

ECOLOGICAL ASPECTS OF BLACK-PINCELLED
MARMOSET (*Callithrix penicillata*) IN THE
CERRADÃO AND DENSE CERRADO OF THE BRAZILIAN
CENTRAL PLATEAU

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ABSTRACT

Ecological data about three free-ranging groups of *C. penicillata* (black-pinelled marmoset) were observed between March and December 1996, in one *cerradão* patch (in the Ecological Reserve of Brazilian Institute of Geography and Statistics, RECOR) and two patches of dense *cerrado* (one in the RECOR and another in the Botanical Garden of Brasília, JBB), situated in the APA (area of environmental protection) of the Gama/Cabeça-de-Veados, Distrito Federal. Each area was visited weekly during three periods of two months – end of the rainy season (01/04 to 31/05), dry season (16/06 to 15/08) and beginning of the rainy season (14/10 to 15/12) – and instantaneous scan records at fifteen minute intervals were made for the vertical and horizontal position of each visible individual of the target group. The group size ranged between 4 and 11 elements. In September, the birth of twins in both groups of the RECOR was observed. Home-range varied from 8.25 to 18.5 hectares, while density ranged from 0.4 to 0.82 ind/ha. Twenty two species of nine tree families were identified as exudate sources. *Qualea grandiflora* (Vochysiaceae), *Vochysia thyrsoidea* (Vochysiaceae), *Schefflera macrocarpum* (Araliaceae) and *Qualea parviflora* (Vochysiaceae) were more explored. Fruits (14 species, two of which were exotics), nectar, honey, arthropods (mainly orthopterans) and bird eggs complete their diet. The main sleep-tree species was *Emmotum nitens* (Icacinaceae). Data from different seasons and studied groups/areas were compared along previous data from this primate species in gallery forests. In the *cerradão* and dense *cerrado* areas *C. penicillata* had a similar group size, however a larger home-range and smaller density than in gallery forests were observed in this study.

Key words: ecology, *cerrado*, black-pinelled marmoset, Primates, Callitrichidae.

RESUMO

Aspectos da ecologia do mico-estrela (*Callithrix penicillata*) em cerradão e cerrado denso no Planalto Central brasileiro

Entre março e dezembro de 1996 foi observada a ecologia de três grupos naturais de *C. penicillata*: em uma mancha de cerradão (na Reserva Ecológica do IBGE, RECOR) e em duas manchas de cerrado denso (uma na RECOR e outra no Jardim Botânico de Brasília, JBB), no Distrito Federal. Cada área foi visitada semanalmente, por três períodos bimestrais – final da estação chuvosa 1 (01/04 a 31/05), estação seca (16/06 a 15/08) e início da estação chuvosa 2 (14/10 a 15/12). Foram feitos registros de varredura instantânea a cada 15 minutos ao longo do dia para as posições vertical e horizontal de todos os animais visíveis do grupo-alvo. O tamanho dos grupos variou entre 4 e 11 membros. Em setembro, ocorreu o nascimento de gêmeos nos dois grupos da RECOR. A área domiciliar esteve entre 8,25 e 18,5 hectares e a densidade, entre 0,40 e 0,82 ind/ha. Foram identificadas 22 espécies arbóreas de 9 famílias como fontes de exsudato, das quais se destacam: *Qualea grandiflora* (Vochysiaceae), *Vochysia thyrsoidea* (Vochysiaceae), *Schefflera*

macrocarpum (Araliaceae) e *Qualea parviflora* (Vochysiaceae). A dieta foi complementada por frutos de 14 espécies, néctar, mel, artrópodos (principalmente ortópteros) e ovos de aves. A principal espécie usada como árvore de pouso foi *Emmotum nitens* (Icacinaceae). Comparando com os dados desta espécie de primata em matas ciliares, não houve diferença quanto ao tamanho de grupo, já as áreas domiciliares foram maiores e as densidades, menores que as de matas ciliares.

Palavras-chave: ecologia, cerrado, mico-estrela, Primatas, calitriquídeos.

INTRODUCTION

Marmosets of the genus *Callithrix* can be classified as mobile ectoparasites of exudate-producing trees, due to their feeding behaviour and way of obtaining exudates (Lacher Jr. *et al.*, 1984). Exudate-producing trees are usually moderately affected by marmosets, such that the negative effects of injuries are minimized (Rizzini & Coimbra-Filho, 1981).

