THE ROLE OF GALLERY FORESTS IN THE DISTRIBUTION OF CERRADO MAMMALS

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(With 1 figure)

ABSTRACT

The Cerrado biome contains a rich mammal community, with an influence from the Amazonian and Atlantic rainforests, principally observed in the gallery forests. In this paper, through literature review, it is shown that the non-volant mammal community of the gallery forests is distinct from the mammal communities of any other physionomy of the Cerrado. Additionally, the gallery forests contain twice as many species common to the rainforests when compared to all the other physiognomies of the Cerrado combined. The gallery forests appear to provide habitat within the Cerrado for rainforest mammals, increasing the biodiversity of this biome. As such, gallery forests may function as dispersion corridors for these species.

Key words: cerrado, dispersion corridors, gallery forests, mammals.

RESUMO

O papel das matas de galeria na distribuição dos mamíferos do cerrado

O bioma dos cerrados contém uma rica comunidade de mamíferos, com influência das matas Amazônica e Atlântica, principalmente observada nas matas de galeria. Neste trabalho, por revisão da literatura, foi demonstrado que a comunidade de mamíferos não voadores das matas de galeria no cerrado é distinta das comunidades de mamíferos de qualquer outro tipo de fisionomia do cerrado. Além disso, as matas de galeria contêm duas vezes mais espécies comuns às matas úmidas que às outras fisionomias do cerrado (*sensu latu*) reunidas. As matas de galeria parecem fornecer hábitat dentro do cerrado (*sensu latu*) para mamíferos das matas úmidas, aumentando a biodiversidade deste bioma. Assim, as matas de galeria podem funcionar como corredores de dispersão para estas espécies.

Palavras-chave: cerrado, corredores de dispersão, mamíferos, matas de galeria.

INTRODUCTION

The Cerrado (*sensu latu*) is the second largest vegetal formation in Brazil, covering an area of approximately 2.0 million km^2 (Ab'Saber, 1971; Eiten, 1972; Felfili & Silva, 1993; Oliveira-Filho *et al*., 1989). It is composed of by phytogeographically distinct areas, from open formations such as *campos limpos*, *campos sujos* and *campos cerrados*, to more closed formations such as cerrado (*sensu stritu*), *cerradão* and gallery forests (Eiten, 1972). With the vegetation of the Cerrado being markedly heterogeneous, the fauna associated with the various phytophysiognomies of the Cerrado is likewise distributed in a hetergeneous manner (Alho, 1993).

The mammal community of the Cerrado gallery forests appears to be strongly influenced by the Amazonian and Atlantic rainforests (Bishop, 1984; Fonseca & Redford, 1984; Mares *et al*., 1986; Nitikman & Mares, 1988; Redford & Fonseca, 1986). The term "community" is used here to describe the set of species known to occur within a particular habitat. Several authors have even suggested that the Cerrado gallery forests function as dispersion corridors between the Atlantic and Amazonian rainforests (Mares *et al*., 1989; Redford & Fonseca, 1986).

The first objective of this paper is to evaluate the degree to which the Cerrado gallery forest mammal community differs from mammal communities of other phytophysiognomies of the Cerrado. Secondly, the respective influences from the Amazonian and Atlantic rainforests over the Cerrado gallery forest mammal community are considered. In so doing, it may be seen as to whether the Cerrado gallery forests actually serve as extentions of suitable habitat for rainforest mammals.

METHODOLOGY

Using information from the literature, a list of non-volant, Cerrado mammal species was constucted (Appendix). As indicated by the literature, species were listed according to their occurrence in the following phytophysiognomies of the Cerrado: gallery forests, *cerradão*, cerrado (*sensu stritu*) and *campos*.

To assess the relative dissimilarity of the gallery forest mammal community in relation to those of other phytophysiognomies of the Cerrado, the occurrence data were analyzed with a Jaccard similarity index, using the program SYSTAT (Wilkinson *et al*., 1992).

