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Medium and large sized mammal assemblages in coastal dunes and adjacent marshes in southern Rio Grande do Sul State, Brazil

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ABSTRACT. This paper presents data on species composition and use of habitat of medium and large sized mammal assemblages in a coastal dunes segment and adjacent marshes at Rio Grande municipality, southern Rio Grande do Sul State, Brazil. Records were obtained through visualization of living animals and identification of footprints, feces and remains. From November 2007 to September 2008, nine 600 m long and 5 m wide linear transects were settled on coastal dunes segment (frontal and intermediate dunes) and adjacent marshes, parallel to ocean shore on a 23 km section at Cassino Beach. Transects were settled in areas under high, medium and low levels of anthropic occupancy (A1, A2 and A3, respectively), being three transects on each area. Fourteen species were recorded, distributed in five orders and 10 families. *Lepus europaeus* was the most frequent species (81.9% of the transect walks), present in all areas and seasons, followed by *Lycalopex gimnocercus* (23.5%) and *Conepatus chinga* (10.3%). Five species were present on A1, seven on A2 and fourteen on A3. Seven species were recorded on frontal dunes, nine on intermediate dunes and 13 on adjacent marshes.

Keywords: conservation, fauna of sand dunes, dunes system, *Lepus europaeus*, *Lycalopex gymnocercus*.

Assembleias de mamíferos de médio e grande porte em dunas costeiras e brejos adjacentes na região Sul do Estado do Rio Grande do Sul, Brasil

RESUMO. O presente estudo apresenta dados sobre a composição de espécies e uso do hábitat de assembleias de mamíferos de médio e grande porte em um trecho no cordão de dunas costeiras e brejos adjacentes no município de Rio Grande, região Sul da Planície Costeira do Rio Grande do Sul, Brasil. Os registros foram obtidos no período de novembro de 2007 a setembro de 2008 por meio da observação direta de indivíduos e carcaças e da identificação de vestígios (pegadas e fezes). Nove transectos lineares de 600 m de extensão e 5 m de largura, paralelos à praia oceânica, foram estabelecidos sobre um trecho de 23 km do cordão de dunas costeiras e brejos adjacentes no Balneário Cassino. Foram amostradas áreas sob alto, médio e baixo grau de antropização (A1, A2 e A3, respectivamente), sendo estabelecidos três transectos em cada área. Os métodos empregados possibilitaram o registro de 14 espécies sendo *Lepus europaeus* a mais frequente (81,9% do total de transecções) e presente em todas as áreas e em todas as estações, seguida de *Lycalopex gymnocercus* (23,52%) e *Conepatus chinga* (10,29%). Cinco espécies foram registradas em A1, sete em A2 e 14 em A3. Sete espécies foram encontradas nas dunas frontais, nove nas dunas intermediárias e 13 nos brejos adjacentes.

Palavras-chave: conservação, fauna de dunas, sistema dunar, *Lepus europaeus*, *Lycalopex gymnocercus*.

Introduction

Mammals (Class Mammalia) comprehend a highly diversified group, being recognized 5,418 species distributed in all of the continents and inhabiting a variety of environments (WILSON; REEDER, 2005). In Brazil there are 688 recorded species and more than 140 occur in the southernmost State of Rio Grande do Sul (REIS et al., 2011a).

Regional mammalian inventories in Rio Grande do Sul State were realized mainly in north and central areas (e.g. CADEMARTORI et al., 2002 and 2003; KASPER et al., 2007a and b; MARQUES; RAMOS, 2001; SANTOS et al. 2004 and 2008; WALLAUER; ALBUQUERQUE, 1986). Most of these sampled areas, however, are characterized by the dominance of forest formations such as Pluvial, Mixed and Dense Ombrophilous forests. In the southern part of the State, mainly characterized by open formations (VIEIRA, 1983), there is few data on species composition of the mammalian fauna in the distinct environments. The only available data include

the observations of Gianuca (1997 and 1998) on some species of rodents, carnivores and lagomorphs found in coastal dunes of Cassino Beach, Rio Grande municipality.

