BRAZILIAN GRACILE OPOSSUM

Gracilinanus microtarsus (JA Wagner, 1842)

FIGURE 1 **-** Adult, São Paulo, Brazil (©Thomas Püttker February 2005).

TAXONOMY: Class Mammalia; Subclass Theria; Infraclass Metatheria; Magnorder Ameridelphia; Order Didelphimorphia; Family Didelphidae; Subfamily Thylamyinae; Tribe Marmosopsini (Myers et al 2006, Gardner 2007). The genus *Gracilinanus* was defined by Gardner & Creighton 1989. There are six known species according to the latest revision (Gardner 2007) two of which are present in Paraguay. The generic name *Gracilinanus* is taken from Latin (gracilis) and Greek (nanos) meaning "slender dwarf", in reference to the slight build of this species. The species name *microtarsus* is Greek meaning "small" (mikros) "feet" (tarsos). There is no fossil record (Pires et al 2008).

The species is monotypic, but Gardner (2007) notes that the entire genus is in urgent need of revision. Costa et al (2003) noted a considerable level of sequence divergence in two clades in southern Brazil separated by the Serra da Mantequiera mountain range and suggested that greater diversity may be involved in the taxon than his currently realised. Furthermore its relationship to the cerrado species *Gracilinanus agilis* needs to be examined, with some authorities suggesting that the two may be at least in part conspecific - as according to some authors there are no consistent cranial differences (Gardner 2007). Costa et al (2003) found the two species to be morphologically and genetically distinct and the two species have been found in sympatry in at least one locality in Minas Gerais, Brazil (Geise & Astúa 2009) where the authors found that they could be distinguished on external characters alone.

Patton & Costa (2003) commented that the species presence at Lagoa Santa, Minas Gerais, the type locality for *G.agilis*, raises the possibility that the type specimen of that species may in fact prove to be what is currently known as *G.microtarsus*. In this case the next available name for *G.agilis* would be *G.beatrix* (O.Thomas 1910).

The description of the cryptic and hitherto unnoticed genus *Cryptonanus* by Voss, Lunde & Jansa (2005) confused the situation yet further. This species is sympatric with *Cryptonanus guahybae* (Tate 1931) in the extreme south of its Brazilian range (Sta Catarina) and also overlaps with *Cryptonanus chacoensis* (Tate 1931) in the western part of its range (Paraguay, southwestern Brazil and Misiones, Argentina). To what extent these species have been confused in the literature is unclear but every effort has been made to quote references that refer unequivocally this species. Synonyms adapted from Gardner (2007):

Didelphys microtarsus JA 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 A.Mirando.Ribeiro 1936:382. Type locality "Humboldt", Santa Catarina Brazil.
Marmosa [(*Thylamys*)] *microtarsus* Cabrera 1958:31. Name combination.
[*Thylamys*] *microtarsus* Reig, Kirsch & Marshall 1987:7. Name combination.
Gracilinanus microtarsus Gardner & Creighton 1989:6. First use of current name.

ENGLISH COMMON NAMES: Brazilian Gracile Opossum (Gardner 2007), Brazilian Gracile Mouse Opossum (Wilson & Cole 2000, Cannevaro & Vaccaro 2007).

SPANISH COMMON NAMES: Marmosa de pies chicos (Massoia et al 2000), Marmosa grácil brasileña (Emmons 1999), Marmosa pie chico (Chebez1996), Comadrejita misionera (Massoia et al 2000), Comadrejita de pies chicos (Cannevaro & Vaccaro 2007), Comadrejita pies chicos (Chebez 2009).

GUARANÍ COMMON NAMES: Anguyá-guaikí (Cannevaro & Vaccaro 2007).

DESCRIPTION: A small, slender mouse opossum with fairly long, lax, rough pelage and long overhairs when compared directly to other members of the genus. Dorsal pelage reddish-brown to chestnut-brown. Individual dorsal hairs with a tricolour pattern, the base being dark brown or gray, tips orange to buffy, and extreme tips dark brown or blackish. The orange-buffy portion of the hairs is longer than in *G.agilis*. When viewed dorsally the head is abruptly paler than the colouration of the body, resulting in a sharp contrast. Eye rings black, large and broad, frequently (though not always) extending from the nose to the ear. Ventral pelage buffy-white, with a dark greyish base to the hairs except for the chin, which has self-based pelage. Glandular areas may show more intense pigmentation. Males possess a gular gland. Ears moderately large and rounded, pale brownish in colour. Vibrissae well-developed and fairly long. Feet pale pinkish. Claws on the manus do not extend beyond the digital pads. 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. Tail unicoloured fuscous, lightly bi-coloured (darker above and paler below) and 1.3-1.5x head and body length. Tail is prehensile and lacks hair on the ventral surface at the tip. Caudal scales are rounded to square, arranged in annular series and each bears three spiny, almost invisible hairs. Females lack a pouch. Mammae are hidden when the female is not lactating, and arrangement is bilateral with one or rarely a few occurring in the medial abdomen. Pectoral mammae 2-0-2 =4 and abdominal-inguinal mammae 5-1-5 = 11, total 7-1-7 = 15. Unused nipples may atrophy however. (Tate 1933, Pires 2008).

