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Gracilinanus microtarsus (Didelphimorphia: Didelphidae)

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Abstract: *Gracilinanus microtarsus* (J. A. Wagner, 1842), called the Brazilian gracile opossum, is a small didelphid that is 1 of 6 species in the genus *Gracilinanus*. It is a sexually dimorphic, solitary marsupial that has a highly seasonal reproductive pattern. It inhabits Atlantic rain forests and semideciduous forests interspersed in the highly seasonal cerrado (savanna-like vegetation) in southeastern and southern Brazil. It prefers locations associated with low canopy cover and it also occurs in habitats altered by anthropogenic events. The species is classified as Least Concern by the International Union for Conservation of Nature and Natural Resources. DOI: 10.1644/851.1.

Key words: Brazil, Brazilian gracile opossum, cuíca, didelphid, insectivorous, marsupial

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Gracilinanus Gardner and Creighton, 1989

Didelphys: J. A. Wagner, 1842:359. Incorrect subsequent spelling of *Didelphis*, not *Didelphis* Linnaeus, 1758.
Grymaeomys Burmeister, 1854:130. Part, proposed as a subgenus of *Didelphis* Linnaeus, 1758.
Marmosa: O. Thomas, 1898:455, 456. Not *Marmosa* Gray, 1821.
Marmosa: O. Thomas, 1909:379. Not *Marmosa* Gray, 1821.
Marmosa: O. Thomas, 1910:502. Not *Marmosa* Gray, 1821.
Marmosa: Cabrera, 1919:34. Part, not *Marmosa* Gray, 1821.
Marmosa: Tate, 1931:10–12. Not *Marmosa* Gray, 1821.
Marmosa: Miranda-Ribeiro, 1936:373, 382. Not *Marmosa* Gray, 1821.
Thylamys: Miranda-Ribeiro, 1936:387. Not *Thylamys* Gray, 1843.
Marmosa: Moojen, 1943:2. Not *Marmosa* Gray, 1821.
Thylamys: Cabrera, 1958:26. Part, not *Thylamys* Gray, 1843.
Tylamys Ávila-Pires, 1968:167. Incorrect subsequent spelling of *Thylamys*, not *Thylamys* Gray, 1843.
Gracilinanus Gardner and Creighton, 1989:4. Type species *Didelphys microtarsus* J. A. Wagner, 1842, by original designation.

CONTEXT AND CONTENT. Order Didelphimorphia, family Didelphidae, subfamily Didelphinae, tribe Marmosini. The genus *Gracilinanus* contains 6 currently recognized species: *G. aceramarcae*, *G. agilis*, *G. dryas*, *G. emiliae*, *G. marica*, and *G. microtarsus*. The following key to *Gracilinanus* species, as well as the synonymies of the genus and the species, were extracted from Creighton and Gardner (2008):

Fig. 1.—Adult female *Gracilinanus microtarsus* from Reserva Biológica de Mogi Guaçu, Mogi Guaçu, São Paulo, Brazil. Photograph was taken in June 2004 and is used with permission of V. Bonato.

1. Dorsal pelage long and lax, chestnut brown in color, and with numerous, conspicuous guard hairs on rump; ventral pelage entirely gray-based with hair tips buffy brown 2

   Dorsal pelage reddish brown, pale brown, or grayish brown and lacking conspicuous guard hairs on rump; ventral pelage self-colored creamy white or, if gray-based, then with white or buffy-white tips 3
2. Tail faintly bicolored, paler ventrally; species known from only the Andes of central Colombia and western Venezuela .... *Gracilinanus dryas*

   Tail unicolored fuscous; species known from only southeastern Peru and the Yungas of Bolivia .... *Gracilinanus aceramarcae*
3. Dorsal pelage warm reddish brown; ventral pelage creamy white (hairs not gray based); tail relatively long, ratio of tail length to head-and-body length more than 1.6 .... *Gracilinanus emiliae*

   Dorsal pelage pale brown, grayish brown, or reddish brown; if reddish brown, ventral pelage entirely gray based; tail relatively shorter 4
4. Dorsal pelage reddish brown to chestnut brown; ventral pelage entirely gray-based; known from only southeastern Brazil .... *Gracilinanus microtarsus*

   Dorsal pelage mottled brown to grayish brown; ventral pelage either gray based or self-colored creamy white 5
5. Dorsal pelage mottled brown to reddish brown, fur texture somewhat wavy in appearance; entire ventral pelage gray basally; distribution north of Rio Amazonas .... *Gracilinanus marica*

   Dorsal pelage short, from pale brown to grayish brown; ventral pelage self-colored creamy white or buff; or, if ventral pelage gray-based, undersides of limbs usually covered with self-colored hairs, distribution south of Rio Amazonas................. .... *Gracilinanus agilis*

***Gracilinanus microtarsus* (J. A. Wagner, 1842)**
Brazilian Gracile Opossum

Didelphys microtarsus J. A. Wagner, 1842:359. Type locality "Ypanema," São Paulo, Brazil.

Grymaeomys microtarsus: Winge, 1893:24. Name combination.

Marmosa microtarsus: O. Thomas, 1900:546. Name combination.

Marmosa microtarsus microtarsus: Tate, 1933:190. Name combination.

Marmosa herhardti Miranda-Ribeiro, 1936:382. Type locality "Humboldt," Santa Catarina, Brazil.

Marmosa [(*Thylamys*)] *microtarsus*: Cabrera, 1958:31. Name combination.

[*Thylamys*] *microtarsus*: Reig, Kirsch, and Marshall, 1987:7. Name combination.

Gracilinanus microtarsus: Gardner and Creighton, 1989:6. First use of current name combination.

CONTEXT AND CONTENT. Context as for genus. *Gracilinanus microtarsus* is treated as monotypic, pending revision (Creighton and Gardner 2008).

NOMENCLATURAL NOTES. The generic name *Gracilinanus* is from the Latin *gracilis* (slender, thin) and Greek *nanos* (dwarf), which reflect the slender form and small body size of the species included in the genus (Gardner and Creighton 1989). The specific epithet *microtarsus* is formed by the Greek prefix *micros* (small) and by the Greek noun *tarsos* (ankle, sole of the foot). Vernacular names include Brazilian gracile opossum, comadrejita (Spanish), cuíca, and catita (Portuguese).

