SMALL MAMMALS OF CHAPADA DOS VEADEIROS NATIONAL PARK (CERRADO OF CENTRAL BRAZIL): ECOLOGIC, KARYOLOGIC, AND TAXONOMIC CONSIDERATIONS

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ABSTRACT

This work is based on a survey of small mammals carried out in the Chapada dos Veadeiros National Park, a natural reserve located in the mountains of the Planalto Central Goiano in the Cerrado of Central Brazil. The 227 specimens collected represented six marsupial and 13 rodent species. Taxonomic, karyologic, and ecologic considerations are present and discussed in the present work. Our data reflected the faunal heterogeneity with respect to both elevation and vegetation because only eight of the 19 species were collected at both high and low elevations. The composition of the small mammal fauna of the park is influenced by predominance of forest formations at low elevations and cerrado with rupestrian areas at high elevations. Presence of endemic species and one undescribed demonstrated that the cerrado has an endemic fauna and a little known diversity of small mammals.

Key words: Brazil, cerrado, karyotype, marsupials, small rodents, taxonomy.

RESUMO

Pequenos mamíferos do Parque Nacional da Chapada dos Veadeiros (Cerrado do Brasil Central): considerações ecológicas, cariológicas e taxonômicas

Este trabalho é baseado em um levantamento sobre pequenos mamíferos realizado no Parque Nacional da Chapada dos Veadeiros, localizado nas montanhas do Planalto Central Goiano, no Cerrado do Brasil Central. Foram coletadas 227 espécimes, representando 6 espécies de marsupiais e 13 de roedores. Considerações taxonômicas, cariológicas e ecológicas são apresentadas e discutidas. Nossos dados refletem a heterogeneidade da fauna em relação à altitude e à vegetação do Cerrado, sendo apenas 8 das 19 espécies coletadas comuns às altitudes elevadas e baixas. A composição da fauna de pequenos mamíferos do parque está influenciada pela predominância de formações florestais nas altitudes baixas e de cerrado rupestre nas altitudes elevadas. A presença de espécies endêmicas e uma ainda não descrita demonstram que o Cerrado apresenta uma fauna endêmica associada, sendo pouco entendida a diversidade de seus pequenos mamíferos.

Palavras-chave: Brasil, Cerrado, cariótipo, marsupiais, pequenos mamíferos, taxonomia.

INTRODUCTION

The cerrado is the most extensive open-vegetation biome of South America and one of the largest savanna-forest complexes in the world. With a core area spanning over 1.8-2 million km^2 on the Brazilian plateau, the cerrado is located in the middle portion of an open-vegetation belt between the Argentinean-Paraguayan Chaco and the caatinga of northeastern Brazil.

This open-vegetation belt separates two major mesophytic biomes, the Atlantic rainforest and the Amazonian rainforest. Enclaves of typical cerrado physiognomy occur within other biomes. At its core area, the cerrado is characterized by an often well-delimited mosaic of vegetation types with abundant ecological islands and corridors, forming a savanna-forest complex (Eiten, 1972, 1983).

The orders Rodentia and Didelphimorphia are the major components of the cerrado mammalian fauna (Redford & Fonseca, 1986). Given the degree of physiognomical complexity of the biome, it is natural that several studies have been devoted to the description of the small mammal composition associated with habitat heterogeneity. These studies primarily center on differences between areas of open vegetation and gallery forest (Henriques & Alho, 1981; Fonseca & Redford, 1984; Mares *et al*., 1986, 1989; Marinho Filho *et al*., 1994; Bonvicino *et al*., 1996a).

But few reports have focused on the historical component in the cerrado's faunal diversity (Redford & Fonseca, 1986) or the variation of fauna composition in relation to the different cerrado floristic sub-compartments. Furthermore, taxonomic studies of the cerrado's small mammal fauna are generally restricted in number of taxa (e.g., Voss & Myers, 1991; Bonvicino & Weksler, 1998; Bonvicino *et al*., 1998, 2002). The limited knowledge of the taxonomy of the cerrado's small mammals (Patterson, 2000) is reflected by several recent studies either describing new species (Moojen *et al*., 1997; Bonvicino & Weksler, 1998; Langguth & Bonvicino, 2002; Bonvicino, 2003), or stressing taxonomic problems (Oliveira, 1998; Bonvicino *et al*., 1999). As a result, species misidentifications are common, including the usage of *nomima nuda* (e.g. *Plectomys paludicola*, Alho *et al*., 1986), or the use of names corresponding to species groups for selected taxa (e.g. *O. subflavus*, Alho *et al*., 1986).

In this paper we present a taxonomic account of the species collected at the Chapada dos Veadeiros National Park in the cerrado of central Brazil. We report on part of the diversity of small mammals of the cerrado and, due to the lack of previous taxonomic studies, we discuss problems of species identification. Finally, we consider some simple ecological and geographical patterns.

MATERIALS AND METHODS

Study site and sampling design

Small mammals were sampled in three areas in the Chapada dos Veadeiros National Park (Fig. 1) representing most of its vegetation and elevation diversity. We followed Eiten (1972, 1983) for identification and description of vegetation types. The park is located in a mountainous region, the Planalto Central Goiano (Radam-Brasil, 1983) that include the highest peak of Goiás State (Pouso Alto, with 1,784 m). Area 1 was sampled in August 1996 and areas 2 and 3 in November 1996. Sherman and Tomahawk traps were spaced 15-20 m on ground line transects.

