Sleeping sites of woolly mouse opossum *Micoureus demerarae* (Thomas) (Didelphimorphia, Didelphidae) in the Atlantic Forest of south-eastern Brazil

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ABSTRACT. *Micoureus demerarae* (Thomas, 1905) is a medium-sized marsupial, around 130 g, with a nocturnal habit and insectivorous-omnivorous diet. From August 2001 to July 2002, seven individuals, three males and four females, were monitored with radio-telemetry in Reserva Biológica União, state of Rio de Janeiro, Brazil, aiming to investigate and describe the sleeping sites used by this marsupial. Fifty eight sleeping sites were located, most of which (70,7%) in palm trees *Astrocaryum aculeatissimum* (Schott) Burret, and the remaining in other tree species (29,3%), a significant difference (χ^2 test; $p < 0.005$). The preference for this palm tree was not different between sexes (χ^2 test; $p = 0.920$). It was possible to locate the exact place where the animal was hiding in 31 sleeping sites (53.4% of total) in palm trees the animals were always in the junction point of petioles and tree trunks, at an average height of 4.66 ± 1.36 m, while in the remaining tree species, seven individuals were in liana tangles and two in tree holes, at an average height of 10.67 ± 2.75 m. This height difference was significant (Mann Whitney test; $p < 0.001$). Results indicate that palm trees are important resources for *M. demerarae*. The observed preference for *A. aculeatissimum* is probably due to higher protection against predators made by the numerous spines of this palm tree species.
KEY WORDS. *Astrocaryum aculeatissimum*, radio-telemetry.

RESUMO. **Sítios de dormida da cuíca *Micoureus demerarae* (Thomas) (Didelphimorphia, Didelphidaa) na Floresta Atlântica do sudeste do Brasil.** *Micoureus demerarae* (Thomas, 1905) é um marsupial de tamanho médio, cerca de 130 g, de hábito noturno e arborícola e dieta insetívora-onívora. No período de agosto de 2001 a julho de 2002, sete indivíduos, três machos e quatro fêmeas, foram acompanhados, através de rádio-telemetria, na Reserva Biológica União, Rio de Janeiro, com o objetivo de investigar e descrever os abrigos utilizados por essa espécie de marsupial. Foram localizados 58 abrigos, a maioria dos quais (70,7%) em palmeiras Iri *Astrocaryum aculeatissimum* (Schott) Burret e o restante em outras espécies de árvores (29,3%), uma diferença significativa (teste χ^2; $p < 0,005$). Esta preferência por palmeiras não foi significativamente diferente entre os sexos (teste χ^2; $p = 0,920$). Em 31 abrigos (53,4% do total) o local exato onde o animal se encontrava pode ser localizado: nas palmeiras os animais sempre estavam alojados no local de inserção dos pecíolos junto ao tronco e a uma altura média de 4,66 ± 1,36 m, enquanto nas demais espécies de árvores, sete animais estavam em emaranhados de cipós e dois em ocos, a uma altura média de 10,67 ± 2,75 m. Esta diferença de altura entre abrigos em iris e não iris foi significativa (teste Mann Whitney; $p < 0,001$). Os resultados indicam que as palmeiras iris são um importante recurso para *M. demerarae*. A preferência por *A. aculeatissimum* se deve provavelmente à maior proteção contra predadores exercida pelos numerosos espinhos presentes nesta espécie.
PALAVRAS CHAVE. Abrigo, *Astrocaryum aculeatissimum*, rádio-telemetria.

The sleeping or resting site is defined as whatever location the animal spends the night (or day) in a physiological state of rest (Day & Elwood 1999). These locations are selected to offer protection against the elements (Aquino & Encarnación 1986) and predators (Hamilton 1982). Locating the sleeping places and refuges of small mammals in an area of forest, using only active searching, is almost impossible. The methods which obtain the best results are 'spool-and-line' (Miles *et al*. 1981, Wooley 1989, Briani *et al*. 2001) and radio-telemetry (Stallings *et al*. 1994, Sunquist *et al*. 1987). Miles *et al*. (1981), using the

'spool-and-line' method successfully located various nests of different mammal species in four study areas in Brazil. In the radio-telemetry research conducted by Stallings *et al*. (1994) with *Kannabateomys amblyonyx* (Wagner, 1845) in an Atlantic Forest area, the authors located various refuges of this species.

Micoureus demerarae occurs in South America, from northern Colombia to northern Argentina (Emmons & Feer 1997). This marsupial has nocturnal habits and can weigh more than 130g. *Micoureus demerarae* is characterized by high mobility, with a predominantly tree-dwelling habit (Charles-Dominique *et al*. 1981, Miles *et al*. 1981, Stallings 1988, Fonseca & Kierulff 1989, Passamani 1995, Pires & Fernandez 1999) and an insectivorous-omnivorous diet (Leite *et al*. 1994; Carvalho *et al*. 1999). There is no published information focusing on resting sites of *M. demerarae*. The aim of the present study is, therefore, to describe the types and respective frequencies of the resting sites used by this species, contributing for a better understanding of its natural history.

