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Medium and Large-sized Mammals in Small Forest Remnants of the Atlantic Forest with Anthropogenic Influences in the North of Paraná

Mamíferos de Médio e Grande Porte em Pequenos Remanecentes Florestais da Mata Atlântica com Influências Antropogênicas no Norte do Paraná

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Abstract

The objectives of this study were to know the community of medium and large-sized mammals in four small forest remnants; collect data on the richness, diversity, equability, dominance and similarity of the animals in the environments studied; verify possibilities of maintenance of these existing populations; analyze the different types of traps used in the collection. Eight monthly collections were carried out, two in each fragment, between the months of July 2008 to June 2009, and three methodologies were used for identification: tracks in sand plots, direct search for remains and sightings in linear transect. Fourteen species were recorded in total. Low diversity is reflected in the dominance of species such as *Cebus nigritus, Procyon cancrivorous, Cerdocyons thous* and *Cuniculus paca* and also by the uneven abundance observed in the values of equability, where the least uniformity was found in area A (0.73) which coincides with the most dominance (0.29). It is possible to infer that a biotic homogenization of mammals is occurring, where richness declines and fewer opportunistic species resist in altered environments. The medium and large-sized mammals that are more specialist in habitat, diet or higher trophic level are sensitive to fragmentation, and replaced by generalist species, better adapted to human disturbance. As for the methodologies, the sand plots had the highest number of records (65%) and species (71%), being the most efficient one. Therefore, although small and not the ideal environment for some species, the forest remnants studied are additional areas for conservation of some opportunistic species, becoming important due to the continued loss of natural habitats and the small size of most conservation units found in Brazil.

Keywords: Mammals. Small remnants. Methodologies. Specialists. Generalists.

Resumo

Os objetivos deste trabalho foram: conhecer a comunidade de mamíferos de médio e grande porte em quatro pequenos remanescentes (fragmentos) florestais; colher dados sobre a riqueza, diversidade, equabilidade, dominância e similaridade dos animais nos ambientes estudados; verificar possibilidades de manutenção dessas populações existentes; analisar os diferentes tipos de armadilhas usados na coleta. Foram realizadas oito coletas mensais, duas em cada fragmento, entre os meses de Julho de 2008 a Junho de 2009, e utilizadas três metodologias para identificação: pegadas em parcelas de areia, busca direta por vestígios e avistamentos em transecção linear. Foram registradas 14 espécies, no total. A baixa diversidade é refletida na dominância de espécies como *Cebus nigritus, Procyon cancrivorus, Cerdocyons thous* e *Cuniculus paca* e também pela abundância pouco uniforme observada nos valores

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de equabilidade, onde a menor uniformidade encontrada foi na área A (0,73) que coincide com maior dominância (0,29). É possível inferir que está ocorrendo uma homogeneização biótica da mastofauna, onde a riqueza declina e um número menor de espécies oportunistas resistem em ambientes alterados. Os mamíferos de médio e grande porte mais especialistas em habitat, dieta ou de maior nível trófico são sensíveis à fragmentação, e substituídos por espécies generalistas, melhores adaptadas às perturbações antrópicas. Quanto às metodologias, as parcelas de areia apresentaram maior número de registros (65%) e de espécies (71%), mostrando-se a mais eficiente. Portanto, apesar de pequenos e por não serem o ambiente ideal para algumas espécies, os remanescentes florestais estudados são áreas adicionais para conservação de algumas espécies oportunistas, tornando-se importantes frente a contínua perda de habitats naturais e ao tamanho reduzido da grande maioria das unidades de conservação encontradas no Brasil.
Palavras chaves: Mamíferos. Pequenos remanescentes. Metodologias. Especialistas. Generalistas.

Introduction

The historical colonization process of northern Paraná, through agriculture and real estate interests, reflects the process of environmental degradation. So over time habitats were gradually transformed into mosaics formed by the remnants of native vegetation and various kinds of crops, besides urbanization (PIRES et al., 2006).