DIAGNOSIS

The following morphological comparisons distinguish *Gracilinanus* from other similar genera. *Gracilinanus* species, unlike *Thylamys*, lack fat storage in the tail and densely granular central palmar and plantar surfaces, but do possess a rostral process of the premaxilla, broader interdigital pads, and relatively longer digits (Creighton and Gardner 2008; Gardner and Creighton 1989). *Gracilinanus* and *Marmosops* have tail scales of different shape, rounded to square and rhomboid, respectively, and the arrangement of tail scales is annular in *Gracilinanus* but spiral in *Marmosops*. *Gracilinanus* species possess maxillary fenestrae, and nonpremolariform lower canines, unlike *Marmosops* (Creighton and Gardner 2008; Gardner and Creighton 1989). Kalinowski's mouse opossum (*Hyladelphys kalinowskii*), described originally as a species of *Gracilinanus* (Hershkovitz 1992), lacks palatine fenestrae, has a shorter rostrum, a conspicuously constricted postorbital region, only 4 mammae, and smaller, nonmolariform deciduous premolars (Creighton and Gardner 2008). Although almost indistinguishable in the field (Voss et al. 2005), cranial comparisons of *Gracilinanus* and *Cryptonanus* show that *Cryptonanus* lacks a rostral process of the premaxilla and well-developed maxillary fenestrae, and has P3 larger than P2, whereas *Gracilinanus* possesses maxillary fenestrae, a rostral process anterior to incisors, and subequal P2 and P3 (Creighton and Gardner 2008; Voss et al. 2005). The pigmy opossum *Chacodelphys formosa*, previously included in *Gracilinanus* as a synonym of the agile gracile opossum (*G. agilis*), is smaller in size, has a shorter tail that lacks a prehensile surface, and also shows craniodental differences such as narrow nasals with parallel lateral margins and low entoconid on the lower molars (Creighton and Gardner 2008).

Gracilinanus microtarsus and *G. agilis* are frequently mistaken for each other because they occur in near-sympatry in some locations of their distribution (Costa et al. 2003). *G. microtarsus* (Fig. 1) has reddish brown dorsal pelage and buffy, gray-based pelage throughout the ventral parts (Costa et al. 2003; Creighton and Gardner 2008). The terminal orange or buffy portion of hair is longer than in *G. agilis*, in which the dorsal color is, in general, paler. The fur is slightly longer and more lax in *G. microtarsus* (Costa et al. 2003). The gray tone of the venter in *G. microtarsus* is darker and the face is paler, resulting in an evident face and body color contrast, whereas in *G. agilis* the top of the head is darker than cheeks and the transition between face and body color is more gradual (Costa et al. 2003). The ocular ring is thinner in *G. agilis* than in *G. microtarsus* and anteroposteriorly restricted. Cranial morphology also allows the distinction between both species, although skulls are considered extremely alike (Costa et al. 2003). The skull of *G. microtarsus* (Fig. 2) is longer, with a longer toothrow, wider braincase, wider zygomatic arches, broader interorbital region, broader and shorter pterygoids, and greater breadth across the pars petrosa (Costa et al. 2003).

GENERAL CHARACTERS

Gracilinanus microtarsus is a small, sexually dimorphic, pouchless mouse opossum. External body and cranial measurements were compiled by Costa et al. (2003) from specimens from 9 localities in Brazil. Average external and cranial measurements (mm) and body mass (g) for males and females, respectively, with parenthetical *SE*, range, and *n* were: length of head and body, 104.00 and 95.20 (14.55, 86–129, 20; 16.86, 81–116, 5); length of tail, 154.20 and 140.20 (7.13, 139–167, 20; 9.34, 131–155, 5); length of hind foot, 17.95 and 15.80 (1.39, 15–20, 20; 0.84, 15–17, 5); length of ear, 20.60 and 22.40 (1.23, 19–23, 20; 0.84, 18–20, 5); body mass, 27.40 and 19.20 (10.62, 17–52, 20; 10.74, 12–37, 5); greatest length of skull, 30.27 and 28.29 (1.54, 28.16–33.20, 12; 1.48, 26.80–29.75, 4); zygomatic breadth, 16.37 and 15.51 (1.13, 14.77–18.38, 12; 1.24, 14.28–16.29, 4); breadth of braincase, 11.94 and 11.63 (0.20, 11.30–12.25, 12; 0.20, 11.35–11.80, 4); width of least interorbital constriction, 5.24 and 4.98 (0.34, 4.73–5.93, 12; 0.28, 4.70–5.29, 4); rostral length, 11.55 and 10.59 (0.79, 10.30–12.98, 12; 0.96, 9.68–11.45, 4); nasal length, 12.98 and 12.13 (1.04, 11.22–14.52, 12; 1.40, 10.61–13.63, 4); rostral width, 4.69 and 4.43 (0.36, 4.32–5.46, 12; 0.39, 4.03–4.85, 4); length of molar toothrow, 5.73 and 5.66 (0.19, 5.50–6.07, 12; 0.20, 5.42–5.90, 4); least pterygoid breadth, 3.32 and 3.36 (0.14, 3.11–3.59, 12; 0.11, 3.25–3.48, 4); petrosal breadth, 8.87 and 8.63 (0.32, 8.00–9.16, 12; 0.38, 8.12–9.01, 4); alisphenoid bulla breadth, 9.61 and 9.31 (0.25, 9.12–10.04, 11; 0.31, 9.04–9.72, 4); and palatal length, 14.70 and 13.75 (0.83, 13.11–16.08, 12; 0.93, 12.75–14.57, 4). Costa et al. (2003) found significant sexual dimorphism in tail, foot, and ear length and also in some cranial measurements such as rostral length, breadth of braincase, greatest length of skull, and palatal length, which were significantly larger in males. Length of head and body and body mass did not differ between males and females (Costa et al. 2003), although in another population from southeastern Brazil, adult males (30–45 g) were heavier than adult females (20–30 g—Martins et al. 2006a, 2006b). The

