

FOOD HABITS AND SEED DISPERSAL BY *Thrichomys apereoides* (RODENTIA: ECHIMYIDAE) IN A BRAZILIAN CERRADO RESERVE

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ABSTRACT: The food habits and seed dispersal promoted by *Thrichomys apereoides* (Rodentia, Echimyidae) were investigated in a Cerrado reserve in southeastern Brazil. Diet was determined by faecal analysis and seed dispersal was tested through seed germination experiments. As a result, 68 scats of *T. apereoides* were collected and in mean 76.5% contained arthropods, hymenoptera being the most frequent food item. Moderate to high germination rates obtained showed that, despite the efficiency of the rodent's feeding apparatus, small sized seeds of pioneer plants passed undamaged through the guts and remained viable. The high consumption of seeds belonging to pioneer plants (*Clidemia urceolata* and *Miconia holosericea*) emphasizes the importance of *T. apereoides* related to dispersal rather than predation for small sized seeds.

RESUMEN: Hábitos alimenticios y dispersión de semillas por *Thrichomys apereoides* (Rodentia: Echimyidae) en una reserva brasileña del Cerrado. Se investigaron los hábitos alimenticios y la dispersión de semillas promovido por *Thrichomys apereoides*, a través de muestras de heces, en una reserva del Cerrado en el sudeste del Brasil. La dieta fue determinada por el análisis de muestras de heces y la dispersión de semillas a través de experimentos de germinación. Se recogieron 68 muestras de heces de *T. apereoides* y en promedio 76.5% contuvieron artrópodos, siendo los himenópteros el alimento más frecuente. Las tasas de germinación fueron moderadas a altas mostrando que, a pesar de la eficiencia del aparato de alimentación de los roedores, pequeñas semillas de plantas pioneras pasaron intactas a través del intestino y se mantuvieron viables. El alto consumo de semillas pertenecientes a las plantas pioneras (*Clidemia urceolata* y *Miconia holosericea*) enfatiza la importancia de *T. apereoides* en relación con la dispersión en lugar de la depredación de pequeñas semillas.

Key words. Cerrado domain. Diet composition. Seed dispersal.

Palabras clave. Dieta. Dispersión de semillas. Dominio del Cerrado.

Rodents are the most diverse group of terrestrial mammals in Neotropical forests (Emmons and Feer, 1997) and play an important role in the seed dispersal and seed predation of several plants species (Paschoal and Galetti, 1995; Adler and Kestell, 1998; Guimarães et al.,

2005). However, the relationship among plants and rodents is complex, because depending on food availability and animal behavior, the same animal can act as seed disperser or as seed predator (Price and Jenkins, 1986; Paschoal and Galetti, 1995; Adler and Kestell,

1998). Despite the wide variety of food items available, the habit of feeding on fruits is widespread in Neotropical small mammals and can be related to dispersal rather than predation for small sized seeds (Vieira et al., 2003; Casella and Cáceres, 2006).

The punaré (*Thrichomys apereoides*) is a medium-sized South American echimyid usually associated with rocky and dryland habitats (Alho, 1982; Eisenberg and Redford, 1999). Recent work recognizes that the genus *Thrichomys* is comprised of at least four monophyletic species with a wide geographic distribution: *T. pachyurus*, that occurs in the Pantanal (Mato Grosso and Mato Grosso do Sul States); *T. inermis*, in the Caatinga (Bahia and Tocantins States); *T. laurentinus*, in the Caatinga (Bahia, Pernambuco, Alagoas, Piauí and Ceará States) and *T. apereoides*, in the Cerrado (Minas Gerais, Goiás and Bahia States) (see Bragio and Bonvicino, 2004; Oliveira and Bonvicino, 2006).

Despite its commonness and wide distribution, many aspects of *T. apereoides* natural history remain poorly known and information on its food habits in the Brazilian Cerrado is lacking. The species have traditionally been regarded as frugivore-herbivore (Fonseca et al., 1996; Oliveira and Bonvicino, 2006), although this claim is not based on detailed studies of its diet.

We here report the results of a study on the diet of *T. apereoides* in a Brazilian Cerrado reserve. Our objective was to describe the diet of the species in the area, compare the patterns found in different seasons (dry versus humid months) and evaluate the viability of the seeds ingested to add information on the trophic ecology of this Neotropical echimyid.