The discontinuity of vegetation led to changes in the ecosystem dynamics increasing the risk of disappearance of many organisms (NEGRÃO; VALLARES-PÁDUA, 2006). The diversity reduction as result of deforestation occurs in the short term, by the immediate loss of species (PAGLIA et al., 2006) and in the long term, by limiting the potential of dispersion and colonization (PRIMACK; RODRIGUES, 2001). Thus, the original populations decline due to lack of time for adaptation of some species and inability of others.

In Brazil, there are 688 recognized species of mammals. Of these 183 are included in the list of mammals of Paraná representing approximately 26.6% of the species in Brazil (REIS et al., 2011). The ecology of this group of animals is poorly known, especially in relation to the collection of species, structure and dynamics of communities (PARDINI; DEBELEY, 2004; ROCHA-MENDES; MIKICH, 2005) because they are difficult to be captured or seen due to their discrete habits and low population densities (NOWAK, 1999).

The Class Mammalia is among the vertebrate groups with worldwide distribution, and there is virtually no biome where they cannot occur (MAMADE; ALBO, 2006). Some aspects such as: body size, reproductive potential, the economic interest and the size of the populations, make these organisms more vulnerable and thus may eventually disappear locally or even be extinct (MARGARIDO; BRAGA, 2004).

In the northern part of the state of Parana, research on medium and large-sized mammals were performed in Mata dos Godoy State Park (690 ha), in Londrina, where 31 species were found (ROCHA; SEKIAMA, 2006) and in the Fazenda *Congonhas* (122 ha), in the municipality of Rancho Alegre, with a recorded 17 species (ALMEIDA et al., 2008). Most of these studies were conducted in protected areas, and in small remnants with up to 20 ha, there is no research to date.

Due to the ecological relevance of mammals in forest dynamics as seed dispersers and food chain controllers, added to a growing threat to their existence due to the fragmentation of habitats, the need for studies is highlighted. Thus, the objectives of this study were to know the medium and large-sized mammal communities in small forest remnants; collect data on the richness, diversity, equability, dominance and similarity of animals in the environments studied; verify the possibility of maintenance of existing populations based on biology of the species; analyze the efficiency of different types of traps in the collection of data in small fragments.

Material and Methods

Study Area

Samplings were conducted in four forest fragments in northern Paraná. According to Köppen, the climate is Cfa (Humid subtropical climate) that is characterized by the absence of defined dry season, hot summers and infrequent frosts. All are remnants of the Atlantic Forest in the phytoecological region of Semideciduous Forest. This vegetation that was once featured in an advanced successional stage (climax) with high diversity of arboreal flora with the following dominant species: *Aspidosperma polyneuron* Müll.Arg. (Apocynaceae), *Euterpe edulis* Mart. (Areceae), *Galesia intergrifolia* Spreng (Phytolacaceae) and *Ficus eximia* Schott. (Moraceae), is now different with secondary vegetation typical of early successional stages as *Cecropia glaziovii* Snethlage. (Cecropiaceae) *Mimosa scabrella* Benth. (Mimosaceae), S*olanum argenteum* Dunal. (Solanaceae) and *Eugenia uniflora* L. (Myrtaceae).

