Small mammals and microhabitat selection in forest fragments in the transition zone between Atlantic Forest and Pampa biome

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Abstract. Natural resources are depleted in fragmented landscapes that have their vegetation also altered. As a result, the microhabitat diversity and the composition and distribution of local species are affected. In this study, we evaluated the small mammals' community diversity, composition and microhabitat selection in two Atlantic Forest fragments, in an ecotone area with the Pampa biome, southern Brazil. We recorded five rodents (*Akodon montensis, Oligoryzomys nigripes, Sooretamys angouya, Juliomys pictipes* and the exotic *Rattus rattus*) and one marsupial (*Didelphis albiventris*). Both fragments were dominated by the generalist rodent *A. montensis. Akodon montensis* and *O. nigripes* showed similar habitat preferences: ground covered by rocks and higher values of vegetation obstruction. *Sooretamys angouya* preferred places with higher abundance of trees. Fruit availability was important for *A. montensis* and *D. albiventris,* highlighting the importance of this food resource for local wildlife, and the potential role of these species as seed predators and dispersers. Small species richness, the presence of an exotic species and high dominance level suggest that the study area is highly degraded.

Keywords. Habitat use; Rodent; Marsupial; Community ecology; Vegetation Structure.

INTRODUCTION

The Atlantic Forest is a complex biome with several vegetational formations, which includes a significant part of Neotropical biodiversity (Tabarelli *et al.,* 2005; SOS Mata Atlântica & INPE, 2011; Leitman *et al.,* 2015). This high diversity is partly due to its great latitudinal extension, from 4°S to 32°S latitude, the widest latitudinal gradient of a tropical forest in the world (Ribeiro *et al.,* 2009). It is also one of the most threatened tropical forests, with agricultural and urban developments being the leading causes of deforestation and fragmentation (Ribeiro *et al.,* 2009; Lira *et al.,* 2012). Fragmentation of natural habitats can promote a reduction in species diversity through the extinction of specialist species (Pardini *et al.,* 2010; Bregman *et al.,* 2014; Matthews *et al.,* 2014). Atlantic Forest fragmentation and its effects on

biodiversity have been intensively studied in the last years, mainly in the northeast (*e.g.,* Lôbo *et al.,* 2011; Leal *et al.,* 2012; Santo-Silva *et al.,* 2016; Filgueiras *et al.,* 2019) and the southeast of Brazil (*e.g.,* Umetsu & Pardini, 2007; Vieira *et al.,* 2009; Almeida-Gomes & Rocha, 2014; Almeida-Gomes *et al.,* 2019). The southern Atlantic Forest, at the border with the Pampa biome, remains the least studied region of this biome regarding fragmentation studies.

Human occupation of the Atlantic Forest also caused structural alteration of the remnants, which could lead to some changes at the microhabitat scale (Chazdon, 2003). Such scale is complex in Neotropical forests, such as the Atlantic Forest, once they show a high variety of vegetation structure (Richards, 1996). Microhabitat has been described as environmental variables that affect the species behavior from an individual per-

spective and determine portions of the home range that are more intensively used (Morris, 1987; Warrick *et al.,* 1998; Akers *et al.,* 2013; Schirmer *et al.,* 2019). It's use has been specially related to resource availability (*e.g.,* Hodara & Busch, 2010; Pinotti *et al.,* 2011; Sponchiado *et al.,* 2012; Corrêa *et al.,* 2018) and protection against predators (*e.g.,* Lima *et al.,* 2010; Melo *et al.,* 2013; Law *et al.,* 2018; Bajaru *et al.,* 2019). Highlighting the importance of microhabitat characteristics in forest fragments, Delciellos *et al.* (2016) found that the quality of vegetation structure had a comparative effect over small mammal richness and composition with fragment isolation and climate seasonality.

Small mammals play key ecological roles in the forest ecosystems, serving as seed dispersers and predators (Bricker *et al.,* 2010; Grenha *et al.,* 2010), insects predators (Kaunisto *et al.,* 2012) and important prey for terrestrial vertebrates (Wang, 2002; Bianchi *et al.,* 2010). Studies on ecology and community structure of small mammal species have the potential to answer important questions related to forest dynamics since these species respond directly to local and regional changes in habitat (Castro & Fernandez, 2004; Hodara & Busch, 2010; Delciellos *et al.,* 2018). In general, specialist species are negatively influenced by habitat loss and alteration whereas generalist species with a wider geographical range are positively influenced, or unaffected by these processes (Pardini *et al.,* 2010; Püttker *et al.,* 2013). Approximately 320 small mammals species have been recorded in Brazil (Quintela *et al.,* 2020). Even though Atlantic Forest is the Brazilian biome with the highest number of studies regarding mammal species (Brito *et al.,* 2009), there is still a significant knowledge gap on species composition

in some areas, such as the southern Atlantic Forest, at the very border with the grassland dominated Pampa biome.

In this study, we investigated species richness, abundance, and composition of a small mammal community in two Atlantic Forest fragments and evaluated the microhabitat selection by the most abundant species. Firstly, we hypothesized the existence of a poor community dominated by common and generalist species, because the sampled fragments are medium to small-sized and the general landscape is poorly forested. Secondly, we hypothesized that small mammals' abundance would be related to fruit availability, an important resource for these species. Additionally, we considered that small mammals would be more abundant in areas where the vegetation structure could provide protection against predators, such as vegetation obstruction.