There are three aspects usually attributed to this genus: (1) the use of edge formations and disturbed or secondary forests; (2) exudate eating when there is fruit shortages; and (3) prey foraging methods (arthropods, molluscs and small vertebrates) (Rylands & Faria, 1993).

The black-pincelled marmoset (*C. penicillata*) inhabits mature gallery forests of the Brazilian Central Plateau, with a distribution ranging from the states of Maranhão and southwest Piauí to the north of São Paulo, including most of Bahia, Minas Gerais and Goiás (Rylands *et al.*, 1993). Their occurrence in the Distrito Federal is conspicuous (Lacher *et al.*, 1981, 1984; Fonseca & Lacher, 1984; Faria, 1984, 1986, 1989; Queiroz, 1991; Cavalcante, 1993; Miranda, 1997). These primates live in family groups of about ten individuals, basically composed of a reproductive couple and their offspring (Faria, 1986). *C. penicillata* is among the most exudativores of genus *Callithrix* (more than 70% of their diet), with little participation of fruits and insects in their diet (Rylands & Faria, 1993). *C. jacchus* and *C. penicillata* are capable of living in the most unfavourable and seasonal habitats. Being considered by Stevenson & Rylands (1988) the two most ecologically successful species, taking into account the large geographic distribution, high population densities and their efficient habitat exploration.

Gallery forests are the typical habitat of the *C. penicillata*, maybe due to the central position occupied by the streams in these environments. However, Fonseca & Lacher (1984) observed individuals of this species living in a *cerradão*; environment with a more opened canopy than of gallery

forests; to almost two kilometer from the closest stream. Apparently, they were successful colonists, because of their ability to stimulate exudate production and to feed from these products, even far from the water stream.

MATERIAL AND METHODS

The study was conducted in the *cerradão* and the dense *cerrado* patches of the APA (Area of Environmental Protection) of the Gama/Cabeça-de-Veado, situated south of Brasília, with an altitude average of 1,100 m. In these areas the *cerrado stricto sensu* predominates, although *scrub grassland* (campo sujo) and *open grassland* (campo limpo) also occur (Fig. 1).

Observations were made during March and December 1996, including: (1) a rainy season (end); (2) a dry season and (3) a rainy season (beginning).

Three areas were weekly sampled during two month periods, totaling nine observation days for each area per season. Observations were held during most of the daylight period, beginning between 6:00 and 7:00, with breaks at 11:30, restarting at 14:00 and ending between 16:00 and 19:00; 436.15 hours of observation in direct visual contact with the marmosets were obtained, indicating an average output of above 50% of time spent during the field observations.

Instantaneous scan records (Altmann, 1974) were made at 15 minutes, being recorded for each visible member of the group:

- horizontal position (based on a 50 m² reference system);
- vertical position, estimated for three height levels (**high**, more than 5 m; **middle**, 2 to 5 m; and **low**, less than 2 m);
- behaviour according to pre-defined categories, part of another paper.

Data were grouped and analysed by month and season. The total amounts and rates obtained for each class were compared for each season and

area studied. At each of the three study sites, the number of quadrats visited were counted monthly in order to estimate the home-range of the studied social groups. An estimated density of the marmosets was calculated in agreement with the square method, by dividing the number of individuals for

each group by the size of the area used (National Research Council, 1981).

The density of each group was calculated by the rate between the average size of the group in the three observation period and the total area used.