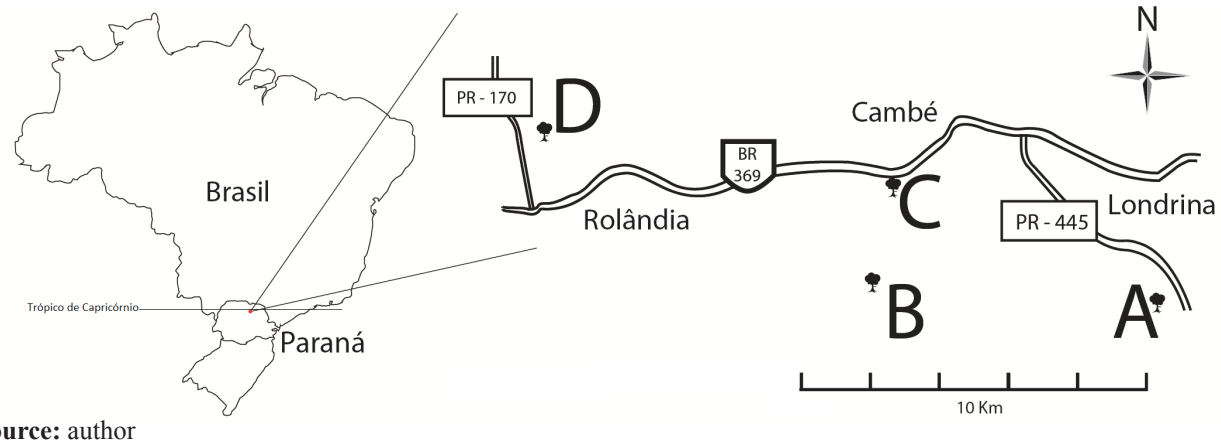
Fragment A corresponds to the Horto Florestal of the State University of Londrina, in Londrina, with approximately 10.4 ha. It has a rectangular shape, and has no kind of water body and is surrounded by buildings of the university.

Fragment B corresponds to Sítio Santana, located in the municipality of Cambé, and has about six hectares. It is part of the riparian forest and is inserted in an agricultural matrix culture of corn, wheat and soybean.

Also located in the municipality of Cambé, fragment C corresponds to the Parque Municipal Histórico, with 5.4 ha. Situated in a peri-urban area, bordering the BR369 and its environment consists of a residential neighborhood and commercial. It has an almost circular form and it has a dam inside it.

Fragment D corresponds to Sítio Casado, in the municipality of Rolândia and has 15 ha. It is part of the riparian forest of the river Caiubi, that in relation to other areas, is in the lowest level of human disturbance and has agricultural matrix culture of grain.

Figure 1 – Collection locations. Horto Florestal Landscap of Uel (10 ha), Londrina; B Sítio Santana (5.4 ha), Cambé; C Historic Municipal Park (6 ha), Cambé; D Sítio Casado (15 ha), Rolândia.



Source: author

Procedure

Eight monthly collections were carried out, two in each fragment, between the months of July 2008 to June 2009, totaling 96. The collection methodology for the identification was divided into three:

I- Tracks in sand plots: four plots were placed in each fragment, with the dimensions of a meter in diameter and three centimeters high. These were filled with fine sand. The plots were distributed to 10 meters from the start of the track and 25 meters between them. Four different baits were used in the center of the plots: fruits (avocado, papaya and banana), corn seed, bacon and sea salt as in the works by Pardini (2003), Reis (2005), and Tomas and Miranda (2006). In the afternoon of the day before each sampling, the sand was wet and homogenized to enable the printing of the tracks. The next day, the impressions of tracks were photographed with scales, measured and recorded.

II- Direct search for traces: it consisted in random search for traces (tracks, feces, carcasses, pellets, vocalizations, odors, territory markings, scratches on tree trunks) for two hours on the sampling days (NEGRÃO; VALLARES-PADUA, 2006; KASPER et al, 2007).

III- Sightings in linear transect were carried out by walking at a steady pace for about 100 meters in the existing tracks in the collection sites, the same of the portions of sand, in the search for animals (THOMAS et al., 2002).

For the data analysis, the absolute frequency of each species was calculated for the comparison of their occurrence in the area. We also calculated the species richness (S) and diversity using the indexes by Shannon-Wiener (H ') and equability (J) followed by t test. It was also verified the Berger-Parker dominance index (d), with all these calculations made in the Past software version 20.9. We also used the similarity ratio of Sorensen, which verifies the similarity between two communities or habitat concerning the particular composition (species) on a local level (RODRIGUES, 2008). Considerations were made on the survival of existing populations.