MATERIAL AND METHODS

The study was carried out in União Biological Reserve (UBR), a 2,400 ha federal reserve administered by the Brazilian Environmental Agency (IBAMA) and located on the borders of Casimiro de Abreu and Rio das Ostras municipalities, in north Rio de Janeiro state, south-eastern Brazil (22°27'36"S, 42°02'15"W). The main vegetation type is dense ombrophilous forest (Ibge 1993). During the study period, annual rainfall was 1,138 mm, with temperatures averaging 24.5ºC. The dry season occurs from April to September, and the wet season from October to March (Lapenta *et al*. 2003).

The work was carried out during the study of Moraes Jr. & Chiarello (2005). Traps baited with pieces of banana and cotton soaked in cod liver oil (Scott Emulsion) were used to capture the animals. The traps were located in the sub-canopy (1 to 2 m high) and on platforms on tree-tops, following Stallings (1988) and Malcolm (1991), with a total capture effort of 1,440 traps-nights. The traps were closed during the radio-telemetry monitoring time to avoid disturbing movements of the animals.

The captured animals were given radio collars manufactured by Wildlife Materials Inc. model SOM-2190. Each individual was followed using radio telemetry for four nights (1800-0600 h) each month. A "Telonics" receptor, model TR-2 (frequency 164-165 MHz), a three-element "Yagi" antenna, and ear-phones were used. The sleeping sites were located using triangulation and progressive approximation to the source of signals ("homing-in"; Kenward 2001). When sleeping sites were encountered, the geographic coordinates, the type of sleeping site (tangles of lianas, hollows in trees, etc) and its height above the ground were recorded. When possible, the exact location of the animal within the sleeping sites was determined and recorded.

RESULTS AND DISCUSSION

Fifty eight sleeping sites of seven radio-collared individuals were found. The number of sleeping sites located varied among animals. This variation occurred because one animal probably managed to remove its radio collar (individual MD-4F), two individuals were predated (individuals MD-0M and MD-2F) and three radio collars did not work perfectly. The individual with the largest number of located sleeping sites was MD-1F, who was monitored for the longest period (four months) (Tab. I).

Table I. Number and type of sleeping sites used by each individual in the União Biological Reserve, Rio de Janeiro.

Individuals	Sleeping sites in palm trees	Sleeping sites in other trees	Total
MD-0M	1	3	4
MD-3M	6	3	9
MD-5M	10	2	12
Total males	17 (68.0%)	8 (32.0%)	25
MD-1F	15	2	17
MD-2F	1	2	3
MD-4F	3	2	5
MD-6F	5	3	8
Total females	24 (72.7%)	9 (27.3%)	33
Total	41 (70.7%)	17 (29.3%)	58

From the total of 58 sleeping sites, 70.7% (n = 41) were located in palms known locally as 'iri' or 'brejaúba', *Astrocaryum aculeatissimum* (Schott) Burret (Fig. 1), while the remaining 29.3% (n = 17) were found in non-palm trees (of several species), a significant difference (χ^2 with Yates correction = 9.121; df = 1; $p < 0.005$). None were found on the ground. Of the 25 sleeping sites used by males, 68% were in palms and 32% in other tree species. Of the 33 sleeping sites used by females, 72.7% were in palms and 27.3% in other trees (Tab. I). These differences between males and females were not significant (χ^2 with Yates correction = 0.010; df = 1; p = 0.920). *Micoureus demerarae* used palm trees with higher frequency than non-palm trees as resting sites (χ^2 with Yates correction = 9.121; df = 1; $p < 0.005$), and this preference was held constant between the two seasons (χ^2 with Yates correction = 1.981; df = 1; p = 0.159) (Tab. II).

In only 31 sleeping sites (53.4% of the total) the exact location of the nest in the tree or tree palm could be determined with certainty. In 100% of these occasions the animals did not change position within the sleeping sites during the diurnal period. Of these 31 nests, 22 were located in palm trees (iri palms), always in the insertion point of petioles in the tree trunk. This part of the palm tree normally accumulates a great amount of dry leaves of other tree species, forming a sort of

Figure 1. The 'iri' palm (*Astrocaryum aculeatissimum*) used as a frequent sleeping site by *Micoureus demerarae* in the União Biological Reserve, Rio de Janeiro. The arrow indicates the exact position of an observed sleeping site.

Table II. Number of sleeping sites observed and expected (in brackets) in the União Biological Reserve, in relation to location (palms and trees) and seasons of the year (dry and wet).

Local of sleeping site	Dry season	Wet season
Palm trees	12 (14.80)	29 (26.2)
Other trees	9 (6.16)	8 (10.8)
Total	21	37

natural nest (Fig. 1). The average height of sleeping sites located in palm trees (n = 22; average = 4.66 ± 1.36 m) was significantly lower than that of sleeping sites located on non-palm trees (n = 9; 10.67 ± 2.75 m)(Mann-Whitney test; U = 4.5; W = 257.5; $p < 0.001$).

