RESPONSE TO NEST AND TRAIL DAMAGE IN ARBOREAL COLONIES OF *NASUTITERMES*

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Abstract. We examined *Nasutitermes*' repair rates of structural damage to the colony in a tropical dry forest. Rates of repair were not significantly different between nests and trails. Nest size was positively correlated to discovery time of nest damage. These results suggest that colony dynamics, particularly the distributions of soldiers and workers, are the determining factors in damage repair. (JLB)

INTRODUCTION (SLS)

The eusocial termite *Nasutitermes* builds nests in the decaying wood of trees in lowland wet forest and forest-edge habitats of Central America (Lubin 1983). These spherical brown nests are made of carton-wood that is chewed up by the worker termites and cemented with a fecal glue (Kricher 1989). Covered trails made of the same substance run along the trunks and branches of the trees from nest to feeding areas.

If either the nest or trail is damaged, resident termites will repair the break. Lubin noted that immediately following a break, individuals in the worker caste "disappear within seconds into the trail or nest" (1983). Soon after, the dark-headed, sharp-jawed soldiers appear to survey the intrusion and eject a turpentine-like sticky substance to discourage would-be predators. Finally, the larger whitish workers return to repair the damaged nest.

In this study we considered the allocation of workers and soldiers to breaks in the trail and the nest itself. We postulated that since the nest houses both the queen and progeny of the colony, the social organization within the nest would be such that such breaches in the structure would cause a faster reaction of soldiers, recruitment of workers, and repair of hole in the nest than in the more peripherally located trails. This assumes that not only are there more workers and soldiers present in the nest, but that there is also more effective communication, or at least a response to a distress signal in the nest. Along these same lines, we hypothesized that a larger colony would repair damage to either the nest or trail faster than a small colony because of the greater total number of workers in the larger colony. With more workers patrolling the structures, there should be a faster response in all aspects of nest repair.

METHODS (KAI)

We conducted our study along the trails and roads near the OTS Biological Station, Palo Verde National Park, Guanacaste Province, Costa Rica (Figure 1). Termite nests found within 10m of the road were chosen on the basis of physical appearance (no cracks or holes) and height from ground (within our reach). Thirty-eight nests were located and measured to determine height and width. A rough volume was then calculated for each nest. Later when the nests were punctured to obtain data, only 19 actually contained termite colonies. We assumed nest size was indicative of colony size.

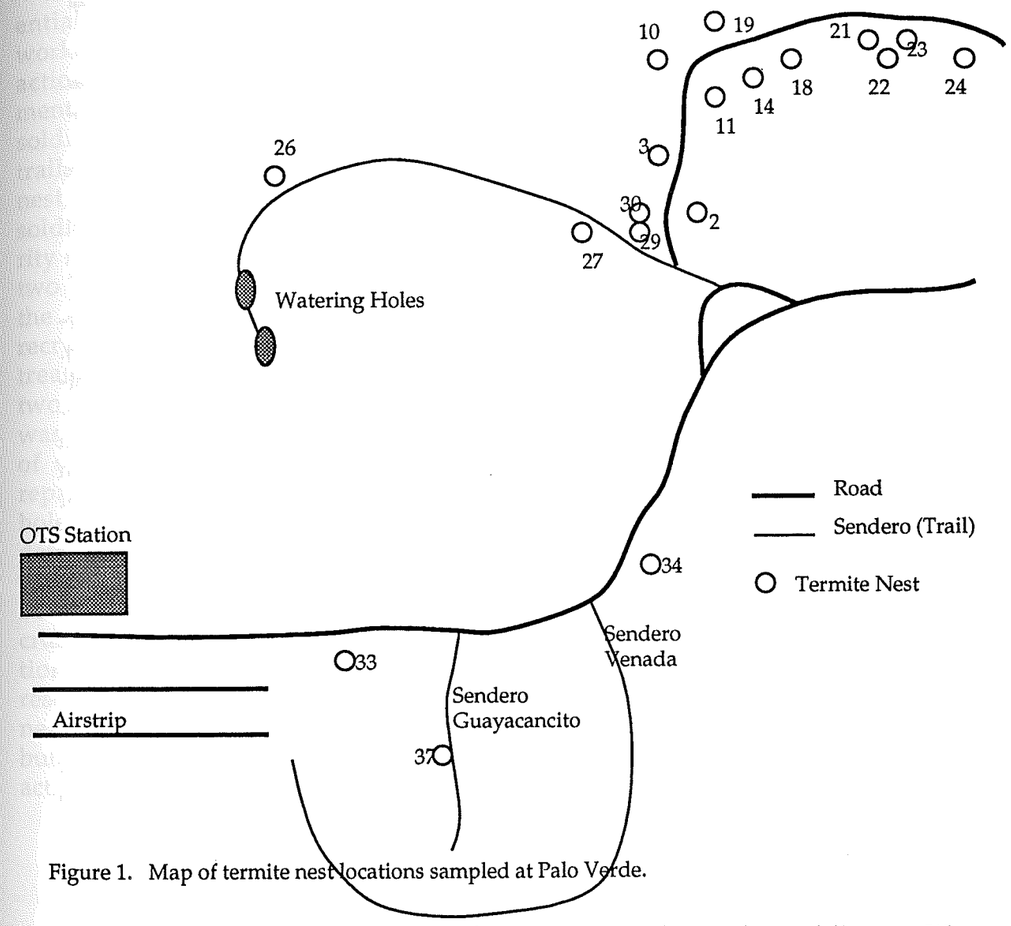

Figure 1. Map of termite nest locations sampled at Palo Verde.

