SURVEY OF TERMITES IN THE DELTA EXPERIMENTAL FOREST OF MISSISSIPPI

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ABSTRACT

Termites were surveyed in the Delta Experimental Forest in west central Mississippi in 1998. Logs, branches, and stumps along three 200-m long, 6-m wide transects were investigated at each of the three study plots. Two subterranean termite species in the family Rhinotermitidae, viz., *Reticulitermes flavipes* (Kollar) and *Reticulitermes virginicus* (Banks), were recorded. *Reticulitermes flavipes* was the common species and constituted 81.3% of the termite occurrences. Of the 685 pieces of wood surveyed, 16.5% had termites. The percentage of the two termite species varied among plots. The percentage of wood materials with signs of termite activity or foraging termites present was positively correlated with the diameter of the wood materials (R = 0.85). The chances of a log, branch, or stump being attacked by these termites increases by 1.3% as the diameter of the wood material increases 1 cm. The percentage of dead wood with sign of termite activity ranged from 11.6% to 67.2% among the sampled plots. Termites were significantly less abundant at Plot 3, which might correspond to a lower elevation and a higher soil moisture.

Key Words: *Reticulitermes flavipes*, *Reticulitermes virginicus*, forest, relative abundance

RESUMEN

Una inspeccion de termitas se llevo a cabo en el bosque del Delta Experimental Forest al centro-oeste de Mississippi en 1998. Se seleccionaron 3 lotes de 200 m de largo por 6 m de ancho y en cada uno de ellos se colectaron troncos, ramas y tocones. Se anotaron dos especies de termitas subterráneas en la familia Rhinotermitidae: *Reticulitermes flavipes* (Kollar) y *Reticulitermes virginicus* (Banks). *R. flavipes* fue la especie mas común y constituyo el 81.3% de las ocurrencias de termitas. De los 685 pedazos de madera inspeccionados, 16.5% tenían termitas. El porcentaje de las dos especies de termitas varió entre lotes. El porcentaje de materiales de madera con señas de actividad de termitas o la presencia de termitas forrajeras fue correlacionada positivamente con el diámetro de los materiales de madera (R = 0.85). La probabilidad de un tronco, rama o tocón ser atacado por estas termitas incremento un 1.3% al incrementar el diámetro de estos materiales por 1 cm. El porcentaje de madera muerta con señas de actividad de termitas vario entre 11.6 a 67.2% entre los lotes muestreados. Las termitas fueron significativamente menos abundante en el Lote 3, lo cual puede corresponder a una elevación mas baja y una humedad de suelo mas alta.

Termites play an important role in forest ecosystems, especially in tropical rain forests, where they occur in extremely dense populations (Harris 1966; Gray 1972; Matsumoto 1976). Termites promote organic matter decomposition, alter soil properties, and provide food to other animals (Wood & Sands 1978; La Fage & Nutting 1978). Although their ecological importance is well known, termites have rarely been quantitatively studied in forests of the United States (Gentry & Whitford 1982; Howard et al. 1982).

Like any other insects, the abundance of termites is influenced by the distribution and quality of their food materials. However, there is very little information regarding the relationship between termites and size or distribution of wood materials (Gentry & Whitford 1982; Jones et al. 1995).

In Mississippi, *Reticulitermes flavipes* (Kollar) and *Reticulitermes virginicus* (Banks) appear to be the most common termite species. In 1998, we conducted a survey of termites in an experimental forest. In this study, we tried to determine the species composition and their foraging activities associated with dead wood in a forest environment. The objectives of this study were to quantitatively describe termite distribution patterns and feeding activities in different forest ecosystems.

MATERIALS AND METHODS

Study Sites

This study was carried out at the Delta Experimental Forest near Stoneville, Mississippi. The study site is mostly level with gentle slopes (<2°) at some sections. The soil type is fine-textured Sharkey clay soil with clay particle content varies from 60 to 85% (Krinard & Johnson 1985). It expands considerably when wet in the winter and

cracks profusely when dry in the summer. The study sites were sometimes under water in the wet winter months (December-February). Average air temperature in January and July from 30-year data is 5.1°C and 27.6°C, respectively (Boykin 1995). The average annual precipitation is 1326 mm.

Three 200 ha experimental plots were delineated for the survey based on differences in tree stand.

