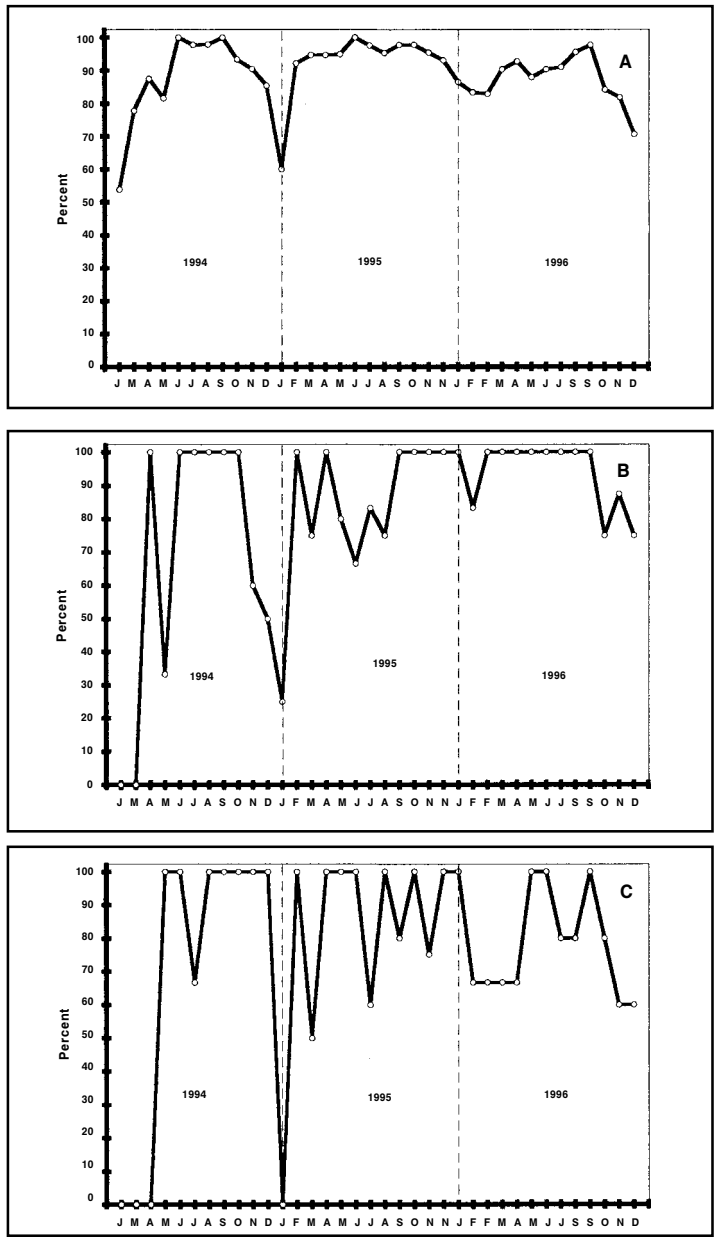

Figure 1. Percentage of monitoring stations occupied by *Reticulitermes* cuticular hydrocarbon phenotypes A, B, and C at the Institute of Forest Genetics, Placerville, CA. Monthly inspections were made from January 1994 through December 1996.

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RESULTS AND DISCUSSION

At IFG 53 monitoring stations were occupied by phenotype A, 10 by phenotype B, and 5 by phenotype C. The Novato site monitoring stations yielded two additional hydrocarbon phenotypes: 14 were used by phenotype A' and 12 by phenotype D. Monitoring stations were never occupied by two phenotypes at the same time. We are fairly confident that four of these hydrocarbon phenotypes, A, B, C, and D represent separate species of *Reticulitermes* because of body weight, soldier head capsule measurements (Haverty and Nelson, 1997), unequivocal agonistic behavior toward one another (Haverty *et al.* 1999), and soldier defense secretion mixtures (Haverty *et al.*, unpublished observations). Although slight differences in cuticular hydrocarbon mixtures and unequivocal agonistic behavior analysis support A and A' phenotypes as a different taxa, they are probably variants of the same species, subspecies, or closely related.

At IFG fewer monitoring stations were occupied by termites during the winter months and the greatest number of stations were occupied during the summer and early fall (Figure 1). IFG monitoring stations occupied by phenotype A had a high occupancy rate with a mean of 89.3% throughout the 3-yr period, while phenotype B and C rates of occupancy showed greater variations with an average of 82.5% for B and 76.7% for C. Because of the fewer number of monitoring stations occupied by phenotypes B and C, oscillations in their occupancy rate were greater. Phenotype C termites occupied only 1 monitoring station until June 20, 1994.