MATERIAL AND METHODS

Study area

The study was carried out from April 2015 to October 2016 in two Atlantic Forest fragments (Fragment 1: 28°08'38"S, 54°45'36"W, 30 ha; Fragment 2: 28°07'33"S, 54°44'57"W, 20 ha) in Cerro Largo municipality, Rio Grande do Sul State, Brazil (Fig. 1). This region is an ecotone between the Atlantic Forest and the grassland dominated Pampa biome. The vegetation is classified as deciduous forest, with Fabaceae being the most abundant botanical family (Souza *et al.,* 2020). The local climate is subtropical (Cfa type, Köppen classification: Peel
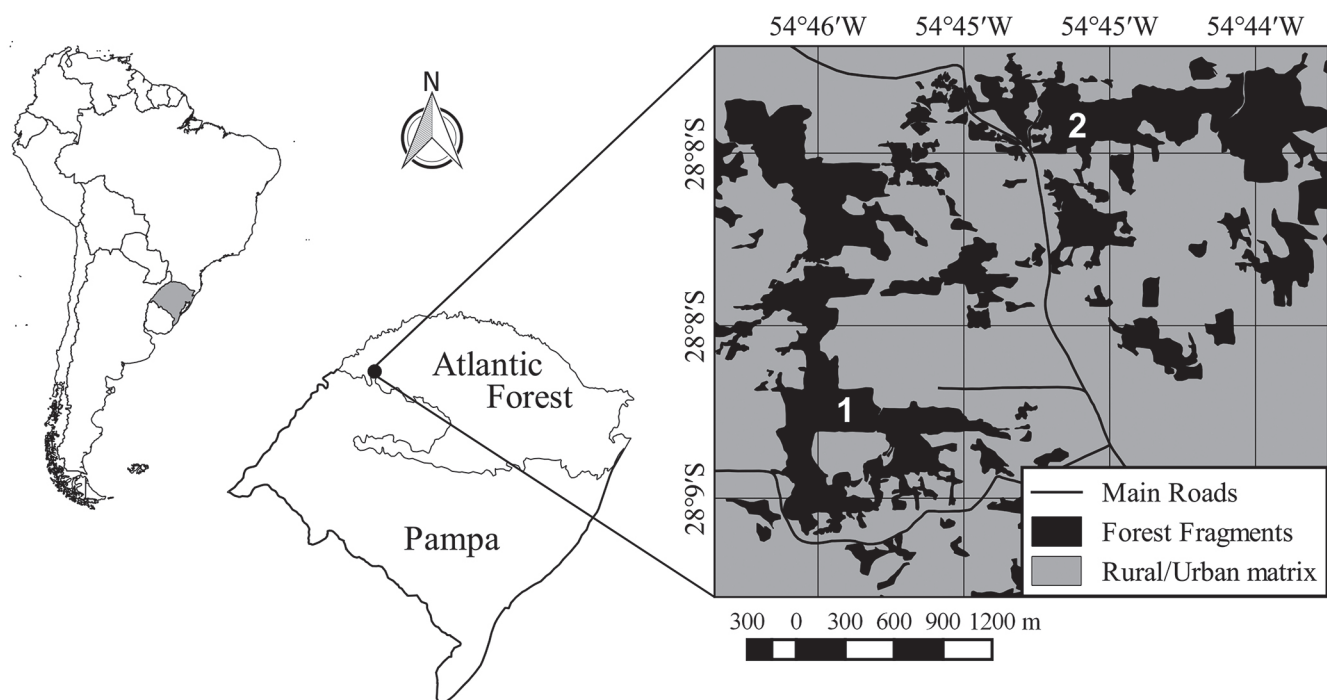

Figure 1. Location of the study area in South America and Rio Grande do Sul State, Brazil. Atlantic Forest and Pampa biome extents in the Rio Grande do Sul. Regional landscape with forest fragments, main roads, and matrix extent. Numbers 1 and 2 indicate the studied fragments (Fragment 1 – 28°08'38"S, 54°45'36"W, 30 ha, Fragment 2 – 28°07'33"S, 54°44'57"W, 20 ha).

et al., 2007) with high annual rainfall (mean: 1,800 mm). The mean temperatures range from 20°C to 30°C in the hottest months (December, January, and February) and 10°C to 20°C in the coldest months (June, July, and August) (Kuinchtner & Buriol, 2001).

Trapping procedures

In each fragment, we sampled small mammals for ten nights per season from Autumn 2015 to Spring 2016. We set three 120 m long transects in each fragment, each with seven trapping stations 20 m apart and at least 25 m from the fragment edge. We used Sherman (31 × 10 × 08 cm) and Tomahawk (45 × 17 × 17 cm) live-traps. In each trapping station, we placed two live-traps – one on the ground and one in the understory (approximately at 1.5 m high) – totalizing 42 live-traps per fragment. Each trap was baited with a mixture of peanut butter, banana, corn flour, sardine, and commercial cod-liver oil. This study was authorized by IBAMA – Brazilian Institute of Environment and Natural Resources (authorization number 469472) and the ethics procedures were authorized by the UFFS Animal Ethics Committee (authorization number 009/CEUA/UFFS/2015).

Species identification

A total of 32 specimens were field-collected and deposited in the Universidade Luterana do Brasil (ULBRA), Museu de Ciências Naturais, Laboratório de Sistemática de Mamíferos (*see* Table S1). An ear plug was sampled from each voucher, which received a numbered tag and was released in the same capture point. The taxonomic identity of specimens was determined either based on morphological analyses of vouchers, compared with museum specimens from ULBRA and published morphological data (Bonvicino *et al.,* 2008) or DNA.

Total DNA was extracted from muscle tissue (ear plug) preserved in ethanol 100% from 26 vouchers, using the PureLink Genomic DNA kit (Invitrogen), following manufacturer protocols. A fragment of 801 base pairs of the mitochondrial DNA (mtDNA) gene cytochrome b (Cytb) was amplified with primers MVZ05 and MVZ16 and conditions described by Smith & Patton (1993). PCR products were cleaned using Exonuclease I and Thermosensitive Alkaline Phosphatase (FastAP; Thermo Scientific) and purified amplicons were directly sequenced (forward strand) in an ABI 3730xl genetic analyzer by Macrogen (Republic of South Korea). Chromatograms were edited and aligned using Geneious v.9.1.8 (Biomatters, available at https://www.geneious.com; Kearse *et al.,* 2012). Using the Local Alignment Search Tool (BLASTN 2.10.1+) (Zhang *et al.,* 2000), the resulting sequences were compared to those in the public database Genbank (NCBI: https://blast.ncbi.nlm.nih.gov) to identify species matches based on sequence similarity. We considered an identity value between 98.5 and 100% as a reliable match for a species (*see* Table S2).

