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Incidence of epigeal nest-building termites in *Brachiaria* pastures in the Cerrado

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ABSTRACT. This study aimed to determine the number of termite epigeal nests and estimate the soil turning capacity of termites in cultivated pasture environments and in a native vegetation area. Surveys were conducted in four areas: three pasture areas and a Cerrado area, measuring 5 ha each. For each nest, the height, the perimeter and diameter at the base were measured. The volume of each mound was calculated. Turned soil was determined by randomly sampling 30 termite mounds in a pasture area for bulk density determinations. The mean number of termite mounds per ha was 408; the highest number of termite nests (672 per ha) was found in the 10-year-old pasture. In terms of termite mound density, there was no difference between the Cerrado, 3-year-old pasture, and 3-year-old intercropped pasture treatments. The total area occupied by termite nests ranged from 0.4 to 1.0%. The mean bulk density of the nest materials was 1.05 g cm^{-3}. The total nests volume ranged from 4 to 11 m^3 ha^{-1}. The total mass of the soil turned by the termites ranged from 3.4 to 13.4 ton. ha^{-1}.

Keywords: turned soil volume, termite, soil macrofauna.

RESUMO. Incidência de térmitas de ninhos epígeos em pastagens de *Brachiaria* no Cerrado. O presente trabalho teve como objetivo determinar o número de ninhos epígeos e estimar a capacidade de revolvimento do solo pelos térmitas em ambientes de pastagens cultivadas e uma área nativa de Cerrado. Foram feitos levantamentos em quatro áreas, sendo três de pastagem e uma de Cerrado com 5 ha cada. Para cada ninho, foram mensurados a altura, o perímetro basal e diâmetro na base. Foi calculado o volume de cada montículo. Para determinar a densidade do solo mobilizado foi feita amostragem ao acaso em ninhos epígeos numa área de pastagem. O número médio de ninhos epígeos por ha foi de 408, o maior número de cupinzeiros está na pastagem dez anos (672 ninhos). Em termos de densidade média de ninhos epígeos não houve diferença entre os tratamentos: Cerrado, pastagem três anos e pastagem consorciada três anos. A área total ocupada pelos ninhos epígeos variou de 0,4 a 1 %. A densidade do solo mobilizado pelos térmitas foi de 1,05 g cm^{-3}. O volume total de solo mobilizado variou de 4 a 11 m^3 ha^{-1}. A massa total de solo mobilizado pelos térmitas foi de 3,4 to 13,4 t ha^{-1}.

Palavras-chave: volume de solo mobilizado, cupim, macrofauna do solo.

Introduction

The Brazilian Cerrado covers an area of 204.7 million hectares (ADÁMOLI et al., 1986). In this area, cultivated pastures represent 49.5 million ha (SANO et al., 2000), of which over 34 million show a loss of productivity (KLUTHCOUSKI et al., 1999). Studies have demonstrated that modifications in the soil's productive functions directly affect the soil macrofauna and that these organisms respond to many anthropic interventions made to the environment (LAVELLE; SPAIN, 2001). Termites play an important role in the soil macrofauna.

Termite ecology, particularly spatial distribution aspects and their relationship with environmental factors, have been the object of many investigations, most of them in Africa, Australia, and United States (ABE et al., 2000; BACHELIER, 1978). The soil macrofauna inventories of the Brazilian Cerrado indicate dominance by termites, both in density and biomass (BENITO et al., 2004; CONSTANTINO, 2005; DIAS et al., 1997). Termites build biogenic structures (galleries, nests and chambers), thus changing the physical properties of the soils they inhabit (BACHELIER, 1978). By means of their mechanical actions into the soil, they contribute, by the formation of stable aggregates, to the protection of the organic matter against a fast mineralization (DECÄENS et al., 2003; LAVELLE; SPAIN, 2001).

There has been great concern in Brazil on the part of farmers with regard to the high incidence of "mound termites" (*cupins de montículo*) in pastures, that is, species whose colonies build epigeal nests in the soil. A substantial part of geophagous termites build their colonies inside the soil. Nevertheless, although a pasture dotted with mounds causes great visual impact, the area occupied by nests, considering a mean area of 0.5 m^2 per mound, with a density of 200 termite mounds per ha, would decrease the pasture area just by 1% (EMBRAPA, 1996).

Although the edaphic macrofauna is relevant for ecosystems to function properly, few studies have been conducted to evaluate the effects of management practices on the soil macrofauna, especially in Cerrado soils. This study aimed to determine the number of epigeal nests and assess the soil turning capacity of termites in cultivated pasture environments and in a native vegetation area.

Material and methods

The study was carried out in a farm at 1000 m a.s.l. on the Brazilian central Plateau (15° 14' S, 47° 42' W) in Goiás State. The climate is sub-humid tropical (mean annual temperature of 23°C) with a rainy season from September to April (mean annual precipitation of 1170 mm). Dry and hot spells, lasting from 5 to 15 days, may occur during this season. The drought period lasts around 4 to 6 months. The soil is a homogeneous dark red, clayey Ferralsol, Latossolo Vermelho according the Brazilian classification (EMBRAPA 2006) containing 650 to 750 g kg^{-1} clay, with an acid pH (between 4 and 5).