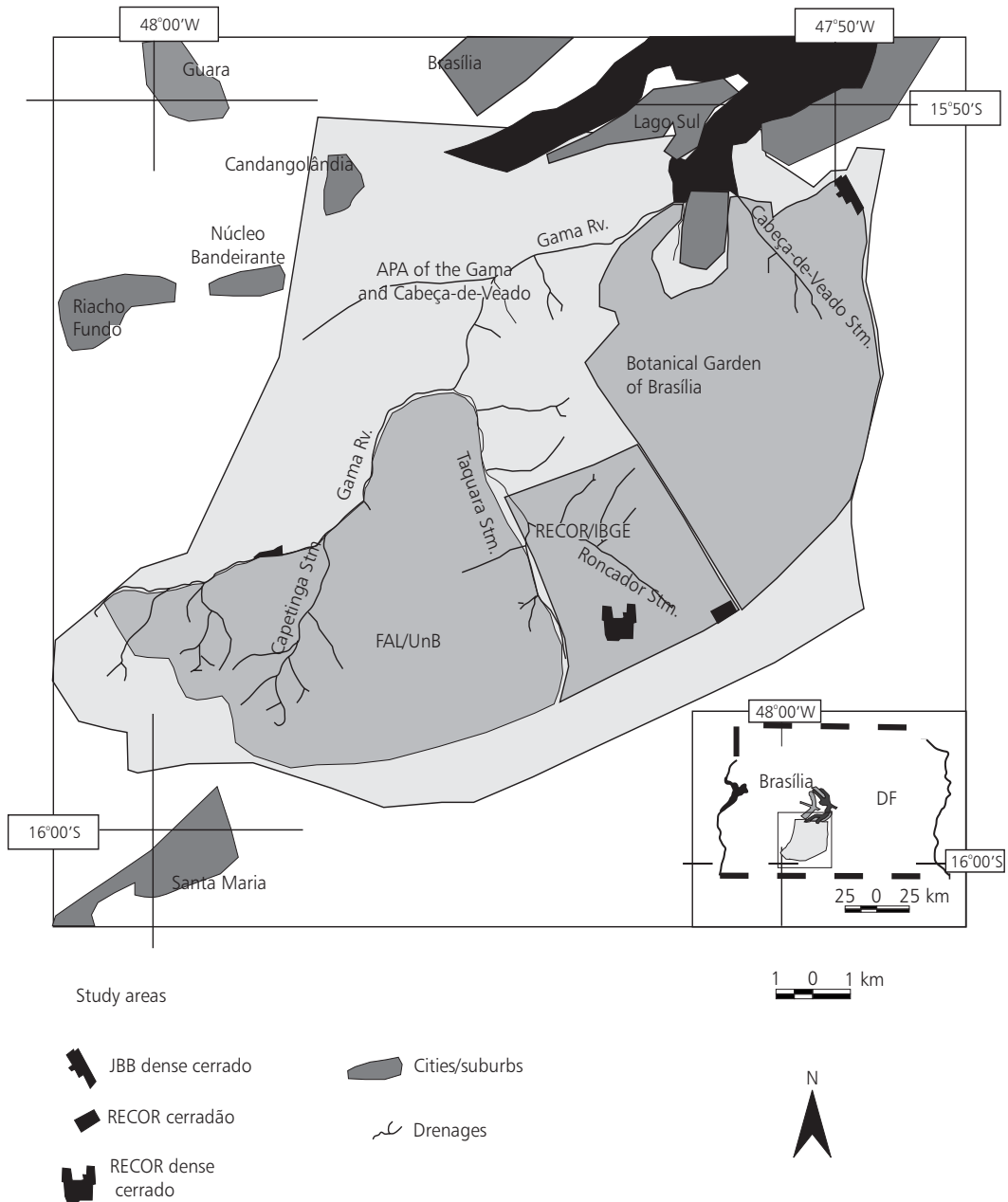


Fig. 1 — Location of study areas in the APA of the Gama and Cabeça-de-Veado.

RESULTS AND CONCLUSIONS

Groups size and composition

The Group A (*cerradão* patch of RECOR), in March to August, was composed by four individuals (an adult reproductive couple, a subadult male and a juvenile). In September, two newborn twin brothers were registered, increasing the to six members (average 4.67). The largest group studied, Group C (dense *cerrado* of JBB), varied between nine to eleven members (average 9.83). Group B (dense *cerrado* of RECOR) was initially composed of eight individuals (average 7.33), however the variation in the components along the six month observation period indicates the possibility that some individuals rested for hours or days isolated from the others. Twins were born in this group in first days of September and the number of members returned to eight (Table 1).

Home range and population density

The Group A used almost all the *cerradão* patch, totalizing 8.25 ha, which corresponds to a local density of 0.57 ind/ha. This area is the least affected by human presence, in spite of being surrounded for roads and be frequently visited by researchers. The local vegetation is somewhat altered because of fires.

The presence of the Group B was recorded in 18 ha of dense *cerrado* and inferred in 0.5 ha. The *cerrado* patch, with variable vegetation densities extends over more than 100 ha, however the quadrat grid system covered only 39.25 ha. The density calculated for Group B was the lowest (0.40 ind/ha). Only once was another marmoset social group

sighted in this area. This group demanded a larger area to satisfy its ecological needs, in spite of the existence of factors that could possibly improve the local occurrence of this species, including: different species of exotic vegetation supplying shelter and food; more effective protection against fires, due to the proximity with of the reserve's headquarters and food remains/scraps.