In a second analysis, the role of the gallery forests for mammals common to the rainforests was examined by listing the Cerrado species which occur in either the Amazonian or Atlantic rainforests (see Appendix). The number of species common to these forests were compared between two groups: the Cerrado gallery forests and all other phytophysiognomies of the Cerrado combined. The data from the cerradão, cerrado (*sensu stritu*) and campos were combined so as to reduce the effect of incongruencies in the literature as well as a lack of information for some phytophysiognomies.

RESULTS

The Jaccard similarity index revealed values less than 0.50 when the gallery forest mammal community was compared with any other mammal community of the Cerrado (Table 1). The phytophysiognomy most similar to the gallery forests in relation to species composition appeared to be the cerrado (*sensu stritu*), with a similarity value of 0.462.

The gallery forests listed 73 species common to one or both of the humid forests, while, even when combined, the other phytophysiognomies of the Cerrado listed only 39 such common species. (Appendix).

DISCUSSION

In relation to species composition, the mammal communities of the respective phytophysiognomies of the Cerrado clearly differ. The gallery forests harbor the majority of species common to the Cerrado (*sensu latu*) and the Brazilian humid forests (Fig. 1).

When comparing mammal communities from the various phytophysiognomies of the Cerrado, all values obtained through the Jaccard similarity index were less than 0.50. This suggests that the mammal communities of these phytophysiognomies must be considered as distinct from one another (Muller-Dombois & Ellenberg, 1925).

Our data agree with the conclusions of Redford & Fonseca (1986) in that the Atlantic rainforest has a greater influence over the mammalian species composition of the Cerrado's gallery forests than does the Amazonian rainforest. Excluding those species which occur in both the Atlantic and Amazonian rainforests, 19 species were found to be common to the Cerrado gallery forests and the Atlantic rainforest, whereas only 8 gallery forest mammals were common to the Cerrado gallery forests and the Amazonian rainforest. A similar pattern of disproportionately high influence from the Atlantic rainforest may be observed in the other phythophysiognomies of the Cerrado (Figure 1). These results were not expected, as the area of the Amazonian forest (6,000,000 km^2: Pires & Prance, 1988) is much greater than the area of the Atlantic rainforest (800,000 km^2: IBGE 1982).

The the mammal community of the gallery forests appeared to be more similar to that of the cerrado (*sensu stritu*) than to those of any other phytophysiognomy of the Cerrado (*sensu stritu*), as was found by Alho *et al.* (1986), considering 25 mammal species. The lack of mammal studies in the cerradão may be considered responsible for the low similarity value between this phytophysiognomy and the gallery forests, considering that *cerradão* is structurally most similar to gallery forest.

Mares *et al*. (1986) found the greatest similarity, in relation to rodent species composition to be between *campos* and cerrado (*sensu stritu*),

and that the gallery forests contained the most distinct rodent community. These results may differ from our conclusions due to the more restricted analysis used by Mares *et al*. (1986), or by particularities of the study site sampled by Mares *et al*. (1986).

Fry (1980) found that the avifauna of the *cerradão* is more similar to the cerrado (*sensu stritu*) than to that of the gallery forest. Our data considering mammals show values of 0.194 between the gallery forest and *cerradão*, and 0.281 between cerrado and *cerradão*. These values suggest that the same pattern found by Fry (1980) for the distribution of avifauna within the Cerrado may also apply to mammals.

The gallery forests considerably boost the diversity of the Cerrado non-volant mammal fauna, providing habitat for species which do not occur in other phytophysiognomies of the Cerrado (Redford & Fonseca, 1986). Additionally, 85% of the bat species found in the Cerrado depend upon gallery forests in some manner (Marinho-Filho & Reis, 1989).

In conclusion, the gallery forests provide habitat for a distinct mammal community within the Cerrado. These riverine forests appear to be the only favorable habitat for many species common to the Amazonian and Atlantic rainforest. For these species, the gallery forests likely serve as the primary, if not only, dispersion corridors within the Cerrado.

Further investigations are needed in order to reveal the extent to which the Cerrado gallery forests have historically served to link the Amazonian and Atlantic rainforests.

TABLE 1

Matrix of Jaccard Similarity Index values, comparing non-volant mammal species composition for each of the various phytophysiognomies of the Cerrado (*sensu latu*).