Microhabitat variables

To understand species associations with microhabitat, we measured 13 variables at each trapping station (Freitas *et al.,* 2002; Vieira *et al.,* 2005). Ground cover in the trapping station was measured with a 0.25 m² horizontally-placed grid divided into 100 equal parts (Freitas *et al.,* 2002). We estimated the percentage of grid cells covered by (Variable 1) leaf litter, (V2) rocks, (V3) herbaceous vegetation, and (V4) bare soil. We repeated this measure in each cardinal direction around each trapping station and averaged across the four directions to characterize the ground cover at each trapping station. Ground cover variables showed high correlation values as they were measured as proportions of the same grid (Hair *et al.,* 2010). Therefore, these variables were grouped in a Principal Component Analysis (PCA) before the microhabitat selection analysis. The two first axis of this Principal Component Analysis, PC1GC, and PC2GC (Table 1), represented 92% of the variation in the original data.

We measured the vegetation obstruction at three heights: (V5) 0 to 0.50 m, (V6) 0.51 and 1.00 m, and (V7) 1.01 and 1.50 m. We used the same grid as above, vertically positioned and estimated the percentage of grid cells with vegetation cover within 3 m. This measurement was performed in each cardinal direction and their average was used to characterize the vegetation obstruction at each trapping station. The vegetation obstruction showed high correlation values (Hair *et al.,* 2010) so we used the average across the three heights in the subsequent analysis.

Additionally, we measured four variables within a 3 m radius of each trapping station. We counted the measured perimeter at breast height (PBH) of all trees and grouped them into three subcategories: (V8) 10 to 30 cm, (V9) 31 to 60 cm, and (V10) above 61 cm. We also recorded the (V11) presence or absence of trees or shrubs with fruits that could be eaten by small mammals. Canopy height (V12) was estimated, always by the same person, by comparing it to an object of known height. Canopy cover (V13) was also estimated by holding the grid horizontally above the head and counting the percentage of grid cells covered by vegetation. All microhabitat variables (expect fruit availability) were estimated once a year and averaged for the subsequent analysis. Fruit availability was estimated seasonally, and an average for each season was used in the subsequent analysis.

A PCA was performed on canopy height, canopy cover, PBH, and vegetation obstruction as these variables showed a high correlation. The two first axes, PC1VS and PC2VS (Table 2), represented 55% of the variation in the

Table 1. Principal Component Analysis values of the four original ground cover variables into the PC1GC and PC2GC. Together, these two axes represented 92% of the variation in the original data.

	PC1GC	PC2GC
Leaf Litter	0.843	0.085
Rocks	0.283	0.759
Herbaceous Vegetation	0.437	0.644
Bare Soil	0.134	0.035

Table 2. Principal Component Analysis values of the six original vegetation variables into the PC1VS and PC2VS. Together, these two axes represented 55% of the variation in the original data.

	PC1VS	PC2VS
Canopy Height	0.503	0.375
Canopy Cover	0.019	0.494
Trees with 1030 cm PBH	0.412	0.424
Trees with 3160 cm PBH	0.231	0.533
Trees above 61 cm PBH	0.531	0.349
Vegetation Obstruction	0.492	0.174

original data and were used in the subsequent analysis of microhabitat selection.

Microhabitat analysis

We analyzed the influence of microhabitat variables in species abundance using Generalized Linear Models (GLM) with a Poisson distribution. To analyze the influence of each variable over the four most abundant species, we created 32 models using all possible combinations of the five variables (PC1GC, PC2GC, PC1VS, PC2VS, and fruits) and a null model (*see* Table S3) for each species.

To carry out model selection, we used the corrected Akaike Information Criteria (AICc) for small sample sizes (Burnham & Anderson, 2002). The top model was the one with the lowest AICc, and all models with ΔAICc less than two were considered important models to explain the small mammal abundance (Burnham & Anderson, 2002). The importance of each variable was evaluated by using the sum of the model's weight that included each variable. The model weight (*wi*) represents the relative like-

lihood of a model considering the set of models created (Burnham & Anderson, 2002). The importance analysis output consists of values ranging between zero and one, where zero represents a variable with no importance and a value of one represents the highest possible importance. Before the analyses, the variables' magnitude orders were standardized so all the variables were on the same scale, allowing comparisons of the magnitude of the effect of each variable. All the analyses were performed in the R, Version 3.5.1 (R Core Team, 2018), and the MuMIn package was used for model selection procedures (Barton, 2018).