At the dense *cerrado* of the Botanical Garden of Brasília (JBB), the Group C occupied 12 ha. Their home-range overlapped more with neighbouring groups, since intergroupal meeting at six points were observed.

The larger population density of Group C, in comparison to the others groups, can be consequence of a larger group size, local floristic composition or proximity with a dry mesophitic forest and orchards of neighbouring residences (food sources): recent urbanization expansion occurring with the development of various suburbs around of the JBB may result habitat lost and anthropogenic action, which in turn could pressure primate populations to seek refuge in the JBB, increasing population density in this area.

When comparing records from the end of the rainy period with records from the beginning, similarities among the data of the three groups indicate a possible influence of the season in habitat use. During these two periods, Group B occupied a larger area than the other two groups, even when employing an estimate for the area use per hour of observation in order to correct possible distortions resulting from differences in visibility of the groups during different periods and between each other (Table 2).

TABLE 1
Size and composition of the *C. penicillata* groups during three study periods.

Groups	Seasons	Adults	Subadults	Young	Child	Total
A	rainy 1	2	0	1	1	4
	dry	2	1	1	0	4
	rainy 2*	3	0	1	2	6
B	rainy 1	6-5	0	1	1	8-7
	Dry	4-5	1	1	0	6-7
	rainy 2*	4	1	1	2	8
C	rainy 1*	5	2	2	2-1	11-10
	dry	5	2	3	0	10
	rainy 2	6	2	1	0	9

* Offspring birth.

TABLE 2
Areas used and area rates for observation times of the three *C. penicillata* groups at the three study periods in the APA of Gama/Cabeça-de-Veado.

Period	A Group		B Group		C Group	
	Area (ha)	Rate (ha/h)	Area (ha)	Rate (ha/h)	Area (ha)	Rate (ha/h)
Rainy season 1	5.0	0.16	11.0	0.23	6.25	0.17
Dry season	4.5	0.10	7.25	0.21	10.25	0.19
Rainy season 2	7.0	0.19	10.75	0.27	4.75	0.20
Total	8.25	0.07	18.5	0.15	12.0	0.10

The values for the home range of *C. penicillata* in this study were higher than those for the same species in gallery forest (3.5 ha, Faria, 1989) and for *C. jacchus* (0.72-1.62 ha, Stevenson, 1978; 4.98 ha, Alonso & Langguth, 1989). The *cerradão*/dense *cerrado* patches have less resources available for the marmosets, and these animals are more dispersed, which could justify the larger size of their home ranges. It's possible that resources availability could be a determinant factor for home range dimensions.

Density in the three areas for this study (0.57, 0.39 and 0.83 ind/ha) was intermediately ranged, compared to others obtained for this species (between 0.03 and 3.89 ind/ha). This large variation in the density may reflect more differences in habitat quality, due to anthropogenic pressures, than differences in group size.

Groups A and B used smaller areas during the dry season, which were increased in the rainy season. The opposite occurred with the Group C, which can be due to stronger intergroupal competition, more fruit offer in the second rainy season, and by water availability to the group near the entrance gate of JBB during the dry season. Smaller home ranges, associated with low densities of marmosets, could result a tendency to occur less intergroupal meeting and maybe, less locomotion, specially during the dry season. This could constitute as an adaptation to save energy and water.

Feeding

Twenty two arboreal species from nine families were found (Table 3) to have holes and/or were observed direct sightings of exudate consumption by *C. penicillata*. The only other research in *cerradão* (Fonseca & Lacher, 1984) registered seven species of three families. Fourteen species had fruits which

were ingested by *C. penicillata* (Table 4). Other food items consumed include nectar of *Mabea fistulifera* and *Cecropia* sp., bulbs of *Cyrtopodium* sp., honey, exotic fruits (banana, apple), invertebrates (grasshoppers, butterflies, moth, caterpillars, pupes, mantoids, spiders) and bird eggs.

Spacial movements

The group moved frequently by relatively oriented movements, repeatedly using certain sites with greater concentration of food resources and/or sleeping-trees, according to the pattern described by Faria (1989).

The middle vegetation layer was the most used, varying between 40% and 60% of the total use (Figs. 2a, b and c). On certain occasions, contrary to a single file formation, individuals moved dispersely or in small groups of two to three members moving in parallel, grouped or in a row, at different heights. Faria (1989) states that in order to forage, the group maintains a weak contact, but with visual and/or vocal contact, being able to "join forces" in different ways for resource exploration.

