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A COMPARISON OF TWO TECHNIQUES FOR DETERMINING ABUNDANCE OF SUBTERRANEAN TERMITES IN AN ARIZONA DESERT GRASSLAND (*)

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SUMMARY

Densities of surface foraging subterranean termites were determined by bait and quadrat techniques. Only two species were found in the bait units whereas five were found in the quadrats. *Heterotermes aureus* (Snyder) and *Gnathamitermes perplexus* (Banks) numbers were reasonably estimated by baiting. However, *G. perplexus* was severely underestimated by quadrats while *H. aureus*, *Paraneotermes simplicicornis* (Banks), *Amitermes wheeleri* (Desneux), and *A. minimus* Light were apparently reasonably estimated. Material examined by any technique should consist of a suitable foraging substrate for the termite species being sampled.

RÉSUMÉ

Comparaison de deux techniques de détermination de l'abondance des Termites hypogés dans une savane semi-désertique de l'Arizona.

Les densités de Termites hypogés qui prélèvent leur nourriture à la surface du sol ont été déterminées au moyen de quadrats et d'appâts; deux espèces seulement ont été attirées par les appâts, alors qu'on en a récolté cinq dans les quadrats. Les densités de *Heterotermes aureus* (Snyder) et *Gnathamitermes perplexus* (Banks) sont estimées de

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façon satisfaisante au moyen des appâts. En revanche, l'abondance de *G. perplexus* est nettement sous-estimée par les quadrats, alors que cette technique fournit apparemment des estimations raisonnables pour *H. aureus, Paraneotermes simplicicornis* (Banks), *Amitermes wheeleri* (Desneux), and *A. minimus* Light. Les matériaux utilisés ou examinés dans n'importe quelle technique doivent évidemment constituer des sources de nourriture appréciées par les Termites que l'on désire échantillonner.

The importance of termites in natural ecosystems has long been recognized in Africa and Australia (Lee and Wood, 1971); however, their role in comminuting and recycling plant material in the United States has only recently been investigated. Bodine and Ueckert (1975) reported a 20 % increase in grass production and a 55 % increase in litter accumulation on a semiarid rangeland in Texas when *Gnathamitermes tubiformans* (Buckley) was eliminated from test plots. During a 3-year period the biomass (live weight) of this species in the upper 30 cm of soil averaged 5.2 g/m^2, and peaked at 22.2 g/m^2 in September, 1972. This almost equaled that of cattle grazing in their study area and surrounding rangeland (5.6 g/m^2). The termites, therefore, may compete with the cattle for grass. Johnson and Whitford (1975) concluded that *G. tubiformans* consumed ca. 50 % of the annual litter production in creosote bush and mesquite-yucca grassland communities in the Chihuahuan Desert of New Mexico. Our studies (Haverty and Nutting, 1975 *a, c*) on termites of the Sonoran Desert also suggest that subterranean species are very important processors of woody detritus.

Sands (1972) has recently reviewed the problems encountered in sampling subterranean termites in tropical environments. The two most common techniques involve setting out attractive baits and taking soil samples (cores or pits). Estimating absolute density of termite populations, even with soil cores, is nearly impossible and has yet to be done (Lee and Wood, 1971). Subterranean termites migrate vertically in the soil so that cores will not always sample their entire habitat. Although we were unable to take soil cores in the dry and rocky soil of our research area, we did develop two techniques to measure surface foraging populations (not absolute densities). We present the methods and compare the results of these techniques below.

METHODS AND MATERIALS

The first technique, outlined in detail by Haverty et al. (1974), employed toilet paper rolls as bait and served to identify the environmental factors governing termite foraging intensity. This technique also provided a weekly average of foraging termites/m^2 over a 53-week period (Haverty et al., 1975). In the second technique (Haverty and Nutting, 1975 *a, b*) all superficial and partially buried wood on the ground within a series of 50-m^2 circular quadrats (« circledrats ») was examined for termites. Forager density, amount of wood available, and preferences for various kinds of wood were calculated from the data collected.

RESULTS AND DISCUSSION

The mean numbers of foragers/m² determined by each technique are presented in Table I. The coefficients of dispersion $\frac{s^2 (n-1)}{\bar{x}}$ were compared using χ^2 (SOUTHWOOD, 1966). This test showed that the termites were not randomly distributed and therefore, the data could not be compared statistically.

TABLE I. — Numbers of surface foragers/m² for five termite species determined by two sampling techniques on the Santa Rita Experimental Range, Pima Co., Arizona.

TABLEAU I. — Nombres/m² des ouvriers récolteurs de cinq espèces de Termites, déterminés par deux méthodes d'échantillonnage sur le Santa Rita Experimental Range, Pima County, Arizona.

Species	Number/m²			
	Bait		Circledrats	
	$\bar{x}$	$s^2/\bar{x}$	$\bar{x}$	$s^2/\bar{x}$
Heterotermes aureus (Snyder)........	3.78	37.87	6.89	32.01
Gnathamitermes perplexus (Banks)...	6.99	6.08	0.35	7.89
Paraneotermes simplicicornis (Banks).	—	—	1.31	34.47
Amitermes spp. *	—	—	1.63	32.79

* *A. wheeleri, A. minimus, A. emersoni* and *A. silvestrianus.*

The most striking difference between the bait and circledrat techniques is that only *Heterotermes aureus* (Snyder) and *Gnathamitermes perplexus* (Banks) attacked the baits. *Paraneotermes simplicicornis* (Banks) was found once in a single roll of paper after we had completed our study. Although none of the *Amitermes* species (*A. wheeleri* (Desneux), *A. minimus* Light, *A. emersoni* Light, and *A. silvestrianus* Light) attacked the bait, all of these species were observed at least once during the circledrat sampling.

The estimate of *H. aureus* foragers was greater with the circledrat technique than with the bait method although the difference was not extreme. This can most probably be explained by the fact that sampling with circledrats was done only at times favorable to termite foraging whereas the bait grid was sampled at 2-hour intervals once each week regardless of environmental conditions. This naturally led to many observations on the grid where no termites were observed. It is also possible that there existed a truly higher population density of *H. aureus* on the area where circledrats were sampled than on the bait sampling grid since the areas were ca. 1.5 km apart.

Estimates of *G. perplexus* foraging density by the two techniques are quite different. The toilet paper rolls provided a highly acceptable substrate, since more than 96 % were attacked by this species (LAFAGE et al., 1973). In sampling only superficial dead wood by the circledrat technique we omitted the primary foraging substrates (grasses, litter drift, and cattle dung) of *G. perplexus* and thereby underestimated its foraging populations. This difference most likely does not reflect actual differences in total populations, rather a difference in the effectiveness of the sampling technique. *P. simplicicornis* and the *Amitermes* spp. feed almost exclusively on sound wood (HAVERTY and NUTTING, 1975 *b*) so that the circledrat technique proved satisfactory for these species but the bait sampling did not. The toilet paper rolls were apparently not acceptable to them. The choice of bait for food material and time of examination are obviously critical to the success of any sampling program for determining the abundance of subterranean termites. One should consider the foraging habits and biology of a species in selecting a sampling technique.

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