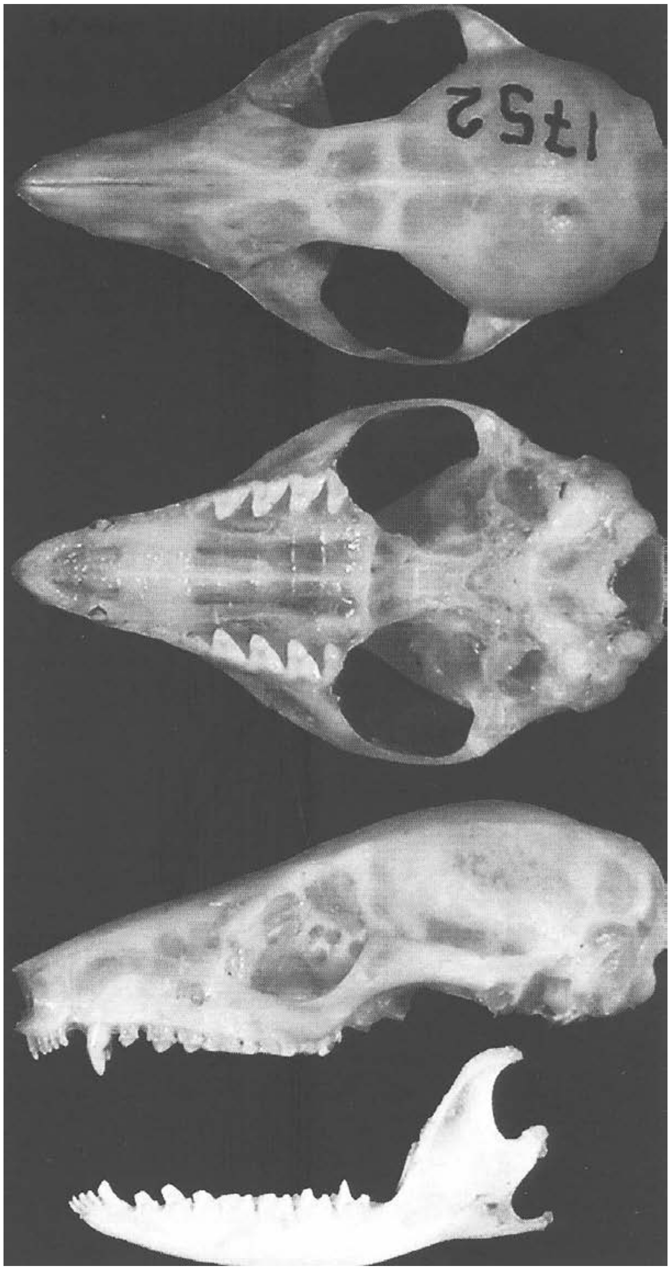

Fig. 2.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of an adult *Gracilinanus microtarsus* (Museu de História Natural, Professor Adão José Cardoso, da Universidade Estadual de Campinas [ZUEC] 1752) from Clube Náutico de Araraquara, Américo Brasiliense, São Paulo State, Brazil. Occipitonasal length is 28.25 mm. Photograph by M. N. F. da Silva.

ratio of length of tail to length of head and body was always > 1.3 and usually < 1.5 (Voss et al. 2005). Dorsal coloration of cover hairs is a modified agouti or tricolor pattern, with hair base dark brown or gray, hair tips orange to buffy, and extreme tips dark brown or blackish (Costa et al. 2003; Hershkovitz 1992). Ventral hairs are bicolored with dark gray base, except on the chin, and terminal portion where tones range from orange through yellow, or cream to white, or colorless (Costa et al. 2003; Hershkovitz 1992). Pelage of glandular areas may be more intensely pigmented (Hershkovitz 1992). Face is paler than the body with a blackish broad ocular ring, broader in *G. microtarsus* than average for *Gracilinanus* (Costa et al. 2003; Hershkovitz 1992). Ears are brown and scrotum is unpigmented (Hershkovitz 1992). Among *Gracilinanus* species, *G. microtarsus* has the most reddish fur. The prehensile tail is unicolored fuscous covered with small rounded to square caudal scales arranged in annular rows, each with 3 spiny hairs (Gardner and Creighton 1989; Voss and Jansa 2003). Claws are fairly uniform in size and shape and do not extend beyond the tips of the digits (Gardner and Creighton 1989; Hershkovitz 1992). Palmar and plantar surfaces have tubercles separated by at least a double row of granules sparsely distributed on central plantar surfaces, and fused into transverse bars on the proximal ventral surface of the digits (Gardner and Creighton 1989).

DISTRIBUTION

Gracilinanus microtarsus occurs in southeastern and southern Brazil in the states of Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (Fig. 3; Brito et al. 2004; Cherem et al. 2004; Costa et al. 2003; Emmons and Feer 1997; Kasper et al. 2007; Pardini et al. 2005; Pardini and Umetsu 2006; Passamani 2000; Passamani et al. 2000; Vaz 2005). Using mitochondrial cytochrome-*b* sequences, Costa et al. (2003) identified 2 phylogeographic clades of *G. microtarsus* separated by the Serra da Mantiqueira mountain range: the southeastern clade (including individuals sampled in the states of São Paulo and Rio de Janeiro) and the Minas Gerais clade.

FOSSIL RECORD

Records from the late Pleistocene of Lagoa Santa, Brazil, earlier considered to correspond to *Thylamys*, seem to correspond to *Gracilinanus agilis* (Creighton and Gardner 2008; Solari 2003). However, there are no known fossil records of *G. microtarsus*.