The most similar pattern among the three groups as shown in Fig. 2, is the frequent use of lower vegetation layer, which increased during the dry season and decreased with the beginning rainy periods, at the year end. This phenomenon can be associated to an increase in insect foraging, taken place mainly at ground level, during the dry season, resulting of the food scarcity. Fruit offer can explain the increased frequency in occupation of the high and middle vegetation layers during the rainy season.

Sleeping trees

In the *cerrado*, the range of tree species used by *C. penicillata* as nocturnal resting places includes:

Emmotum nitens, *Vochysia thyrsoidea*, *Inga* sp., *Mabea fistulifera*, *Dalbergia violacea* and *Styrax ferrugineus*, suggesting that the arboreal species is not the most important factor. Features like large size, large top, intense branching, abundant foliage and

localization near certain food resources (exudate and fruit trees) may influence sleep-tree choice by marmoset.

However, in the *cerradão*, the use of *E. nitens* as resting/sleeping tree prevailed.

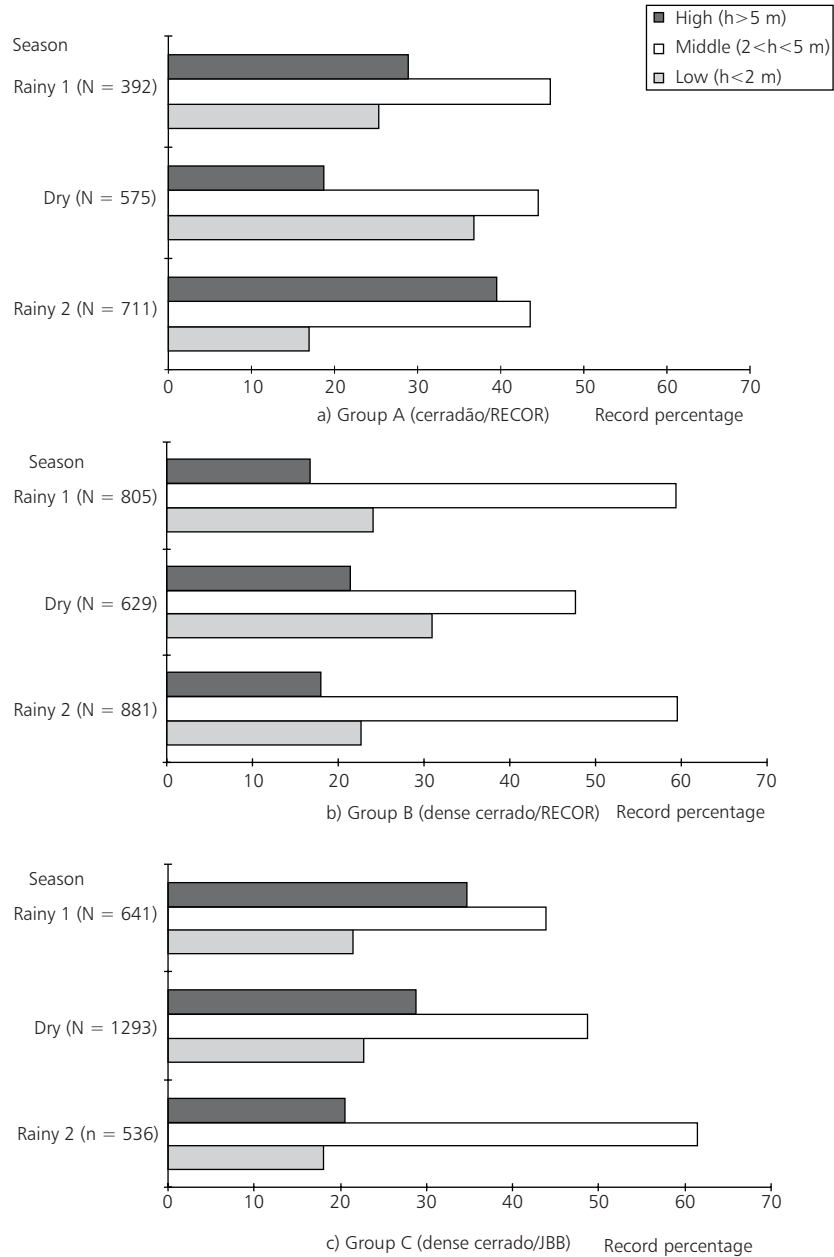


Fig. 2 — Vertical distribution percentages of the *C. penicillata* groups observed in the three study areas, at the different seasonal periods (rainy 1, dry and rainy 2 seasons).