Dune ecosystems are considered "extreme biological importance" areas for conservation in Brazilian coast (MMA, 2002). In parallel, an increasing disturbance and mischaracterization of these environments due to tourism, urbanization, cattle grazing and silviculture is observed in southernmost Brazilian coastal plain (GIANUCA, 1997; SEELIGER; COSTA, 1998). Therefore, unguided management and expansion of the urban areas can represent a serious threat for mammalian populations in coastal dune formations in the State. Aiming to contribute for the knowledge and conservation of biodiversity in these systems, herein we present data on species composition, habitat occupancy and abundance of medium and large sized mammals (body mass higher than 1 kg) in areas under distinct levels of human occupancy in a coastal dune stretch and adjacent marshes in southernmost Brazil.

Material and methods

Study area

The municipality of Rio Grande (31°47'02''- 32°39'45'' S; 52°03'50'' - 52°41'50'' W) is located in southern coastal plain of Rio Grande do Sul State, southern Brazil. It has an area of 2,834 km² and low altimetric levels, between sea level and two meters, except by dune formations, which can reach to seven meters. The climate in the region is classified as Cfa of Köppen, with temperatures varying from 9.5°C in July (minimum average) to 27.2°C (maximum average). The monthly precipitation average is 104 mm and the rainiest months are July, August and September (VIEIRA, 1983).

The study area comprehends a stretch of 23 km in the coastal dune system (frontal and intermediate dunes) and adjacent swamps in Cassino Beach, located between Patos Lagoon discharge channel ("Rio Grande channel") and "Navio Altair" coastal stream (32°18"065" - 52°16'057"W".), parallel to the oceanic shore (Figure 1).

Vegetation in coastal dunes is composed mainly by gramineous and herbaceous species, being the most commum *Blutaparon portulacoides*, *Cakile maritima* and *Panicum racemosum* in frontal dunes and *Panicum racemosum*, *Andropogon arenarius*, *Hydrocotyle bonariensis*, *Senecio crassiflorus*, *Asclepias mellodora*, *Androtrichum trigynum*, *Spartina ciliata* in intermediate dunes (CORDAZZO; SEELIGER, 1995; SEELIGER, 1998a). The adjacent marshes are usually intermittent, remaining flooded during the rainiest period and presenting humid or saturated soil in low rainfall periods. Vegetation in these areas is composed mainly by herbaceous such as *Androtrichum trigynum*, *Phyla canensis*, *Bacopa monnieri*, *Juncus acutus*, *Hydrocotyle bonariensis* and *Typha dominguensis* (SEELIGER, 1998b).

Data sampling

Data were obtained from November 2007 to September 2008. Nine 600 m long and 5 m wide linear transects were settled in the sampled stretch, distributed in three distinct subareas classified according to degree of human disturbance, being: A1) area between Patos Lagoon channel and the trade center (32°09'342"S - 52°06'003"W e 32°10'450"S - 52°08'424"W), presenting the highest density of anthropic occupancy, intense vehicles traffic, tourism and recreational activities, intensive cattle grazing and garbage deposition; A2) area in southwards from Aquaculture Marine Station of Federal University of Rio Grande (32°12'192"W - 52°10'312"W e 32°14'098"S - 52°12'514"W), characterized by a moderate degree of anthropic occupancy, with vehicle traffic, tourism and recreational activities more concentrated in summer months and intensive cattle grazing; A3) area near to "Navio Altair" coastal stream (32°15'595"S - 52°14'290"W and 32°18"065" - 52°16'057"W"), characterized by the lowest degree of anthropic occupancy, with vehicle traffic, tourism and recreational activities more concentrated in summer months and moderate cattle grazing.