Area 1 (A1 – 14º04'S, 47º45'W, near Morro do Chapéu, 65 km SSW of Cavalcante), whose collecting elevation ranged from 550 to 740 m, is in the lowest part of the park. A1 is a forest formation domain with extensive gallery forests bordered by cerradão (an evergreen vegetation with few deciduous trees but floristically different from semi-deciduous forest). A total of 991 trap-nights were spent in gallery forest (GF), cerradão (CD), cerrado rupestre (CR: thinly wooded savanna vegetation with rock outcrops), cerrado *sensu stricto* (CE: wooded savanna), and campo úmido (CU: a mesic grassland). Area 2 (A2 – 14º01'S, 47º31'W, near Pouso Alto, 14 km NNW of Alto Paraíso), in the highest part of the park between 1,300 and 1,500 m of altitude, is a domain of open vegetation formations with extensive areas of cerrado rupestre and natural grass fields. A total of 1,208 trap nights were spent in GF, CE, CR, and CU. Area 3 (A3 – 14º07'S, 47º41'W, near Morro da Baleia, 20 km W of Alto Paraíso), which included collecting altitudes ranging from 1,000 to 1,200 m, is a domain of open vegetation formations with extensive areas of vereda (VE: wet headwater prairies with palms) and natural fields. A total of 466 trap-nights were placed in GF, campo cerrado (CC: scarcely wooded savanna), and VE.

Chromosome preparations of rodent specimens were obtained from bone marrow cultures in RPMI 1640, 20% fetal calf serum, ethidium bromide (5 µg/ml), and colchicine (10^{-6} M) for 2 h. The abbreviation FN refers to autosome fundamental number. Skins and skulls are deposited in the mammal collection of the Museu Nacional (MN, Universidade Federal do Rio de Janeiro, Brazil). Collected specimens are listed in the species account; the abbreviation CRB preceding field number digits stands for C. R. Bonvicino. External measurements were obtained from collected adult specimens. Measurements (in millimeters) taken from adult specimens were head/body length (HB), tail length (T), feet length, including claws (F), internal length of the ear (E), and weight, in grams (W).

RESULTS

Six marsupial and 13 rodent species were collected. The marsupials *Micoureus demerarae*, *Didelphis albiventris*, and *Gracilinanus agilis* were trapped only in the lower part of the park (A1), *Thylamys velutinus* and *Monodelphis umbristriata* only in the highest part of the park (A2), and *Monodelphis domestica* in both. The rodents *Oryzomys lamia*, *Oligoryzomys* sp. 1, and *Proechimys roberti* were collected only in A1; *Oligoryzomys* sp. 2, *Pseudoryzomys simplex*, and *Galea* cf. *flavidens* only in the high part of the park (A2 – A3); and *Thrichomys* sp., *Calomys expulsus*, *Oxymycterus delator*, *Necromys lasiurus*, *Oryzomys megacephalus*, *Oryzomys scotti*, and *Nectomys rattus* in both areas.

SPECIES ACCOUNT

Didelphimorphia – Didelphidae
***Didelphis albiventris* Lund, 1840**

Taxonomy: populations of the white-eared opossum occurring in cerrado have been synonymized as *D. albiventris* (*D. albiventris albiventris sensu* Cerqueira, 1985).

Distribution: Paraguay; Uruguay; Northern Argentina; Bolivia; and northeastern (NE), central (C), and southern (S) Brazil, in cerrado, caatinga, the Pantanal, chaco, and humid pampa (Cerqueira, 1985; Gardner, 1993); finally, disjunct distributions in Peru, Ecuador, Colombia, southern Venezuela, French Guyana, Suriname, and northern (N) Brazil may represent other taxa (see above).

Ecological notes and reproduction: a single pregnant female (six embryos) collected in cerrado *sensu stricto* at the edge of gallery forest (area A1, August).

Specimen collected: MN46514
***Micoureus demerarae* (Thomas, 1905)**

Taxonomy: *M. demerarae*, as recognized by Gardner (1993), includes several forms previously accepted as valid species or subspecies of the *Marmosa cinerea* group (Tate, 1933). *M. demerarae* is probably a composite, and Patton *et al*. (2000) regarded the Atlantic Forest populations as a distinct taxon (*M. limae*); however, Gardner (1993) treated *M. limae* and *M. paraguayanus* as synonymous with *M. demerarae*. The assignment of the *Micoureus* population in Chapada dos Veadeiros National Park (PNCV) to *M. demerarae* is provisional, as a more comprehensive analysis of the status of this genus is needed.

Distribution: Colombia, Peru, Bolivia, Venezuela, French Guyana, Guyana, Surinam, and N and C Brazil, in cerrado, caatinga, Amazon Forest, and the Pantanal (Patton *et al*., 2000).

Ecological notes and reproduction: six individuals collected, three in gallery forest, two in cerrado *sensu stricto* and 1 in *cerrado rupestre* (area A1). Females were not pregnant or carrying pouched young (August).