FORM AND FUNCTION

Form.—Vertebral formula is 7 C, 13 T, 5 L, 2 S, 30 Ca, total 57. The arrangement of teats is bilateral with 1 or rarely a few occurring in the medial abdomen (Hershkovitz 1992). General teat formula is 7–1–7 = 15, of which the pectoral is 2–0–2 = 4, and the abdominal–inguinal is 5–1–5 = 11 (Hershkovitz 1992). Gular glands are present and are more developed in males (Hershkovitz 1992). Urogenital and rectal tracts open into the cloaca (Hershkovitz 1992). Mature males possess a bifid glans penis; however, that of suckling young is simple or single-headed. As penis develops, a division appears along the middle of the urethral canal (Hershkovitz 1992). In the outer surface of the glans penis there are miniature spines, fine spiral grooves or canals, and lappets or other fleshy extrusions (Hershkovitz 1992).

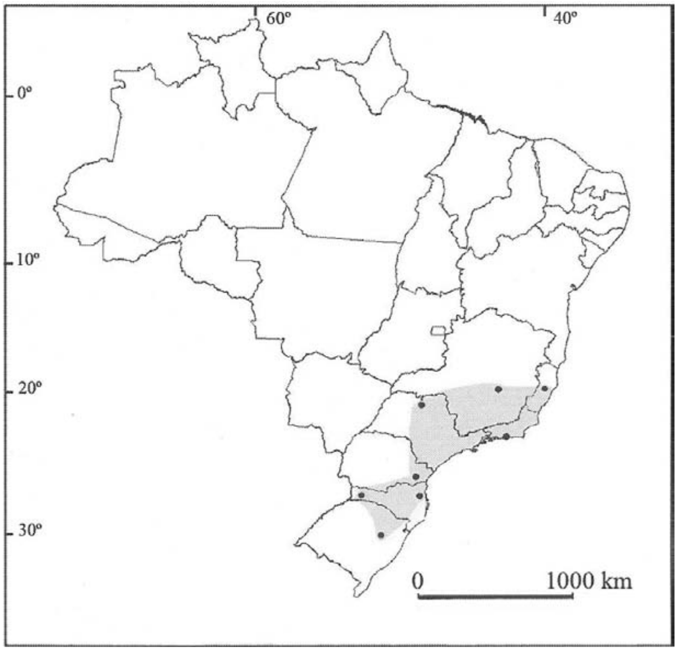

Fig. 3.—Geographic distribution of *Gracilinanus microtarsus*. Map redrawn from Creighton and Gardner (2008). Marginal localities are represented by dots (•).

Cranial morphology has been described in detail by Hershkovitz (1992). Nasal bones are narrow, parallel-sided for their anterior two-thirds, flaring abruptly into the nasomaxillary. The superior borders of the frontal bone may differ in shape, being rounded, squared, or raised as weak temporal ridges that disappear at or on the parietal bones. The borders behind the postorbital constriction may be parallel or slightly divergent. The temporal ridges do not unite to form a sagittal crest. The palate is highly perforated with 3 pairs of medial fenestrae that differ in size. The posterolateral fenestrae are moderate in size, usually about one-third to one-half the breadth of M4 (Gardner and Creighton 1989). Maxillary fenestrae are consistently present (Voss and Jansa 2003). Auditory bullae are relatively large but not different from other species in Didelphinae (Hershkovitz 1992). Anteromedial process of the alisphenoid portion of the auditory bulla is present. Dental formula is i

5/4, c 1/1, p 3/3, m 4/4, total 50. The P3 and lower premolars are the last teeth to erupt, preceded by the eruption of M4, after the shedding of the deciduous 3rd molariform upper premolar (Astúa and Leiner 2008; Tribe 1990). The 3rd definitive premolar is usually smaller than the 2nd, and the upper incisors increase slightly in size from I2 through I5 (Creighton and Gardner 2008). Calcaneal pattern follows the continuous pattern defined by Szalay (1982): the primitively separate facets of the dorsal surface of calcaneus and plantar surface of astragalus are coalesced into 1 facet (Hershkovitz 1992).

Function.—The combination of 2 pigments, eumelanin (blackish) and pheomelanin (reddish brown), determine the hair color (Hershkovitz 1992). *Gracilinanus microtarsus* is the most saturated with pheomelanin among *Gracilinanus* species, giving the fur its reddish aspect (Hershkovitz 1992). The functional teat formula may be as described above, but it can vary depending on the number of attached young because unused nipples may atrophy (Hershkovitz 1992). According to Hershkovitz (1992:13) "in copulation erection separates the prongs, switches off the urinary system, and switches on the ejaculatory." Growth appears to be continuous throughout life and the few individuals that survive to the next breeding season are always larger than younger conspecifics of breeding age (Hershkovitz 1992; Martins et al. 2006a).

Didelphids tend to have lower body temperature and lower basal rates of metabolism than eutherians with the same body mass (McNab 1978). *G. microtarsus* has comparatively low minimal thermal conductance, which compensates for its small body size in maintaining a temperature differential with the environment. In spite of a large temperature differential, at the minimum body temperature of 16°C, *G. microtarsus* was shown to enter daily torpor, which may last up to 8 h (McNab 1978; Morrison and McNab 1962).

ONTOGENY AND REPRODUCTION

Gracilinanus microtarsus has a highly seasonal pattern of reproduction in both the Atlantic rain forest and cerrado (savannah-like vegetation) biomes (Martins et al. 2006a; Passamani 2000; Tubelis 2000). Estrus is nearly synchronous, with matings occurring in a short period between August and September (Martins et al. 2006a). Pregnant and lactating females are observed mostly from September to December, which corresponds to the warm-wet season in both biomes (Martins et al. 2006a; Passamani 2000; Tubelis 2000). Reproductive females have significantly higher residual basal metabolic rates than do nonreproductive females (Duarte and Cruz-Neto 2007).

Tubelis (2000) found lactating females using artificial bamboo nest boxes and observed 8–12 ($\bar{X} = 9.7 \pm 1.2$ *SD*, $n = 9$) attached young per female, whereas Martins et al. (2006a) reported 1 female with 9 attached young. Because foraging females seem to leave their offspring in the nest when young are more fully developed, Martins et al. (2006a) also estimated litter size of the remaining females captured based on the number of functional nipples (5–14 nipples, $\bar{X} = 10.9 \pm 2.3$ *SD*, $n = 15$). Weaning is likely to occur at 2–3 months of age because small young (weighing about 8–10 g) become trappable in November (Martins et al. 2006a).