Discovery time, (the time it took soldiers to swarm around the hole) was measured by punching holes uniform in diameter and depth in nests and trails. The same instrument (a screwdriver) was used in all penetrations to ensure hole size consistency. Depth of penetration into the nest was standardized at 2.5cm. The coverings of trails were simply shells so the depth of the hole was not an issue. It was necessary to make these deep holes into the nest to stimulate a response from the soldiers. We assumed this would not interfere with our data because previous observations indicated that damage was repaired by first repairing the outside; hence diameter of the hole should be the rate determining factor. We also assumed that holes to both the nest and trail would be considered vital injuries that required immediate repair. We determined that the nest was abandoned if no response from soldier termites was obtained after 10min.

We calculated worker recruitment time by recording the time from

initial discovery to appearance of the first worker. The nests were then watched and rate of repair was calculated from initial worker arrival to complete repair. We observed each nest until completion, or for at least an hour. If a nest was not completed at this time it was checked at regular intervals. Particularly slow moving nests were assigned a maximum completion time of 3hr due to the spatial distributions of the nests and the time constraints of the experiment.

Table 1. Times (sec) of discovery, recruitment and repair in the trail and nest of *Nasutitermes* at Palo Verde.

Discov. Time	Range	Mean	s. d.	n
nest	0-1230	367	485	15
trail	0-805	105	215	18
Recruitment Time				
nest	60-4536	839	1227	15
trail	52-1163	322	302	18
Repair Time				
nest	980-10,013	3402	2111	15
trail	880-9903	3197	2162	18

Results (SLS)

Discovery of a hole by soldiers, recruitment of workers and repair of the holes in both the nest and trail varied over a range of times (Table 1). Because of the large standard deviation and the relatively small sample sizes, a Mann-Whitney U test was used to compare these three rates between the nest and the trail. No statistically significant differences were found for discovery time ($U=231$, $0.05<p<0.10$), for recruitment time ($U=238$, $p<0.05$), or for repair rate ($U=148$, $p>0.10$).

Table 2. Spearman rank correlations for size of nest vs. time of discovery, recruitment and repair.

	Nest	Trail
Discovery	$r_s = 0.502$ $p < 0.05$	$r_s = =0.025$ $p > 0.05$
Recruitment	$r_s = 0.036$ $p > 0.05$	$r_s = -0.249$ $p > 0.05$
Repair	$r_s = 0.321$ $p > 0.05$	$r_s = 0.010$ $p > 0.05$

Nest volumes ranged from 0.01-0.23m^3, and averaged 0.07m^3 (n=19). The relationships between nest volume (size) and times of discovery, recruitment, and repair in nest and on trails were examined by Spearman Rank correlation analysis. None of the correlations were statistically significant, except for the effect of nest size on time of discovery (Table 2).

Discussion (JLB)

Our results showed no significant differences between rates of repair to damage of nests and trails. It is likely that only a finite number of workers can repair a hole of fixed diameter. In contrast to our predictions, we found that discovery and recruitment times for damage in the two locations was different, and although the discovery times do not meet our significance level ($p<0.05$), we believe they are indicative of a trend.

Several possible explanations exist for these results. We assumed all nest holes were vital injuries. If the nest hole damaged an abandoned or less vital area of the nest, the danger from the main trail damaage (leading to food sources) could have been comparatively greater and therefore necessitated a more rapid response. Differential distributions of soldiers and workers may explain differences in reaction time (discovery and recruitment) for the two types of damage. If soldiers spend more time patrolling trails and are relatively scarce in the nest, this would cause a time lag in soldiers swarming to the nest. Security needs of the nest could explain the two patterns of repair observed during the experiment. Once workers were recruited to the trail, most soldiers retreated from the hole, leaving only two or three to guard until the hole was closed. In the nest, large numbers of soldiers remained throughout the repair process, lining the edge of the hole. This suggests that in the nest, defense against invaders is a higher priority than immediate repair; it may be more advantageous to delay recruitment of workers to ensure protection from further invasion. Further research could address these areas of nest organization, caste spatial distribution, and dynamics of defense interaction with soldiers and workers.

Our predictions of faster reaction time and repair rate for larger nests than for smaller ones were not supported by our results. This could be due at least in part to the high variance in the data and the small sample size. Nonetheless, these results indicate that the ratios of the number of soldiers and workers to nest size is more important than the absolute numbers. Further experimentation is needed to investigate the different resource bases of different sized colonies and their effects on the process of damage repair.

Literature Cited

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