Three transects were settled in each sample subarea (A1, A2 and A3) (Figure 1). Each transects was divided in three parallel 200 m long segments, settled in biotopes of frontal dunes, intermediate dunes and adjacent marsh. Transects were walked twice per year season, totalizing eight samples in each transect. The total walked distance was 43,200 m, equally distributed between year season and subareas.

Each transect repetition was evaluated qualitatively according to the presence and absence of species. The species were recorded by identification of footprints, feces, remains (bones, skins) and visualization of living animals. Transects were walked by a single watcher, at an average speed of 2 km h^{-1}. All the found remains were moved to avoid recounting. Identification of vestiges and remains were based in author's experience, consults to specialists and field guides of Becker and Dalponte (1999), Borges and Tomás (2004), Oliveira

and Cassaro (2005) and De Angelo et al. (2008). Cingulate burrows were identified based on the entrance format, height and width accordingly to Anacleto and Diniz-Filho (2008).

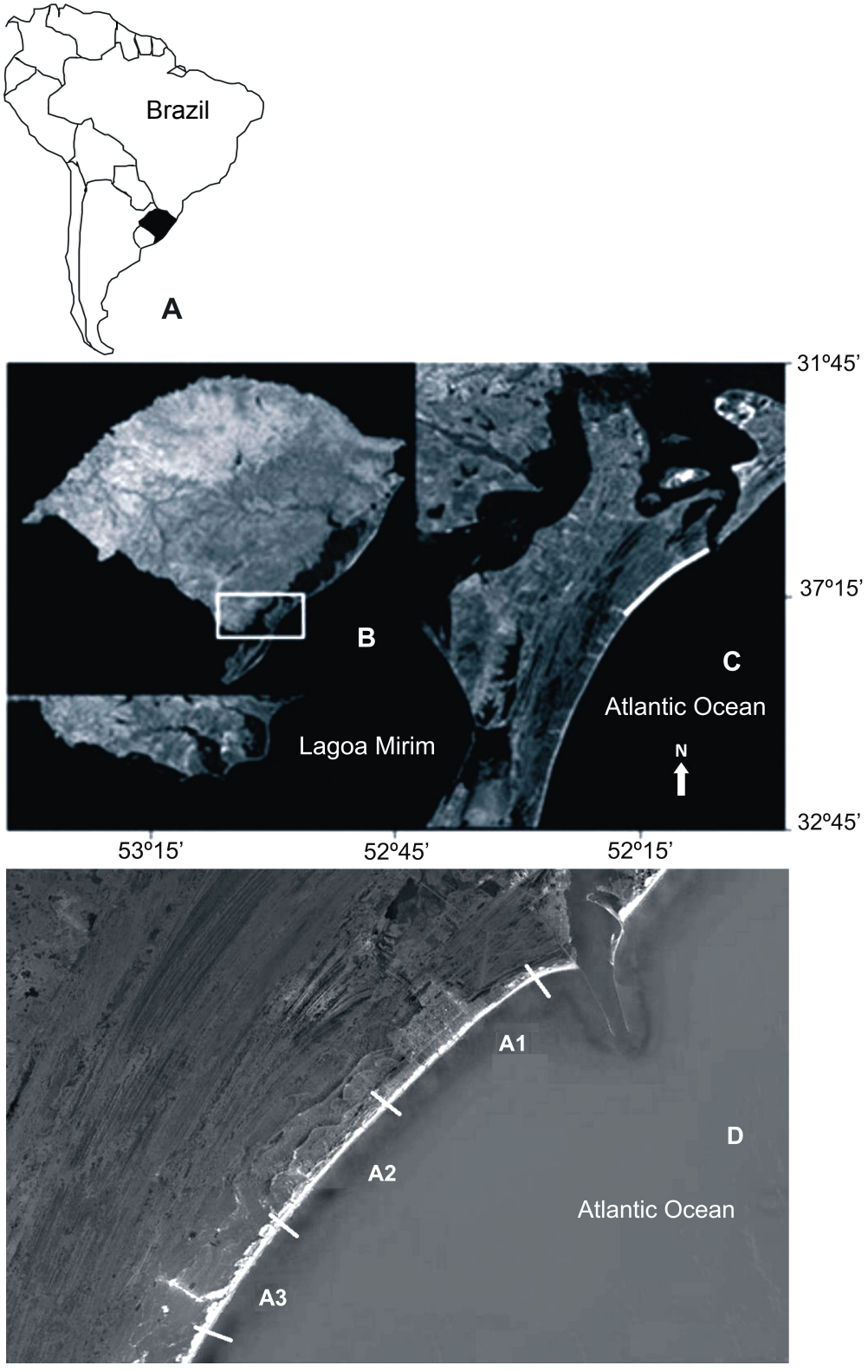

Figure 1. Location of Rio Grande do Sul State (A), part of southern Coastal Plain (B) and study area (C (white line), D), being A1, A2 and A3 areas under high, medium and low level of human occupancy, respectively.

Distinction between *Dasypus novemcinctus* and *D. hybridus* footprints were based on the size as shown in Becker and Dalponte (1999). Distinction between *Leopardus geoffroyi* and domestic cat footprints were based in size and morphological differences shown in Oliveira and Cassaro (2005). The recorded species were classified accordingly to Reis et al. (2011a). Chi-square test (χ^2) was used to verify if there are significant differences in species richness recorded among subareas (A1, A2 and A3), at a significance level of 5%.

Results

A total of 14 species of medium and large sized mammals (13 native and one exotic) was recorded in the sampled stretch, distributed in five orders and 10 families (Table 1).