Patterns of dental eruption in *G. microtarsus* follow stages described for didelphid marsupials (Macedo et al. 2006). Individuals are recorded as young when M1 or M2 erupt, as subadults when M3 erupts, and as adults when M4 erupts. First-year male and female *G. microtarsus* are subadults from December to March and adults thereafter, although reproduction does not occur until August when individuals are 1 year old. Testes in adult males are permanently in the scrotum (Martins et al. 2006a). Soon after the beginning of the breeding season, males suffer high mortality rates that are potentially caused by detrimental effects of stress generated by agonistic interaction between individuals competing for females. However, mortality is not complete and a small fraction of males may survive to reproduce again in the next year's breeding season, which characterizes *G. microtarsus* as partially semelparous (Martins et al. 2006b).

ECOLOGY

Gracilinanus microtarsus is solitary, nocturnal, and inhabits the Atlantic rain forests and semideciduous forests interspersed in the highly seasonal cerrado in southeastern and southern Brazil (Cherem et al. 2004; Gargaglioni et al. 1998; Kasper et al. 2007; Lyra-Jorge and Pivello 2001; Martins et al. 2006a; Pardini et al. 2005; Pardini and Umetsu 2006; Passamani 2000; Vaz 2005). *G. microtarsus* was shown to be associated with locations with reduced canopy cover, being captured in 2nd-growth forests and disturbed fragments of habitat (Püttker et al. 2008b). It also occurs in anthropogenic habitats, such as plantations of *Eucalyptus* (Umetsu and Pardini 2007). Abundance of *G. microtarsus* did not differ between large connected and small isolated forest fragments, thus suggesting the species is not vulnerable to fragmentation (Pardini et al. 2005). Although *G. microtarsus* is regarded as arboreal, being frequently captured in traps placed in the understory and canopy of forests, it can also forage on the ground (Vieira and Monteiro-Filho 2003).

Gracilinanus microtarsus frequently uses tree hollows, as has been suggested by observations of this species using abandoned nests of the mottled piculet (*Picumnus nebulosus*—Cáceres and Pichorim 2003) and artificial bamboo nest boxes (Loretto 2006; Tubelis 2000). Nests built by *G. microtarsus* are composed mainly of dry leaves and have a central chamber where individuals rest (Cáceres and

Pichorim 2003; Tubelis 2000). Tubelis (2000) suggested that female *G. microtarsus* build nests only during the breeding season. An individual male also was observed by one of us (E. G. Martins) in a nest made of dry leaves built inside a Sherman trap (H. B. Sherman Traps, Inc., Tallahassee, Florida) that failed to trigger. Home-range size (mean ± *SD*) of *G. microtarsus* in cerrado was estimated during a 12-month period as 0.12 ± 0.09 ha for females and 0.14 ± 0.18 ha for males (Fernandes 2007). Home-range size was not affected by season in males and females. Home-range size was larger for males than for females, probably due to sexual size dimorphism because males are larger than females (Fernandes 2007).

Density of a population inhabiting a cerrado remnant in southeastern Brazil ranged from 6.5 to 23.4 ($\bar{X}$ = 11.3 ± 3.6 *SD*) individuals/ha and was higher from December to March and lower from September to November (Martins et al. 2006a). An estimate of female monthly survival rate was about 90% both in the pre- and postmating period, whereas monthly survival rate of males decreased from about 90% in the premating period to about 47% in the postmating period (Martins et al. 2006c). Longevity in this species ranges from 1 to 2 years, with females being more likely to live longer than 1 year (Martins et al. 2006a, 2006b). Sex ratios seem to be male-biased (1.4 males : 1.0 females—Passamani 2000).

Diet of *G. microtarsus* was investigated in the Atlantic rain forest and the cerrado of southeastern Brazil and the results suggested that this is a primarily insectivorous and opportunistic forager (Martins and Bonato 2004; Martins et al. 2006c). In both ecosystems, the diet of *G. microtarsus* is composed mainly of insects, such as termites (Isoptera); ants and wasps (Hymenoptera); curculionid, meloid, scarabaeid, alleculid, tenebrionid, chrysomelid, and elaterid beetles (Coleoptera); bugs (Hemiptera); cockroaches (Blattodea); crickets and grasshoppers (Orthoptera); moths (Lepidoptera); dipterans (Diptera); barkflies (Psocoptera); and mayflies (Ephemeroptera). In addition to insects, spiders (Araneae), snails (Pulmonata), and fruits (*Solanum*, *Passiflora*, and *Miconia*) also were detected in the diet of *G. microtarsus* (Martins and Bonato 2004; Martins et al. 2006c). Although fruit consumption by this species may be low, *G. microtarsus* was shown to be an important disperser of Araceae seeds in an area of Atlantic forest in southeastern Brazil (Vieira and Izar 1999).

The number of food items consumed by individual *G. microtarsus* is strongly affected by sex and season in the cerrado, with males consuming larger numbers of food items than females and food consumption being higher in the cool-dry season than in the warm-wet season (Martins et al. 2006c). Sex and season also affect individual-level diet variation in *G. microtarsus*. Interindividual diet variation is moderate between females in both the warm-wet and cool-dry seasons and males in the warm-wet season. On the other hand, interindividual diet variation between males in the cool-dry season is very low because all individuals consume mostly termites (Isoptera—Martins et al. 2008).

Parasites of *G. microtarsus* include the nematode *Pterygodermatites jägerskiöldi* (Torres et al. 2007) and larvae of the botfly *Metacuterebra* (A. X. Linhares, pers. comm.). Male *G. microtarsus* may be particularly susceptible to parasite infestation after the beginning of the breeding season (Martins et al. 2006a, 2006b). Püttker et al. (2008a) found relatively low prevalence of nematodes in *G. microtarsus* and no differences between sexes regarding body condition or nematode prevalence.