Four areas measuring 5 ha each were selected, three under pasture and one under native Cerradão: i) Cerradão, ii) "past 3" (*Brachiaria brizantha* pasture, renovated three years earlier), iii) "paststy 3" (*Brachiaria brizantha* pasture intercropped with *Stylosanthes guianensis* var. *vulgaris*, cv Mineirão, renovated three years earlier), and iv) "past 10" (10-year-old *Brachiaria brizantha* pasture, established after deforesting a native forest savanna area). The "past 3" and "paststy 3" areas are parcels resulting from the renovation of a 7-year-old low productivity pasture. They were renovated using a heavy harrow at a depth of 15 cm; the *Brachiaria* grass was not reseeded and developed from the soil seed bank and the preexisting roots. A fertilization of 90 kg ha^{-1} P_2O_5 as Gafsa phosphate and 74 kg ha^{-1} sulfur as flower of sulfur was applied. The pastures were managed by adjusting the grazing pressure according to forage availability. The soil macrofauna was initially characterized in these areas (BENITO et al., 2004).

Within each area, four plots of 1000 m^2 were delimited to evaluate the incidence of the termite mounds on the pastures. The height, perimeter, largest diameter and smallest diameter at the base of each mound were measured with a measuring tape. The basal area was obtained by the mean between the largest and the smallest diameter, via the formula used to calculate the area of the ellipse, $A = \pi * a * b$, where "a" is half of the largest diameter and "b" is half of the smallest diameter. In order to estimate turned soil density, cube-shaped samples were taken at random with a hoe and a handsaw, from 28 termite mounds in the "past 10" area, and their volumes were then calculated. The samples were weighed and oven-dried at 105°C during 72h, and then weighed again after drying. Turned soil volume was calculated using the equation $V = 1/3 * \pi R^2 * h$, where R (m) is mound radius and h (m) is mound height.

Soldiers from 30 epigeal nests were sampled in the older pasture to determine genera found, since a nest may contain more than one species, in addition to the species that built the nest.

The data were compared inside each class by Kruskal-Wallis test, Dunn test was processed using Bioestat (AYRES et al. 2007)

Results and discussion

Termites genera

Twelve Isoptera morphospecies were found within 11 genera, most of them of the Subfamily Nasutitermitinae: *Cornitermes* sp.1, *Labiotermes* sp.1, *Procornitermes* sp.1, *Procornitermes* sp.2, *Armitermes* sp.1, *Cyranotermes* sp.1, *Embiratermes* sp.1, *Nasutitermes* sp.1, *Syntermes* sp.1, and *Curvitermes* sp.1 and subfamily *Termitinae*: *Orthognatotermes* sp.1, *Spinitermes* sp.1.

Epigeal nest density

In this study, the number of termite nests ranged from 195 to 672 ha^{-1} (Figure 1). This result is similar to those found by Kaschuk et al. (2006), who obtained 270 to 518 termite nests in five areas, of Cambisol and Nitisol. The "past 10" had the highest number of termite nests, 672 ha^{-1}, differing from the other areas. The number of termite nests did not differ between the renovated pastures and the Cerradão. According to Constantino (2005), this is related to pasture age, pasture management and the fact that termites are able to digest cellulose, the food being more abundantly supplied in older pastures. Another important aspect to be taken into consideration is pasture age at evaluation time. It can be observed that the older the pasture, the greater the number of termite nests per ha.

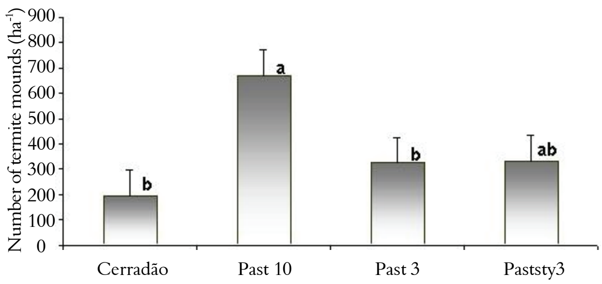

Figure 1. Total number of termite mounds per ha in soils under *Brachiaria* pastures and in the Cerradão area (values followed by the same letter are not significantly different at p < 0.05, Dunn test).

Area occupied by epigeal nests

The "Past 10" had the smallest mean basal area occupied by each mound (Table 1), although this area showed a high number of mounds. There were no differences between the Cerradão, "Past 3", and "Paststy 3" areas.

One of the concerns regarding the number of mounds is a potential reduction in the usable area of pastures Fernandes et al. (1998) pointed out that pastures could be considered to be degraded due to the presence of termite mounds in the area. However, according to Czepak et al. (2003), there is no proof of damage caused by termite mounds in pastures, and a high number of termite nests may not be associated with significant reductions in grazing areas.

Cosenza and Carvalho (1974) stated that in some pastures with infestations of about 160 termite nests per ha, there were no reductions in pasture yield, quality or plant cover when compared with non-infested areas.