Measurements: HB = 134-174, T = 193-252, F = 25-28, E = 25-30, W = 65-110.

Specimens collected: MN46880-881, 46883-885.

***Gracilinanus agilis* (Burmeister, 1854)**

Taxonomy: *G. agilis*, as defined by Gardner & Creighton (1989), Hershkovitz (1992), and Gardner (1993), includes as synonymous all forms regarded as subspecies by Tate (1933); however, this arrangement lacks character corroboration (Hershkovitz, 1992). All forms described for the cerrado of central Brazil have been synonymized as *G. agilis* (*G. agilis agilis* of Tate, 1933; see also Cabrera, 1957).

Distribution: Uruguay, Paraguay, Argentina, Bolivia, and NE and C Brazil, in cerrado, caatinga, chaco, and the Pantanal (Hershkovitz, 1992);

disjunct distribution in Peru and Colombia may represent another taxon (see above).

Ecological notes and reproduction: 19 individuals collected, 11 in cerrado *sensu stricto*, 7 in cerradão, and 1 in campo úmido (area A1). Females were not pregnant or carrying pouched young (August).

Measurements: HB = 92-129, T = 126-164, F = 12-22, E = 20-24, W = 20-45.

Specimens collected: MN46538-550, 46552, 46568, 46576.

***Monodelphis domestica* (Wagner, 1842)**

Taxonomy: *M. domestica* is the only name used for the majority of gray short-tailed opossum populations, including all those in the cerrado. An isolate population in Marajó, an island in the delta of the Amazon river, Amazon State, is taxonomically controversial, being regarded as a distinct species by some authors (*M. maraxina*; see Pine, 1979; Gardner, 1993).

Distribution: Bolivia, Paraguay, and NE and C Brazil, in the cerrado, caatinga, and chaco (Gardner, 1993).

Ecological notes and reproduction: 22 individuals collected, 2 in cerradão, 8 in cerrado *sensu stricto*, 5 in gallery forest, 5 in cerrado rupestre, 2 in campo úmido, and 1 in campo cerrado (areas A1 and A3). Females were not pregnant or carrying pouched young (August and November).

Measurements: HB = 105-200, T = 62-89, F = 15-27, E = 17-24, W = 34-75.

Specimens collected: MN46572-580, 46582-586.

***Monodelphis umbristriata* Miranda-Ribeiro, 1936**

Taxonomy: the specific status of *M. umbristriata* was recently altered following comparisons among *M. umbristriata*, *M. rubida,* and *M. americana* that showed differences in pelage and cranial characters (Lemos *et al*., 2000).

Distribution: known only in the cerrado of central Brazil (Lemos *et al*., 2000).

Ecological notes: A single individual collected in gallery forest (area A2).

Measurements: HB = 155, T = 60, F = 21, E = 18, W = 90.

Specimen collected: MN46570.

***Thylamys velutinus* (Wagner, 1842)**

Taxonomy: *T. velutinus* is the only species of *Thylamys* occurring in the cerrado of central Brazil (Palma, 1995). Although Gardner (1993) synonymized *T. karimii* with *T. pusillus*, Palma (1995) presented morphological arguments for the inclusion of *T. karimii* under *T. velutinus*, and restricted the distribution of *T. pusillus* to Paraguay, Bolivia, and Argentina. The characters of the single captured specimen match those given by Tate (1933) and Palma (1995).

Distribution: NE, SE, and C Brazil, in the cerrado, caatinga and Atlantic Forest (Palma, 1995).

Ecological notes: A single individual collected in campo úmido, at the edge of gallery forest (area A2).

Measurements: HB = 111, T = 76 (measurements taken from the voucher specimens).

Specimen collected: CRB1075 (skull and skeleton only).

RODENTIA

Caviidae

***Galea* cf. *flavidens* (Brandt, 1835)**

Taxonomy: *G. flavidens* is considered a valid species (e.g., Cabrera, 1961; Woods, 1993), with clear morphological differences from *G. spixii*; however, its relationship with *G. bilobidens* is controversial (Paula-Couto, 1950), as has been including *G. bilobidens* within the genus *Galea*. For this reason, based on morphological characters we tentatively refer to our specimens as *Galea* cf. *flavidens*.

Distribution: Brazil (Woods, 1993), restricted to the cerrado by Redford & Fonseca (1986).

Ecological notes and reproduction: three individuals collected in cerrado rupestre (area A2). One pregnant female (one embryo) was collected in November.

Measurements: HB = 205-231, F = 43-47, E = 24-25, W = 150-330.

Specimens collected: CRB1078, 1089, 1108.

Echimyidae

***Thrichomys* sp. (Lund, 1839)**

Taxonomy and karyotype: *Thrichomys apereoides* was traditionally considered the only

valid species of the genus (Woods, 1993). Recently, this genus was shown to be polytypic and proper names have been proposed: *Thrichomys inermis* (populations with 2n = 26, FN = 48), *Thrichomys pachyurus* (populations with 2n = 34), *Thrichomys apereoides apereoides* (populations with 2n = 28, FN = 50), *Thrichomys apereoides laurentius* (populations with 2n = 30, FN = 54), and *Thrichomys* sp. (populations with 2n = 30, FN = 56; Bonvicino *et al*., 2002). Karyologic analyses of collected specimens showed 2n = 30, FN = 56 (Fig. 2A).