RESULTS

Community composition

Overall, 198 individuals of six species, five rodents (sequence identity match of two retrieved from NCBI; Table S2), and one marsupial, were recorded in 406 captures over 5,320 trap-nights (7.61% trapping success). The most abundant species was *Akodon montensis* (Thomas, 1913; 219 captures of 101 individuals), followed by *Oligoryzomys nigripes* (Olfers, 1818; 87 captures of 50 individuals), *Sooretamys angouya* (Fischer, 1814; 52 captures of 20 individuals), *Didelphis albiventris* (Lund, 1840; 43 captures of 19 individuals), *Juliomys pictipes* (Osgood, 1933; 2 captures of 1 individual during Winter 2016 on Fragment 1), and the exotic *Rattus rattus* (Linnaeus, 1758; 1 individual during Summer 2016 on Fragment 2). *Akodon montensis* individuals were captured during all seasons but were most abundant during 2015 winter and spring, and 2016 winter (Fig. 2A). For *O. nigripes,* the
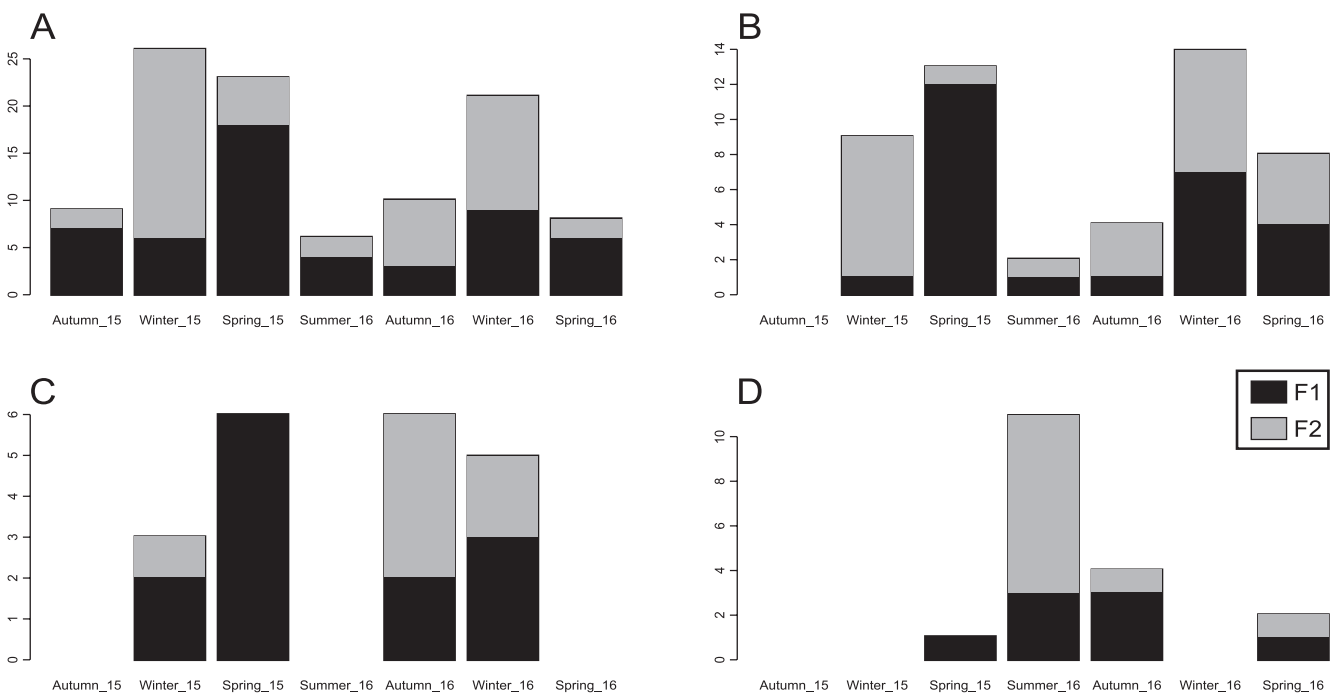

Figure 2. Number of individuals captured for the four most abundant species of small mammals in two forest fragments of Atlantic Forest between Autumn 2015 and Spring 2016 in Cerro Largo, Rio Grande do Sul, Brazil. (A) *Akodon montensis;* (B) *Oligoryzomys nigripes;* (C) *Sooretamys angouya;* (D) *Didelphis albiventris.* F1 = Fragment 1; F2 = Fragment 2.

highest abundance was recorded during 2015 spring and 2016 winter (Fig. 2B). *Sooretamys angouya* had similar abundance during all seasons (Fig. 2C) and *D. albiventris* was most abundant during summer 2016 (Fig. 2D).

The rarefaction curve (*see* Fig. S4) indicated that the sampling effort was enough to characterize community richness, as it remained stable for more than 215 captures.

Microhabitat variables

The variables driving microhabitat selection varied among the four species. Three models had a ΔAICc ≤ 2 for *A. montensis* (Fig. 3A), which included fruit, PC2GC, PC1VS, and PC2VS as the most important variables (importance values ranging from 0.99 to 0.68; Table 3). For

Table 3. Importance of microhabitat variables for four species of small mammals in two forest fragments of Atlantic Forest in Cerro Largo, Rio Grande do Sul, Brazil. Variables' importance values closer to 1.0 indicate greater importance of this variable.

Importance	PC1GC	PC2GC	PC1VS	PC2VS	Fruit
Akodon montensis	0.47	0.99	0.94	0.68	0.99
Oligoryzomys nigripes	0.24	0.57	0.63	0.25	0.33
Sooretamys angouya	0.26	0.23	0.23	0.95	0.25
Didelphis albiventris	0.29	0.25	0.26	0.24	0.78

PC1GC = first axis of the PCA for soil variables;
PC2GC = second axis of the PCA for soil variables;
PC1VS = first axis of the PCA for vegetation structure;
PC2VS = second axis of the PCA for vegetation structure.

O. nigripes, five models were selected (four models with variables – Fig. 3B – and the null model: AIC 168.2); the most important variables were PC1VS and PC2GC (importance value of 0.63 and 0.57; Table 3). For *S. angouya* only one model was selected (Fig. 3C), and PC2VS was the most important variable (importance value of 0.95; Table 3). *D. albiventris* had two models selected (Fig. 3D) and fruit availability was the most important variable influencing microhabitat selection (importance value of 0.78; Table 3).

