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Research Article

Herpetofauna associated with termite mounds in a pasture, Mato Grosso do Sul State, Brazil

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ABSTRACT - The termites (Isoptera) are known as "engineers of the ecosystem", because they have the ability to modify the environment where they live with the construction of their mounds, which have specific climatic conditions, constituting a unique microenvironment used by other species. The present study was designed to characterise and quantify the occurrence of termitophile herpetofauna in an area of Cerrado (savanna) converted into pasture in Mato Grosso do Sul, Brazil. It also aims to evaluate termite mounds as an ecological resource for the herpetofauna. We investigated 90 mounds of *Cornitermes cumulans* in an area of 50 ha. We found a total of 18 species of herpetofauna (n=121 individuals). This included six amphibian species and 12 species of reptile. The amphibians were recorded in 41 mounds, with reptiles in 44 mounds. The structure of termite mounds and their cavities can assist amphibians and reptiles in thermoregulation, avoiding excessive exposure and desiccation in open areas, providing 'stepping stones' in the landscape. In addition to offering favourable living conditions, and protection from predators for many species, the mounds of *C. cumulans* may provide an important source of food, which suggests that termite mounds in open fields have an important ecological function for herpetofauna.

INTRODUCTION

The Cerrado, nominated as one of 34 biodiversity hotspots worldwide, is considered an area of extreme importance for conservation by presenting high biological richness and a high rate of endemism (Myers, 1988; Myers et al., 2000). Despite its biological value, it is estimated that more than 55% of its native vegetation has been removed, and less than 3% of its area is protected in reserves (Machado et al., 2004a, b). The constant degradation that this biome is suffering, especially through agricultural intensification and the suppression of native vegetation, implies changing or even complete degradation of specific microhabitats utilised by several groups of fauna, include herpetofauna, which may result in the loss of biodiversity, reducing the size of populations, and causing local extinctions (Primack, 2002). Information about the use of resources in natural or altered environments is important for the understanding of ecological processes, such as local intra- and interspecific interactions.

Termites (Isoptera) are well known as social insects with about 2751 described species in the world (Constantino, 1999). Many are considered pests. They build nests (known as termite mounds) that outcrop as knolls on the surface of pastures, and in other areas not subject to tilling (Maranho & Avila, 2007). They are abundant in almost all tropical terrestrial ecosystems, and in the Brazilian Cerrado, some species have achieved high densities (Constantino, 1999). The ability to modify the environment in which they live, by construction of their nests, makes termites "engineers of the ecosystem" (Dangerfield et al., 1998). Ecosystem engineers are organisms that affect the availability of resources for other species through physical changes in biotic and abiotic materials (Jones et al., 1994).

The termite mounds consist of an outer layer of very hard soil around a soft inner core, composed of fecal material, and crushed and ground vegetable matter, which often extends

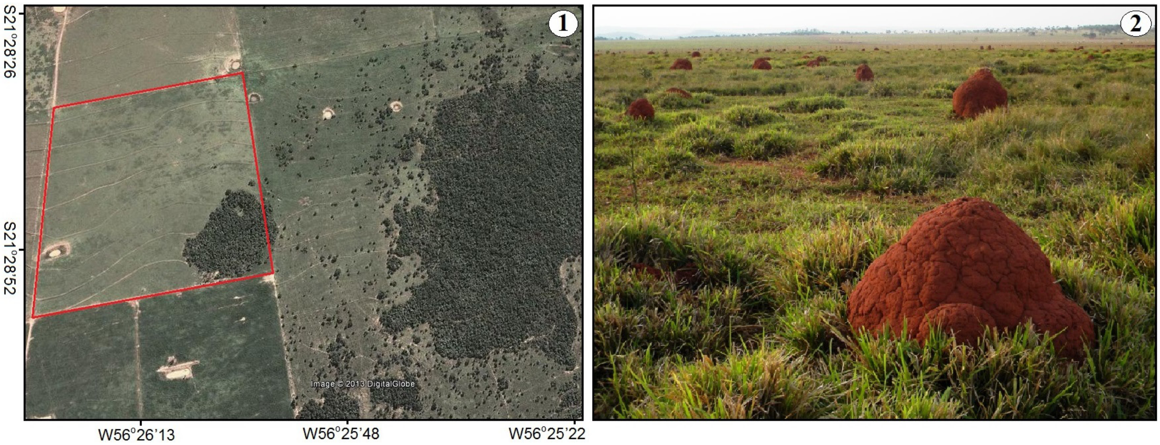

Figure 1. 1) Overview of the fragments of Cerrado and areas of pastures of Cabeceira do Prata, Jardim, MS. Delimitation in red indicates the area of study where were termite mounds were examined for study of the herpetofauna associated. 2) The Area of pasture, showing the termite mounds of *C. cumulans* investigated in this study.