Plot 1 is a sweetgum (*Liquidambar styraciflua* L.) plantation established in 1964-65 at 3 × 3-m spacing. The diameter at breast height is 23.4 ± 1.2 (mean ± standard error) cm. Some sugarberries (*Celtis laevigata* Willdenow) have grown into small to large trees. Common shrubs were: sugarberry, hawthorn (*Crataegus* spp.), willow oak (*Quercus phellos* L.), Chinese privet (*Ligustrum sinense* Loureiro), and blackberry (*Rhubus* sp.).

Plot 2 is a naturally regenerated tree stand. Major trees species were: red oaks (*Quercus* spp.), sweetgum, sugarberry, overcup oak (*Quercus lyrata* Walter), green ash (*Fraxius pennsylvanica* Marshall), and elms (*Ulmus* spp.). Common understory shrubs were: Chinse privet, swamp dogwood (*Cornus stricta* Lamarck), Eastern swampprivet (*Forestiera acuminata* (Michaux) Poiret), American snowball (*Styrax americana* Lamarck), green ash, elms, deciduous holly (*Ilex decidua* Walter), and blackberry.

Plot 3 is an even-aged stand of natural regeneration resulting from a clearcut in 1937. Major tree species were: green ash, cottonwood (*Populus deltoides* Marshall), sugarberry, sweetgum, red oaks, black willow, elms, and white oaks. Understory shrubs were similar to Plot 2 but at a much lower density. This plot is at a slightly lower elevation than plots 1 and 2 and is more likely to be flooded in wet winter months.

Soil water content of the plots was measured on September 15, 1999. The precipitation during one month prior to the sampling date was 35.3 mm. The precipitation during the same period of 1998 was 68.1 mm. Nine soil samples were taken from the three transects of each plot. The soil was taken from 0-9 cm of the "A" layer. Then they were dried in an oven at 105°C for 48 hrs. Soil moisture content was determined by the difference between fresh soil weight and dry soil weight over fresh soil weight.

Survey

A survey of termites was conducted from October 20 through November 25, 1998 in plots 1, 2, and 3, in that order**.** Weather data in the three plots during the survey were: average maximum air temperature 22.9, 29.5, and 17.6°C, respectively; average minimum air temperature 8.6, 13.6, and 8.1°C, respectively; average daily rainfall 0.3, 1.5, 6.4 mm, respectively (Stoneville weather station, http://www.deltaweather.msstate.edu/). At each plot, three 200-m long, 6-m wide transects in north-south direction were delineated. Diameter at the large end of all logs, branches, and stumps >3 cm in diameter and partially or entirely within each transect was measured. Each was examined for the presence of termites or signs of termite activity. Termite galleries, fecal debris, and/or body parts were noted as signs of termite activity. Determining whether termite galleries exist in wood was usually not difficult. Galleries made by other arthropods had a more regular shape and not connected to each other into great lengths or width. Soil particles often exist in termite galleries or on surface of the wood. There were occasions when the wood materials were too decayed to determine whether or not termites had existed before. These wood materials were not included in the analysis. Results were recorded as three categories: I) with live termites, II) with sign of termite activity, or III) without termites and no sign of termite activity. When live termites were found, soldiers were collected for species determination. Host trees were not identified. Termite soldiers were examined under an Olympus SZX12 dissecting scope. Typically, two or three termite soldiers which are representative of the soldiers in size and morphology were examined. More soldiers were examined if necessary to determine the species. Termites were identified to species using the key provided by Scheffrahn & Su (1994), and identifications of representative specimens were verified by Rudolf Scheffrahn. Voucher specimens have been deposited in collections of Stoneville Research Quarantine Facility, USDA Agricultural Research Service, Stoneville, MS.

Statistical Analysis

The presence or absence of live termites or signs of termite activity in dead wood materials were recorded as 1 or 0, respectively. The wood materials were grouped into 6 categories according to diameter. The actual diameter of the 6 categories ranged from 3-5.9, 6-8.9, 9-11.9, 12-14.9, 15-17.9, and ≥18 cm, respectively. Analysis of Variance (ANOVA) was performed to test for differences between diameter groups and plots using PROC MIXED of the SAS software (SAS Institute 1999). Then the data were further analyzed for the trend between diameter of the wood materials and presence of termites or signs of termite activity. R^2 of the regression equation was determined by the ratio of the sum of squares for diameter groups as a trend with 1 degree of freedom divided by the sum of squares for diameter groups with 5 degrees of freedom. Soil moisture content data of the plots were compared by Tukey's Studentized Range Test after ANOVA. All analyses were performed by SAS software (SAS Institute 1999).