There was no apparent fluctuations in the occupancy rates at Novato site (Figure 2). Once a station became active, it was seldom abandoned. For phenotype A' the mean monitoring station occupancy rate was 74.4% throughout the 2-yr period. For phenotype D the mean monitoring station occupancy rate was 93.5% for the same period.

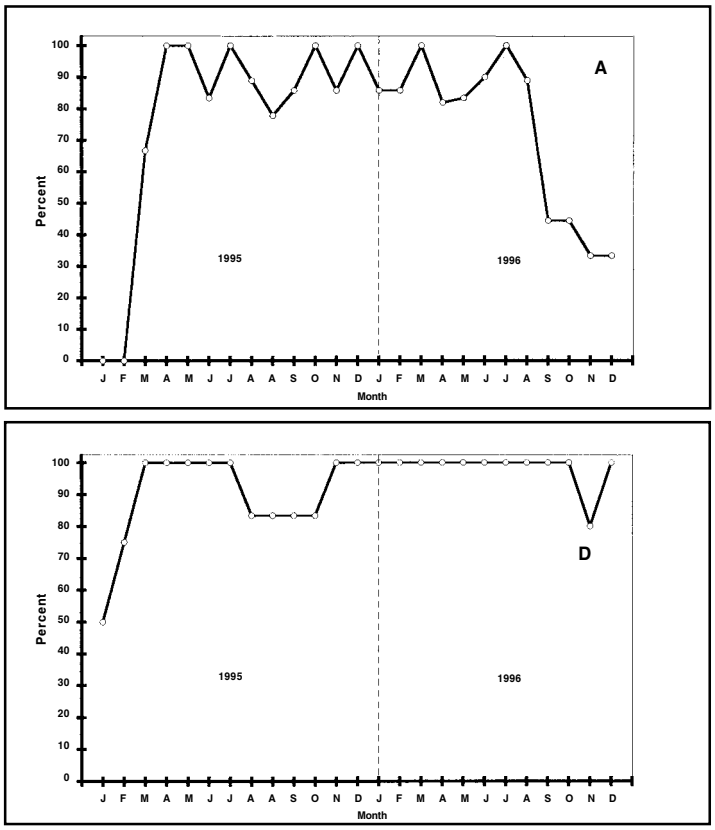

Figure 2. Percentage of monitoring stations occupied by *Reticulitermes* cuticular hydrocarbon phenotypes A' and D at the Novato, CA site. Monthly inspections were made from January 1995 through December 1996.

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Seasonal trends in number of termites within a monitoring station at both IFG and Novato were also observed. Depending on phenotype the total number of termites in a monitoring station varied drastically. This difference was primarily due to the number of monitoring stations occupied by each phenotype. The maximum number of termites collected at IFG was in October 1995 (188,750); 82% of the total number of termites collected were from phenotype A monitoring stations (Figure 3). The number of foragers was low in the late fall through early spring and high from early spring to late fall, with a peak in foraging from June through October. Each summer, during July or August, we observed a reduction of the number of foragers present.