SKELETAL CHARACTERISTICS: Skull short and broad with pointed muzzle. Nasals narrow, moderately expanded basally. The upper 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. Borders behind the postorbital constriction parallel or slightly divergent. Palate long and strongly fenestrated with three pairs of medial fenestrae differing in size. Posterolateral fenestrae are moderate in size, usually about one-third to one-half the breadth of M4. Zygomata expanded. Bullae large and rounded with distinct processes. Anteromedial process of the alisphenoid portion of the auditory bulla is present. Temporal ridges well-spaced, not uniting to form a sagittal crest. Supraorbital ridges sharp-edged and with incipient processes.

Maxillary palatal vacuities, rostral process of the premaxillae and a secondary foramen ovale all present, representing the primary distinguishing features differentiating *Gracilinanus* from *Cryptonanus*. (Tate 1933, Gardner & Creighton 1989, Voss et al 2005, Pires et al 2009).

There is disagreement as to whether or not cranial characteristics can be used to distinguish this species from *G.agilis*, and Gardner (2007) states "we have found no trenchant cranial features to separate these species". Costa et al (2003) note that the posterolateral vacuities on the palate are "always smaller than posteromedial vacuities", they being larger or of comparable size in *G.agilis*. Teta et al (2007) add that the interorbital constriction, brain case and zygomatic arches are proportionately wider in this species than in *G.agilis*.

Costa et al (2003) found that rostrum length, width of braincase, greatest length of skull, and palate length were all larger in males than females. They provide the following measurements for a sexed sample (males n=12, females n=4): *Greatest Length of Skull* male 30.27mm (+/-1.54) female 28.29mm (+/-1.48); *Interorbital Width* male 5.24mm (+/-0.34) female 4.98mm (+/-0.28); *Least Pterygoid Width* male 3.32mm (+/-0.14) female 3.36mm (+/-0.11); *Zygomatic Width* male 16.37mm (+/-1.13) female 15.51mm (+/-1.24); *Petrosal Width* male 8.78mm (+/-0.32) female 8.63mm (+/-0.38); *Width of Alisphenoid Bulla* male 9.61mm (+/-0.25) female 9.31mm (+/-0.31); *Cranial Depth* male 9.97mm (+/-0.33) female 9.57mm (+/-0.18); *Rostrum Length* male 11.55mm (+/-0.79) female 10.59mm (+/-0.96); *Rostrum Width* male 4.69mm (+/-0.36) female 4.43mm (+/-0.39); *Palate Length* male 14.70mm (+/-0.83) female 13.75mm (+/-0.93); *Nasal Length* male 12.98mm (+/-1.04) female 12.13mm (+/-1.40); *Width of Braincase* male 11.94mm (+/-0.20) female 11.63mm (+/-0.20).

Vertebral formula 7 C, 13 T, 5 L, 2 S, 30 Ca, total 57 (Pires et al 2008).Calcaneal pattern continuous (Szalay 1982). Primitively separate facets of the dorsal surface of calcaneus and plantar surface of astragalus are coalesced into a single facet (Hershkovitz 1992).

DENTAL CHARACTERISTICS: I5/4 C1/1 P 3/3 M 4/4 = 50. Incisors increase slightly in size from I2 to I5. P2 and P3 of approximately equal height, though be aware of the affects of teeth wear in older specimens. Canines short and close together. C1 accessory cusps are absent. Tooth rows convergent. M3 anterior cingulum complete. (Tate 1933, Gardner & Creighton 1989, Voss, Lunde & Jansa 2005). P3 and lower premolars are the last teeth to erupt, preceded by the eruption of M4 following the shedding of the 3rd molariform upper premolar. Young individuals are characterised as those with M1 and M2 erupted, subadults with M3 erupted and adults with M4 erupted (Pires et al 2008).