below ground up to 40 cm. Due to the peculiarity of their structure, size, and nature of their construction, termite mounds can provide conditions for various uses by herpetofauna, including breeding places (Knapp & Owens, 2008) with stable temperature and humidity (Darlington, 1991), foraging and food resources (Gandolfi & Rocha, 1996; Peña, 2000; Flemming & Loveridge, 2003) and microhabitats for temporary or permanent shelter. Termites are also considered an abundant and important component of the diet of many generalists and specialists (Wood & Sands, 1978), which can be termed "termitophilous" (Cunha & Morais, 2010).

The Cerrado herpetofauna plays important and well-defined roles in the food chain, including the population control of a series of organisms. However, information about interactions between amphibians and reptiles and termite mounds in Brazil are scarce (Gandolfi & Rocha, 1996; Penã, 2000; Colli et al., 2006; Moreira et al., 2009; Rodrigues et al., 2009). This study aimed to characterise and quantify the occurrence of termitophile herpetofauna in termite mounds of *Cornitermes cumulans* (Kollar, 1832) in an area of Cerrado in the southern portion of the state of Mato Grosso do Sul, originally covered by typical vegetation of the Cerrado and currently converted into pasture. Another objective was to examine whether the external shape (height and circumference) of nests determines the rate of occupancy by amphibians and reptiles.

MATERIALS AND METHODS

The study was carried out at Cabeceira do Prata Farm (S 21º27' / W 056º26'), located in the municipality of Jardim, Mato Grosso do Sul (MS), in the vicinity of the Bodoquena Range National Park, inserted within the biodiversity corridor Miranda - Bodoquena Range (Brambilla & Pellin, 2006). The region is situated inside the Cerrado (savanna grassland) habitat zone, which also contains Atlantic Forest remnants (Hirota & Piotzoni, 2012). The climate of the region is characterised by a spring rainy season with high ambient temperatures (especially December to March) and a dry winter season with low pre-dawn temperatures that can reach close to 0°C (especially May and July). The average annual temperature is 22°C. Surplus water ranges from 1200 to 1400 mm for seven to eight months, and a water deficiency of 200 to 350 mm for three months (Amaral, 1989). The area is characterized by small remnants of Cerrado, surrounded by pasture of the grass cultivar *Urochloa decumbens*, and livestock. All mounds of *C. cumulans* examined in this study were distributed in an area of pasture of 50ha (Fig. 1).

The fieldwork was carried out in spring (rainy season, a period whose temperatures are higher) during the period of 29-31 January 2010. A total of approximately 200 termite mounds present in the study area, we randomly selected 90 mounds of *C. cumulans*. With the aid of a tape measure, measurements were taken of the height and circumference of the base of