Results

In the total of the four fragments, 14 species were recorded, distributed in six orders and 11 families (Table 1) organized by the phylogenetic sequence of Willson and Reeder (2005).

Five of the species were common in all four fragments: *D. albiventris* and *D. novemcinctus*, with greater occurrence in area A; *C. thous* and *D. azarae*, both with larger amount of records in area C; *N. nasua*, most commonly found in area B. In each fragment there was a unique species: *C. nigritus* in A, *G. cuja* in B, *P. cancrivorous* in C and *C. paca* in D.

Data on species richness were similar in the four places, being in fragments A and C equal to eight and in areas B and D equal to nine. The Shannon index values suggest that area A has diversity of species compared to the others ($p < 0.05$). In addition, the dominance values show that fragment A has a greater number of individuals of few species followed by fragments B, C and D, respectively.

Table 1 - Absolute frequency, diversity and dominance indexes of medium and large-sized terrestrialmammals in four forest remnant fragments.

	Absolute frequency %			
Species	A (10. 4ha)	B (6ha)	C (5.4ha)	D (15ha)
Didelphis albiventris Lund, 1840	27.70	8.20	6.90	12.35
Dasypus novemcinctus Linnaeus, 1758	20.48	9.84	5.17	4.94
Cebus nigritus (Goldfuss, 1809)	40.96	0.00	0.00	0.00
Lepus europaeus (Pallas, 1778)	0.00	9.84	0.00	3.70
Leopardus tigrinus (Schreber, 1775)	0.00	4.92	0.00	12.35
Cerdocyon thous (Linnaeus, 1766)	6.02	9.84	24.14	14.81
Eira Barbara (Linnaeus, 1758)	0.00	6.56	8.62	0.00
Galictis cuja (Molina, 1782)	0.00	4.92	0.00	0.00
Nasua nasua (Linnaeus, 1766)	1.20	39.34	18.97	6.17
Procyon cancrivorous (G. [Baron] Cuvier, 1798)	0.00	0.00	12.07	0.00
Hydrochoerus hydrochaeris Brisson, 1792	1.20	0.00	10.34	8.64
Cuniculus paca Wagler, 1830	0.00	0	0.00	28.40
Dasyprocta azarae Illiger, 1811	2.41	6.56	13.79	8.64
Total recording	83	61	58	81
Total of species	7	9	8	9
Shannon-Weiner (H)	1.41	1.91	1.97	2.02
Pielou Equability (J)	0.73	0.87	0.95	0.92
Dominance	0.29	0.20	0.15	0.16

Source: author

When the similarity between the areas are compared (table 2), we notice a higher similarity between fragments B and C with 83% and a lower between A and B 59%.

Table 2 – Sorensen's similarity index between the sampled areas

Áreas	A	B	C	D
A	1	0,59	0,75	0,71
B		1	0,83	0,66
C			1	0,71
D				1

Source: author

As for the methodologies used, the prints in area plots proved more effective, with greater total number of records (65.4%) and species (6); followed by the direct search for traces (26%; 3) and sightings in transect (8.6% 2).

Through studies on the biology of the species we can infer that *D. albiventris* and *L. europaeus* will persist in small forest remnants; *L. tigrinus*, *E. Barbara*, *G. cuja* and *P. cancrivorous* are likely to disappear.

Discussion

Since the last decades of the 19th century Paraná has gone through several economic cycles responsible for the cut down of the Atlantic Forest, which once occupied more than 16 million hectares, 83% of the territory. Deforestation occurred rapidly, and currently the area corresponding to the native forest is about eight hundred thousand ha, 5% of the original, and also animal species were lost due to the disappearance of their habitats (GUBERT FILHO, 2010). For this reason, the values of the results of species richness were low, since the fragments are small and do not gather enough resources to maintain viable populations (WILSON, 1988).

