TIJUCA NATIONAL PARK: TWO PIONEERING RESTORATIONIST INITIATIVES IN ATLANTIC FOREST IN SOUTHEASTERN BRAZIL

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(With 1 figure)

ABSTRACT

As a contribution to the environmental history of the Tijuca National Park, we report on two pioneering restorationist initiatives and list its the mammal species now found in this urban park. The Tijuca National Park (TNP), a 3,200 ha urban park covered by secondary tropical forest, is located within Rio de Janeiro, in southeastern Brazil. The two restorationist initiatives were a pioneer tropical forest restoration project in the nineteenth century and a fauna management project in the 70' s. The mammal list presented here was based on specimens in the **Museu Nacional do Rio de Janeiro** and on publications. The mammal community of TNP is composed of 49 species, of which 11 are on regional red lists, and four are on the 2003 IUCN Red List of Threatened Species. Occurrence of these threatened species and the park history itself made the TNP a priority site for studying conservation, management, and monitoring. Besides maintaining fauna and flora (including threatened species) diversity, the park benefits the population of Rio de Janeiro by providing water, green areas, and recreational and touristic opportunities.

Keywords: environmental history, conservation, mammals, tropical forest, urban park.

RESUMO

Parque Nacional da Tijuca: Palco de duas iniciativas clássicas de restauração da Mata Atlântica no Sudeste do Brasil

Estudos sobre monitoramento, regeneração florestal e manejo de fauna devem usar a história ambiental como referência para compreender o passado da área de estudo e para monitorar os resultados desses estudos. Para criar a base da história ambiental para o Parque Nacional da Tijuca, relatamos duas iniciativas clássicas de restauração e a lista das espécies de mamíferos que ocorrem atualmente neste parque urbano, que depende dessas iniciativas. O Parque Nacional da Tijuca (PNT) é um parque urbano de 3.200 ha coberto por floresta tropical secundária e cercado pela cidade do Rio de Janeiro, no Sudeste do Brasil. No PNT, ocorreram duas iniciativas clássicas de restauração: a pioneira restauração da floresta tropical no século XIX e o projeto de manejo da fauna nos anos 70. A lista de mamíferos foi baseada em publicações e nos espécimens depositados no Museu Nacional do Rio de Janeiro. A comunidade de mamíferos do PNT é composta por 49 espécies, sendo 11 incluídas nas listas vermelhas regionais e quatro espécies na Lista Vermelha de Espécies Ameaçadas da IUCN de 2003. A ocorrência dessas espécies ameaçadas e a história do parque tornaram o Parque Nacional da Tijuca uma área de estudo prioritária para monitoramento, conservação e manejo. Além do PNT ser um parque urbano importante para a manutenção da diversidade da fauna e da flora, incluindo as espécies ameaçadas, também melhora a qualidade de vida da população da cidade do Rio de Janeiro, fornecendo áreas verdes, recreação, turismo e abastecimento de água. Concluindo, enfatizamos a grande importância da história ambiental no Parque Nacional da Tijuca para a composição atual da comunidade de mamíferos.

Palavras-chave: história ambiental, conservação, mamíferos, floresta tropical, parque urbano.

INTRODUCTION

Historical ecology encompasses all data, techniques, and perspectives derived from paleoecology; land use history, based on archival and documentary research; and long-term ecological research, involving monitoring and experiments extending over decades (Swetnam *et al*., 1999). However, studies of this type are few with respect to tropical forests. The general lack of historical data about such regions makes studies of their environmental history unusually challenging. In addition, the results of such research on a regional or global scale increases our appreciation of the dynamic nature of landscapes, and provides a frame of reference within which to examine changing patterns and processes (Simmons, 1993; Dean, 1996; Swetnam *et al.*, 1999).

In Brazil, monitoring studies have resulted in experimental designs and development of improved methodologies appropriate to local characteristics, in addition to which forest regeneration initiatives have been carried out (Garay & Dias, 2001; Cullen Jr. *et al.*, 2003; Parrotta & Knowles, 1999; Almeida, 2000; Primack & Rodrigues, 2001; Camargo *et al.*, 2002; Kageyama & Gandara, 2003). Moreover, various projects exist on fauna reintroduction and management of the tamarins *Leontopithecus chrysopygus* (Callitrichidae, Primates) in **Parque Estadual do Morro do Diabo** (São Paulo State), and *Leontopithecus rosalia* in **Reserva Biológica de Poço das Antas and Reserva Biológica União** (Rio de Janeiro State) (Primack & Rodrigues, 2001; Fernandez *et al.*, 2003). All of these projects and studies may gain perspective through a knowledge of environmental history as related to particular study sites.