Distribution: NE and C Brazil, in cerrado of Tocantins, Goiás, and Minas Gerais States.

Ecological notes and reproduction: 25 individuals collected, 16 in cerrado rupestre, 5 in cerrado *sensu stricto*, 2 in cerradão, 1 in campo cerrado, and 1 in campo úmido (areas A1, A2 and A3). One pregnant female (one embryo) was collected in November.

Measurements: HB = 187-214, T = 138, F = 39-46, E = 20-25, W = 170-335.

Specimens collected: MN50177.

***Proechimys roberti* Thomas (1901)**

Taxonomy and karyotype: *P. roberti* has been considered a junior synonym of *P. longicaudatus* (Woods, 1993), or as a valid species (Patton, 1987; Pessoa *et al*., 1990) or, further, as subspecies of either *P. longicaudatus* (Moojen, 1948; Cabrera, 1961) or *P. cayennensis* (= *P. guyannensis*) (Ellerman, 1940). Karyologic, morphologic, and molecular analysis showed that *P. roberti* is a valid species of the *guyannensis* species group (*sensu* Patton, 1987), with *P. oris* a junior synonym (Weksler *et al*., 2001). Karyologic analyses showed 2n = 30, FN = 54-55 (Fig. 2B). Variation in FN was due to a single pericentric inversion in one member of a small autosome pair.

Distribution: S of the Amazon river, C and N Brazil (Federal District, Minas Gerais, Goiás, Tocantins, Maranhão and Pará), in cerrado and the Amazon Forest (Weksler *et al*., 2001).

Ecological notes and reproduction: 32 individuals collected, 27 in gallery forest, 3 in cerradão, and 2 in cerrado *sensu stricto* on the edge of gallery forest (area A1). Five pregnant females were collected in August (2-3 embryos each).

Measurements: HB = 178-285, T = 115-181, F = 42-55, E = 26, W = 120-410.

Specimens collected: MN50193-223, 50227.

Muridae

***Nectomys rattus* (Pelzen, 1883)**

Taxonomy and karyotype: *N. rattus* is considered a junior synonym of *N. squamipes* (Musser & Carleton, 1993) but Bonvicino *et al*. (1996b) showed that the populations with 2n = 52 and 2n = 56, previously considered two karyologic variants within *N. squamipes* (Maia *et al*., 1984), were different species that produced sterile hybrids due to abnormal spermatogenesis. *Nectomys rattus* is the most appropriate name for *Nectomys* with 2n = 52 (Bonvicino, 1994). Karyologic analysis showed 2n = 52, FN = 52 (Fig. 2C).

Distribution: E Magdalena river basin in Colombia, throughout Venezuela (high and median Orinoco river basin), Peru (Ucayali river basin), Paraguay (Paraguay river basin), and Brazil (in the Paraguay and Amazons river basins; Bonvicino, 1994).

Ecological notes and reproduction: 11 individuals collected in gallery forest and vereda, always near water streams (areas A1, A2, and A3). Females were not pregnant (August and November).

Measurements: HB = 168-245, T = 182-244, F = 49-56, E = 21-26, W = 130-340.

Specimens collected: MN46873, 46889-892, 46895, 50291.

***Pseudoryzomys simplex* (Winge, 1887)**

Taxonomy and karyotype: *Pseudoryzomys* is considered to be a monospecific genus with all previously described species and subspecies regarded as synonyms of *P. simplex* (Voss & Myers, 1991; Musser & Carleton, 1993). Karyologic analysis showed 2n = 56, FN = 54.

Distribution: N Argentina, W Paraguay, E Bolivia, and E and C Brazil, in cerrado, caatinga, chaco, and Pantanal (Voss & Myers, 1991).

Ecological notes and reproduction: 2 individuals collected in vereda (area A3). Females were not pregnant (November).

Measurements: HB = 115-124, T = 115, F = 29, E = 18, W = 45-55.

Specimens collected: CRB1115, 1127.

***Oryzomys megacephalus* (Fischer, 1814)**

Taxonomy and karyotype: *O. megacephalus* has priority over the much-used name *O. capito* (Langguth, 1966; Musser *et al*., 1998). Several species of *Oryzomys* were formerly included as

synonyms or subspecies under *O. capito* (e.g. Cabrera, 1961), but a series of reports found a large karyologic and morphologic variability among included forms (Gardner & Patton, 1976; Musser *et al*., 1998). The revision of Musser *et al*. (1998) partially rectified this situation, with a preliminary specific delimitation of *O. megacephalus* that included all cerrado populations. Karyologic analysis showed 2n = 54, FN = 62 (Fig. 2D). This karyotype had previously been attributed to *O. capito laticeps* (Svartman & Almeida, 1992) and *O. megacephalus* (Musser *et al*., 1998).

Distribution: Paraguay, Peru, southern Venezuela, Guyana, French Guyana, Suriname, and central and northern Brazil in the cerrado and Amazon Forest (Musser & Carleton, 1993).

Ecological notes and reproduction: 11 individuals collected, 9 in gallery forest, 1 in cerradão, and 1 in cerrado *sensu stricto* (areas A1 and A2). One pregnant female was collected in August (3 embryos) and one in November (4 embryos).