DISCUSSION

Our results indicate that the local habitat is highly degraded. The small mammal community had a low species richness and was dominated by a single generalist species (*A. montensis*). The species composition also evidences the degradation status of the study area as most of the species are generalists adapted to anthropogenic landscapes in Atlantic Forest biome and no threatened species were recorded. In comparison, Melo *et al.* (2011) found 12 small mammals species in the Parque Estadual do Turvo (PET), a 17,000 ha forest in a protected area, 120 km from our study area. The small mammal community at our study site represents a subset of the PET community, suggesting that the community was affected by the fragmentation process. All native rodents captured in our study were represented at the PET. However, the congeneric marsupial species *D. aurita* was present at the PET (Melo *et al.,* 2011) whereas *D. albiventris* was present
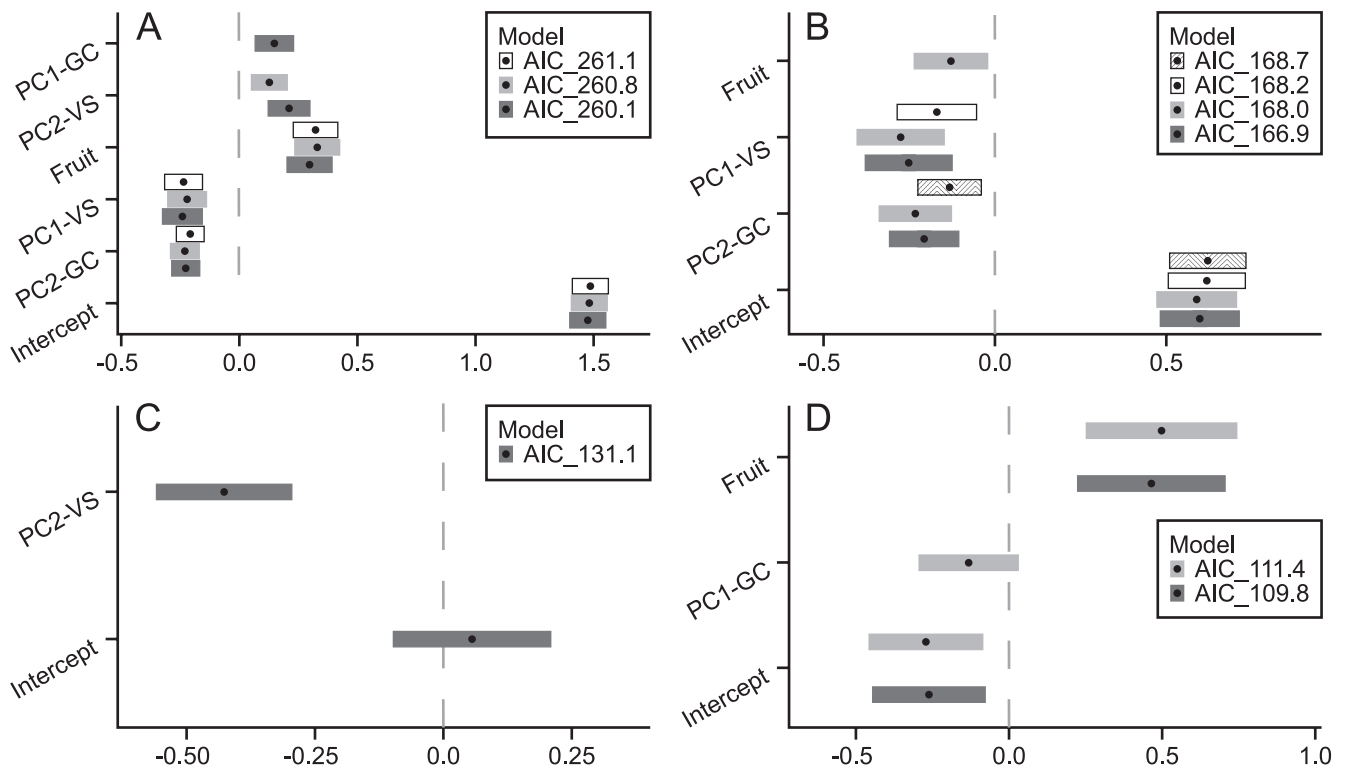

Figure 3. Variables coefficients and their confidence intervals in the models selected (with ΔAIC ≤ 2) for each small mammal species. (A) *Akodon montensis;* (B) *Oligoryzomys nigripes;* (C) *Sooretamys angouya;* (D) *Didelphis albiventris.* PC1GC = first axis of the PCA for soil variables; PC2GC = second axis of the PCA for soil variables; PC1VS = first axis of the PCA for vegetation structure; PC2VS = second axis of the PCA for vegetation structure.

at our study site. Both fragments sampled in our study had the same species richness and similar abundance of the four most common species. This suggests that it is likely for most of the fragments in the regional landscape to have a similar small mammals' composition, once they are all similar small forest fragments surrounded by agricultural and urban areas.

The low species richness may also be related to the latitudinal position of the study area. Our fragments are in the southern portion of the Atlantic Forest biome, outside the tropical region. Studies with a similar methodology in the Atlantic Forest have found between six to 21 species, and, in general, studies in lower latitudes had greater species richness (*e.g.,* Pardini *et al.,* 2005; Vieira *et al.,* 2009; Lima *et al.,* 2010; Maestri *et al.,* 2014). The PET itself, the most preserved forest area in the southernmost portion of Atlantic Forest, had lower species richness than other well-preserved forests further north (Melo *et al.,* 2011). While several factors, such as fragment size, isolation, habitat amount and matrix type (*e.g.,* Pardini, 2004; Umetsu & Pardini, 2007; Vieira *et al.,* 2009), interact to determine small mammals richness in fragmented landscapes, latitudinal was recently shown to be an important factor driving on small mammal richness in 122 forest fragments in Atlantic forest (Rodrigues *et al.,* 2020).

In general, rodents were most abundant during winter. This could be due to a lower food availability making the trapping baits more attractive when compared with seasons of higher food availability. A higher abundance of *O. nigripes* during winter has been observed in the southern region of the Atlantic Forest, both in Araucaria Forest (Galiano *et al.,* 2013) and in Dense Ombrophilous Forest (Antunes *et al.,* 2009). However, for *A. montensis,* no relationship was previously found between population peaks and seasons in the south of Atlantic Forest (Antunes *et al.,* 2010; Galiano *et al.,* 2013). In the southeast of Brazil, where rainfall rather than temperature drives seasonality, a higher abundance of rodents was related to food scarcity during the dry season instead of the winter season (Dalmaschio & Passamani, 2003).

The key variables influencing microhabitat selection varied among the small mammal species. *Akodon montensis* and *O. nigripes* showed similar preferences in the ground cover and vegetation variables, preferring ground covered by rocks and higher vegetation obstruction. Both variables can provide protection against predators while the animal is moving on the ground. The null model was among those selected for *O. nigripes,* decreasing our confidence regarding microhabitat selection for this species. *Akodon montensis* and *S. angouya* differed in preference for tree abundance, with *S. angouya* preferring a higher abundance of trees while *A. montensis* showed the inverse relationship. The positive relationship with higher abundance of trees may indicate a preference of *S. angouya* for more preserved characteristics within the forest fragment.

Habitat segregation can facilitate species coexistence through resource partitioning (Schoener, 1974; Rosenzweig, 1981; Abreu & Oliveira, 2014). Previous studies demonstrated that small mammal species tend to coexist more often than would be expected in highly heterogeneous environments, while the inverse pattern is observed in environments with lower heterogeneity (Stevens *et al.,* 2012; Camargo *et al.,* 2018). Our results suggest that resource partitioning may be supporting coexistence of *A. montensis* and *S. angouya*. Additionally, if the landscape would be fully preserved, with greater microhabitat heterogeneity, this would allow more microhabitat segregation opportunities and, therefore, more species would occur in this area.