TABLE 3
Arboreal species found with holes produced by *C. penicillata*.

Species	Family	Dense cerrado/ RECOR		Dense cerrado/ JBB		Cerradão/ RECOR		Total N
		N	%	N	%	N	%	
<i>Qualea grandiflora</i> *	Vochysiaceae	54	31.4	46	39.3	14	12.0	114
<i>Vochysia thyrsoidea</i> *	Vochysiaceae	12	7.0	15	12.8	57	48.7	84
<i>Schefflera macrocarpum</i> *	Araliaceae	32	18.6	18	15.4	26	22.2	76
<i>Qualea parviflora</i> *	Vochysiaceae	21	12.2	14	12.0	12	10.3	47
<i>Qualea multiflora</i>	Vochysiaceae	16	9.3	19	16.2			35
<i>Sclerobium paniculatum</i>	Leguminosae	11	6.4					11
<i>Enterolobium ellipticum</i>	Leguminosae	5	2.9					5
<i>Hymenaea stigonocarpa</i>	Leguminosae	4	2.3					4
<i>Caryocar brasiliense</i>	Caryocaraceae	4	2.3					4
<i>Styrax ferrugineus</i> *	Styracaceae	1	0.6	2	1.7	1	0.9	4
<i>Inga</i> sp.	Leguminosae	3	1.7					3
<i>Vochysia elliptica</i>	Vochysiaceae	2	1.2			1	0.9	3
<i>Blepharocalyx salicifolius</i>	Myrtaceae	1	0.6			1	0.9	2
<i>Acosmium dasycarpum</i>	Leguminosae	2	1.2					2
<i>Chamaecrista</i> sp.	Leguminosae	2	1.2					2
<i>Emmotum nitens</i>	Icacinaceae					2	1.7	2
not identified	Leguminosae			2	1.7			2
<i>Vochysia rufa</i>	Vochysiaceae	1	0.6			1	0.9	2
<i>Anadenanthera</i> sp.	Leguminosae			1	0.9			1
<i>Eriotheca pubescens</i>	Bombacaceae					1	0.9	1
<i>Vochysia pyramidalis</i>	Vochysiaceae					1	0.9	1
<i>Kielmeyera coriacea</i>	Guttiferae	1	0.6					1
Total		172	100.0	117	100.0	117	100.0	406

* Species listed also by Fonseca & Lacher (1984).

TABLE 4
Plants species which fruits are used as feed by *C. penicillata*, at each study area.

Season	Dense cerrado/JBB	Dense cerrado/RECOR	Cerradão/RECOR
Rainy 1	<i>Duguetia furfuracea</i>	<i>Syzygium jambolana</i> ☼ <i>Passiflora</i> sp.	
Dry	<i>Tapura amazonica</i>	<i>Schefflera macrocarpum</i> †	<i>Schefflera macrocarpum</i> †
Rainy 2	<i>Brosimum gaudichaudii</i> † <i>Duguetia furfuracea</i> <i>Guapira graciliflora</i> <i>Miconia albicans</i> † <i>Miconia ferruginata</i> † <i>Miconia</i> sp. † <i>Simarouba versicolor</i> <i>Siphoneugena densiflora</i>	<i>Brosimum gaudichaudii</i> † <i>Inga</i> sp. <i>Miconia ferruginata</i> † <i>Miconia</i> sp. †	<i>Alibertia</i> sp. <i>Blepharocalyx salicifolius</i> <i>Brosimum gaudichaudii</i> † <i>Miconia albicans</i> † <i>Miconia ferruginata</i> †

☼ Exotic species;

† Species with record fruits consumed in two or in the three study areas.