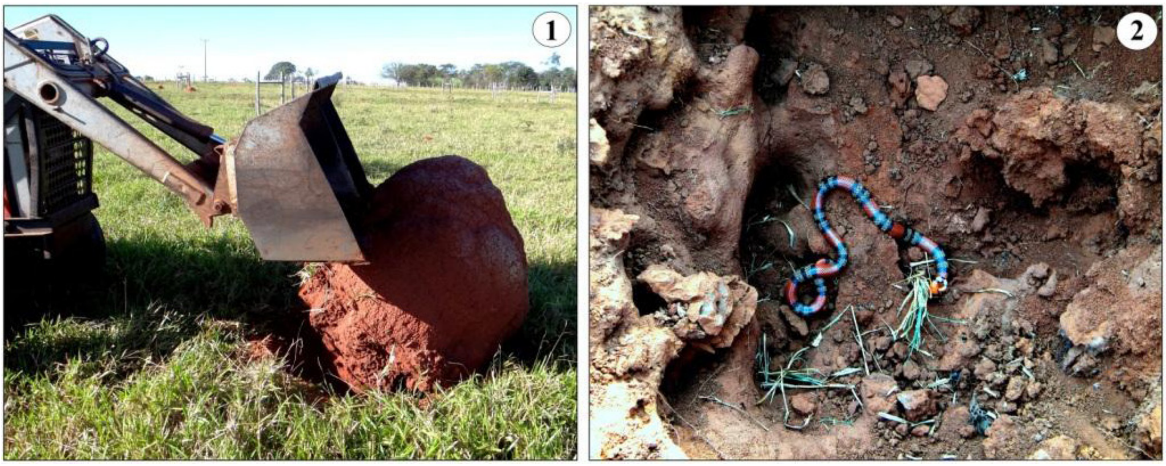

Figure 2. 1) Tipping termite mounds with the help of the tractor. 2) A specimen of coral snake *Micrurus frontalis* (Elapidae) found in an underground cavity within a nest.

each mound in metres. For each mound, we calculated the base area (πr²). For tipping and opening termite mounds, we used a tractor with an excavator bucket, which removed the epigeal (above ground) and hypogeal (below ground) portions of the nests simultaneously (Fig. 2). We then searched for amphibians and reptiles using snake hooks and tweezers for five minutes, prioritising cavities found in the hypogeal portion of the nest (Fig. 2). Subsequently the mound was fragmented with the aid of a pick-axe, to examine the interior. All specimens of amphibians and reptiles captured were wrapped in plastic and/or cotton bags to facilitate photography and identification. Specimens that couldn't be identified in the field were retained, fixed in 10% formalin, preserved in alcohol 70ºGL for further identification, and deposited in the Zoological Reference Collection of the UFMS (ZUFMS). The nomenclature used for amphibians follows Segalla et al. (2012), and for reptiles Bernils & Costa (2012). To examine whether the basal area of termite was related to occupation abundance by termitophile herpetofauna, simple regression analysis was performed.

RESULTS

Among the 90 termite mounds examined, 80% were occupied by amphibians and/or reptiles. Nests ranged in height from 50 to 110 cm (77.3 ± 13.19); in diameter from 196 to 390 cm (280.46 ± 40.87); and in basal area from 31 to 121 cm (64 ± 19.21). The frequency of occupation by herpetofauna showed no statistical relationship with the external characteristics of termite mounds (height, diameter and basal area).

We found a total of 18 species (n=121). Six anuran amphibians (n= 68) were distributed in families Leptodactylidae (2 spp), Hylidae (2 spp) and Microhylidae (2 spp). The 12 reptile species (n=53) comprised eight snakes (Colubridae, 5 spp; Viperidae, 2spp; Elapidae, 1 sp), three lizards (Gymnopthalmidae, 2 spp; Mabuyidae, 1 sp) and one amphisbaenid (Amphisbaenidae) (Table 1).

Amphibians were recorded in 41 termite mounds (45.5%). Of these, on four occasions multiple species were recorded. The most abundant species were *Scinax fuscovarius* (n= 30) and *Chiasmocleis albopunctata* (n=23), found in 23.3% and 10% respectively of termite mounds investigated (Table 1). Reptiles were found in 44 of the sampled termites (48.8%), dominated by *Cercosaura* cf. *ocellata* (n = 16), found in 16.9% of nests (Table 1). The snakes accounted for 19.8% of the total number of animals recorded.

In 18 nests we observed the simultaneous presence of anuran amphibians and reptiles, with the former greater in number. The greatest abundance observed in the same mound was five individuals. On one of four such occasions, we observed four specimens of the frog *C. albopunctata* and the snake *Sibynomorphus turgidus*.

DISCUSSION

The high herpetofauna occupancy rate (80%)