	Gallery Forest	Cerradão	Cerrado	Campos
Gallery Forest	1.000			
Cerradão	0.234	1.000		
Cerrado	0.464	0.346	1.000	
Campos	0.250	0.371	0.370	1.000

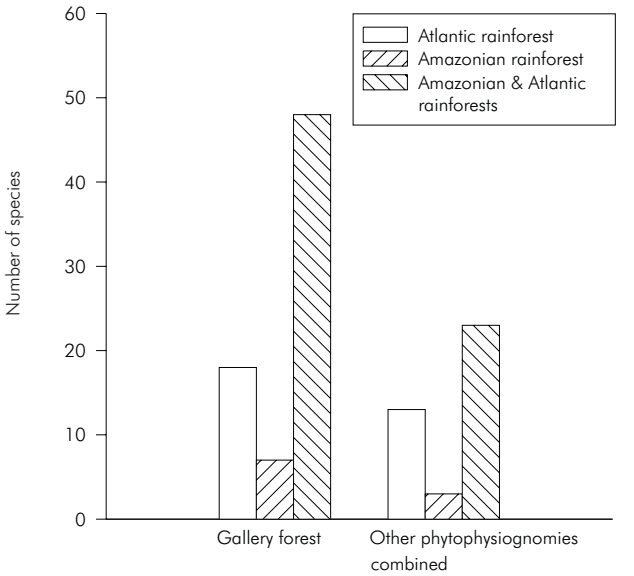

Fig. 1 — Number of non-volant Cerrado (*sensu latu*) mammal species common to the Atlantic and/or Amazonian rainforests, divided into two groups: gallery forests and other Cerrado phytophysiognomies combined.

APPENDIX

Species	*Humid Forest*		*Phytophysiognomy of the Cerrado (sensu latu)*			
	Atlantic	**Amazon**	**Gallery forest**	**Cerradão**	**Cerrado**	**Campos**
Marsupialia						
Didelphis albiventris	8		3,4,10,12,16	3,4,10	3,4,10	3,13
Marmosa cinerea	15,19	15,19	3		3	
M. murina	8,15,19	8,15,19	3,10,16	3	3	
M. incana	8,22,14					
M. velutina	15,19				20	
M. noctivaga	8					
M. constantiae			16			
Gracilinanus agilis	15,19	15,19	3,4,12,16,18		3	
Monodelphis domestica	8,15,19	15,19	3,4,10,16		10	13
M. umbistriata	8		3		15	
M. americana	8,14		3,4,12,16,18		3	
M. kunzi			3		3,13	
M. rubida	8					
Caluromys philander	8,15,19	8,15,19	3,16			
C. lanatus		8,14	3,16		3	
Lutreolina crassicaudata	15,19	15,19	3,16		3	
Philander opossum	8,15,19	8,15,19	3,4,10,16	4,10	3,4,10	4
Chironectes minimus	8	15,19	3,4,12,13,16			
Metachirus nudicaudatus	15,19	15,19	3,16		3	
Rodentia						
Oryzomys ratticeps	8		3,16		3	
O. subflavus	15,19		1,10	1,3,10,13,17	1,3,10,13,17,20	1,3,10,13,17
O. oniscus			1			
O. capito (=O. oniscus)	15,19	8,15,19	1,3,4,10,12,14,16,18			
O. lamia			1,3,10,16,19		3	
O. utiaritensis			15		15	
O. microtis			3,10,13,15	1,3,10,13	1,3,7,10,15	1,3,7,10,13
Oligoryzomys chacoensis			16			
O. nigripes	15,19		2,16,18			
Oecomys cleberi			4,16			
O. simplex			1			
O. concolor (=O. roberti)		15,19	3,4,10,12,13,14,18		3	10
O. bicolor			3,4,12,13,14,16,18			
Holochilus brasiliensis		22,14	3,10,16			
H. sciureus						
Pseudoryzomys simplex			2,9,10,15,16,19		10,17	
Wiedomys pirrhorhinos	15,19		16		3	
Nectomys squamipes	15,19	15,19	3,4,10,11,12,14,16			
Rhipidomys mastacalis	15,19	15,19	1,3,4,11,12,14,16,18			
Juscelinomys candango					10	
Akodon reinhardti					3,13,15	3,13
A. cursor			4,14,16		4	
Bibimys labiosus						
Bolomys lasiurus	15,19	15,19	1,3,4,10,12,16,17,18	1,3,4,10,17	1,3,4,7,10,14,20	1,3,4,6,7,10,14
Plectomys paludicola					6	4,6,15
Oxymycterus roberti	15,19		3,4,16		6	3,4,6,10,14
O. rutilans	15,19					
Calomys callosus			1,4,7,10	4,10	4,10,20	3,4,10,14
C. expulsus			1	1	1	1
C. laucha			7		7	7
C. tener			4	4	4,7,20	3,4,7
Neacomys spinosus	15,19	8,15,19				
Blarinomys breviceps	8,15,19					
Kunsia fronto			16	3	3	
K. tomentosus			16			
Coendou prehensilis	8	8,15,19	3,13,14,16			
Sphigurus villosus	15,19					
Proechimys spp.		15,19	3,4,10,12,13,14,16			
Clyomys laticeps	8		3			
Carterodon sulcidens	14		3		3,5	5
Thalpomys lasiotis	14		4	4	3,4,7,20	1,3,4,7,14