Remains of *G. microtarsus* were found in scats of the crab-eating fox (*Cerdocyon thous*—Gatti et al. 2006). Consumption of unidentified *Gracilinanus* species also was recorded for predator species that occur in the distributional range of *G. microtarsus*, such as the white-tailed hawk (*Buteo albicaudatus*—Granzinolli 2003), oncilla (*Leopardus tigrinus*), ocelot (*L. pardalis*—Facure 2002), and maned wolf (*Chrysocyon brachyurus*—Queirolo and Motta-Júnior 2007).

Gracilinanus microtarsus has been successfully captured in pitfall traps (Lyra-Jorge and Pivello 2001; Pardini et al. 2005; Pardini and Umetsu 2006; Umetsu et al. 2006) and Sherman and Tomahawk live traps (Tomahawk Live Trap Co., Tomahawk, Wisconsin—Brito et al. 2004; Martins et al. 2006a; Pardini and Umetsu 2006; Passamani 2000; Passamani et al. 2000). Baits most commonly used for attracting *G. microtarsus* to live traps include banana, peanut butter, and cod-liver oil (Martins et al. 2006a; Passamani 2000). Ear tags have proven successful in marking individual *G. microtarsus* (Martins et al. 2006a).

GENETICS

Gracilinanus microtarsus has a diploid number (2n) of 14 chromosomes and a fundamental number (FN) of 24 (Carvalho et al. 2002). The karyotype consists of 3 pairs of large submetacentric (pairs 1, 2, and 3), 1 pair of medium-sized metacentric (pair 4), and 2 pairs of small submetacentric (pairs 5 and 6) autosomes. The 2 smallest chromosomes in the complement are the X, which is a submetacentric chromosome, and the Y, which is an acrocentric chromosome (Carvalho et al. 2002). Extensive sequence polymorphism at the class II genes of the major histocompatibility complex has been reported for *G. microtarsus* sampled from the Atlantic rain forest in the state of São Paulo (Meyer-Lucht et al. 2008). Positive selection, recombination, and transspecies polymorphism apparently explain the observed generation and maintenance of major histocompatibility complex diversity (Meyer-Lucht et al. 2008).

Using mitochondrial cytochrome-*b* sequences and morphological characters, Costa et al. (2003) identified 3 phylogeographic clades of genus *Gracilinanus* in eastern and central Brazil and considered *G. agilis* and *G. microtarsus* as valid species. Examination of the cytochrome-*b* data also suggested that the samples allocated to *G. microtarsus* in their study might represent 2 separate species.

CONSERVATION

A 2008 assessment found no major threats to this species (even though there is considerable deforestation in parts of its distribution), a tolerance for habitat modification, and large population sizes (Brito et al. 2008). Therefore, *Gracilinanus microtarsus* is classified as Least Concern by the International Union for Conservation of Nature and Natural Resources (2009).

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LITERATURE CITED

Astúa, D., and N. O. Leiner. 2008. Tooth eruption sequence and replacement pattern in woolly opossums, genus *Caluromys* (Didelphimorphia: Didelphidae). Journal of Mammalogy 89: 244–251.

Ávila-Pires, F. D. de. 1968. Tipos de mamíferos recentes no Museu Nacional, Rio de Janeiro. Arquivos do Museu Nacional 53: 161–191.

Brito, D., D. Astúa de Moraes, D. Lew, and P. Soriano. 2008. *Gracilinanus microtarsus*. In International Union for Conservation of Nature and Natural Resources 2009. IUCN Red list of threatened species. Version 2009.2. www.iucnredlist.org, accessed 29 December 2009.

Brito, D., L. C. Oliveira, and M. A. R. Mello. 2004. An overview of mammalian conservation at Poço das Antas Biological Reserve in southeastern Brazil. Journal for Nature Conservation 12:219–228.

Burmeister, H. 1854. Systematiche Uebersicht der Thiere Brasiliensis, welche während einer Reise durch die Provinzen von Rio de Janeiro und Minas Geraës gesammelt oder beobachtet wurden von Dr. Hermann Burmeister. Säugethiere (Mammalia). Georg Reimer, Berlin, Germany.

Cabrera, A. 1919. Genera Mammalium: Monotremata, Marsupialia. Museo Nacional de Ciências Naturales, Madrid, Spain.

Cabrera, A. 1958. Catálogo de los mamíferos de América del Sur. Revista Del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia". Zoologia 4(1):1–308. [Dated 1957; published 1958, see notice on p. 308.]

Cáceres, N. C., and M. Pichorim. 2003. Use of an abandoned mottled piculet *Picumnus nebulosus* (Aves, Picidae) nest by the Brazilian gracile mouse opossum *Gracilinanus microtarsus* (Mammalia, Didelphidae). Biociências 11:97–99.

Carvalho, B. A., L. F. B. Oliveira, A. P. Nunes, and M. S. Mattevi. 2002. Karyotypes of nineteen marsupial species from Brazil. Journal of Mammalogy 83:58–70.

Cherem, J. J., P. C. Simões-Lopes, S. Althoff, and M. E. Graipel. 2004. Lista dos mamíferos do estado de Santa Catarina, sul do Brasil. Mastozoologia Neotropical 11:151–184.

Costa, L. P., Y. L. R. Leite, and J. L. Patton. 2003. Phylogeography and systematic notes on two species of gracile mouse opossums, genus *Gracilinanus* (Marsupialia: Didelphidae) from Brazil. Proceedings of the Biological Society of Washington 116:275–292.

Creighton, G. K., and A. L. Gardner. 2008. Genus *Gracilinanus* Gardner and Creighton, 1989. Pp. 43–50 in Mammals of South America. Vol. 1: marsupials, xenarthrans, shrews, and bats (A. L. Gardner, ed.). University of Chicago Press, Chicago, Illinois. [Dated 2007; published 2008.]

Duarte, L. C., and A. P. C. Cruz-Neto. 2007. Reproductive energetics in gracile mouse opossum: lean mass and basal metabolic rate in males and females. Comparative Biochemistry and Physiology, A. Comparative Physiology 148:S99–S102.

Emmons, L. H., and F. Feer. 1997. Neotropical rainforest mammals: a field guide. University of Chicago Press, Chicago, Illinois.