Fruit availability had a positive influence for *A. montensis* and *D. albiventris*. This is highly expected, as several species of small mammals in the Atlantic Forest have a diet based on fruit and seeds (Paglia *et al.,* 2012). Therefore, they can also contribute to seed dispersal (Bricker *et al.,* 2010; Grenha *et al.,* 2010). Vieira *et al.* (2006) found that *A. montensis* individuals feed intensely on fruits, but also on invertebrates and fungi. Fruits are one of the most important items on *D. albiventris* diet (Cantor *et al.,* 2010), with opportunistic consumption (Cáceres, 2002). These species can help pioneer plants and forest regeneration, by dispersing their seeds in more suitable environments, since, as generalist species, they can move more frequently along forest edges and matrix (Cáceres *et al.,* 1999; Cáceres, 2006).

CONCLUSION

Our study found a poor small mammal community in forest fragments as we recorded only six species and the community was strongly dominated by the generalist rodent. The low species richness and presence of an exotic species (*R. rattus*) suggest that the study area is highly degraded. *Akodon montensis* and *O. nigripes* showed similar habitat preferences, with ground covered mainly by rocks and with greater vegetation obstruction. *Sooretamys angouya* preferred places with a higher abundance of trees. Fruit availability was important for *A. montensis* and *D. albiventris,* highlighting the importance of this food resource for local wildlife, and the potential role of these species as seed predators and dispersers.

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SUPPLEMENTARY ONLINE MATERIAL

Table S1. Specimens deposited at Museu de Ciências Naturais (MCNU), Laboratório de Sistemática de Mamíferos, Universidade Luterana do Brasil – ULBRA. MCNU = identification number of the specimen in the MCNU collection. Data = data that the specimen was collected in the field. Material = type of material that is deposited at MCNU.

MCNU	Species	Data	Coordinate	Material
4404	*Akodon montensis*	17/III/2015	28°08'38"S, 54°45'36"W	Skull + Skin + Seq. cyt B
4405	*Akodon montensis*	19/III/2015	28°08'38"S, 54°45'36"W	Skull + Skin + Seq. cyt B
4406	*Akodon montensis*	25/III/2015	28°08'38"S, 54°45'36"W	Skull + Skin + Seq. cyt B
4407	*Oligoryzomys nigripes*	04/V/2015	28°07'33"S, 54°44'57"W	Skull + Skin + Seq. cyt B
4408	*Akodon montensis*	30/VI/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4409	*Sooretamys angouya*	23/VI/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4410	*Sooretamys angouya*	24/VI/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4411	*Akodon montensis*	25/IX/2016	28°08'38"S, 54°45'36"W	Skull + Skin
4412	*Sooretamys angouya*	05/VII/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4413	*Oligoryzomys nigripes*	06/V/2015	28°07'33"S, 54°44'57"W	Skull + Skin + Seq. cyt B
4414	*Rattus rattus*	25/I/2016	28°07'33"S, 54°44'57"W	Skull
4415	*Sooretamys angouya*	28/IV/2016	28°07'33"S, 54°44'57"W	Skull + Skin
4416	*Juliomys pictipes*	28/VI/2016	28°08'38"S, 54°45'36"W	Skull + Skin
4417	*Sooretamys angouya*	26/IX/2016	28°08'38"S, 54°45'36"W	Skull + Skin
4418	*Akodon montensis*	19/I/2016	28°08'38"S, 54°45'36"W	Skull
4419	*Akodon montensis*	27/VI/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4420	*Akodon montensis*	25/III/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4421	*Akodon montensis*	04/V/2015	28°07'33"S, 54°44'57"W	Skull
4422	*Akodon montensis*	08/V/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4423	*Akodon montensis*	10/V/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4424	*Oligoryzomys nigripes*	26/VI/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4425	*Akodon montensis*	01/VII/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4426	*Akodon montensis*	03/VII/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4427	*Akodon montensis*	06/VII/2015	28°07'33"S, 54°44'57"W	Skull
4428	*Akodon montensis*	13/X/2015	28°08'38"S, 54°45'36"W	Skull + Skin
4429	*Oligoryzomys nigripes*	13/X/2015	28°08'38"S, 54°45'36"W	Skull
4430	*Akodon montensis*	14/X/2015	28°08'38"S, 54°45'36"W	Skull
4431	*Oligoryzomys nigripes*	24/X/2015	28°07'33"S, 54°44'57"W	Skull + Skin
4432	*Akodon montensis*	08/VII/2016	28°07'33"S, 54°44'57"W	Skull + Skin
4433	*Akodon montensis*	28/I/2016	28°07'33"S, 54°44'57"W	Skull
4434	*Akodon montensis*	28/VI/2016	28°08'38"S, 54°45'36"W	Skull + Skin
4435	*Akodon montensis*	08/VII/2016	28°07'33"S, 54°44'57"W	Skull + Skin

Table S2. Species assignment based on DNA sequences (fragment of the Cytochrome b gene) using the program BLASTN 2.10.1+ (Zhang *et al.,* 2000) in the NCBI database (https://blast.ncbi.nlm.nih.gov).

Specimen ID	Alignment Result	Total Score	Query Cover	Per. identity	Accession
LCE 4401	*Akodon montensis* voucher TK63783	1184	100%	100.00%	JX538380.1
LCE 4408	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4414	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4416	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4402	*Akodon montensis* voucher TK63783	1173	100%	99.69%	JX538380.1
LCE 4404	*Akodon montensis* voucher TK66183	1173	100%	99.69%	JX538365.1
LCE 4440	*Akodon montensis* voucher TK63783	1184	100%	100.00%	JX538380.1
LCE 4441	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4405	*Akodon montensis* voucher TK63783	1157	100%	99.22%	JX538380.1
LCE 4444	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4406	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4451	*Akodon montensis* voucher TK66183	1179	100%	99.84%	JX538365.1
LCE 4407	*Akodon montensis* haplotype 11	1162	100%	99.38%	EF206813.1
LCE 4445	*Oligoryzomys nigripes* isolate AC52	1134	99%	98.75%	DQ825987.1
LCE 4435	*Oligoryzomys nigripes* isolate MN37697	1162	100%	99.38%	DQ826003.1
LCE 4449	*Oligoryzomys nigripes* isolate MN37697	1173	100%	99.69%	DQ826003.1
LCE 4450	*Oligoryzomys nigripes* isolate MN37697	1179	100%	99.84%	DQ826003.1

Table S3. Fit and selection statistics of models affecting small mammals microhabitat selection in two forest fragments in the southernmost portion of Atlantic Forest biome, Brazil. Models with delta AIC ≤ 2 for each species are shown in bold.