As a contribution to the environmental history of the Tijuca National Park, we here report on two pioneering restorationist initiatives and list the mammal species currently found within the park, and which may be part of the long-term results of these initiatives.

STUDY SITE

The Tijuca National Park (TNP) is located in the middle of Rio de Janeiro (22° 55' - 22° 00' S and 43° 11' - 43° 19' W) in the Maciço da Tijuca Mountains, southeastern Brazil (IBDF, 1981) (Fig. 1). One of the world's largest (3,200 ha) urban parks, TNP is divided into three subunits delimited in 1967: Tijuca Forest, Serra da Carioca, and Pedra da Gávea/Pedra Bonita (IBDF, 1981), and is of high

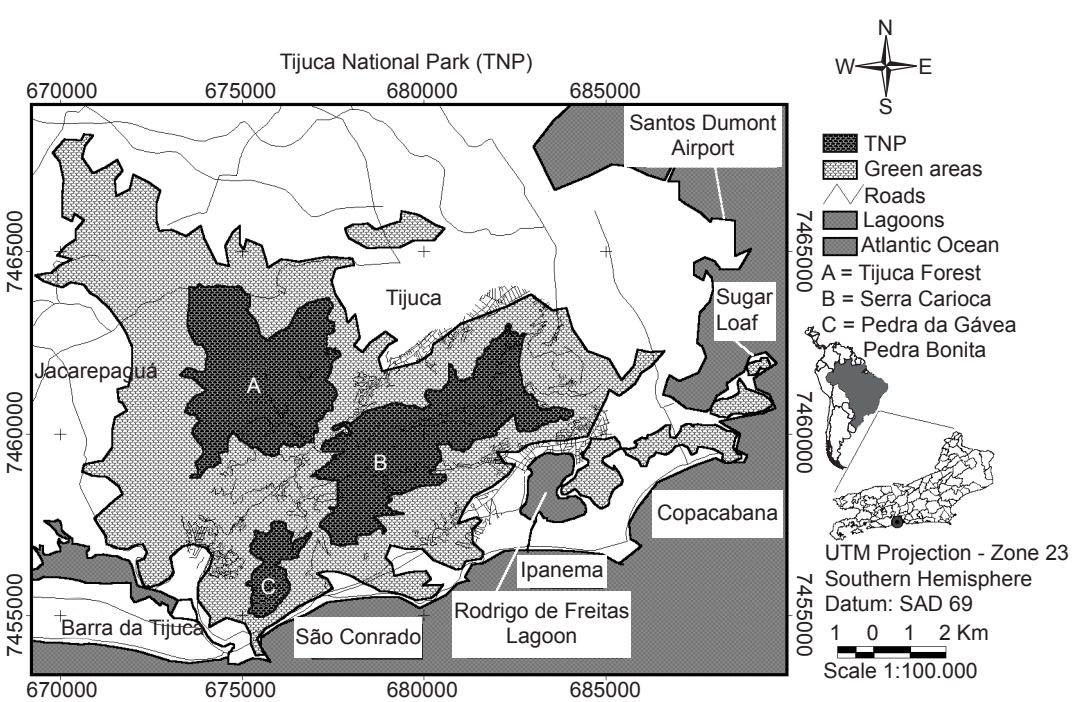

Fig. 1 — Location of Tijuca National Park.

biological importance for conservation of Atlantic forest and its fauna, particularly reptiles, birds, and mammals (Brasil, 2000).

The climate is tropical with rainy summers and dry winters. A thermal gradient of 0.4 °C/100 m was calculated for temperature variation with altitude (80 m to 1,021 m) (Mattos *et al.*, 1976). Below 500 m high, precipitation exceeds 2,000 mm yearly, mean temperature of the warmest month is above 22 °C, and that of the coldest is higher than 18 °C. At areas above 500 m, precipitation is similar and mean temperature of the coldest month is less than 18 °C (Mattos *et al.*, 1976). The TNP vegetation is typical of tropical rain forest, characterized by big trees, palms, ferns, epiphytes, and lianas. The more frequent plant families are Leguminosae, Sapotaceae, Bombacaceae, Euphorbiaceae, Meliaceae, Lauraceae, Lecythidaceae, Moraceae, and Melastomataceae (CCN, 1966).