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REFERENCES

- ALONSO, C. & LANGGUTH, A., 1989, Ecologia e comportamento de *Callithrix jacchus* (Primates: Callitrichidae) numa ilha de floresta atlântica. *Rev. Nordestina Biol.*, 6(2): 105-137.
- ALTMANN, J., 1974, Observational study of behavior: sampling methods. *Behaviour*, 49: 226-267.
- CAVALCANTE, R. J., 1993, *Inventário e censo da comunidade de primatas da mata de galeria do Córrego da Onça*, DF. Dissertation for acquisition of Forest Engineer graduation, not-published. UnB, Brasília, 23p.
- FARIA, D. S., 1984, Uso de árvores gomíferas do cerrado por *Callithrix jacchus penicillata*. In: M. T. de Mello (ed.), *A Primatologia no Brasil*. Sociedade Brasileira de Primatologia, Brasília, pp. 83-96.
- FARIA, D. S., 1986, Tamanho, composição de um grupo social e a área de vivência (home-range) do sagüi *Callithrix jacchus penicillata* na mata ciliar do córrego Capetinga, Brasília, DF. In: M. T. de Mello (ed.), *A primatologia no Brasil - 2*. Sociedade Brasileira de Primatologia, Brasília, pp. 87-105.
- FARIA, D. S., 1989, *O grupo social em Callithrix penicillata, o mico-estrela do Planalto Central brasileiro: estudo realizado na floresta de galeria do Córrego Capetinga, Brasília, DF*. Doctoral Thesis, not-published, Departamento de Psicologia Experimental, USP, São Paulo, 150+215p.
- FONSECA, G. A. B. & LACHER JR., T. E., 1984, Exudate-feeding by *Callithrix jacchus penicillata* in semideciduous woodland (*cerradão*) in Central Brazil. *Primates*, 25(4): 441-450.
- LACHER JR., T. E., FONSECA, G. A. B., ALVES JR., C. & MAGALHÃES-CASTRO, B., 1981, Exudate-eating, scent-marking and territoriality in wild populations of marmosets. *Anim. Behav.*, 29: 306-307.
- LACHER JR., T. E., FONSECA, G. A. B., ALVES JR., C. & MAGALHÃES-CASTRO, B., 1984, Parasitism of trees by marmosets in a Central Brazilian gallery forest. *Biotropica*, 16: 202-209.
- MIRANDA, G. H. B. de, 1997, Observações preliminares sobre o padrão de atividade do mico-estrela (*Callithrix penicillata*) no cerrado denso e *cerradão* da Reserva Ecológica do IBGE, Brasília, DF. In: L. L. Leite & C. H. Saito (eds.), *Contribuição ao conhecimento ecológico do Cerrado*. Universidade de Brasília, Departamento de Ecologia, pp. 241-245.
- NATIONAL RESEARCH COUNCIL, 1981, *Techniques for the study of primate population ecology*. National Academy Press, Washington, 232p.
- QUEIROZ, H. L., 1991, Levantamento das populações de três espécies de primatas na Fazenda Sucupira, Brasília, DF. In: A. B. Rylands & A. T. Bernardes (eds.), *A primatologia no Brasil - 3*. Fundação Biodiversitas/Sociedade Brasileira de Primatologia, Belo Horizonte, pp. 369-374.
- RIZZINI, C. T. & COIMBRA-FILHO, A. F., 1981, Lesões produzidas pelo sagüi, *Callithrix p. penicillata* (E. Geoffroy, 1812), em árvores do cerrado (Callitrichidae, primates). *Rev. Brasil. Biol.*, 41(3): 579-583.
- RYLANDS, A. B. & FARIA, D. S., 1993, Habitats, feeding ecology, and home range size in the genus *Callithrix*. In: A. B. Rylands (ed.), *Marmosets and tamarins: systematics, behaviour, and ecology*. Oxford Science Publications, Oxford, pp. 262-272.
- RYLANDS, A. B., COIMBRA-FILHO, A. F. & MITTERMEIER, R. A., 1993, Systematics, geographic distribution, and some notes on the conservation status of the Callitrichidae. In: A. B. Rylands (ed.), *Marmosets and tamarins: systematics, behaviour, and ecology*. Oxford University Press, Oxford, pp. 11-77.
- STEVENSON, M. F., 1978, The behavior and ecology of the common marmoset (*Callithrix jacchus*). In: H. Rothe, H. J. Wolters & J. P. Hearn (eds.), *Biology and behaviour of marmosets*. Gottingen, Eingenvverlag, pp. 298.
- STEVENSON, M. F. & RYLANDS, A. B., 1988, The marmosets, genus *Callithrix*. In: R. A. Mittermeier, A. B. Rylands, A. F. Coimbra-Filho & G. A. B. Fonseca (eds.), *Ecology and behavior of Neotropical primates, 2nd vol.* W.W.F., Washington, pp. 131-222.