In this study, it was observed that the total area occupied by termite nests ranged from 0.4 to 1% (Table 1), which does not correspond to a considerable area loss to the point of hampering pasture development. The need must be pointed out for adequate management that contemplates a balance between the quantity of termite mounds and the pasture.

The epigeal nest density per sampled area and the mean area of each nest define the total area occupied per ha. It is known that the number of epigeal nests tends to increase in areas that are not adequately managed. Therefore, older pastures will tend to present higher infestation levels, as observed in Figure 1. The main limiting factor for the development of those species will be the available forage supplied by the pasture.

Table 1. Number of termite mounds per area according their height, area, volume and mass (in each row, means followed by the same letter are not significantly different at p < 0.05, Dunn test).

	Cerradão	Past10	Past3	Paststy3
Total number of mounds per area (n/4000 m^2)	78	270	130	134
Height (m)				
≤ 0.15	30 a	212 a	52 bc	62 b
0.15 - 0.83	48 a	58 a	78 a	72 a
Basal Area (m^2)				
≤ 0.25	55 c	240 a	81 bc	103 b
0.25 - 0.5	11 b	15 b	39 a	22 ab
> 0.5	12 a	15 a	10 a	9 a
Area (%) per ha	0.4	0.7	0.8	1.0
Volume (m^3)				
≤ 0.015	53 c	238 a	70 bc	95 b
0.015 - 0.125	22 b	27 b	55 a	36 ab
> 0.125	3 a	5 a	5 a	3a
Mass (kg)				
≤ 15	53 c	238 a	69 bc	95 b
15 - 125	21 b	26 b	55 a	36 ab
> 125	4 a	6 a	6 a	3 a

Height of mounds

Several nests up to one meter in height were found in the studied areas. The tallest termite nests were found in the Cerrado area (0.5 - 1 m tall), without difference between "past 3" and "paststy 3"; however, a higher number of termite nests was observed in the "past 10" treatment, with heights between 0 and 0.1 m (Table 1). The smaller height could be related to pasture age (10 years); during this time, the species evolve and the colonies abandon their nests, which gradually break up by the effect of erosion, with an important role played by cattle trampling.

Turned soil mass and volume

The termites transport soil particles from different depths to the surface and deposit them in mounds, forming the epigeal nests. With a mean bulk density of 1.05 g cm^{-3}, the mass of the soil turned by the termites ranged from 3.4 to 13.4 ton. ha^{-1} which corresponds to a volume from 4 to 11 m^3 ha^{-1} (Figure 2). We can consider that a part of these masses are over estimated, because many species constructed with organic matter the central part of the nests. These data do not corroborate the results of Kaschuk et al. (2006), who found higher turned soil volume values, ranging from 8.11 to 63.3 m^3 ha^{-1}; others results showed 7.5 m^3 ha^{-1} $year^{-1}$ (SARCINELLI et al., 2009). So, the variability of soil masses transported to the epigeal nests has to be related to the diversity of species, soil type and especially to different weather conditions observed in the survey locations. The highest turned soil mass, 13.4 ton. ha^{-1} was obtained on "past 10" plot; although this plot showed a higher number of termite nests, it had the mounds with one of the largest occupied areas (0.7 %), which denotes different species from those observed in the other plots. The smallest soil mass was found in the Cerradão plot, which had the lowest incidence of epigeal nests. We suggest, as previously observed (BENITO et al., 2004), that under the cultivated pastures with a long time, here 10 years of pastured system, even when they are in decline from a cattle production point of view, the soil termite community is reestablished.

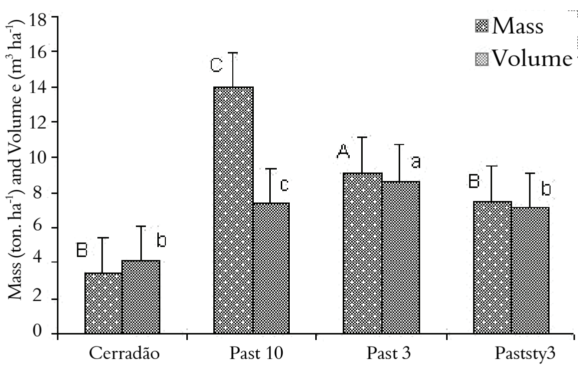

Figure 2. Turned soil mass and volume per ha in soils under *Brachiaria* pastures and Cerradão area (means followed by the same letter are not significantly different at $p < 0.05$, Dunn test).

Conclusion

Termites do not induce loss of grazing areas, termite's mounds represented from 0.4 to 1% of the surfaces. The mean soil volumes in epigeal mounds ranged from 4 to 11 m^3 ha^{-1}, highest value was observed for a period of 3 years. In the old pasture the number of termite mounds was higher with a slightly lower occupied area than in younger pastures that tend to be more homogeneous in terms of mounds density and size.

According to results of the renewed pastures, the structure and the size of termite mounds populations were influenced by trophic inputs.

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