Results and Discussion

Species Composition and Distribution of Termites

Among the 685 branches, logs, and stumps examined, 114 (16.5%) had live termites. Two termite species were found, *Reticulitermes flavipes* (Kollar) and *R. virginicus* (Banks). Species were not identified in 7 samples because no soldiers were collected. Among the 107 identified termite samples, *R. flavipes* and *R. virginicus* were found in 12.7% and 2.9% of the samples, respectively (Table 1). *Reticulitermes flavipes* was most frequently encountered and occurred in 81.3% of the termite samples. This is similar to observations by Howard et al. (1982) in southern Mississippi. The relative abundance of *R. virginicus* in plots 1-3 was 7.7%, 21.4%, and 53.8%, respectively. The high percentage in Plot 3 was not precise because termites in 7 of the 20 samples were not identified. However, the percentage of *R. virginicus* in Plot 3 was at least 35.0%, which was still higher than the other plots. This higher percentage might relate with higher soil moisture. Soil moisture in Plot 3 (21.4 ± 0.8%) was significantly higher than that in Plot 1 (19.8 ± 0.8%) measured on September 15, 1999 ($F = 12.90$; df = 2, 24; $P = 0.0002$). As reported by Howard et al. (1982), *R. flavipes* tends to occupy higher, more arid places in southern Mississippi.

The percentage of samples with signs of termite activity in plots 1-3 was 60.0%, 67.2%, and 11.6%, respectively. The percentage in plots 1 and 2 was significantly higher than Plot 3 ($F = 132.76$; df = 2, 508; $P < 0.0001$) (Fig. 1). The much lower termite activity that observed in Plot 3 might indicate unsuitable conditions for termites, especially for *R. flavipes*. Plot 3 tended to be flooded for a longer period of time and more frequently than plots 1 and 2 during the winter months. This might have created an unsuitable condition for termites to survive in the winter.

Live termites were found in 24.8%, 22.2%, and 7.0% of the logs, branches, and stumps in plots 1-3, respectively. The percentage of wood materials with termites in Plot 3 was significantly lower than that in plots 1 and 2 (Fig. 1) ($F = 23.04$; df = 2, 674; $P < 0.0001$). This pattern is same as the result on the percentage of wood with signs of termite activity. The lower temperatures during the survey might have an impact on the low number of termite occurrences in Plot 3. However, the difference between percentage of wood with termites and that with signs of termite damage in Plot 3 is proportionally smaller than those in plots 1 and 2 (Fig. 1). This suggests that the influence of temperature on termite occurrences in Plot 3 was not significantly higher than that in plots 1 and 2.

Relationship between Termite Activity and Size of Wood Materials

Most of the wood samples in the three plots were <12 cm in diameter. The percentage of wood samples with diameter ≥12 cm in the plots 1-3 was 1.8%, 5.1%, and 19.7%, respectively. A cause-effect relationship existed between percentage of samples with signs of termite activity and diameter of the wood ($F = 20.34$; df = 1, 508; $P < 0.0001$; $R^2 = 0.73$) (Fig. 2). The chance of a sample being infested by termites increased 1.3 ± 0.3% as the diameter of the wood increased 1 cm. Perhaps this is because larger wood materials tend to maintain moisture, which is important for termite survival and foraging. According to the regression equation, *Percentage* = 0.327 + 0.013 *diameter*, even a very small dead branch such as 1 cm in diameter will have a 34% chance of having been attacked by termites.

The percentage of samples with termites present was also positively correlated with diameter of the wood material ($F = 30.82$; df = 1, 674; $P < 0.0001$; $R^2 = 0.72$) (Fig. 3). The chance of a sample with termites present increased 1.3 ± 0.2% as the diameter of the wood materials increased 1 cm.

In conclusion, we found two species of termites in the Delta Experimental Forest near Stoneville, Mississippi. *Reticulitermes flavipes* was the most common termite species. The occurrence of termites varied with site conditions. Selection of

Table 1. Relative abundance of 2 termite species in 3 plots of the Delta Experimental forest, Mississippi.