Measurements: HB = 114-158, T = 107-162, F = 27-35, E = 17-25, W = 30-100.

Specimens collected: MN46859, 46861, 46863-867, 46870-871, 50290.

***Oryzomys lamia* Thomas, 1901**

Taxonomy and karyotype: *O. lamia* was considered a junior synonym of *Oryzomys russatus* (= *O. intermedius*) by Musser *et al*. (1998), but its karyotype and morphology clearly differed from other *Oryzomys* species (Bonvicino *et al*., 1998). Karyologic analysis showed 2n = 58, FN = 84 (Fig. 2E).

Distribution: endemic to the cerrado of C Brazil (Minas Gerais and Goiás States).

Ecological notes and reproduction: seven individuals collected, three in gallery forest, two in cerradão, one in cerrado *sensu stricto* on the edge of gallery forest, and one in campo úmido on the edge of gallery forest (A1). Females were not pregnant (August).

Measurements: HB = 141-161, T = 131-160, F = 34-36, E = 20-25, W = 40-85.

Specimens collected: MN46826, CRB926, 964, 968, 969, 983, 1024.

***Oryzomys scotti* Langguth and Bonvicino, 2002**

Taxonomy and karyotype: this taxon is the most common species of the *Oryzomys subflavus* species group. It differs from the other taxa of the *Oryzomys subflavus* species group in its smaller body size, proportionally larger ear, lighter pelage coloration, and the presence of an alisphenoid strut. It differs from other cerrado *Oryzomys* species (not belonging to *O. subflavus* group) by its long incisive foramen, and absence of well-defined limits between the ventral and dorsal coloration. Karyologic analysis showed 2n = 58, FN = 72 (Fig. 2F).

Distribution: endemic in Brazilian cerrado (Federal District and Minas Gerais, Bahia, Southern Goiás, Mato Grosso do Sul, and Rondônia States).

Ecological notes and reproduction: 14 individuals collected, 7 in cerrado *sensu stricto*, 3 in cerrado rupestre, 3 in campo úmido, and 1 in campo cerrado (areas A1 and A2). Two pregnant females were collected in August (3 and 4 embryos each).

Measurements: HB = 137-168, T = 139-169, F = 30-35, E = 19-25, W = 50-100.

Specimens collected: MN61674-680, 61682, 61684-688.

***Oligoryzomys moojeni* Weksler & Bonvicino, 2005**

Taxonomy and karyotype: this is a recently described species belonging to the small-sized and yellow-bellied *Oligoryzomys* species group (composed of *O. fornesi*, *O. flavescens*, and *O. microtis*; Bonvicino & Weksler, 1998), and having a different chromosome complement from all other described *Oligoryzomys* species. Karyologic analysis showed 2n = 70, FN = 74 (Fig. 2G).

Distribution: endemic in the cerrado of C Brazil (Minas Gerais, Goiás, and Tocantins states).

Ecological notes and reproduction: 12 individuals collected, 6 in cerrado *sensu stricto*, 2 in campo úmido on the edge of cerrado *sensu stricto*, 3 in open gallery forest with bamboo trees, and 1 in cerradão on the edge of cerrado *sensu stricto* (area A1). Two pregnant females were collected in August (3 embryos each).

Measurements: HB = 77-97, T = 93-132, F = 21-25, E = 12-16, W = 10-25.

Specimens collected: MN50287, 50307-315, 50377-378.

***Oligoryzomys rupestris* Weksler & Bonvicino, 2005**

Taxonomy and karyotype: this is another undescribed *Oligoryzomys* species with a different chromosome complement from all other members thus far described of that species, and presenting one of the lowest diploid numbers in this genus. Karyologic analysis showed 2n = 46, FN = 52 (Fig. 2H). A similar karyotype was previously attributed to *Oligoryzomys* sp.1 (Silva & Yonenaga-Yassuda, 1997).

Distribution: endemic to high altitude areas in the cerrado of C Brazil (Minas Gerais, Bahia, and Goiás states).

Ecological notes and reproduction: 9 individuals collected in cerrado rupestre or on the edge of this vegetation (area A2). Females were not pregnant (November).

Measurements: HB = 65-99, T = 105-138, F = 20-25, E = 12-17, W = 10-20.

Specimens collected: MN50286, 50322-328.

***Necromys lasiurus* (Lund, 1841)**

Taxonomy and karyotype: several subspecies have been described for *Necromys lasiurus* (= *Bolomys lasiurus*) but karyologic and morphometric analysis revealed a homogeneous species throughout much of its distribution (Macêdo & Mares, 1987; Svartman & Almeida, 1993). The taxonomic status of E Amazon populations is still controversial due to their marked morphometric and developmental differences from cerrado populations (Macêdo & Mares, 1987), of which all forms have been synonymized under *B. lasiurus*. Karyologic analyses showed 2n = 34, FN = 34 (Fig. 2I).

Distribution: E Bolivia, Paraguay, N Argentina, and Brazil S of the Amazon river in cerrado, caatinga, chaco, the Pantanal and the Atlantic Forest (Alho, 1982; Macêdo & Mares, 1987).