Costa et al (2003) provide the following measurements for a sexed sample (males n=12, females n=4): *Length of Molar Tooth Row* male 5.73mm (+/-0.19) female 5.66mm (+/-0.20).

GENETIC CHARACTERISTICS: 2n=14, NA=24 (Geise & Astúa 2009). Three pairs are large submetacentric (pairs 1, 2 and 3), pair 4 is a medium metacentric and pairs 5 and 6 are small submetacentric. X chromosome is a small metacentric, Y chromosome is a small acrocentric. C-banding patterns showed small blocks of constitutive heterochromatin located at the pericentromeric regions of all autosomes and the X chromosome, while the Y chromosome was entirely heterochromatic. Ag-NORs were only present on the short arm of autosome pair 6. (Carvalho et al 2002).

Extensive sequence polymorphism at the class II genes of the major histocompatibility complex has been reported in this species from São Paulo, Brazil. Positive selection, recombination and transspecies polymorphism seem to explain the observed generation and maintenance of major histocompatibility complex diversity (Meyer-Lucht et al. 2008).

TRACKS AND SIGNS: No information.

EXTERNAL MEASUREMENTS: A small Mouse Opossum, though it averages larger than the closely related *G.agilis,* especially in tail length. Tail, foot and ear measurements are longer in males than females, but head and body length and weight do not differ significantly (Costa et al 2003).

Costa et al (2003) provide the following measurements for a sexed sample (males n=20, females n=5): **HB:** male 10.4cm (+/- 1.455, range 8.6-12.9cm) female 9.52cm (+/- 1.686, range 8.1-11.6cm); **TA:** male 15.42cm (+/- 0.713, range 13.9-16.7cm) female 14.02cm (+/- 0.934, range 13.1-15.5cm); **HF:** male 1.79cm (+/- 0.139, range 1.5-2cm) female 1.58cm (+/- 0.084, range 1.5-1.7cm); **EA:** male 2.06cm (+/- 0.123, range 1.9-2.3cm) female 1.92cm (+/- 0.084, range 1.8-2cm); **WT:** male 27.4g (+/- 10.62, range 17-52g) female 22.4g (+/- 10.74, range 12-37g.).

Geise & Astúa (2009) gave the following measurements for a sexed sample from Brazil (males n=6, females n=2): **HB:** male 10.78cm (+/- 1.93, range 8.1-14cm) female 9.90cm (+/- 0.28, range 9.7-10.1cm); **TA:** male 15.68cm (+/- 1.05, range 13.9-16.7cm) female 14.75cm (+/- 1.06, range 14-15.5cm); **WT:** male 28.1g (+/- 11.1, range 14-46g) female 26g (+/- 2.8, range 24-28g.)

Passamani (1995) gives the following measurements for three specimens from Atlantic Hill forest in Espirito Santo State, Brazil (published as *G.agilis* - M.Passamani pers. comm.): **TL:** 25.73cm (+/- 12.7); **TA:** 15.1cm (+/- 5.7); **FT:** 1.7cm (+/- 0.8); **WT**: 20.8g (+/- 1.3).

Fernandes et al (2010) chartered the change in body mass by sex for a population in São Paulo on a monthly basis: November - male 11g (n=1), female 8g (+/-2, n=7); December - male 13g (+/-2, n=10), female 10g (+/-2, n=15); January - male 14g (+/-1, n=7), female 13g (+/-2, n=15); March - male 18g (+/-2, n=9), female 14g (+/-3, n=9); May - male 18g (+/-2, n=6), female 15g (+/-1, n=6); June - male 23g (+/-3, n=5), female 16g (+/-1, n=5); July - male 26g (+/-2, n=5), female 17g (+/-2, n=4); August - male 29g (+/-4, n=7), female 18g (+/-1, n=2).

SIMILAR SPECIES: Recently documented in Paraguay, this species is said to prefer humid Atlantic Forest, whilst the similar *G.agilis* is found in subhumid forest in semi-arid zones. However the presence of the two species in sympatry in Minas Gerais, Brazil means that differences in habitat preference are probably not as clear as once thought.