Species richness was significantly higher in A3 when compared to A1 and A2 (χ^2 = 6,22; g.l. = 2; p = 0.045). *Lutreolina crassicaudata*, *L. gymnocercus*, *C. chinga* and *L. europaeu*s occurred in all subareas. *Didelphis albiventris*, *D. novemcinctus* and *L. longicaudis* were recorded in A2 and A3, while *M. coypus* was recorded in A1 and A3. *Euphractus sexcinctus*, *D. hybridus*, *L. geoffroyi*, *G. cuja*, *P. cancrivorus* and *H. hydrochaeris* were recorded only in A3 (Table 1).

In relation to the sampled biotopes, the species *L. europaeus, L. gymnocercus, L. longicaudis, M. coypus* and *D. novemcinctus* were recorded in both frontal and intermediate dune and adjacent marsh. *Conepatus chinga, G. cuja* and *H. hydrochaeris* were recorded in intermediate dune and adjacent marsh. *Procyon cancrivorus* was recorded in frontal dune and adjacent marsh while *D. albiventris* was found in frontal and intermediate dune. *Euphractus sexcinctus*, *L. geoffroyi*, *D. hybridus* and *L. crassicaudata* were recorded only in adjacent marsh (Table 1).

Lepus europaeus was the most frequent species, being recorded in 81.9% of the 72 transect walks performed. *Lycalopex gymnocercus* was the second species in the frequency rank (23.52%), followed by *Conepatus chinga* (10.29%), *Lontra longicaudis* (6.61%), *Dasypus novemcinctus* (5.5%), *Galictis cuja* and *Lutreolina crassicaudata* (2.20% each), *Didelphis albiventris*, *Eupractus sexcinctus*, *Procyon cancrivorus* and *Myocastor coypus* (1.47% each), *Dasypus hybridus*, *Leopardus geoffroyi* and *Hydrochoerus hydrochaeris* (0.73% each) (Figure 2).

Table 1. Species and supraespecific categories, subareas, biotopes of encounter and types of records of medium and large sized mammals recorded in a costal dunes segment and adjacent marshes in municipality of Rio Grande, southern Coastal Plain of Rio Grande do Sul State. A1 = area under high level of human occupancy, A2 = area under medium level of human occupancy, A3 = area under low level of human occupancy, DF = frontal dunes, DI = intermediate dunes, MA = adjacent marshes, FO = footprints, FA = faeces, BU = burrows, MU = mucus, SI = sightings, CA = carcass.