The study site, Parque Estadual do Rio Preto (PERP), is located in the central part of Minas Gerais State (18° 09'S, 43° 23'W), southeastern Brazil. This reserve is an important (12 000 ha) remnant of the Brazilian Cerrado (savanna-like vegetation), one of the most endangered ecosystems of the world (Myers et al., 2000). The study was conducted in a gallery forest remnant, at 950 m above sea level. The an-

nual rainfall ranges from 8.25 mm to 223.19 mm concentrated mainly in the rainy season (October-March), although some rain may occur during the dry season (April-September).

Rodents were captured weekly from February 2005 to March 2006 using 100 mesh-wire live traps (30 X 15 X 15 cm). The traps were placed on the ground at 20 m intervals, along two lines 50 m apart. During four nights in each month the traps were baited with a mixture of banana and cotton balls soaked with cod-liver oil during the afternoon and checked for captures of rodents during the following morning. All animals were marked with numbered ear tags and released. Scats on the trap floor and those defecated by the individuals during the manipulation were collected. One fecal sample was considered as being all feces produced by one animal in a night.

The diet of *T. apereoides* was determined through the analysis of scats. Scats were washed in a 0.1 mm-mesh sieve in the laboratory and the food items were examined with a stereomicroscope. Food items were assigned to the following categories: arthropods (Coleoptera, Hymenoptera, Isoptera, and Hemiptera), seeds, other plant parts (flower and fruit fragments) and unidentified material. Food items were identified to the lowest possible taxonomic category by comparison with a reference collection of invertebrates and seeds from the study area. When present, seeds were counted in each fecal sample to estimate seed predation level (proportion of the total number of broken seeds by the total number of seeds in scats). The bait residue was detected and excluded during the scats analyses.

The relative frequency of occurrence (Korschgen, 1987) was used to determine the contribution of each item in all food categories to the diet of *T. apereoides*. This statistic was calculated as the relative frequency of scats containing a particular food item multiplied by 100 (Korschgen, 1987). The chi-square test (Sokal and Rohlf, 1995) was applied to test the hypothesis of no difference between the composition of the diet within the dry and rainy seasons.

Seeds found in scats were counted and placed in closed Petri dishes (diameter = 9 cm) containing wet absorbing paper to verify germination. Seeds were monitored weekly for seed germination. As a control experiment, seeds of the same plant species consumed by the rodent were collected directly from fruiting plants in the area of the study. They were tested for germination as described above.

Sixty eight scats from 26 individuals of *T. apereoides* were collected during the study. Arthropods were present in 89.7% of the samples in the dry season and 58.6% in the rainy season (**Table 1**). The most frequent group was Hymenoptera followed by Isoptera, Hemiptera, and Coleoptera. Unidentified arthropods were found in 71.8% of the samples in the dry season and in 31% in the rainy season. Seeds were present in only 15.4% of the samples in the dry season and in 27.4% in the rainy season. Fruits of the pioneer plants, *Clidemia urceolata* and *Miconia holosericea* (Melastomataceae), were consumed in high

proportions, these two species whose total number of seeds in scats was estimated at around 456 seeds, were responsible for 80.2% of all seeds dropped. The percentage of predated *C. urceolata* seeds was 33% (n = 272) and for *M. holosericea* 28% (n = 184). Other plant parts (flower and fruit fragments) were present in 26.4% of the samples (**Table 1**).

There was a significant increase in the rate of consumption of seeds and other plants parts during the rainy season ($\chi^2 = 4.516$, $df = 1$, $p < 0.05$).

Germination tests showed that only small seeds (≤ 1 mm long) belonged to pioneer plants, such as *C. urceolata* and *M. holosericea*, remained viable after passage through the digestive tract of *T. apereoides*. Seeds greater than 1 mm were found destroyed (Melastomataceae seeds) or were rejected (Meliaceae). All seeds from fruit species consumed by *T. apereoides* presented moderate (= 39%) to high germination rates (over than 70%). Fruits of *C. urceolata* were among the most frequently consumed and present signifi-

Table 1

Number of samples with respective food items and its relative frequency of occurrence (in %) found in scats of *Trichomys apereoides* in the PERP, Brazil (n = total number of scats analyzed).