G.microtarsus has uniformly reddish-brown to chestnut-brown dorsal pelage, with an abruptly paler and clearly contrasting snout. Dorsally *G.agilis* is paler in direct comparison, with a more grizzled greyish-brown appearance and a snout that becomes gradually paler towards the nose. Crucially the ventral pelage of *microtarsus* is almost entirely grey-based except for the chin; that of *agilis* is not grey-based on the chin, throat, upper breast and scrotal area. In direct comparison the grey bases of *microtarsus* are somewhat darker than those of *agilis*. *G.microtarsus* has a notably blacker and more extensive ocular patch which reaches to the nose and often to the ears, and is "not pinched" anteriorly. The face is conspicuously and contrastingly paler than dorsum. Morphometrically the tail is typically >140mm and ears usually <21mm, those of *G.agilis* generally <140mm and >21mm respectively (Costa et al 2003).

When using only external characters *Gracilinanus* should be separated from *Cryptonanus chacoensis* with utmost care. The most reliable characteristic is an examination of the belly pelage, it being greyish basally in *Gracilinanus* and self-coloured basally in *Cryptonanus*. Measurements and examination of skull characteristics may be necessary for confirmation in some cases. Typically the tail of *Cryptonanus* is shorter when compared to head and body length (usually <1.2x) than that of *Gracilinanus* (1.2-1.5x) though there may be some overlap at the extremes. Tail length is typically in the range 95-117mm for adult *Cryptonanus* and 110-165mm for *Gracilinanus*. More reliable is the ratio of premolar heights, with P2<P3 in *Cryptonanus* and the two of approximately equal height in *Gracilinanus* - though be aware of the affects of teeth wear in older specimens. On the canine C1 accessory cusps are present basally in *Cryptonanus* that are absent in *Gracilinanus*. Upon direct comparison *Gracilinanus* has larger ears, longer vibrissae and broader ocular rings than *Cryptonanus*, but these characters are difficult to judge when presented with a single specimen. Cranially maxillary palatal vacuities, rostral process of the premaxillae and a secondary foramen ovale are all present in *Gracilinanus* but absent in *Cryptonanus*. Additionally *Cryptonanus* tends to be somewhat more terrestrial in habits than *Gracilinanus*.

The species can be easily separated from the two species of Paraguayan *Thylamys* by the fact that members of that genus have distinctly tricoloured pelage, whereas *Gracilinanus* is uniformly-coloured dorsally. *Thylamys* also habitually exhibit some degree of incrassination (fat deposits) in the tail and have highly granular surfaces to the feet, neither character being exhibited by this species. Furthermore the species occurring in eastern Paraguay, *Thylamys macrurus*, is considerably larger than *Gracilinanus*. *Marmosa paraguayana* and *constantiae* are much larger with thick woolly pelage and broadly pale-tipped, bicoloured tails. (Voss, Lunde & Jansa 2005).

DISTRIBUTION: In Paraguay the species has been reported only from the Mbaracayú Biosphere Reserve in Departamento Canindeyú, though it may prove to be more widespread in the Atlantic Forest region (de la Sancha 2009, 2010).

Its presence in Provincia Misiones, Argentina has been the subject of considerable debate (Teta et al 2007, Chebez 2009). Chebez (1996) notes it for the departments of Cainguás, Candelaria and Oberá, but some of these citations are based on craneal remains from *Tyto alba* pellets (Massoia 1988) and some authors claim that the skull is not reliably distinguishable from *G.agilis* (Gardner 2007). A photograph of a specimen from General Belgrano "may be assignable to this species" (Chebez 2009), and indeed the animal photographed does possess the reddish pelage and large black ocular patches that may be expected in this species. However, whilst these previous records may or may not be this species some elements of doubt remain and the first documented record that undoubtedly refers to this species in Argentina is from departamento Candelaria, Provincia Misiones (Teta et al 2007).

In Brazil Geise & Astúa (2009) recorded the species as far north as Chapada Diamantina, Bahía State, and noted other specimens from Minas Gerais and Rio de Janeiro states. Pinto et al (2009) captured the species in Espírito Santo. Gardner (2007) notes localities in Sao Paulo and Paraná States. Brown (2004) additionally maps the species for Santa Catarina and Rio Grande do Sul. There is a slight area of overlap in distribution with *G.agilis* in Minas Gerais, Brazil and though the two species may be more widely sympatric, actual records of sympatry are scarce (Geise & Astúa 2009).