AMPHIBIA	No. of specimens	Frequency occurrence (%)
HYLIDAE		
Snouted tree-frog (*Scinax fuscovarius*) (A. Lutz, 1925)	30	29.5
Sharp-snouted tree-frog (*Scinax nasicus*) (Cope, 1862)	2	2.8
LEPTODACTYLIDAE		
Cei's white-lipped frog (*Leptodactylus chaquensis* Cei, 1950)	4	5.6
Mustached frog (*Leptodactylus mystacinus*) (Burmeister, 1861)	4	5.6
MICROHYLIDAE		
White-spotted humming frog (*Chiasmocleis albopunctata*) (Boettger, 1885)	23	12.6
Muller's termite frog (*Dermatonotus muelleri*) (Boettger, 1885)	5	7.0
REPTILIA		
MABUYIDAE		
Dunn´s Mabuya (*Manciola guaporicola*) (Dunn, 1935)	6	8.4
GYMNOPHTHALMIDAE		
Cercosaura cf. ocellata	16	16.9
Cercosaura cf. schreibersii	5	7.0
AMPHISBAENIDAE		
Red worm lizard (*Amphisbaena alba* Linnaeus, 1758)	2	2.8
COLUBRIDAE		
Almaden ground snake (*Erythrolamprus almadensis*) (Wagler, 1824)	3	4.2
Striped ground snake (*Lygophis meridionalis*) (Schenkel, 1901)	1	1.4
Green racer (*Philodryas mattogrossensis* Koslowsky, 1898)	4	5.6
Slug-eating snake (*Sibynomorphus turgidus*) (Cope, 1868)	4	5.6
False lancehead (*Xenodon merremii*) (Wagler, 1824)	2	2.8
ELAPIDAE		
Coral snake (*Micrurus frontalis*) (Duméril, Bibron & Duméril 1854)	5	7.0
VIPERIDAE		
Crossed pit viper (*Bothrops alternatus* Duméril, Bibron & Duméril, 1854)	1	1.4
South American lancehead (*Bothrops mattogrossensis* Amaral, 1925)	4	5.6

Table 1. Richness, abundance and frequency of reptiles and amphibians found in termite mounds (*C. cumulans*) in an area of pasture in Cabeceira do Prata Farm, Jardim, Mato Grosso do Sul, Brazil.

demonstrates the importance of *C. cumulans* mounds as a resource for amphibians and reptiles in an area of pasture, especially an area that is degraded. No association was found between the size of termite mounds and the richness of anuran amphibians and reptiles inhabiting them (r^2 = 0.02). Conversely, in a study carried out on pasture in the state of Goiás in Brazil, Cunha & Morais (2010), found a positive relationship between the basal area of the epigean mound and the richness of termitophilous inhabitants, such that older and larger termite mounds had a tendency to contain a greater number of species, including ants, cockroach, earthworms, beetles, spiders, anurans and diplopods.

In addition to offering favourable conditions for nesting (SD pers. obs.) and refuge against predators for many species, the nests of *C. cumulans* may provide an important source of food, sheltering a wide range of items as potential food resources. Termites constitute an important resource for lizards of the Brazilian Cerrado (Costa, 2005). Some microhylids, such as *D. muelleri* recorded in this study, have an ecological niche compatible with its occurrence in termite mounds with fossorial habits and specialised prey of ants and termites actively seeking these prey, which they consume in large quantities (e.g. Lieberman, 1986).

The modulated temperature and humidity found in nests of *C. cumulans* (Sight & Sight, 1981) can help amphibians and reptiles by aiding thermoregulation. The form of semi-spherical cavities, present mainly in the underground portions of nests, may constitute thermoregulation sites for many ectothermic species. It has previously been shown that lizards are able to thermoregulate by actively selecting termite mounds (Gandolfi & Rocha, 1996), and these sites can have an important influence on lizard thermoregulation (Rocha & Bergallo, 1990; Bujes & Verrastro, 2006) The present study was carried out in spring (rainy season, a period whose temperatures are higher), but it is expected that seasonal fluctuations can change the behaviour and the use of available resources. Depending on the season, different groups may appear or be absent in termite mounds. Hence sampling in different climatic conditions (mainly temperature and moisture) would probably identify a greater number of amphibians and reptiles using termite mounds in the region studied. Under unfavourable conditions, such as low temperatures, suitable microhabitats are important both for the maintenance of their basal metabolic conditions, to avoid predation (Huey et al., 1977; Avery et al., 1982; Adolph, 1990). In this sense, the richness and species composition and abundance of individuals can be even higher in the winter, when these termite mounds operate as important resources for herpetofauna.

Termites are generally misunderstood, and tend to be viewed as pests that degrade pasture, rather than insects that perform a valuable ecological role for termitophile species. Termites are considered key species by Redford (1984), and the destruction of their colonies can lead to a negative effect over the broader biodiversity of an area (Fleming & Loveridge, 2003), promoting a cascade of local extinctions (Gilbert, 1980). Therefore, the "ecological engineering" value of termite mounds should be more thoroughly studied as a potential tool for the maintenance and conservation of ecosystems.

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