Variables included in the models	AICc	delta	weight
Akodon montensis			
PC1soil + PC2soil + PC1veg + PC2veg + fruit	**260.1**	**0.00**	**0.360**
PC2soil + PC1veg + PC2veg + fruit	**260.8**	**0.66**	**0.259**
PC2soil + PC1veg + fruit	**261.1**	**0.95**	**0.224**
PC1soil + PC2soil + PC1veg + fruit	263.2	3.04	0.079
PC2soil + PC2veg + fruit	265.7	5.56	0.022
PC1soil + PC2soil + PC2veg + fruit	265.8	5.64	0.021
PC2soil + fruit	267.3	7.18	0.010
PC1soil + PC2soil + PC1veg + PC2veg	268.7	8.61	0.005
PC1veg + fruit	269.5	9.41	0.003
PC1soil + PC2soil + fruit	269.6	9.46	0.003
PC1soil + PC1veg + PC2veg + fruit	270.7	10.58	0.002
PC1veg + PC2veg + fruit	270.8	10.69	0.002
PC1soil + PC2veg + fruit	271.0	10.89	0.002
PC2veg + fruit	271.1	10.99	0.001
PC1soil + PC1veg + fruit	271.2	11.09	0.001
PC2soil + PC1veg	272.3	12.14	0.001
PC1soil + fruit	272.5	12.41	0.001
PC2soil + PC1veg + PC2veg	272.5	12.41	0.001
PC1soil + PC2soil + PC1veg	272.7	12.58	0.001
PC1soil + PC2soil + PC2veg	281.3	21.15	0.000
PC2soil	282.9	22.78	0.000
PC2soil + PC2veg	283.5	23.37	0.000
PC1soil + PC2veg	283.6	23.47	0.000
PC1soil + PC1veg + PC2veg	284.6	24.49	0.000
PC1soil + PC1veg	285.3	25.13	0.000
PC1veg	286.0	25.92	0.000
PC1veg + PC2veg	287.9	27.79	0.000
PC1soil + PC2veg	288.3	28.20	0.000
PC1soil	288.8	28.70	0.000
null	289.5	29.34	0.000
PC2veg	291.2	31.11	0.000
Oligoryzomys nigripes			
PC2soil + PC1veg	**166.9**	**0.00**	**0.153**
PC2soil + PC1veg + fruit	**168.0**	**1.10**	**0.088**
null	**168.2**	**1.30**	**0.080**
PC1veg	**168.2**	**1.31**	**0.080**
PC2soil	**168.7**	**1.82**	**0.062**
PC1soil + PC2soil + PC1veg	169.2	2.32	0.048
PC2soil + PC1veg + PC2veg	169.2	2.33	0.048
PC1veg + fruit	169.8	2.91	0.036
fruit	170.0	3.09	0.033
PC2veg + fruit	170.1	3.19	0.031
PC1soil	170.3	3.35	0.029
PC1soil + PC2soil + PC1veg + fruit	170.3	3.35	0.029
PC1soil + PC1veg	170.3	3.44	0.028
PC2soil + PC1veg + PC2veg + fruit	170.4	3.49	0.027
PC2soil + fruit	170.4	3.51	0.026
PC2soil + PC2veg	170.9	3.98	0.021
PC1soil + PC1soil	171.0	4.06	0.020
PC2veg + fruit	171.7	4.78	0.014
PC1veg + PC2veg + fruit	171.7	4.78	0.014
PC1soil + PC2soil + PC1veg + PC2veg	171.8	4.86	0.014
PC1soil + PC1veg + fruit	171.9	4.99	0.013
PC1soil + fruit	172.0	5.10	0.012
PC1soil + PC2veg	172.3	5.39	0.010
PC1soil + PC1veg + PC2veg	172.5	5.61	0.009
PC2soil + PC2veg + fruit	172.6	5.64	0.009
PC1soil + PC2soil + fruit	172.7	5.76	0.009
PC1soil + PC2soil + PC1veg + PC2veg + fruit	172.9	6.04	0.008
PC1soil + PC2soil + PC2veg	173.3	6.41	0.006
PC1soil + PC2veg + fruit	174.1	7.17	0.004
PC1soil + PC1veg + PC2veg + fruit	174.2	7.27	0.004
PC1soil + PC2soil + PC2veg + fruit	175.1	8.16	0.003