HABITAT: Frequently stated as endemic to the Atlantic Forest region, though recent evidence suggests that though the bulk of the distribution is in this region, their habitat preference is not exclusively confined to Atlantic Forest. Geise & Astúa (2009) captured the species in the coastal region of Brazil in Atlantic Forest described as dense ombripholous and semideciduous forest, and in Bahía specimens were also taken in cerradón and deciduous seasonal forest. Talamoni & Dias (1999) captured 9 of 11 individuals in semideciduous forest and 2 of 11 in gallery forest in northeastern São Paulo State, but they did not capture the species in nearby campos cerrado.

Umetsu & Pardini (2007) registered the species in a eucalyptus plantation in São Paulo, Brazil suggesting the possibility that the species can adapt to highly modified environments. However Passamani & Ribeiro (2009) working in a forest island surrounded by a coffee plantation caught just one individual in the coffee plantation compared to 30 individuals in the forest island, and suggested that the artificial habitat was more likely used as a corridor by the species and that specimens captured in the coffee plantation were dispersing. Passamani & Fernandes (2011) however did not detect any movement between forest fragments in this species.

Bonvicino et al (2002) captured a single specimen in very disturbed Atlantic Forest in Brazil. They considered it to be a common (but not abundant) and widespread species occurring in conserved and altered vegetation. Püttker et al (2008) concluded that the species preferred areas with an open canopy and hence was frequently found in young or disturbed forests. As a result they were able to occupy anthropogenic habitats and were equally abundant in small or large forest fragments. Similar results were obtained by Rocha et al (2011) who found the species more common in a more degraded corridor than in a forest fragment or a nearby coffee plantation.

Pardini et al (2005) demonstrated that population density was not associated with fragment size and that the species was able to tolerate considerable habitat fragmentation. Passamani & Fernandez (2011) however noted that the species was more abundant in large (2.9 individuals/1000 trap nights, +/-1.0) or small (4.1 individuals/1000 trap nights, +/-1.1) fragments than medium (0.8 individuals/1000 trap nights, +/-0.4) fragments. Abundance however could not be correlated to the fragment size.

Passamani (2000) notes that the species was most frequently captured at mid-heights (65% of time) in Espirito Santo, but was also captured on the ground (3%) and in low strata (31%). Vieira & Izar (1999) also captured this species in the canopy, at mid-levels and on the ground indicating that it uses all levels of the forest. Vieira & Montero-Filho (2003) captured this species significantly more often in the canopy than on the ground, and as a result they considered it mainly arboreal.

ALIMENTATION: Though long suspected to be principally omnivorous, very little data existed to support that claim until recently. Additionally marked sexual dimorphism in size raises important questions about dietary variation in this species. Larger males may be expected to have different energetic requirements to females for example, whilst seasonal breeding may also lead to a change in diet associated with the stresses of breeding for females and the seasonal availability of resources likely also plays a role in influencing diet (Martins et al 2006c).

Foraging Behaviour and Diet Martins & Bonato (2004) suggested that the species has an insectivorous-omnivorous diet and reported the following gut contents for five individuals of this species from Atlantic Forest in São Paulo State, Brazil: Coleoptera 34.5% (Curculionidae 23.1%, Scarabaeidae 3.8%, unidentified larvae 3.8%, unidentified family 3.8%); Orthoptera 11.5%; Araneae 11.5%; Lepidoptera 11.5% (adults 7.7%, larvae 3.8%); Hymenoptera 11.5% (Formicidae 7.7%, Sphaecidae 3.8%); Isoptera 3.8%; Gastropoda, Pulmonata 3.8%); Unidentified order 3.8%. They attributed the lack of plant matter to possible seasonal factors and also to the fact that the sample came from a secondary forest in which perhaps suitable vegetable matter may be of rare occurrence. Investigating predation of Araceae, Vieira & Izar (1999) had earlier recorded seeds of *Anthurium harrisii* in fecal samples from São Paulo State.