Biological diversity has been used to describe forms of life, ecological roles that people play and the genetic diversity they contain (WILCONX, 1984). The low diversity as a consequence of fragmentation is reflected in the dominance of species by observing the frequencies of *C. nigritus* in fragment A (40.96%), *P. cancrivorous* in area B (39.34%), *C. thous* in fragment C (24.14%) and *C. paca* in area D (28.4%). It is also demonstrated by the uneven abundance observed in the values of equability, where the least uniformity was found in area A (0.73) which coincides with greater dominance (0.29). It is possible to infer that a biotic homogenization of mammals is occurring, where the richness declines and fewer opportunistic species that are resistant to changing environments are expanding in terms of the number of individuals, as shown above in the values of dominant species (MAGNUSSON, 2006), changing the food web and forming a new ecosystem.

The composition of the mammals of the four fragments in relation to richness, showed 83% similarity between fragments B and C. It is believed that this high similarity is related to the size of areas, due to the difference of only 0.6 ha, and also the phytoecological similarity. When comparing the largest fragment (D = 15ha) with the smallest ones (B=6ha and C = 5.4 ha), we observe minor similarities, which are 59% between D and B and 66% between D and C.

Due to the human disturbance on native communities, especially by the reduction of habitats, the forest, once continuing, has become more vulnerable, subject to wind, noise, smells and diversity of fauna dependent on the previous balance declined (ODUM, 2007). Thus, if the remnants were added, totaling 36 ha, they would support a greater number of species, because the protected area would increase, and with a greater availability of niches in natural conditions, a greater number of species would potentially be able to survive in these areas (ODUM, 1959).

Analyzing population characteristics such as reproduction, habitat use and diet, we can make predictions about the future of these species in the fragments concerning the viability of these.

Didelphis albiventris and *L. europaeus* may persist in the areas because they are not demanding about the quality of habitat. Another factor is the reproductive efficiency, which in these species occurs twice a year, with short pregnancies with averages of 14 and 40 days and large offspring up to 14 and 8 offspring per litter, respectively (ACHAVAL et al., 2004). *Didelphis albiventris* is adapted to anthropomorphized environments, living in any kind of shelter, even in urban areas and feeding on all sorts of debris, even human waste. Lepus europaeus has its diet based on herbs found in several locations and grains from crops, and when threatened they can reach 60 kilometers per hour during the flight (REIS et al., 2011).

In relation to the four common species in the four fragments *D. novemcinctus, C. thous, N. nasua* and *D. azarae* have features that allow their existence in small areas. They reach sexual maturity at about one year of life; there is more than one pregnancy per year and in each litter there are two or more offspring (NOWAK, 1999) (RODRIGUES; AURICCHIO, 1994) (BONVINCINO; OLIVEIRA, 2008). Still, they can go through extensive nonforest areas, they are able to survive in agriculture areas with little forest cover; they can subsidize their diet with easy prey such as chicken (MICHALSKI et al. 2006). They are generalist concerning their diet, being considered with opportunistic diet they have already been recorded eating human garbage, and also altered habitats provide conditions for the establishment of large populations of R strategist species (DAJOZ, 2005), such as small rodents, which are also source of food resources for this group.

Rodents *H. hidrochaeris* and *C. paca* are efficient breeders when compared to other large mammals, with each female generating up to eight and two offspring, respectively, per year and reach sexual maturity in the first year of life (BONVINCINO; OLIVEIRA, 2008). They are opportunistic concerning their diet, and can occupy areas with agricultural matrix (PEREZ, 1992). So, the main threat is not related to modification of their natural environment, but to illegal hunting for food or sport, common culture of the inhabitants of rural areas (GUIMARÃES, 2008; NOGUEIRA-FILHO; NOGUEIRA, 2000).