APPENDIX (*continuação*)

Species	*Humid Forest*		*Phytophysiognomy of the Cerrado (sensu latu)*			
	Atlantic	**Amazon**	**Gallery forest**	**Cerradão**	**Cerrado**	**Campos**
T. cerradensis					20	
Thrichomys apereoides			3,4,10,16	4,10	4,10	3,4,13
Echimys brasiliensis	8		15,16,19			
Ctenomys brasiliensis						
C. minutus						
Eurizigomatomys gulara	14		3,4			
Galea flavidens					15	
G. spixii		15,19	10		3	10,14
Cavia aperea	15,19		3,13			3,13
Kerodon rupestris						
Hydrochaeris hydrochaeris	8,15,19	8,15,19	3,5,10,14,16			
Dasyprocta azarae	8,15,19		3,16			
D. punctata		8,15,19				
D. prymnolopha		15,19				
Agouti paca	8,15,19	8,15,19	3,5,10,16			
Carnivora						
Chrysocyon brachyurus			3,10,16	3,10	3,10,13	3,10
Speothos venaticus	8,15,19	8,15,19	3		3	
Dusicyon thous	15,19	15,19	3,16	3		
D. vetulus			3	3	15	
Procyon cancrivorus	8,15,19	8,15,19	3,16			
Nasua nasua	8,15,19	8,15,19	3,16	3		
Potos flavus	15,19	8,15,19	16			
Eira barbara	8,15,19	8,15,19	10,13,16		13	
Galictis vitatta	8,15,19	8,15,19	16			
G. cuja	15,19		3,16		3	
Conepatus chinga	15,19	15,19	16			
C. semistriatus		8,15,19	3,16			
Pteronura brasiliense	8,15,19	8,15,19	3,16			
Lutra longicaudis	8,15,19	8,15,19	16			
Panthera onca	15,19	8,15,19	3,16			
Felis colocolo						
F. concolor	8,15,19	8,15,19	3,16			
F. pardalis	8,15,19	8,15,19	3,16			
F. wiedii	8,15,19	8,15,19	3,16			
F. yagouaraoundi	8,15,19	8,15,19	3,10,16			
F. tigrina	8,15,19	8,15,19	3,16			
Lagomorpha						
Sylvilagus brasiliensis	8,15,19	8,15,19	3,13,16	10	10	10
Edentata						
Myrmecophaga tridactyla	8,15,19	8,15,19	16			
Tamandua tetradactyla	8,15,19	8,15,19	16		10,13	
Bradypus variegatus	8,15,19	8,15,19	16			
Dasypus septemcinctus	8,22	8	12,16			13
D. novemcinctus	8,15,19	8,15,19	12,13,16	10	10,13	
Tolypeutes matacus						
T. tricinctus	15,19					
Priodontes maximus	8,15,19	8,15,19	16		13	
Cabassous unicinctus	8,15,19	8,22	16		13	10,13
C. tatouay	15,19					
Euphractus sexiinctus	8	8	16		10	
Perissodactyla						
Tapirus terrestris	8,15,19	8,15,19	3,16			
Artiodactyla						
Tayassu tajacu	8,15,19	8,15,19	3,16		3	
T. pecari	8,15,19	8,15,19	3,16		3	
Mazama americana	8,15,19	8,15,19	3,10,13,16		3,10,13	
M. gouazoubira	8,15,19	8,15,19	3,16		3	
Ozotoceros bezoarticus			3			3,10,13
Blastocerus dichotomus			3			3
Primata						
Callithrix penicillata	15,19		3,10,16	10		
C. argentata		15,19	3			