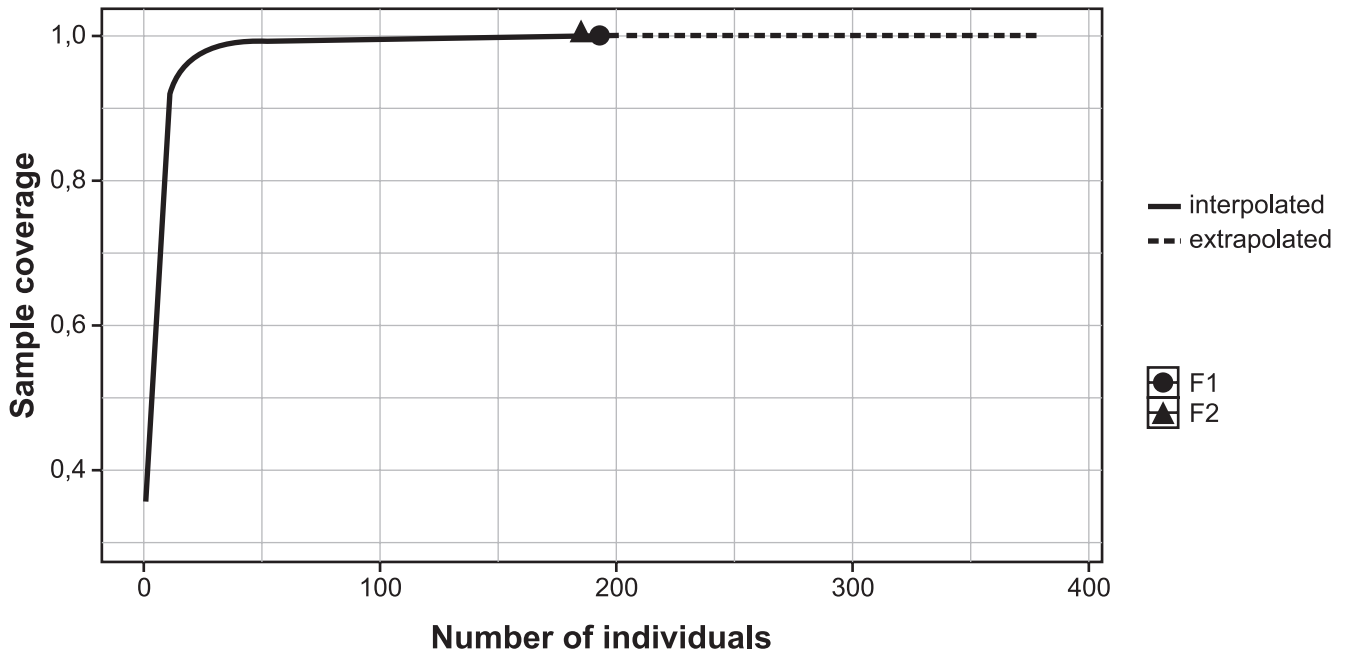| Variables included in the models	AICc	delta	weight
Sooretamys angouya			
PC2veg	**131.9**	**0.00**	**0.316**
PC2veg + fruit	134.1	2.18	0.107
PC1soil + PC2veg	134.2	2.25	0.103
PC2soil + PC2veg	134.2	2.30	0.100
PC1veg + PC2veg	134.2	2.31	0.099
PC1soil + PC2veg + fruit	136.4	4.50	0.033
PC2soil + PC2veg + fruit	136.5	4.59	0.032
PC1veg + PC2veg + fruit	136.5	4.61	0.031
PC1soil + PC2soil + PC2veg	136.6	4.67	0.031
PC1soil + PC1veg + PC2veg	136.6	4.69	0.030
PC2soil + PC1veg + PC2veg	136.6	4.73	0.030
PC1soil	138.1	6.14	0.014
PC1soil + PC2soil + PC2veg + fruit	139.0	7.04	0.009
PC1soil + PC1veg + PC2veg + fruit	139.0	7.07	0.009
PC2soil + PC1veg + PC2veg + fruit	139.1	7.15	0.009
PC1soil + PC2soil + PC1veg + PC2veg	139.2	7.24	0.008
null	139.7	7.78	0.006
PC1soil + PC2soil	140.2	8.30	0.005
PC1soil + fruit	140.4	8.50	0.005
PC1soil + PC1veg	140.5	8.54	0.004
PC2soil	141.4	9.46	0.003
PC1soil + PC2soil + PC1veg + PC2veg + fruit	141.7	9.75	0.002
fruit	141.8	9.92	0.002
PC1veg	141.9	9.96	0.002
PC1soil + PC2soil + fruit	142.6	10.66	0.002
PC1soil + PC2soil + PC1veg	142.6	10.73	0.001
PC1soil + PC1veg + fruit	142.8	10.93	0.001
PC2soil + fruit	143.7	11.74	0.001
PC2soil + PC1veg	143.7	11.77	0.001
PC1veg + fruit	144.1	12.19	0.001
PC1soil + PC2soil + PC1veg + fruit	145.1	13.22	0.000
PC2soil + PC1veg + fruit	146.1	14.18	0.000
Didelphis albiventris			
fruit	**109.8**	**0.00**	**0.231**
PC1soil + fruit	**111.4**	**1.65**	**0.101**
PC2soil + fruit	111.8	2.08	0.082
PC1veg + fruit	111.8	2.08	0.081
PC2veg + fruit	112.0	2.24	0.075
null	112.3	2.56	0.064
PC1soil + PC2soil + fruit	113.6	3.81	0.034
PC1soil + PC1veg + fruit	113.7	3.90	0.033
PC1soil + PC2veg + fruit	113.8	4.07	0.030
PC1veg	114.0	4.23	0.028
PC2soil + PC1veg + fruit	114.2	4.40	0.026
PC2soil + PC2veg + fruit	114.2	4.48	0.025
PC1veg + PC2veg + fruit	114.2	4.48	0.024
PC1soil	114.4	4.61	0.023
PC2soil	114.4	4.66	0.022
PC2veg	114.5	4.76	0.021
PC1soil + PC2soil + PC1veg + fruit	116.1	6.30	0.010
PC1soil + PC2soil + PC2veg + fruit	116.1	6.31	0.010
PC1soil + PC1veg	116.2	6.40	0.009
PC1soil + PC1veg + PC2veg + fruit	116.2	6.42	0.009
PC2soil + PC1veg	116.3	6.54	0.009
PC1veg + PC2veg	116.3	6.54	0.009
PC1soil + PC2soil	116.6	6.81	0.008
PC1soil + PC2veg	116.6	6.86	0.007
PC2soil + PC1veg + PC2veg + fruit	116.7	6.95	0.007
PC2soil + PC2veg	116.7	6.97	0.007
PC1soil + PC1veg + PC2veg	118.5	8.77	0.003
PC1soil + PC2soil + PC1veg	118.6	8.82	0.003
PC1soil + PC2soil + PC1veg + PC2veg + fruit	118.7	8.91	0.003
PC2soil + PC1veg + PC2veg	118.7	8.97	0.003
PC1soil + PC2soil + PC2veg	118.9	9.13	0.002
PC1soil + PC2soil + PC1veg + PC2veg	121.1	11.31	0.001

Figure S4. Rarefaction curve for both studied fragments in the Atlantic Forest biome, Brazil. Sample coverage is the proportion of the total number of individuals that belong to the species detected in the sample. F1 = Fragment 1 (28°08′38″S, 54°45′36″W); F2 = Fragment 2 (28°07′33″S, 54°44′57″W).