Plot	Number of wood materials examined	Wood materials with termites					
		R. flavipes		*R. virginicus*		*Reticulitermes* spp.	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
1	210	48	22.9	4	1.9	0	—
2	189	33	17.5	9	4.8	0	—
3	286	6	2.1	7	2.4	7	2.4
Total	685	87	12.7	20	2.9	7	1.0

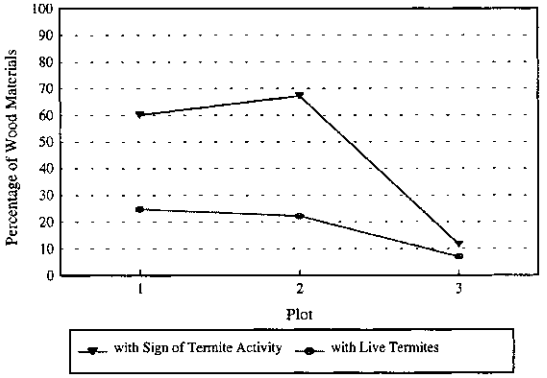

Fig. 1. Percentage of dead wood samples with termites or with signs of termite activity in Delta Experimental Forest, Mississippi.

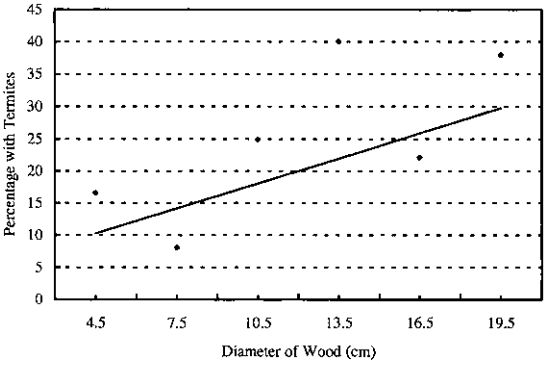

Fig. 3. Relationship between diameter of wood samples and the percentage with termites present (*Percentage* = 0.044 + 0.013 × *diameter*, R^2 = 0.72, n = 678).

wood materials by the two termite species was positively correlated with the diameter of the wood materials. This has practical significance for termite control and baiting studies. It provides an estimate of the probability of termite attack on wood materials.

Gentry & Whitford (1982) sampled lowland hardwood forests and pine plantations in South Carolina (similar latitude as in our study location), and found that the occurrences of *R. flavipes* and *R. virginicus* varied among different habitats. *Reticulitermes flavipes* represented 26.6-60% of the termites, which was lower than what we observed on the 3 sites on the Delta Experimental Forest. In their study, nearly all the wood greater than 2 cm diameter had signs of termite usage. The termite population or activity in their study location was much higher than in our study location.

We measured the length of every piece of wood in this survey. The wood materials were grouped into 4 categories according to their length. The actual length of the 4 categories ranges from <3, 3-5.9, 6-8.9, and ≥9 m, respectively. Although the length of wood had significant effect on the percentage of wood with live termites (F = 11.23; df = 3, 666; P < 0.0001), it did not have significant effect on the percentage of wood with signs of termite activity (F = 0.67; df = 3, 502; P = 0.57). A long branch with small diameter may be less likely to be attacked by termites than a short branch with large diameter. Therefore, length alone is not a good predictor for estimating the probability of termite attack on the wood materials.

Jones et al. (1995) found a positive relationship (R^2 = 0.50) between volume of wood and dry wood termite colony size on Mona Island, Puerto Rico. In a laboratory experiment, Hedlund and Henderson (1999) found termite consumption rate increased as the wood volume increased. Termites foraged less actively when larger wood existed. These findings support our conclusion that larger wood tends to be more attractive for termites to feed on. So, size of the wood materials measured by diameter or volume is important for termite foraging activities.

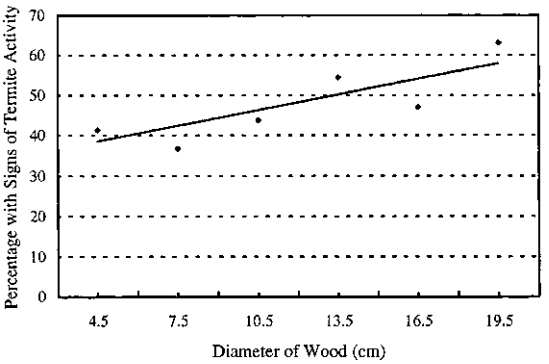

Fig. 2. Relationship between diameter of wood samples and the percentage with signs of termite activity (*Percentage* = 0.327 + 0.013 × *diameter*, R^2 = 0.73, n = 512).

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