Several animals used the same sleeping sites more than once. The male MD-5M was the individual who used the same sleeping sites most often, sleeping in the same palm tree five times and in another one four times. The individual with the longest monitoring period (MD-1F) used the same sleeping site three times during the month in which she was recaptured for radio-collar replacement. Handling of this female allowed us to ascertain that she was lactating.

It was reported in a previous paper (Moraes Jr. & Chiarello 2005) that sleeping sites of *M. demerarae* are located inside or close to the areas most intensely used by these animals, suggesting that they concentrate their activities close to their sleeping sites. This study is the first record of *M. demerarae* using o *A. aculeatissimum* as a sleeping site. Interestingly, the sleeping sites in this palm tree were always located in the insertion point of petioles in the tree trunk. This is a sheltered place, so perhaps it allows better protection against sunlight for the strictly nocturnal *M. demerarae* (Emmons & Feer 1997). More importantly, this palm tree has many spines on its trunk and leaves (Fig. 1) a physical barrier that certainly offer protection against predators. This reasoning is corroborated by the finding that resting places in palm trees were located at significantly lower heights above the ground when compared to nests located in non-palm trees. We also believe, however, that this particular location (the insertion point of petioles) may additionally serve as potential sources of food, as many invertebrates can hide there, as observed by Wooley (1989) in New Guinea.

In the study of *Didelphis marsupialis* Linnaeus, 1758 by Sunquist *et al*. (1987), the authors did not find a significant difference between the types of resting places used by males and females, but observed that males change their sleeping sites more frequently than females. They also observed a significant difference in the type of resting site used between seasons for all monitored individuals, unlike the observed in present study. In the wet season, for example, the sleeping sites of *D. marsupialis* were located most frequently on the ground, and in trees during the dry season (Sunquist *et al*. 1987). As *D. marsupialis* has a scansorial habit (Emmons & Feer 1997) it can use a larger variety of sleeping sites. On the other hand, no nest was found on the ground in the present study, which indicates the predominantly arboreal habit of *M. demerarae* (Passamani 1995, Pires & Fernandez 1999).

In the study by Miles *et al*. (1981) the authors located three sleeping sites of *Marmosa cinerea* Temminck, 1824 (= *Micoureus demerarae*), of eight individuals followed using the 'spool and line' technique. The animals were found in tree hollows and palms, always far from the ground, corroborating the results of the present study. However, these authors did not manage to verify the frequency with which the animals used these sleeping places. The repeated use of sleeping sites observed in some animals is important, and could be understood as a strategy to stay close to food sources, better efficiency against predators, territorial defence or care for offspring.

Stallings *et al*. (1994) observed, for example, that the bamboo rat *Kannabateomys amblyonyx* used one or two sleeping sites more than 50% of the time, arguing that this might be related to territorial protection. As the females of *M. demerarae* are territorial (Pires *et al*. 1999), the location and frequency of use of their sleeping sites could also be important factors in territorial defence against neighbouring females. For males, however, the location of nests could be influenced by the location of food resources in the environment and perhaps by the location of female sleeping sites during the reproductive season.

The fact that *M. demerarae* makes intensive use of the 'iri' palm (*Astrocaryum aculeatissimum*), which has a large geographic distribution, from the state of Bahia to Santa Catarina, occurring in evergreen costal forests and in open areas (Lorenzi *et al*. 1996), suggests that this palm species could be an important resource for *M. demerarae*. Unfortunately we have no information about the density of this palm in the study area. Data from another site located further north (Espirito Santo state) with a similar forest type (lowland moist forest) indicates, however, that *A. aculeatissimum* occurs at density of 2 individuals/0.1 ha (> 10 cm at breast height; Peixoto & Gentry 1990). If extrapolated to a larger sampling plot, this figure would generate an approximate density of 20 palms/ha, that might be considered as intermediate density when compared to other Atlantic forest tree species (Peixoto & Gentry 1990, Sanchez *et al*. 1999). Other studies carried out in the Atlantic Forest demonstrate that Arecaceae (= Palmae) is generally among the most important family in terms of number of individuals (Sanchez *et al*. 1999). Moreover, these authors consider *A. aculeatissimum* as a species of early secondary succession, that is, those species that establish soon after forest disturbance (Sanchez *et al*. 1999). Considering these information we speculate that *M. demerarae* is using an resource that is probably not rare in the forest, particularly those forest fragments highly impacted by edge effects or other anthropogenic disturbances such as fire and selective logging.

We sometimes tend to overestimate the importance of food sources for the survival of individuals in a particular forest site, not considering that other types of resources such as shelters or sleeping sites might be equally important. In this sense, given the intense fragmentation of the Atlantic forest, perhaps the presence *A. aculeatissimum* constitute an important factor for the successful establishment of dispersing individuals into new areas (or fragments), or for maintenance of metapopulations in a matrix of degraded forest fragments (Brito & Fernandez 2000). Of course, the factors influencing the choice and use of sleeping sites are complex and varied and therefore a larger number of animals should be monitored in other sites of the Atlantic forest to proper test these hypothesis.

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