Martins et al (2006c) documented the diet of the species in the cerrado of São Paulo State through examination of fecal samples. They found the following items in the diet from 146 fecal samples: Isoptera 61.6% (mainly *Syntermes* sp), Coleoptera 52.7%, Hymenoptera 44.5%, Lepidoptera 16.4%, Blattodea 11%, Araneae 10.3%, Hemiptera 8.9%, Orthoptera 8.2%, Diptera 4.1%, Pulmonata 2.7%, Psocoptera 2.1%, Ephemeroptera 1.4%, and remains of three plant species *Solanum* 6.8% (Solanaceae), *Passiflora* 6.2% (Passifloraceae) and *Miconia* 2.7% (Melastomataceae). In faeces sampled in the warm-wet season (n=51) Coleoptera (62.7%) were the most frequent food resource, followed by Isoptera (45.1%) and Hymenoptera (Formicidae) (41.2%), whereas in the cool-dry season (n=95) Isoptera (70.5%) were the most frequent food resource, followed by Coleoptera (47.4%) and Hymenoptera (Formicidae) (46.3%). Coleopteran remains identified to family level were Curculionidae 14.4%, Meloidae 6.8%, Scarabaeidae 4.8%, Alleculidae 1.4%, Tenebrionidae 1.4%, Chrysomelidae 0.7% and Elateridae 0.7%. The most prominent ant genera that could be identified in remains were *Pachycondyla* 8.9% and *Odontomachus* 3.4%. The number of food items detected in the faeces of males was greater than that of females in the wet season (male 4 items +/-4.2 vs females 3.1 items +/-2) and the dry season (male 6.9 items +/-8 vs females 3.2 items +/-2.1). The authors concluded that although the species is nominally omnivorous, plant matter in fact plays only a very limited role in the diet and that invertebrates are the main prey. The diet reflected the abundance of invertebrates in the study area and the species was thus classified as an opportunistic forager.

In regards to seasonal and sexual variation in diet, Martins et al (2006c) noted that seasonal partially semelparous breeding is likely to impact on energy requirements in both sexes. Males face high energy costs in searching for a mate and this probably takes place during a short period at the end of the dry season, being followed by a die-off of males. Males can thus be expected to show increased consumption in the cool-dry season in order to build up fat stores prior to the search for a mate. This result is reflected in the greater number of food items reflected in faecal samples during the dry season. The highest reproductive costs for females are associated with lactation and so females would be expected to show increased energy requirements during the warm, wet season when they are breeding and again this is reflected in the data.

Martins et al (2006d) confirmed this by demonstrating that the food niche width becomes broader in males during the cool-dry season and narrower in females, implying that food resource consumption in males is broader during this season.

Martins et al (2008) found that the individual similarity of male diet in the cool-dry season was due to an increased reliance on Isoptera, an abundant, high-value and clumped food source that is easily harvested. Concentrating on this food source allowed males to maximise their energy intake during this season with a view towards meeting the high energy costs required for reproduction.

Pereira et al (2009) considered the role of this species as a seed disperser for *Miconia* (Melastomataceae). They experimentally fed captive individuals with fruits of M.*cinnamomifolia* and *M.albicans* and compared germination rates of seeds passed through the marsupials guts with a control group. They observed no difference in germination rates of *M.cinnamomifolia*, but found a greater germination speed in seeds of *M.albicans* that came from the fecal samples. This demonstrated that the species has the potential to be a seed disperser of *Miconia*.

Diet in Captivity Individuals have been caught in Sherman traps baited with banana pulp, peanut butter and cod liver oil (Martins et al 2006b, 2006c).

REPRODUCTIVE BIOLOGY: The species is partially semelparous and shows markedly seasonal breeding. Reproduction typically occurs once in a lifetime followed by death, resulting in discrete, virtually non-overlapping generations (Martins et al 2006b). Martins et al (2006b) noted a sharp decline in the numbers of males captured after the beginning of the breeding season, though the number of females captured remained constant. Males that were captured in the postmating period showed signs of deteriorating body condition such as fur loss on the rump and high parasite loads, states that are typically associated with low survival rates in marsupials. As a result the declining capture rate of males was attributed to postbreeding mortality. Of the males they marked and recaptured just 18% survived to the second breeding season. As a result the species was considered partially semelparous, with mortality sharp following the first breeding, but not complete. Passamani (2000) noted a slight bias in sex ratios male 1.4 : 1 females.

Seasonality Martins et al (2006a) documented the seasonality of breeding of this species in the cerrado of São Paulo State. They found reproductive females from September (end of the cool.dry season) to March (end of the warm.wet season). All females captured from September to December were in reproductive condition. One female was captured with a litter of 9 newborns attached to teats, and based on the number of functional nipples the mean litter size was estimated as 10.9 (+/-2.3, n=15).

Passamani (2000) noted that 21 of 25 specimens captured in the wet season (>150mm per month) in Espírito Santo, Brazil showed signs of reproduction, whilst none of 31 those caught in drier seasons did. The breeding season is from October to March, with the first juveniles being caught in January. He detected a sex ratio of one female to every 1.4 males. Adult males have the testes permanently in the scrotum meaning that only the reproductive condition of females can be adequately assessed under field conditions (Martins et al 2006).