PIONEERING TROPICAL FOREST RESTORATION IN BRAZIL

From the sixteenth to the nineteenth centuries, tropical forest in Rio de Janeiro was gradually substituted by sugarcane, coffee plantations, and pastureland (Dean, 1996; Amador, 1997). Intense land use and deforestation caused problems in the city's water supply (CCN, 1966; Castro Maya, 1967; Scheiner, 1976; Drummond, 1988). Mainly for this reason, Manuel Gomes Archer was hired at the end of the nineteenth century by Emperor D. Pedro II to start a flora restoration project (Scheiner, 1976; Dean, 1996; Amador, 1997; Drummond, 1997; Pádua, 2002). From 1862 to 1874, Archer and a few slaves planted about 72,000 seedlings of native and exotic tree species, *e.g.*, palms, bamboos, cedro rosa (*Cedrela fissilis*), jacaranda (*Machaerium* sp.), sapucaia (*Lecythis pisonis*), jaqueira (*Artocarpus integrifolia*), and eucaliptus (*Eucalyptus* spp.) (CCN, 1966; Drummond, 1997). Seedling sources were located in the Paineiras Forest, Archer's farm in Guaratiba, and in the Botanical Garden of Rio de Janeiro. This reforestation project of Archer did not include the whole of what is presently Tijuca National Park; however in the area within the original project and which then became part of TNP, the result was an environment conducive to natural forest regeneration (Drummond, 1988; Coimbra-Filho *et al.*, 1973; Dean, 1996). This was because heterogeneous and predominantly native species of trees were used in this project, unlike the procedure usually followed in forest plantation at that time (Drummond, 1988).

Subsequently, Archer's successor, Gastão Luís Henrique D'Escragnolle concentrated on park infrastructure, which resulted in turning Tijuca Forest into an area appropriate for public recreation (Drummond, 1988).

In 1861, the first conservation area in Brazil was established in Tijuca Forest and Paineiras (BRASIL, 1998). In 1961, to protect the water reservoir of Rio de Janeiro, this area became the Tijuca National Park (Scheiner, 1976; Drummond, 1997; BRASIL, 1998).

THE SECOND RESTORATION PROJECT: FAUNA

In the nineteen-seventies, Adelmar Coimbra-Filho and Antonio Aldrighi and their group began a fauna restoration project in Tijuca National Park, in the course of which an imbalance in populations of some species was observed. For instance, the marmoset *Callithrix jacchus* (Callitrichidae, Primates), an introduced species from the Brazilian northeast, reproduced so quickly that bird populations were being threatened because of egg predation (Coimbra-Filho & Aldrighi, 1971). Their project consisted of recovering reptiles, birds, and mammals; cultivating plant species (such as bromeliads and orchids) present in the diet of these fauna; reintroducing vanished species; and controlling predator populations and hunters (Coimbra-Filho & Aldrighi, 1971). The species chosen fit criteria specifying (1) a population compatible with, and having a home range smaller than, the area of Tijuca National Park; (2) habits not conducive to soil erosion; and (3) being a seed dispersor or a prey of rare predators (Coimbra-Filho & Aldrighi, 1971; Coimbra-Filho & Aldrighi, 1972; Coimbra-Filho *et al.*, 1973).

From 1969 to 1973, the fauna restoration project reintroduced one reptile species (*Boa constrictor*), 25 bird species, and 7 mammal species (Table 1). The group of Coimbra-Filho and Aldrighi introduced five snakes, 914 birds, and 58 mammals that had been captured by hunters in other forests of Rio de Janeiro State (Coimbra-

TABLE 1
Number of individuals (reptiles, birds, and mammals) introduced into the Tijuca National Park from 1969 to 1973.