Food items	Dry season (n =39)	Wet season (n = 29)	Total (n = 68)
ARTHROPODS (TOTAL)	89.7	58.6	76.5
Coleoptera	2.6	10.3	5.9
Hymenoptera	30.8	27.6	29.4
Isoptera	10.2	6.9	8.8
Hemiptera	5.1	—	2.9
Unidentified Arthropods	71.8	31.0	54.4
SEEDS (TOTAL)	15.4	27.6	20.6
Melastomataceae	—	—	—
<i>Clidemia urceolata</i> DC.	2.6	20.7	10.3
<i>Miconia holosericea</i> (L.) DC.	7.7	3.4	5.9
Unidentified Melastomataceae	—	3.4	1.5
Unidentified seeds	5.1	—	2.9
OTHER PLANT PARTS (TOTAL)	15.4	37.9	26.4
FRUITS FRAGMENTS	—	—	—
<i>Cabralea canjerana</i> (Vell.) Mart.	—	10.3	4.4
Unidentified fruits	12.8	—	7.3
FLOWER FRAGMENTS	—	—	—
Lauraceae	2.6	—	1.5
Unidentified flowers	5.1	27.6	14.7

cant germination rates ($\chi^2 = 19.253$, $df = 1$, $p < 0.01$), following by *M. holosericea* ($\chi^2 = 13.392$, $df = 1$, $p < 0.01$).

The terms “insectivore”, “herbivore” and “frugivore” refer to animals whose diets contain over 50% of arthropods, green plant parts or fruits respectively, whereas “omnivore” refers to those species in whose diets no particular category prevails (Giannoni et al., 2005).

Although *Thrichomys apereoides* belongs to a genus of rodents usually classified as a frugivore-herbivore (Fonseca et al., 1996), our results suggested that arthropods, especially hymenopterans and isopterans, were an important food source. The high consumption of arthropods may indicate an active search of this resource, mainly during the drier season. A pronounced insectivorous habit was also found by Talamoni et al. (2007) for sigmodontine rodents in a Cerrado reserve, in the Parque Estadual Serra do Rola-Moça, Minas Gerais State, Brazil. According the definition of the terms, this study supports the suggestion that *T. apereoides* is an insectivorous rodent but also consumes fruits and other plant parts at different proportions in dry and rainy seasons.

The consumption of fruits and other plant parts were higher during the rainy season; however, the increased consumption of these items on a seasonal basis may reflect fruit availability in the field. The fruiting of many zoochoric plants in South American forests coincides with the rainy season (Charles-Dominique et al., 1981); and according to Mantovani and Martins (1988), in the Cerrado biome one expects a reduction in the availability of plant food resources during the dry season. We should also consider that the importance of fruits and arthropods in the diet of *T. apereoides*, in the present study, may be underestimated; because all rodents are equipped with chisel-like, growing incisors, and a series of grinding cheek teeth and a jaw that can move laterally as well as forward and backward (Price and Jenkins, 1986). This feeding apparatus allows them to process arthropods, seeds, fruits and herbaceous mate-

rial efficiently, which is in agreement with the relative frequency of occurrence of unidentified material found in scats.

Seed dispersal by rodents is often difficult to investigate (Guimarães et al., 2005) due to their efficient food mastication (Talamoni et al., 2007). However, this close plant-animal interaction may be directly related to seed size (Casella and Cáceres, 2006) and in most cases rodents may act as either seed predators and seed dispersal agents (Adler and Kestell, 1998; Brewer, 2001; Fedriani, 2005). Guimarães et al. (2005) reported the rejection by Neotropical echimyids (such as *Proechimys*) of large seeds belonging to *Syagrus romanzoffiana* (Palmae) near the parent plant, consuming only the pulp. A similar pattern might have occurred here, because seeds greater than 1 mm belonging to *Cabralea canjerana* (Meliaceae) were destroyed or perhaps rejected near the parent plant and just fibrous pulp appeared in scats.

The high consumption of small seeds belonging to pioneer plants allows speculation on the role of *T. apereoides* as a potential seed disperser. Despite the efficiency of the rodent feeding apparatus (Price and Jenkins, 1986) the small sized seeds consumed (≤ 1 mm) remain viable after passing undamaged its digestive tract. Thus, small seeds would have good chances to be dispersed and their probability of germination in the field is likely to be high. Previous studies have noted that echimyids may be important dispersal agents in Neotropical forests (Forget, 1990; Adler and Kestell, 1998). The small number of seeds destroyed and the moderate to high germination rates obtained during the germination experiments emphasize the importance of *T. apereoides* as a potential pioneer plant disperser in Cerrado areas.

Since this medium-sized South American echimyid presents a wide geographic distribution (Bragio and Bonvicino, 2004) living in several types of environments (Alho, 1982; Eisenberg and Redford, 1999) its effective contribution as seed dispersers or seeds predators needs additional research.

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