Pregnancy Tubelis (2000) reported litter sizes of 8 to 12 in São Paulo State, with a mean of 9.67 (n=9). Females give birth in a cavity containing a leaf nest, but all suckling females found in nest boxes had naked young, suggesting that they leave the nest soon after parturition.

GENERAL BEHAVIOUR: Solitary and nocturnal (Pires et al 2008).

Home Range Passamani (2000) calculated that females remained in his trapping area for a mean of 4.3 months and a maximum of 9 months, with a mean recapture rate of 4.8. Males remained in the trapping area for a mean of 2.3 months and only one individual was present for nine months, with the mean recapture rate for males of 3.3. These figures are consistent with the short life cycle of the species and hence probably not related to movements.

Martins et al (2006a) calculated that the mean distance moved by individuals in their 1.24ha trapping grid was just 27m (+/-5.3). Monthly population estimates ranged from 8 to 29 individuals (mean 14 individuals, +/-4.5). Population density peaked between December and March and remained at a high intermediate value until August, decreasing at the beginning of reproduction in September. Monthly population density estimates ranged from 6.5 to 23.4 individuals/hectare (mean 11.3 individual/hectare, +/.3.6).

Fernandes et al (2010) noted a positive correlation between mass and greater size of home range. They noted that a male that did not change in mass (21g) between the warm-wet and cool-dry season did not show a change in home range size from 1350m^2, whilst a male that increased from 16 to 22g between the two seasons also increased its home range size from 1800m^2 to 6300m^2. A similar but less dramatic pattern was seen in females with the following increases in mass and home range observed in X individuals: 14-17g, 1463-1688m^2; 12-16g, 2363-2700m^2; 14-15g, 563-675m^2. One female reversed the pattern 11-15g, 2587-900m^2.

Locomotion Delciellos & Vieira (2006) studied arboreal locomotion of this species on horizontal branches in PN Serra dos Orgãos, Rio de Janeiro State, Brazil. A maximum velocity of 16.68 (+/-3.19) x body length/second was recorded on support branches of 10.16cm diameter, and a minimum velocity of 10.03 (+/-0.22) x body length/second was recorded on support branches of 2.54cm diameter. Minimum number of strides per second was 6.50 (+/-0.43) on a flat surface and maximum number of stride lengths per second was 10.83 (+/-1.91) on support branches of 10.16cm diameter. Range of stride length was from 1.23 to 1.44 x body length.

The relative velocity of small arboreal didelphids was higher than that of other tested didelphids of larger body size and/or terrestrial habits. High velocity was achieved by increasing stride frequency more than stride length. They showed reduced velocity on a flat board as a result of reduced stride length and frequency. Increasing the stride frequency may be a tactic used for stability in order to reduce branch sway. (Delciellos & Vieira 2007).

Delciellos & Vieira (2009) investigated climbing performance of this species on nylon ropes of three diameters 0.6cm, 0.9 and 1.25cm. When climbing the species kept its head and body well clear of the vertical substrate. Respective velocities (stride length x stride frequency) of 3.99 (+/-1.98), 4.52 (+/-1.57) and 6.03 (+/-2.97) were recorded for the three rope diameters. Number of strides per second respectively were 5.00 (+/-1.28), 5.56 (+/-1.31) and 6.64 (+/-1.14) for the three rope diameters. Stride length when related to body length was 0.77 (+/-0.18), 0.81 (+/-0.17) and 0.892 (+/-0.20) respectively.

Refuges Tubelis (2000) examined a total of 15 nests built in deliberately placed nest boxes in São Paulo, Brazil. Nine of those nests contained a female with suckling young, and another nest contained a heavily pregnant female that gave birth two days later after being taken into captivity. Nestboxes of varying sizes were used without prejudice and the estimated density of nests based on occupied nest boxes was 0.5/hectare. Nests were kept clean, with no urine or faeces in the chamber, and were built entirely of leaves of varying size and shape. Mean number of leaves per nest was 147.1 (+/-33.2, range 96-188) and mean total weight of leaves was 18.68g (+/-5.55, range 11.09-28.26g). The nest had a central chamber with side walls formed from several leaves arranged in an orderly side-by-side manner. The leaves forming the roof of the nest were disordered. Most leaves were dry, suggesting they were collected on the ground, but some leaves were green and had apparently been harvested from nearby shrubs. Due to the seasonality of nest building coinciding with the breeding period it would seem that nests in cavities are built for reproductive purposes.