Leopardus tigrinus, Eira Barbara, Galictis cuja and *Procyon cancrivorous* may be doomed in the medium term. These carnivores, top chain, have low absolute frequency, indicating that their populations are small or that they may be the last examples. We believe that some of their phenotypic characteristics and habits corroborate the existence of these in the areas, but are not sufficient to maintain a viable population size. Environmental disturbances, which compromise the integrity of areas, such as a fire, would decimate the remaining subjects. *Leopardus tigrinus* is the smallest Brazilian feline; it has fur that camouflages itself in the environment; it has nocturnal habits in addition to being a skilled climber (CHEIDA et al., 2011), features that allow its existence in these places, however, according to Oliveira (2010), in forest fragments in agricultural matrix, the species has an area of life of eight km² for two males and two km² for one female, larger than the areas studied. *Eira Barbara* shelters itself in burrows and hollow of trees, they are fast, excellent swimmers and can climb. For each female, the area of life reaches 16 km² and for each male, 24 km² (MICHALSKI, 2006). *Galictis cuja*, by having elongated body and short members, can run close to the ground and hide in small holes or low vegetation (CHEIDA ET AL., 2011). There are no data about its area of life, but its low frequency of occurrence in a single fragment found, allows us to suggest that its population is no longer viable. *Procyon cancrivorous*, although having similar sizes and eating habits as *Cerdocyon thous*, needs a living area larger than 6.95 km² for a male (BIANCHI,

2009), but few studies have been done with this species (MORATO et al. 2004), making it difficult to understand the effects of fragmentation on this species.

Another clear reason for which unusual species still occur in small remnants is longevity. It is possible that these are the last ones. Often, in highly anthropomorphized places, *Panthera onca* individuals are observed. They are there only because of their age but in no condition to survive as a population. *Leopardus tigrinus* can live up to 15 years, *Eira Barbara* 18 years, *Galictis cuja* 11 years and *Procyon cancrivorous* 20 years. Except the first one, the other ages are provided in captivity (CHEIDA et al., 2011). Thus, it is likely that they remain in these remnants, as it has not died yet.

Cebus nigritus is another species that may disappear, despite its adaptability to environments altered by human activities and survival in areas of fragmented and degraded forests (ROCHA, 2000). Most of the records of these animals occurred at the edge of the fragment or its matrix, which is related to the provision of food (bread, banana, orange) by man, reflecting a high population density due to the large amount of available resource. However, we observed that there is only one group in the fragment and that they do not move to other fragments, besides observing the malformation of members in some individuals. And therefore, even if that population is growing in the area, it is susceptible to damage by the loss of genetic variability by inbreeding, tending to decrease the probability of survival of this population over time (SILVEIRA; REIS, 2008). To allow the permanence of this population it is necessary to make the management in order to increase the genetic variability of this population.

As for the methodologies used, the sand plots had the highest number of records (65%) and species (71%), being the most efficient for small fragments. We suggest, in order not to underestimate the data, the combined techniques of tracks in sand plots, direct search for traces and transect sighting, since some species such as *Hydrochoerus hidrochaeri* and *Procyon cancrivorous* may not be lured by the bait. Thus, it is possible to reduce the sampling error generated by the difficulties of studying medium and large-sized mammals due to the nocturnal habits, the low population density and size of areas.

As demonstrated in other studies of medium and large-sized mammals more specialist in habitat, diet or with higher trophic level are sensitive to fragmentation, being replaced by generalist species, better adapted to human disturbance.

However, although small and for not being the ideal environment for the species, the forest remnants studied are additional areas for conservation of some opportunistic species, becoming important due to continued loss of natural habitats and the small size of most conservation units found in Brazil.

It is important that these areas be declared as of permanent preservation in order to protect biological diversity, in addition to the implementation of reforestation in the surroundings, to reduce the physical and biological disorders that cause the edge effect. Another important measure to be taken is to educate society about the importance of maintaining biodiversity which is a natural resource, immeasurable and irretrievable.

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