Classes	Orders	Families	Species	Number of introduced individuals
Reptilia	Squamata	Boidae	*Boa constrictor*	5
Aves	Tinamiformes	Tinamidae	*Crypturellus tataupa*	19
Aves	Galliformes	Cracidae	*Penelope superciliaris*	5
Aves	Galliformes	Phasianidae	*Odontophorus capueira*	8
Aves	Columbiformes	Columbidae	*Leptotila rufaxila*	13
Aves	Psittaciformes	Psittacidae	*Brotogeris tirica*	34
Aves	Psittaciformes	Psittacidae	*Pionopsitta pileata*	2
Aves	Psittaciformes	Psittacidae	*Pyrrhura cruentata*	66
Aves	Psittaciformes	Psittacidae	*Pyrrhura frontalis*	42
Aves	Psittaciformes	Psittacidae	*Pyrrhura leucotis*	95
Aves	Piciformes	Ramphastidae	*Baillonius bailloni*	26
Aves	Piciformes	Ramphastidae	*Ramphastos vitellinus*	47
Aves	Piciformes	Picidae	*Melanerpes flavifrons*	14
Aves	Passeriformes	Cotingidae	*Procnias nudicollis*	12
Aves	Passeriformes	Muscicapidae	*Platycichla flavipes*	20
Aves	Passeriformes	Muscicapidae	*Turdus rufiventris*	19
Aves	Passeriformes	Emberizidae	*Cacicus haemorrhous*	40
Aves	Passeriformes	Emberizidae	*Coryphospingus pileatus*	29
Aves	Passeriformes	Emberizidae	*Euphonia violacea*	30
Aves	Passeriformes	Emberizidae	*Euphonia xanthogaster*	30
Aves	Passeriformes	Emberizidae	*Icterus cayanensis*	46
Aves	Passeriformes	Emberizidae	*Saltator maximus*	2
Aves	Passeriformes	Emberizidae	*Saltator similis*	171
Aves	Passeriformes	Emberizidae	*Tangara cyanocephala*	55
Aves	Passeriformes	Emberizidae	*Tangara seledon*	86
Aves	Passeriformes	Emberizidae	*Thraupis sayaca*	3
Mammalia	Xenarthra	Myrmecophagidae	*Tamandua tetradactyla*	4
Mammalia	Xenarthra	Bradypodidae	*Bradypus torquatus*	11
Mammalia	Xenarthra	Bradypodidae	*Bradypus variegatus*	14
Mammalia	Xenarthra	Dasypodidae	*Dasypus novemcinctus*	1
Mammalia	Rodentia	Sciuridae	*Sciurus aestuans*	2
Mammalia	Rodentia	Dasyproctidae	*Dasyprocta leporina*	25
Mammalia	Artiodactyla	Cervidae	*Mazama americana*	1

Filho *et al.*, 1973) by foresters (*Instituto Brasileiro de Desenvolvimento Florestal*). As result of this project, Coimbra-Filho *et al.* (1973) discovered the rodent *Dasyprocta leporina,* the existence of which in TNP had until then been unrecorded. Other successful reintroductions by Coimbra's group included the sloth *Bradypus torquatus* and the birds *Crypturellus tataupa*, *Pyrrhura cruentata*, *Pyrrhura frontalis*, *Pyrrhura leucotis*, *Baillonius bailloni*, *Ramphastus vitellinus*, *Euphonia violacea*, *Euphonia xanthogaster,* and *Tangara cyanocephala*. Coimbra-Filho (2000) recorded the recovery of the toucan *Ramphastus vitellinus* 30 years after the project's implantation.

But Coimbra's group also experienced some setbacks: the species *Cacicus haemorrhous* and *Icterus cayanensis* were not subsequently found (Coimbra-Filho *et al.*, 1973). In commenting on

these results, they cited lack of control measures against hunters and ornamental plant collectors.

UPDATED RESULTS OF BOTH PROJECTS

The project of Archer and the Aldrighi and Coimbra Filho group were pioneering and ambitious, and resulted in one of the world's largest urban parks, which is singular in being covered by secondary tropical forest and modified by high occurrence of exotic species (Drummond, 1997). Aldrighi and Coimbra Filho's species introduction project introduced, sometimes successfully, various species. Together, these projects have promoted in TNP a process of succession into mature forest (Oliveira, 2002) in which many vertebrate species now are found as a result of introduction or migration. This study presents in tables 1 and 2 a list of these species, which is based in part on studies (Coimbra-Filho & Aldrighi, 1971; Coimbra-Filho & Aldrighi, 1972; Coimbra-Filho *et al*., 1973; Bueno, 1998; Esbérard, 1999) and in part on specimens the data for which was recorded from 1940 to 1999 and is now in the **Museu Nacional do Rio de Janeiro**. Records show the presence of 8 species of Didelphimorphia, 3 of Xenarthra, 25 of Chiroptera, 3 of Primates, 4 of Carnivora, and 6 of Rodentia (Table 2) in Tijuca National Park. Of these 49 species, 7 are classified as threatened and are included on the red list of the Municipality of Rio de Janeiro (Conde *et al.*, 2000), 7 species are on the red list of Rio de Janeiro State (Bergallo *et al*., 2000), 2 are on the Brazilian red list (Brasil, 2003) and 4 are on the 2003 IUCN Red List of Threatened Species (IUCN, 2003a).

Leopardus wiedii and *Myotis ruber* were on all three regional red lists, whereas *Monodelphis* aff. *theresa*, *Caluromys philander*, *Chironectes minimus,* and *Monodelphis americana* were included in 2003 IUCN Red List (Table 2). The occurrence of these threatened species within this park has made the Tijuca National Park a prioritized site for studying conservation and management of tropical Atlantic forest. We suggest further studies to evaluate vulnerability of vertebrate species populations. Another topic for study is possible effects of exotic plant species on native ones, e.g., between jaqueira (*Artocarpus integrifolia*) and seedlings of native species, which may impede the successional process.