APPENDIX (*continuação*)

Species	*Humid Forest*		*Phytophysiognomy of the Cerrado (sensu latu)*			
	Atlantic	**Amazon**	**Gallery forest**	**Cerradão**	**Cerrado**	**Campos**
C. melanura			16			
C. jacchus	15,19		3,13,16			
Aotus trivirgatus	8,15,19	15,19	3			
Cebus apella	8,15,19	8,15,19	3,10,13,16			
Alouatta caraya			3,13,16		13	

1 - Alho (1981); 2 - Alho (1982); 3 - Alho (1993); 4 - Alho *et al.* (1986); 5 - Bishop (1974); 6 - Borchert & Hansen (1983); 7 - Dietz (1983); 8 - Emmons (1990); 9 - Fonseca (1996); 10 - Fonseca & Redford (1984); 11 - Lacher (1992); 12 - Mares & Ernest (1995); 13 - Mares *et al*. (1989); 14 - Mares *et al*. (1986); 15 - Marinho-Filho & Gastal (1997); 16 - Marinho-Filho & Reis (1989); 17 - Mello & Moojen (1979); 18 - Nitikman & Mares (1987); 19 - Redford & Fonseca (1986); 20 - Vieira & Baumgarten (1995)

REFERENCES

AB'SÁBER, A. N., 1971, A organização natural das paisagens inter e subtropicais brasileiras. *In:* M. G. Ferri (ed.), *III Simpósio sobre o Cerrado*, Brasília, DF, pp. 1-14.

ALHO, C. J. R., 1981, Small mammal populations of the brazilian cerrado: the dependence of abundance and diversity on habitat complexity. *Revista Brasileira de Biologia, 41*(1): 228-230.

ALHO, C. J. R., 1982, Brazilian rodents: their habitats and habits. *In*: M. A. Mares & H. H. Genoways (eds.), *Mammalian Biology in South America*. Special Publication of the Pymatuning Laboratory of Ecology, University of Pittsburg.

ALHO, C. J. R., 1993, Distribuição da fauna num gradiente de recursos em mosaico. *In*: M. N. Pinto, *Cerrado*. Editora Universidade de Brasília, Brasília, DF, 2ª ed., pp. 213-262.

ALHO, C. J. R., PEREIRA, L. A. & COSTA, A. P., 1986, Patterns of habitat utilization by small mammal populations in Cerrado biome of Central Brazil. *Mammalia, 50*: 448-460.

BISHOP, I. R., 1984, An annotated list of caviomorph rodents collected in North-eastern Mato Grosso, Brazil. *Mammalia, 38*(3): 490-501.

BORCHERT, M. & HANSEN, R. L., 1983, Effects of flooding and wildfire on valley side wet campo rodents in Central Brazil. *Revista Brasileira de Biologia, 44*(3): 229-240.

DIETZ, J. M., 1983, Notes on the natural history of small mammals in Central Brazil (general notes). *Journal of Mammalogy, 64*(3): 521-523.

EITEN, G., 1972, The cerrado vegetation of Brazil. *Botanical Review, 38*: 205-341.