Facure, K. G. 2002. Ecologia alimentar de duas espécies de felinos do gênero *Leopardus* em uma floresta secundária no sudeste do Brasil. Ph.D. dissertation, Universidade Estadual de Campinas, Campinas, Brazil.

Fernandes, F. R. 2007. Área de vida de *Gracilinanus microtarsus* (Didelphimorphia: Didelphidae): inferências baseadas nos métodos do polígono convexo mínimo e modelagem estatística. M.S. thesis, Universidade Estadual de Campinas, Campinas, Brazil.

Gardner, A. L., and G. K. Creighton. 1989. A new generic name for Tate's (1933) *microtarsus* group of South American mouse opossums (Marsupialia: Didelphidae). Proceedings of the Biological Society of Washington 102:3–7.

Gargaglioni, L. H., M. E. Batalhão, M. J. Lapenta, M. F. Carvalho, R. V. Rossi, and V. P. Veruli. 1998. Mamíferos da Estação Ecológica de Jataí, Luiz Antônio, São Paulo. Papéis Avulsos de Zoologia 40:267–287.

Gatti, A., R. Bianchi, C. R. X. Rosa, and S. L. Mendes. 2006. Diet of the crab-eating fox, *Cerdocyon thous* (Carnivora, Canidae) in Paulo Cesar Vinha State Park, Espírito Santo State, Brazil. Mammalia 70:153–155.

Granzinolli, M. A. M. 2003. Ecologia alimentar do gavião-do-rabo-branco *Buteo albicaudatus* (Falconiformes: Accipitridae) no município de Juiz de Fora, sudeste do estado de Minas Gerais. M.S. thesis, Universidade de São Paulo, São Paulo, Brazil.

Gray, J. E. 1821. On the natural arrangement of vertebrose animals. London Medical Repository 15(1):296–310.

Gray, J. E. 1843. List of the specimens of Mammalia in the collection of the British Museum. British Museum (Natural History) Publications, London, United Kingdom.

Hershkovitz, P. 1992. The South American gracile mouse opossums, genus *Gracilinanus* Gardner and Creighton, 1989 (Marmosidae, Marsupialia): a taxonomic review with notes on general morphology and relationships. Fieldiana: Zoology 70:1–56.

International Union for Conservation of Nature and Natural Resources. 2007. International Union for Conservation of Nature and Natural Resources Red list of threatened species. www.iucnredlist.org, accessed 29 December 2009.

Kasper, C. B., M. J. Feldens, F. D. Mazim, A. Schneider, C. V. Cademartori, and H. C. Z. Grillo. 2007. Mamíferos do Vale do Taquari, região central do Rio Grande do Sul. Biociências 15: 53–62.

Linnaeus, C. 1758. Systema naturae per regna tria naturae, secundum classis, ordines, genera, species cum characteribus, differentiis synonymis, locis. Vol. 1. Laurentii Salvii, Stockholm, Sweden.

Loretto, D. 2006. Demografia e seleção de habitat de marsupiais arborícolas neotropicais com o uso de ninhos artificiais. M.S. thesis, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

Lyra-Jorge, M. C., and V. R. Pivello. 2001. Combining live trap and pitfall to survey terrestrial small mammals in savanna and forest habitats, in Brazil. Mammalia 65:524–530.

Macedo, J., D. Loretto, M. V. Vieira, and R. Cerqueira. 2006. Classes de desenvolvimento em marsupiais: um método para animais vivos. Mastozoología Neotropical 13:113–136.

Martins, E. G., M. S. Araújo, V. Bonato, and S. F. dos Reis. 2008. Sex and season affect individual-level diet variation in the Neotropical marsupial *Gracilinanus microtarsus* (Didelphidae). Biotropica 40:132–135.

Martins, E. G., and V. Bonato. 2004. On the diet of *Gracilinanus microtarsus* (Marsupialia, Didelphidae) in an Atlantic rainforest fragment in southeastern Brazil. Mammalian Biology 69:58–60.

Martins, E. G., V. Bonato, C. Q. da-Silva, and S. F. dos Reis. 2006a. Seasonality in reproduction, age structure and density of the gracile mouse opossum *Gracilinanus microtarsus* (Marsupialia: Didelphidae) in a Brazilian cerrado. Journal of Tropical Ecology 22:461–468.

Martins, E. G., V. Bonato, C. Q. da-Silva, and S. F. dos Reis. 2006b. Partial semelparity in the Neotropical didelphid marsupial *Gracilinanus microtarsus*. Journal of Mammalogy 87:915–920.

Martins, E. G., V. Bonato, H. P. Pinheiro, and S. F. dos Reis. 2006c. Diet of the gracile mouse opossum (*Gracilinanus microtarsus*) (Didelphimorphia: Didelphidae) in a Brazilian cerrado: patterns of food consumption and intrapopulation variation. Journal of Zoology (London) 269:21–28.

McNab, B. K. 1978. The comparative energetics of Neotropical marsupials. Journal of Comparative Physiology, B. Biochemical, Systemic, and Environmental Physiology 125:115–128.

Meyer-Lucht, Y., C. Otten, T. Püttker, and S. Sommer. 2008. Selection, diversity and evolutionary patterns of the MHC class II DAB in free-ranging Neotropical marsupials. BMC Genetics 9: 1–14.

Miranda-Ribeiro, A. de. 1936. Didelphia ou Mammalia–ovovivipara. Marsupiaes, didelphos, pedimanos ou metatherios. Revista do Museu Paulista 20:246–427.

Moojen, J. 1943. Alguns mamíferos colecionados no nordeste do Brasil com a descrição de espécies novas e notas de campo. Boletim do Museu Nacional (Rio de Janeiro) Zoologia 5:1–14.

Morrison, P. R., and B. K. McNab. 1962. Daily torpor in a Brasilian murine opossum (*Marmosa*). Comparative Biochemistry and Physiology 6:57–68.

Pardini, R., S. Marques de Souza, R. Braga-Neto, and J. P. Metzger. 2005. The role of forest structure, fragment size and corridors in maintaining small mammal abundance and diversity in an Atlantic forest landscape. Biological Conservation 124: 253–266.