THE IMPORTANCE OF TIJUCA NATIONAL PARK

Besides TNP being an important urban park because it maintains fauna and flora diversity, which includes threatened species, this park also contributes to the well-being of Rio de Janeiro's population of almost six million people (IBGE, 2003). Coles & Bussey (2000) advocated that, to benefit human neighborhoods, woodlands should be within a 5-10 min walking distance of residences, of a size natural to woodland environments (a 2 ha minimum), and older than 25 years. The Tijuca National Park meets this description and is, therefore, a significant tourist attraction (Drummond, 1997). Moreover, the park is a source of the city's water supply and has one of its lowest air-pollution levels because of reduced traffic density and effects of the wind patterns and abundant vegetation (Barcellos *et al.*, 1998; Azevedo *et al.*, 1999).

CONCLUSION

The restorationist projects of both Archer and Coimbra-Filho and his group are of historical importance, since they ultimately resulted in making Tijuca National Park into one of the world's largest urban parks.

While some of the techniques and methods previously used are now outdated and been replaced by others, their effects carry over until the present time, and they are part of the historical framework in which to view modern projects having the same aim (Almeida, 2000; Primack & Rodrigues, 2001; IUCN, 2003b; Kageyama & Gandara, 2003). It is hoped that in describing these two projects and their results over time, others may inspire similar projects for tropical forests of developing countries.

Finally, we stress the great relevance of Tijuca National Park's environmental history to the current mammal community composition. If no forest had been recovered through Archer's reforestation project, and Coimbra-Filho and Aldrighi had not undertaken their restoration project, it is probable that Tijuca National Park as it is today would not exist.

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TABLE 2
List of mammal species presently occurring in Tijuca National Park and their threat status.

Orders	Species	MRJ	SRJ	BR	IUCN
Didelphimorphia	*Caluromys philander*				LR/nt
	Chironectes minimus		ST		LR/nt
	Didelphis aurita				
	Metachirus nudicaudatus				
	Micoureus demerarae				
	Monodelphis americana				LR/nt
	Monodelphis aff. theresa		PEX		VU/A1c
	Philander frenatus				
Xenarthra	*Bradypus variegatus*	VU			
	Tamandua tetradactyla	VU			
	Dasypus novemcinctus				
Chiroptera	*Anoura caudifer*				
	Artibeus cinereus		VU		
	Artibeus fimbriatus				
	Artibeus jamaicensis				
	Artibeus lituratus				
	Artibeus obscurus				
	Carollia perspicillata				
	Chiroderma doriae	VU	VU		
	Desmodus rotundus				
	Diphylla ecaudata				
	Eptesicus brasiliensis				
	Eumops auripendulus				
	Glossophaga soricina				
	Histiotus velatus				
	Lasiurus borealis				
	Lonchophylla mordax				
	Micronycteris megalotis				
	Molossus molossus				
	Myotis nigricans				
	Myotis ruber	VU	VU	VU	
	Platyrrhinus lineatus				
	Pygoderma bilabiatum				
	Sturnira lilium				
	Tonatia bidens				
	Vampyressa pusilla				
Primates	*Callitrix jacchus*				
	Cebus apella				
	Saimiri sciureus				
Carnivora	*Cerdocyon thous*				
	Nasua nasua				
	Procyon cancrivorus	VU			
	*Leopardus wiedii**	CE	VU	VU	
Rodentia	*Agouti paca*		VU		
Rodentia	*Dasyprocta leporina*	VU			
	Oxymycterus dasytrichus				
	Rattus rattus				
	Sciurus aestuans				
	Sphiggurus villosus				

*probably; MRJ = Red list of Municipality of Rio de Janeiro (Conde *et al.*, 2000); SRJ = Red list of Rio de Janeiro State (Bergallo *et al.*, 2000); BR = Brazilian red list (Brasil, 2003); IUCN = 2003 IUCN Red List of Threatened Species (IUCN, 2003a); PEX = Probably extinct, *i.e.*, no records in last 30 years (Bergallo *et al.*, 2000); CE = Critically endangered (IUCN, 1994); VU = Vulnerable (IUCN, 1994); VU/A1c = Vulnerable, *i.e.*, population reduction whether observed, estimated, inferred, or suspected of at least 20% over the last 10 years or three generations, whichever is the longer, based on a decline in area of occupancy, extent of occurrence, and/or quality of habitat (IUCN, 1994); ST = Presumed threatened, *i.e.*, species requiring heightened conservationist attention (Bergallo *et al.*, 2000); and LR/nt = Lower Risk/Near Threatened (IUCN, 1994).

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