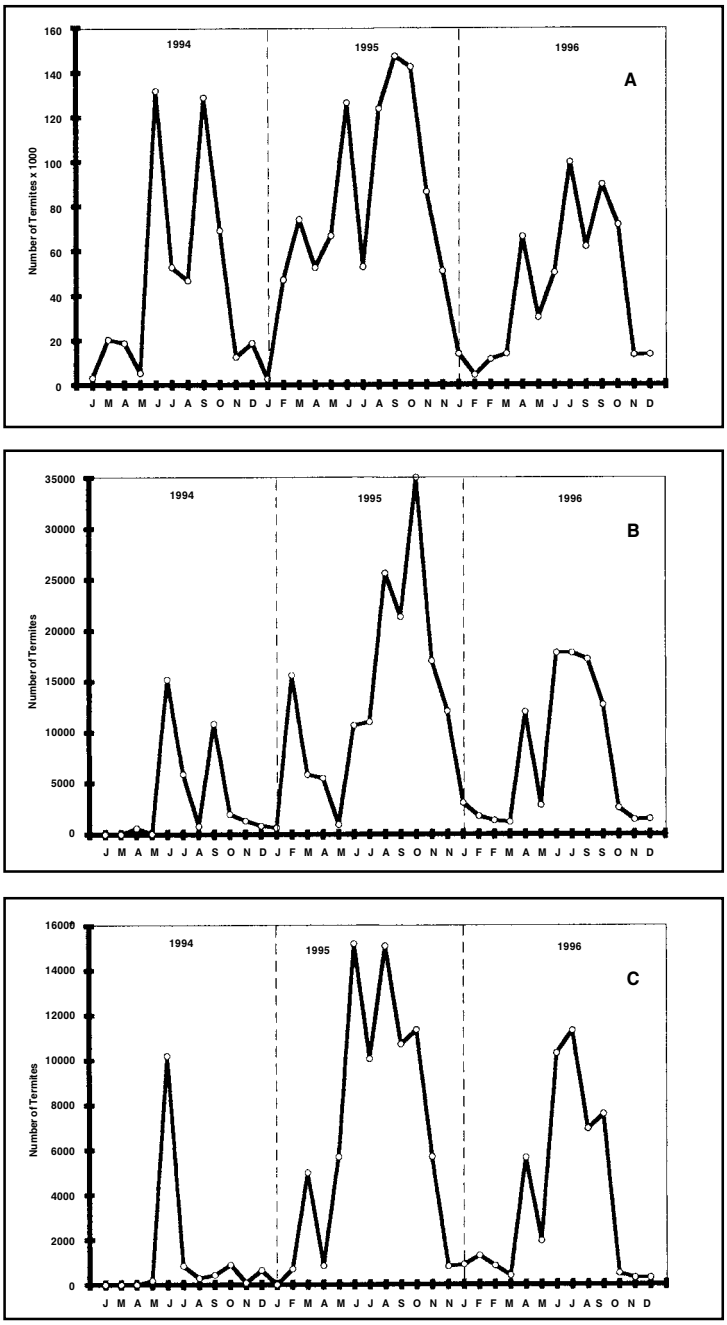

Figure 3. Total number of termites in cuticular hydrocarbon phenotypes A, B, and C collected from monitoring stations at the Institute of Forest Genetics in Placerville, CA over a 3-yr period.

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Generally, the pattern at the Novato site was one of low forager numbers in the late fall through early spring and high foraging intensity from early spring to late fall, with a peak in foraging from June through November or December (Figure 4). The greatest number of foragers appeared to be Phenotype A' when phenotype D workers were lower. When phenotype D numbers were high, however, phenotype A' numbers were low. The decrease in number of foragers present in the summer seemed to occur earlier than at IFG.

In conclusion, the monitoring station design we utilized in this study (Lewis *et al.*, 1998) appears to be an excellent tool for studying and collecting *Reticulitermes* species. Understanding the cycle of foraging is relevant to bait technology and expected optimal results. It is important to be able to determine when a drop in termite activity is a result of baiting and elimination or reduction of a colony rather than the seasonal aspects of foraging.

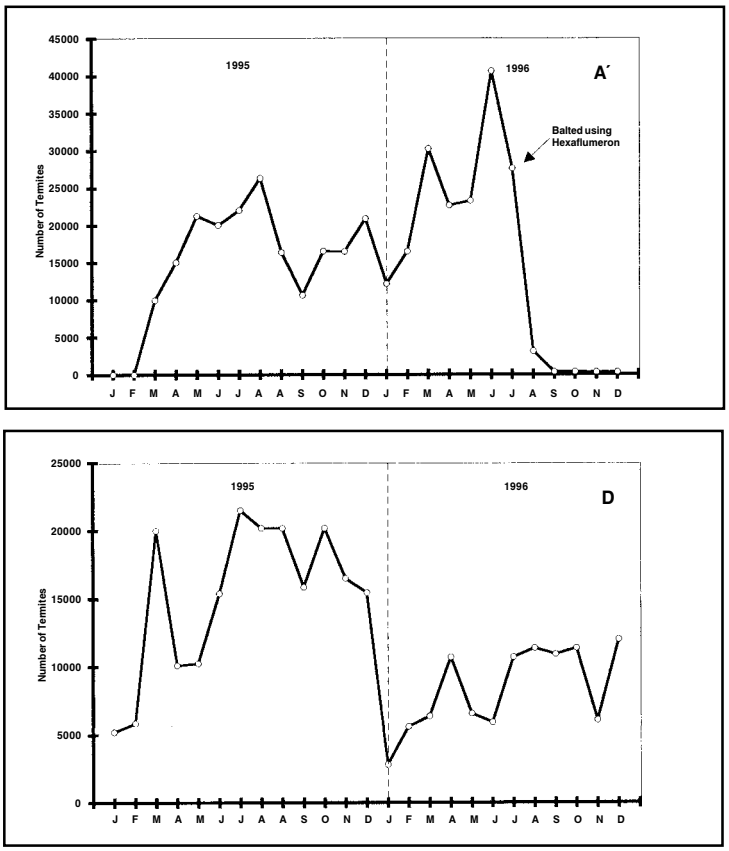

Figure 4. Total number of termites in cuticular hydrocarbon phenotypes A' and D collected from monitoring stations at the Novato, CA site over a 2-yr period.

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