EMMONS, L. H., 1990, *Neotropical Rainforest Mammals – A field guide*. The University of Chicago Press, Chicago, 281p.

FELFILI, J. M. & SILVA JR., M. C., 1993, A comparative study of Cerrado (*sensu stricto*) vegetation in Central Brazil. *Journal of Tropical Ecology, 9*: 277-289.

FONSECA, G. A. B. ,1996, *Lista Anotada dos Mamíferos do Brasil*.

FONSECA, G. A. B. & REDFORD, K. H., 1984, The mammals of IBGE's ecological reserve, Brasília, and an analysis of the role of gallery forests in increasing diversity. *Revista Brasileira de Biologia, 44*: 518-523.

FRY, C. H., 1980, Ecological distribution of birds in Northeastern Mato Grosso State, Brazil. *Anais da Acadêmia Brasileira de Ciências, 42*: 285-303.

IBGE – Instituto Brasileiro de Geografia e Estatística, 1982, *Anuário Estatístico do Brasil*. SEPLAN, Brasília, DF.

LACHER, T. E., 1992, Ecological aspects of reproductive patterns in South American small rodents. *In: W. C.* Hanlett (ed.), *Reproductive Biology of South American Vertebrates*. Springer-Verlag, NY, pp. 283-294.

MARES, M. A., BRAUN, J. K. & GETTINGER, D., 1989, Observations on the distribuition and ecology of the mammals of the Cerrado grasslands of Central Brazil. *Annals of Carnegie Museum, 58*: 1-60.

MARES, M. A. & ERNEST, K. A., 1995, Population and community ecology of small mammals in a gallery forest of Central Brazil. *Journal of Mammalogy, 86*(3): 850-868.

MARES, M. A., ERNEST, K. A. & GETTINGER, R. D., 1986, Small mammal community structure and composition in the Cerrado province of Central Brazil. *Journal of Tropical Ecology, 2*: 289-300.

MARINHO-FILHO, J. S. & GASTAL, M. L., 1998, Mamíferos das matas ciliares dos Cerrados do Brasil Central (no prelo).

MARINHO-FILHO, J. S. & REIS, M. L., 1989, A fauna de mamíferos associada às matas de galeria. *In*: L. H. Barbosa (coord.), *Simpósio sobre Mata Ciliar*. Anais. Fundação Cargill, Campinas, SP.

MELLO, D. A. & MOOJEN, L. E., 1979, Nota sobre uma coleção de roedores e marsupiais de algumas regiões do Cerrado do Brazil Central. *Revista Brasileira de Pesquisa Médica e Biológica, 12*: 288-291.

MUELLER-DOMMBOIS, D. & ELLENBERG, H., 1925, *Aims and methods of vegetation ecology*. John Wiley & Sons., 547p.

NITIKMAN, L. Z. & MARES, M. A., 1988, Ecology of small mammals in a gallery forest of Central Brazil. *Annals of Carnegie Museum, 56*: 75-95.

OLIVEIRA-FILHO, A. T., SHEPHERD, G. J., MARTIN, F. R. & STUBBLEBINE, W. H., 1989, Environmental factors affecting physiognomic and floristic variation in an area of cerrrado in central Brazil. *Journal of Tropical Ecology, 5*: 413-431.

PIRES, J. M. & PRANCE, G. T., 1988, The Amazon forest: a natural heritage to be preserved. *In*: G. T. Prance (ed.), *Extinction is forever*. New York Botanincal Garden, pp. 158-194.

REDFORD, K. H. & FONSECA, G. A. B., 1986, The role of Gallery Forests in the Zoogeography of the Cerrado's non-volant Mammalian Fauna. *Biotropica, 18*(2): 126-135.

VIEIRA, E. M. & BAUMGARTEN, L. C., 1995, Daily activity patterns of small mammals in a Cerrado area from Central Brazil. *Journal of Tropical Ecology, 11*: 255-262.

WILKINSON, L., HILL, M., WELNA, J. P., BIRKENBEUEL, G. K., 1992, *SYSTAT for Windows: Statistics, Version 5 Edition*. Evanson, IL: SYSTAT, Inc., 750p.