Ecological notes and reproduction: 21 individuals collected, 4 in vereda, 3 in cerrado rupestre on the edge of campo úmido, 2 in cerrado *sensu stricto*, and 12 in campo úmido (areas A1, A2 and A3). Females were not pregnant (August and November).

Measurements: HB = 83-136, T = 66-91, F = 20-26, E = 13-17, W = 40-80.

Specimens collected: MN46811, 46813, 46818, 46820-824, 46828, 46830, 46832.

***Oxymycterus delator* Thomas, 1903**

Taxonomy and karyotype: *Oxymycterus* specimens of the cerrado of C Brazil have been traditionally identified as *O. roberti* (Hershkovitz, 1994). However, a taxonomic revision of the genus (Oliveira, 1998) showed that cerrado populations are included in *O. delator*, a species that was formerly restricted to Paraguay, and that *O. roberti* has restricted distribution in S Goiás and Minas Gerais. Karyologic analyses showed 2n = 54, FN = 62 (Fig. 2J). All species of this genus (*sensu* Hershkovitz, 1998) share the same karyotype.

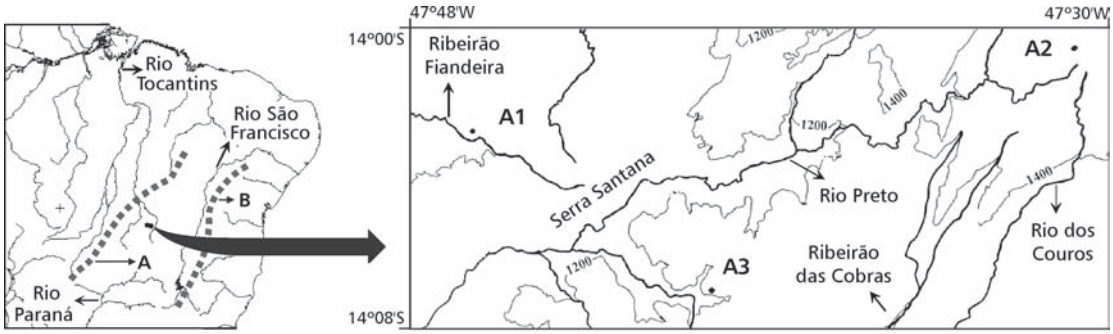

Fig. 1 — n Chapada dos Veadeiros National Park located in the Planalto Central Goiano (A), separated by the rio São Francisco from the Planalto do Espinhaço mountains (B). Collecting sites in Chapada dos Veadeiros National Park. A1: near Morro do Chapéu, 65 km SSW of Cavalcante; A2: near Pouso Alto, 14 km NNW of Alto Paraíso; A3: near Morro da Baleia, 20 km W of Alto Paraíso.