Pires et al (2008) note an observation of a male building a nest inside a Sherman trap that failed to trigger, suggesting that nest building is not entirely associated with breeding. Cáceres & Pichorim (2003) mentioned the reuse of an abandoned nest of the Mottled Piculet *Picumnus nebulosus*.

Mortality Hershkovitz (1992) lists snakes, owls and lizards, as well as "any large predator large enough to gulp down a mouse-size morsel" as potential predators. Gatti (2006) reported remains of this species in 1 of 131 scats of Crab-eating Fox *Cerdocyon thous*, and Chebez (2009) mentioned *Gracilinanus* remains in pellets of Barn Owl *Tyto alba* which he suggested should be attributed to this species.

Parasites Püttker et al (2006) found low rates of nematode parasitism in this species attributing it to the decreased infection possibility associated with an arboreal lifestyle. Infection with nematodes in this population was 44.4% (n=18). No difference was found in parasitism rates between sexes. Meyer-Lucht et al (2010) related this lower parasite load to high population wide diversity in MHC DAB gene complexes. In this study they found helminth prevalence to be between 66.7 to 78.1% and mean nematode intensity to range from 1.37 to 1.75. They found eight nematode morphotypes, two Hymenolepid cestodes and a single egg of a trematode in this species. *Marmosops incanus*, a species with a similar lifestyle but low diversity in MHC DAB gene complexes showed much higher rates of parasitism, though the diversity of parasite species was identical in both species.

Torres et al (2007) report the Rictulariid nematode *Pterygodermatites* (*Paucipectines*) *jagerskioldi* Lent and Freitas, 1935 from the small intestine of this species in Rio de Janeiro State. Pires et al (2008) report larvae of the botfly *Metacuterebra*.

Linardi (2006) lists the ticks *Ornithonyssus brasiliensis* (Macronyssidae) and *Didelphoecius palmeirensis* (Atopomelidae) for this species.

Physiology Two pigments determine hair colour in the genus, eumelanin (blackish) and pheomelanin (reddish brown). *Gracilinanus microtarsus* is the most saturated with pheomelanin among *Gracilinanus* species, giving the fur its reddish aspect (Hershkovitz 1992).

At the minimum body temperature of 16ºC this species has been shown to enter into torpor, which may last for up to eight hours (Morrison & McNab 1962, McNab 1978). This species has a base level of 1.8cm^3 O_2/g-hr, thermal conductance of 0.258cm^3 O_2/g-hr-ºC, and a critical temperature of 28ºC.

The lowest value recorded was 0.25cm^3 O_2/g-hr at 16ºC and at a lower ambient temperature this body temperature was maintained by increased metabolism. Mean body temperatures recorded were: by day 33.2ºC (+/-1.7ºC) and by night 35.7ºC (+/-0.9ºC). Torpor was observed only between 7am and 6pm, with a single exception (Morrison & McNab 1962).

Duarte & Cruz-Netto (2007) note that basal metabolic rate was significantly higher in reproductive females than in non-reproductive females once the effect of the lean mass of 34% was removed. Lean mass accounted for 56% of the variation of BMR in males, but there was no difference in the residual BMR between reproductive and non-reproductive males.

Longevity This is a short-lived species with adults typically annual or more rarely surviving to a second year (Martins et al 2006b). Following the bulk of breeding around October to December there is a gradual replacement of the adults in the population with juveniles, which have then reached maturity prior to breeding the following September (Martins et al 2006a). Martins et al (2006c) estimated survival rate of about 90% in both sexes, with that of males declining to 47% in the postmating period, but remaining constant in females. Ear tags have been successfully used for marking individuals.

VOCALISATIONS: No information.

HUMAN IMPACT: None.

CONSERVATION STATUS: Globally considered to be of Low Risk Least Concern by the IUCN, on account of its wide distribution, tolerance of habitat modification, large population size and occurrence in protected areas. See http://www.iucnredlist.org/apps/redlist/details/9421/0 for the latest assessment of the species.

This species has only recently been documented in Paraguay, but has proved to be far more widespread and common than previously thought in its Brazilian range, and in some areas is one of the most commonly trapped small mammals (Passamani et al 2000, Passamani & Fernandez 2011). Though most frequent in Atlantic Forest, the species is not endemic to that habitat as was previously thought and hence is probably overlooked. The species is probably best considered Data Deficient in Paraguay pending further distributional data.

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FIGURE 2 **-** Adult, São Paulo, Brazil (©Thomas Püttker January 2007).