Taxa	Subarea	Biotopes	Type of records
Didelphimorphia			
Didelphidae			
Didelphis albiventris Lund, 1840	A2, A3	DF, DI	FO
Lutreolina crassicaudata (Desmarest, 1804)	A1, A2, A3	MA	FO
Cingulata			
Dasypodidae			
Dasypus hybridus (Desmarest, 1804)	A3	MA	FO, BU
Dasypus novemcinctus Linnaeus, 1758	A2, A3	DF, DI, MA	FO, BU, SI
Euphractus sexcinctus (Linnaeus, 1758)	A3	MA	FO, BU
Lagomorpha			
Leporidae			
Lepus europaeus (Pallas 1778)	A1, A2, A3	DF, DI, MA	FO, FE, SI
Carnivora			
Canidae			
Lycalopex gymnocercus (G. Fischer, 1814)	A1, A2, A3	DF, DI, MA	FO
Procyonidae			
Procyon cancrivorus (G. Cuvier, 1798)	A3	DF, MA	FO
Mustelidae			
Lontra longicaudis (Olfers, 1818)	A2, A3	DF, DI, MA	FO, FE, MU, SI
Galictis cuja (Molina, 1782)	A3	DI, MA	
Mephitidae			
Conepatus chinga (Molina, 1782)	A1, A2, A3	DI, MA	FO
Felidae			
Leopardus geoffroyi (d'Orbigny & Gervais, 1844)	A3	MA	FO
Rodentia			
Caviidae			
Hydrochaerus hydrochaeris (Linnaeus, 1766)	A3	DI, MA	FO
Myocastoridae			
Myocastor coypus (Molina, 1782)	A1, A3	DF, DI, MA	FO, CA

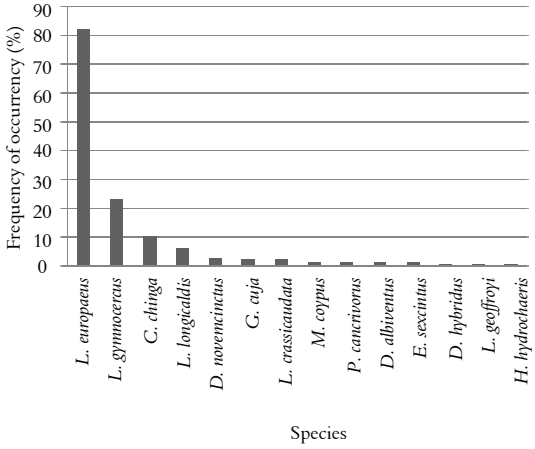

Figure 2. Relative frequency of medium and large sized mammal species on 72 transect walks performed in a 23 km stretch of costal dunes and adjacent marshes in municipality of Rio Grande, southern Coastal Plain of Rio Grande do Sul, State.

Discussion

According to Cáceres et al. (2007), all the species recorded in the present study occur in open areas or have wide distribution. The carnivores *L. longicaudis* and *L. geoffroyi*, however, are listed in the "Red List of Threatened Fauna in Rio Grande do Sul, State" (INDRUSIAK; EIZIRIK, 2003), being classified as Vulnerable and Threatened, respectively. *L. longicaudis* is also cited as Almost Threatened in "List of Threatened Brazilian Fauna" (MACHADO et al., 2005) and Data Deficient in IUCN "World Red List" (IUCN, 2010) while *L. geoffroyi* is classified as Almost Threatened in "List of Threatened Brazilian Fauna (MACHADO et al., 2005) and IUCN "World Red List" (IUCN, 2010). Once both species were absent in the subarea under high human occupation, the occurrence of *L. longicaudis*, *L. geoffroyi* and other less tolerant species in dune and adjacent systems may be conditioned to the maintenance of habitat features (soil, vegetation, hydrology) in considerable areas.