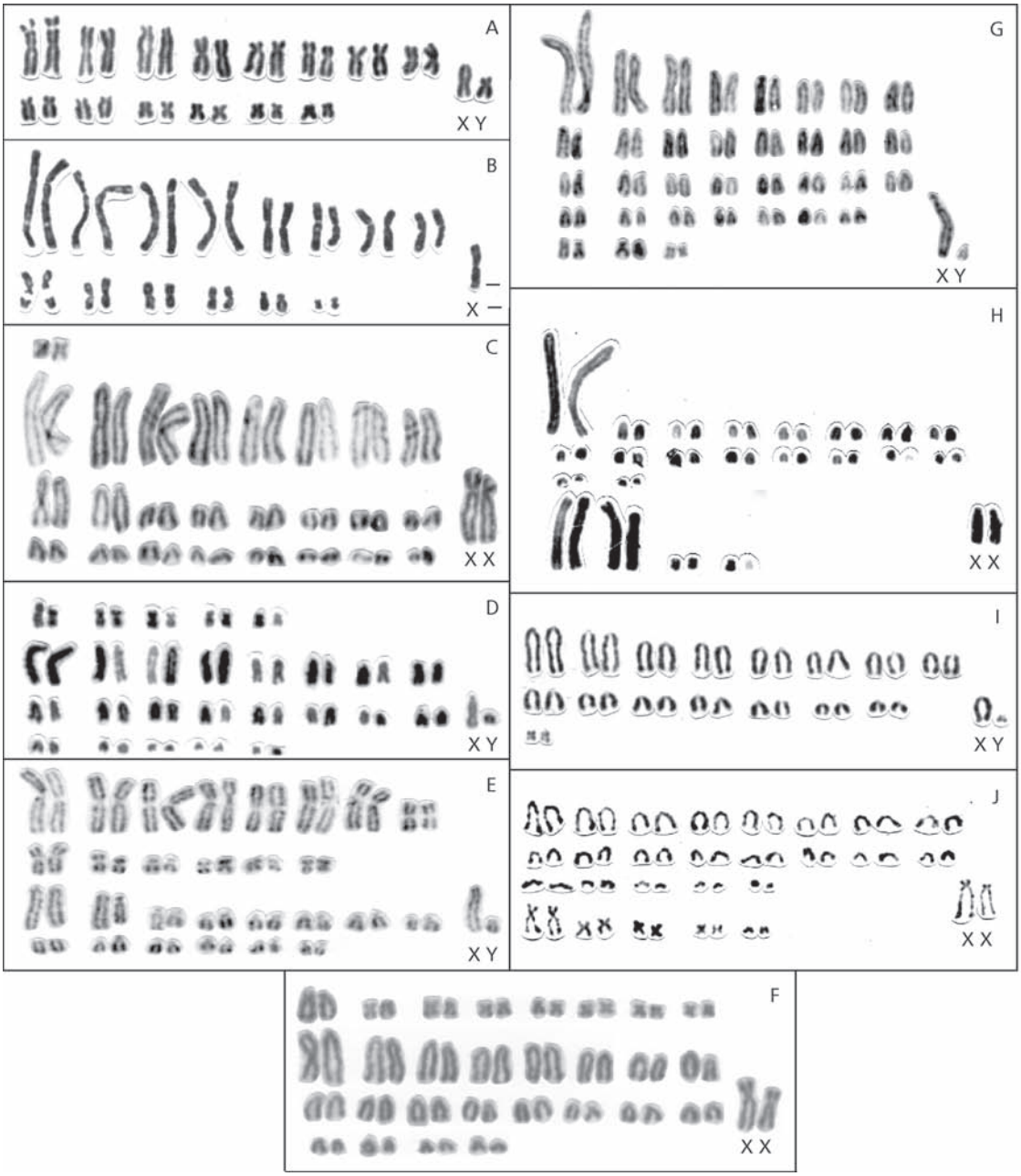

Fig. 2 — Conventional giemsa-stained karyotypes of: (A) *Thrichomys* sp. (male MN50177), (B) *Proechimys roberti* (male MN50213), (C) *Nectomys rattus* (female MN46873, (D) *Oryzomys megacephalus* (male MN43006), (E) *Oryzomys lamia* (male CRB983), (F) *Oryzomys scotti* (male MN61679), (G) *Oligoryzomys moojeni* (male MN50314), (H) *Oligoryzomys rupestris* (female MN50324), (I) *Necromys lasiurus* (male MN46824), (J) *Oxymycterus delator* (female MN46640). X = X chromosome, Y = Y chromosome.

Distribution: Paraguay and C Brazil, in the cerrado and chaco (Oliveira, 1998).

Ecological notes and reproduction: 25 individuals collected, 22 in vereda and 3 in campo úmido (areas A2 and A3). Four pregnant females were collected in November (2-5 embryos each).

Measurements: HB = 120-179, T = 69-121, F = 22-31, E = 14-22, W = 65-115.

Specimens collected: MN46619-631, 46633-641, 46648.

***Calomys expulsus* (Lund, 1841)**

Taxonomy and karyotype: *C. expulsus* had been considered either a junior synonym (Musser & Carleton, 1993) or a subspecies (Hershkovitz, 1962) of *C. callosus*. However, karyologic and morphological analysis showed that *C. expulsus* is a valid species (Bonvicino & Almeida, 2000). Karyologic analyses showed 2n = 66, FN = 68. Another karyotype has been attributed to *C. expulsus* (2n = 36, FN = 66; Geise *et al*., 1996) but it belongs to an undescribed species.

Distribution: C and NE Brazil, in the cerrado (Federal District, Bahia, Minas Gerais, and Goiás) and caatinga (Pernambuco and Piauí).

Ecological notes and reproduction: seven individuals collected, three in cerrado *sensu stricto*, two in campo úmido, one in gallery forest, and one in cerrado rupestre (areas A1 and A2). Females were not pregnant (August and November).

Measurements: HB = 102-122, T = 72-88, F = 18-22, E = 14-19, W = 25-35.

Specimens collected: MN61583-589.

DISCUSSION

Our species list constitutes convincing evidence of the limited knowledge of the taxonomy of small mammals in the cerrado. Of the 19 collected species, 12 have recently been reviewed or described. This is the case of *Oligoryzomys rupestris* and *Oligoryzomys moojeni* (Weksler & Bonvicino, 2005), *Monodelphis umbristriata* (Lemos *et al*., 2000), *Thylamys velutinus* (Palma, 1995), *Proechimys roberti* (Weksler *et al*., 2001), *Nectomys rattus* (Bonvicino *et al*., 1996), *Pseudoryzomys simplex* (Voss & Myers, 1991), *Oryzomys megacephalus* (Musser *et al*., 1998), *Oryzomys lamia* (Bonvicino *et al*., 1998), *Oryzomys scotti* (Langguth & Bonvicino, 2002), *Oxymycterus delator* (Oliveira, 1998), and *Calomys expulsus* (Bonvicino & Almeida, 2000). One of the collected species is presently undescribed (*Thrichomys* sp.), one is probably composite (*Micoureus demerarae*), and one is as yet unclassified (*Galea* cf. *flavidens*). The lack of taxonomic resolution combined with the currently imprecise delimitation of their distribution patterns undermines the study of ecological or historical processes behind the existing structure of small mammal communities of the cerrado.