Pardini, R., and F. Umetsu. 2006. Pequenos mamíferos não-voadores da Reserva Florestal do Morro Grande—distribuição das espécies e da diversidade em uma área de Mata Atlântica. Biota Neotropica 6:1–22.

Passamani, M. 2000. Análise da comunidade de marsupiais em Mata Atlântica de Santa Teresa, Espírito Santo. Boletim do Museu de Biologia Mello Leitão 11/12:215–228.

Passamani, M., S. L. Mendes, and A. Chiarello. 2000. Non-volant mammals of the Estação Biológica de Santa Lúcia and adjacent areas of Santa Teresa, Espírito Santo, Brazil. Boletim do Museu de Biologia Mello Leitão 11/12:201–214.

Püttker, T., Y. Meyer-Lucht, and S. Sommer. 2008a. Effects of fragmentation on parasite burden (nematodes) of generalist and specialist small mammal species in secondary forest fragments of the coastal Atlantic forest, Brazil. Ecological Research 23: 207–215.

Püttker, T., R. Pardini, Y. Meyer-Lucht, and S. Sommer. 2008b. Responses of five small mammal species to micro-scale variations in vegetation structure in secondary Atlantic forest remnants, Brazil. BMC Ecology 8:1–10.

Queirolo, D., and J. C. Motta-Júnior. 2007. Prey availability and diet of the maned wolf in Serra da Canastra National Park, southeastern Brazil. Acta Theriologica 52:391–402.

Reig, O. A., J. A. W. Kirsch, and L. G. Marshall. 1987. Systematic relationships of the living and Neocenozoic American "opossum-like" marsupials (suborder Didelphimorphia), with comments on the classification of these and of the Cretaceous and Paleogene New World and European metatherians. Pp. 1–89 in Possums and opossums: studies in evolution (M. Archer, ed.). Surrey Beatty & Sons, Chipping North, Australia.

Solari, S. 2003. Diversity and distribution of *Thylamys* (Didelphidae) in South America, with emphasis on species from the western side of the Andes. Pp. 82–101 in Predators with pouches: the biology of carnivorous marsupials (M. Jones, C. Dickman, and M. Archer, eds.). CSIRO Publishing, Melbourne, Australia.

Szalay, F. S. 1982. Phylogenetic relationship of the marsupials. Geobios, Mémoire Spécial 6:177–190.

Tate, G. H. H. 1931. Brief diagnosis of twenty-six apparently new forms of *Marmosa* (Marsupialia) from South America. American Museum Novitates 493:1–14.

Tate, G. H. H. 1933. A systematic revision of the marsupial genus *Marmosa*. Bulletin of the American Museum of Natural History 66:1–250.

Thomas, O. 1898. On seven new small mammals from Ecuador and Venezuela. Annals and Magazine of Natural History, Series 7, 1: 451–457.

Thomas, O. 1900. List of the mammals obtained by Dr. G. Franco Grillo in the province of Parana, Brazil. Annali di Museo Civico Storia Naturale di Genova, Series 2, 20:546–549.

Thomas, O. 1909. New species of *Oecomys* and *Marmosa* from Amazonia. Annals and Magazine of Natural History, Series 8, 3:378–380.

Thomas, O. 1910. On mammals collected in Ceará, N.E. Brazil by Fräulein Dr. Snethlage. Annals and Magazine of Natural History, Series 8, 6:500–506.

Torres, E. L., A. Maldonado, and R. M. Lanfredi. 2007. *Pterygodermatites* (*Paucipectines*) *jägerskiöldi* (Nematoda: Rictulariidae) from *Gracilinanus agilis* and *G. microtarsus* (Marsupialia: Didelphidae) in Brazilian pantanal and Atlantic forest by light and scanning electron microscopy. Journal of Parasitology 93: 274–279.

Tribe, C. J. 1990. Dental age classes in *Marmosa incana* and other didelphoides. Journal of Mammalogy 71:566–569.

Tubelis, D. P. 2000. Aspects on the breeding biology of the gracile mouse opossum *Gracilinanus microtarsus* in a second growth forest in southeastern Brazil. Papéis Avulsos de Zoologia 41:173–185.

Umetsu, F., L. Naxara, and R. Pardini. 2006. Evaluating the efficiency of pitfall traps for sampling small mammals in the Neotropics. Journal of Mammalogy 87:757–765.

Umetsu, F., and R. Pardini. 2007. Small mammals in a mosaic of forest remnants and anthropogenic habitats—evaluating matrix quality in an Atlantic forest landscape. Landscape Ecology 22: 517–530.

Vaz, S. M. 2005. Mamíferos coletados em Pedra Branca, município de Paraty, Rio de Janeiro, Brasil. Revista Brasileira de Zoologia 22: 1164–1169.

Vieira, E. M., and P. Izar. 1999. Interaction between aroids and arboreal mammals in the Brazilian Atlantic rainforest. Plant Ecology 145:75–82.

Vieira, E. M., and E. L. A. Monteiro-Filho. 2003. Vertical stratification of small mammals in the Atlantic rain forest of south-eastern Brazil. Journal of Tropical Ecology 19:501–507.

Voss, R. S., and S. A. Jansa. 2003. Phylogenetic studies on didelphid marsupials II. Nonmolecular data and new IRBP sequences: separate and combined analyses of didelphine relationships with denser taxon sampling. Bulletin of the American Museum of Natural History 276:1–82.

Voss, R. S., D. P. Lunde, and S. A. Jansa. 2005. On the contents of *Gracilinanus* Gardner and Creighton, 1989, with the description of a previously unrecognized clade of small didelphid marsupials. American Museum Novitates 3482:1–34.

Wagner, J. A. 1842. Diagnosen neuer Arten brasilischer Säugethiere. Archiv für Naturgeschichte 8:356–362.

Winge, H. 1893. Jordfundne og nulevende Pungdyr (Marsupialia) fra Lagoa Santa, Minas Geraes, Brasiliens. E Museo Lundii, Kjöbenhavn 2:1–149.

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