Except for *D. albiventris*, all the other species were found in adjacent marshes. The highest richness observed in this habitat could be related to the high productivity and food resource availability in these humid systems (SEELIGER, 1998b), when compared to xerophytic features of the dune formations. The habitat generalist species, *D. albiventris*, however, occurs in palustrine systems such as swamps and reed (ACHAVAL et al., 2007), and may also occur in marshes adjacent to coastal dunes. Importantly, *D. hybribus*, observed only in marsh areas in the present study, was already found in the dune systems by Gianuca (1997).

In relation to dune biotopes, it was observed a similar richness in frontal and intermediate systems, despite of the differences in species composition. An interesting fact is the footprints of *M. coypus* and *H. hydrochaeris* in dune biotopes, at distances greater than 300 m from waterbodies (coastal streams, marshes, pluvial channels). The occurrence of these rodents in dune habitats may be related to the use of psamophile vegetation as a food resource. Nevertheless, these and other ecological aspects of mammal species in the dune system require further researches.

In the present study we verified the presence of *L. europaeus*, *L. gymnocercus, L. crassicaudata, M. coypus* and *C. chinga* in areas under high anthropization degree. *Lepus europaeus* is native in Europe and it is considered agricultural pest in several countries in South America, presenting a remarkable adaptability and inhabiting both open as forested areas (GRIGERA; RAPOPORT, 1983; JAKSIC et al., 2002; REIS et al., 2011b). In study area, the European hare is commonly hunted with the aid of trained dogs, and despite the constant removal of individuals, vestiges of this species were found in large quantities in all established transects, indicating its high abundance. The possible environmental impacts cause by *L. europaeus* in dune biotopes are unknown, but it is known that the species assumed the role of competitive face of native herbivores in areas with high population densities (AURICCHIO; OLMOS, 1999). The carnivores *L. gymnocercus* and *C. chinga* inhabit mainly the open areas (CHEIDA et al., 2011) and in southern coastal plain were found even in densely urbanized areas (F.M. Quintela, pers. obs.), indicating the high degree of adaptation of these species to modified environments. The didelphid *L. crassicaudata* and the rodent *M. coypus* are also commonly found associated with aquatic environments in disturbed areas in the region, being the first recorded using human dwelling as shelter (F.M. Quintela, pers. obs.). Santos et al. (2008) also determined the occurrence of *L. europaeus*, *L. crassicaudata*, *M. coypus*, *L. gymnocercus* and *C. chinga* in highly modified habitats in Central Depression of Rio Grande do Sul State, being the tree first classified as "constant" in their sampling.

Another relevant aspect is the presence of domestic animals (dogs, cats, pigs, equines and cattle), verified in all sampled areas. According to IUCN (2000), exotic species represent the second major threat to biodiversity. Galetti and Sazima (2006), in an urban Atlantic Forest fragment, evaluated the impact of feral

dogs, reporting predation on didelphimorphs, rodents, cingulates, primates and artiodactylas. Feral cats are also considered a grave problem in natural environments, preying on native species and competing with autochthonous species of the same trophic position, beside the fact of pathogen transmission to wild populations (DICKMAN, 1996). No less concerning are the effects of grazing, also evidenced in all sampled areas. The intensive cattle and horse grazing implies in reduction of vegetal covering responsible dune fixedness, leading to destabilization and loss of function of the habitat (GIANUCA, 1997). Therefore, disturbance and modification of habitat features caused by domestic animals may be affecting the native mammalian fauna in costal dunes and adjacent systems.

Conclusion

In the present study we observed the inverse relationship between species richness and degree of human occupancy, which highlights the impacts of anthropization on medium and large sized mammal assemblages in dune environments and adjacent marshes in southernmost Brazil. This inventory contributes to the knowledge of faunal diversity in subtropical coastal dunes and associated habitats, warning about threats and providing support for conservation measures.

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