Although our collecting methodology was not intended to produce quantitative data for analyzing differences of the small mammal structure and composition associated with habitat heterogeneity, our qualitative results indicated a marked compositional difference between different phytophysiognomies that has been extensively documented in previous studies (e.g., Mello & Moojen, 1979; Henriques & Alho, 1981; Fonseca & Redford, 1984; Alho *et al*., 1986; Mares *et al*., 1986, 1989; Bonvicino *et al*., 1996a). Seven species were predominantly found in gallery forest (*Didelphis albiventris*, *Micoureus demerarae*, *Monodelphis umbristriata*, *Proechimys roberti*, *Nectomys rattus*, *Oryzomys megacephalus*, and *Oryzomys lamia*), three in cerrado rupestre (*Galea* cf. *flavidens*, *Thrichomys* sp., and *Oligoryzomys* sp. 2) and three in vereda and campo úmido (*Oxymycterus delator*, *Pseudoryzomys simplex*, and *Thylamys velutinus*). Six species were extensively distributed throughout cerrado habitats but three of them were not found in gallery forest (*Oryzomys scotti*, *Necromys lasiurus*, and *Gracilinanus agilis*) while the other three occurred in this vegetation (*Monodelphis domestica*, *Oligoryzomys* sp.1, and *Calomys expulsus*). With the exception of very few cases each species was captured in the same habitat as recorded in previous studies except for very few cases, which is probably due to the small sample size of some taxa. Our data also showed the heterogeneity of cerrado small mammal fauna across elevations since only eight of the 19 species were collected at both high and low elevations. The extensive areas of forest formations at low elevations and of cerrado rupestre at high elevations are probably the main factor influencing the compositional heterogeneity of the small mammals from these two areas of Chapada dos Veadeiros National Park.

Several authors have stressed the importance of gallery forest in boosting the diversity of the cerrado non-volant mammal fauna. This is because such areas are extensions or corridors of Amazonian and Atlantic forests into cerrado and, therefore, enable species adapted to these mesophytic habitats to inhabit open vegetation in the cerrado biome (Fonseca & Redford, 1984; Redford & Fonseca, 1986; Mares *et al*., 1986; Marinho-Filho, 1994). Our data is a further indication of the importance of gallery forest in housing a large parcel of cerrado diversity. Nevertheless, of the 19 species collected in the park, only 4, which are mesophytic-adapted species (*Nectomys rattus*, *Oryzomys megacephalus*, *Proechimys roberti* and *Micoureus demerarae*), were distributed throughout the gallery forest of the cerrado and the Amazon forest. Other species occurring in the park have been listed as being present in the Atlantic or Amazon forests but, as mentioned previously, this was done without adequate taxonomic criteria. In addition, some scale factors account for erroneous conclusions. Thus, major biomes have been delimitated without considering either the mosaic transitional areas between them or, in the case of forested biomes, enclaves of cerrado vegetation types within them.

Our results indicated that the level of endemicity of the cerrado small mammalian fauna may be higher than previously estimated (Redford & Fonseca, 1986). Six cerrado-endemic species were found in the park, representing one third of the collected species. Endemic species were present in almost all types of vegetation including gallery forest (*Monodelphis umbristriata*, *Oryzomys lamia*), cerrado rupestre (*Oligoryzomys* sp. 2), and various cerrado structural types (*Oryzomys scotti*, *Oligoryzomys* sp. 1, and *Thrichomys* sp.). Fonseca & Redford (1984) reported 11 endemic, non-volant mammals, for the cerrado, including 10 small mammals. Three of the listed species (*O. lamia, M. umbristriata*, and *Galea flavidens*) occurred in the park while two others are in fact non-endemic to the cerrado (*Pseudoryzomys simplex* and *Oligoryzomys utiaritensis*, a synonym of *Oligoryzomys nigripes*) and six endemic species were not found in the park. These species are *Echimys braziliensis*, *Ctenomys brasiliensis*, *Carterodon sulcidens*, *Juscelinomys candango*, *Thalpomys lasiotis* (= *Akodon reinhardti*), and *Lycalopex vetulus*. Other small mammal species reported to be endemic in the cerrado include *Oryzomys marinhus* (Bonvicino, 2003), *Juscelinomys huanchacae*, and *J. guaporensis* (Emmons, 1999), *Thalpomys cerradensis* (Hershkovitz, 1990), and *Oecomys cleberi* (Locks, 1981). Consequently, the total number of endemic cerrado forms is 17, of which 16 correspond to small mammals.

The data presented in the present work only allow hypotheses that involve historical and ecological factors to explain the present cerrado. To explain the small mammal diversity of the cerrado requires hypotheses based on more rigorous taxonomic studies of the cerrado taxa, further research on delimitation of their distribution in the vegetation mosaic of the cerrado, as well as comparisons with taxa found in extra-core cerrado locations. The importance of gallery forest in the formation of present cerrado mammalian fauna is well established. Probably equally important, as shown by species currently inhabiting only these environments, is the open vegetation belt composed of caatinga, cerrado, and chaco. Hypotheses relative to the specific process by which fauna in different areas of the cerrado, such as the high altitude sites that appear to contain similar endemic fauna not found at lower altitudes, are material for future research. Suggested sites for carrying out such investigations are the Planalto Central Goiano of the Brazilian Plateau (Pouso Alto in PNCV, in Serra Santana) and the Planalto do Espinhaço mountains of Eastern Brazil (Pico das Almas, Bahia, and Serra do Cipó, Minas Gerais, Fig. 2) where *Oligoryzomys* sp. 2 has also been collected (Silva & Yonenaga-Yassuda, 1997).

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