



## Litter size and reproductive condition of small mammals in southern Goiás, Brazil

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### Abstract

Litter size and reproductive conditions are important in natural history. However, this information is scarce in scientific literature. Here, we presented litter size data for eight small mammal species (four marsupials and four rodents) and investigated the reproductive conditions of three small rodent species in the transition between the Atlantic Forest and Cerrado in central Brazil. We counted the number of young born, the number of embryos found in the uterus, and recorded the presence of well-developed teats and evident scrotum to evaluate the reproductive condition. The litter sizes ranged from one (*Oecomys bicolor*) to 11 (*Gracilinanus agilis* and *Marmosa murina*). We did not find evidence of reproductive seasonality. The pattern found here is similar to other studies carried out in different locations of South America.

**Keywords:** *Gracilinanus agilis*, Marsupials, *Rhipidomys macrurus*, Rodents.

### Resumen

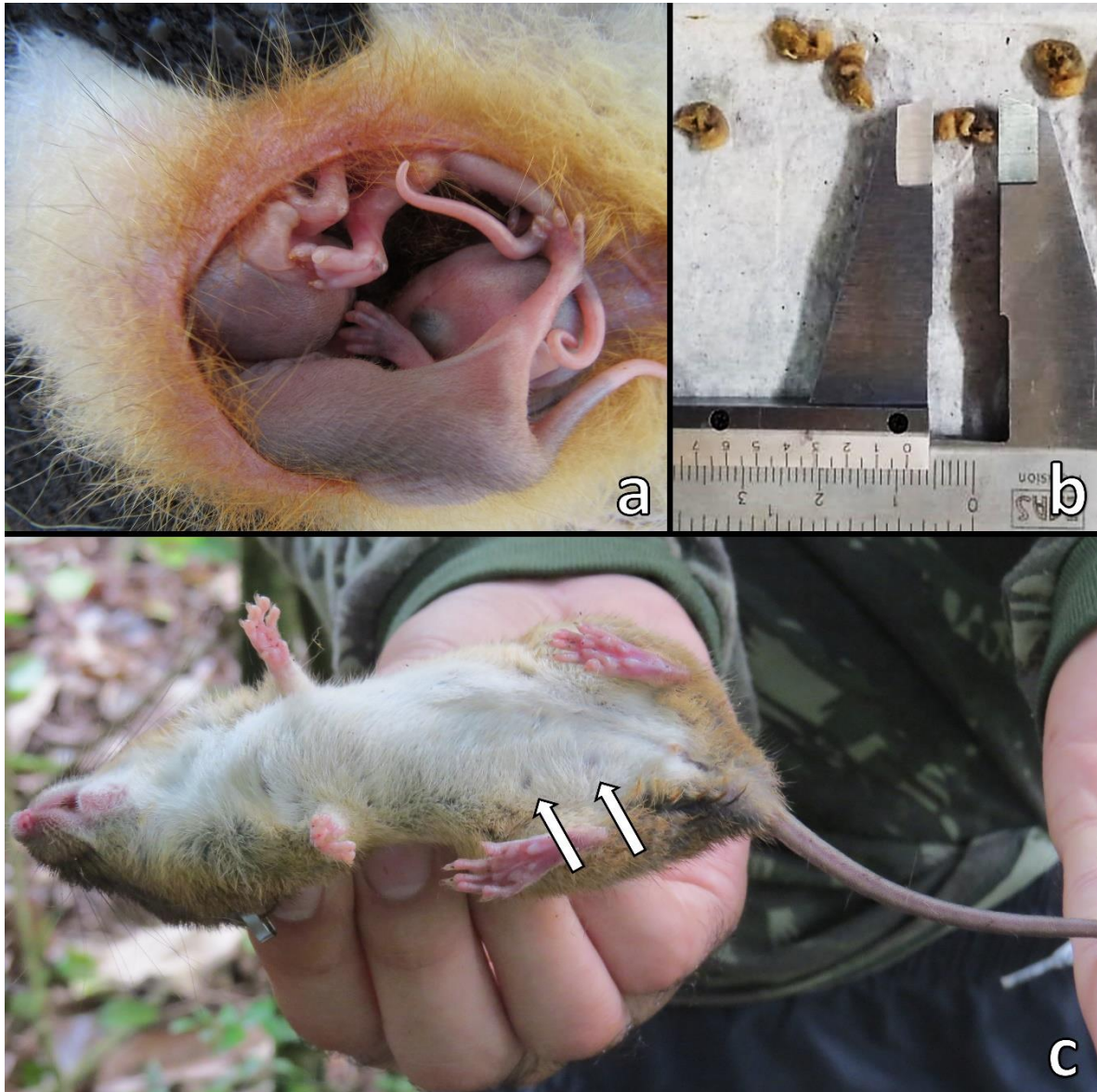
El tamaño de la camada y las condiciones reproductivas son importantes en la historia natural. Sin embargo, esta información es escasa en la literatura científica. Aquí, presentamos datos sobre el tamaño de camada de ocho especies de pequeños mamíferos (cuatro marsupiales y cuatro roedores) e investigamos las condiciones reproductivas de tres especies de pequeños roedores en la transición entre el Bosque Atlántico y el Cerrado en el centro de Brasil. Contamos el número de crías nacidas, el número de embriones encontrados en el útero, registramos la presencia de pezones bien desarrollados y escroto evidente para evaluar la condición reproductiva. El tamaño de las camadas varió de uno (*Oecomys bicolor*) a 11 (*Gracilinanus agilis* y *Marmosa murina*). No encontramos evidencia de estacionalidad reproductiva. El patrón encontrado aquí es similar a otros estudios realizados en diferentes lugares de América del Sur.

**Palabras clave:** *Gracilinanus agilis*, Marsupials, *Rhipidomys macrurus*, Rodents.

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Litter size and reproductive conditions are important traits for understanding the natural history and ecological issues of small mammals (Sikes & Ylönen 1998; Silva et al. 2015). However, this information is scarce in scientific literature and disproportionally distributed between marsupials (Fleming 1973; Wooller & Richardson 1992; Loeb & Schwab 1987; Cáceres 2000; Cáceres et al. 2012; Catzeflis et al. 2018) and small rodents (Caroli et al. 2000;

Mallmann et al. 2011; Silva et al. 2015). Marsupials and small rodents comprised two of the most diverse nocturnal mammal groups, occurring in a variety of environments (e.g., grassland, scrubland, dry and humid forest, and riparian forest) and vertical stratum (ground, understory, and canopy). While also displaying diversity in their locomotor habits and diet (Gardner 2008; Patton et al. 2015). Thus, these traits (like habit nocturnal and small size) difficulties a complete knowledge about the reproductive condition of small mammals under natural conditions. Here, we present novel data about the litter size of eight small mammal species (four marsupials and four rodents) and investigated the reproductive conditions of three small rodent species in a transitional region between the Atlantic Forest and Cerrado in central Brazil.



**FIGURE 1.** Approaches used to estimate the litter size and reproductive conditions in small mammals. (a) *Didelphis albiventris* with pouch young born. (b) Embryos of *Gracilinanus agilis* in the uterus. (c) Presence of well-developed teats (arrow) in a female of *Oecomys bicolor*.

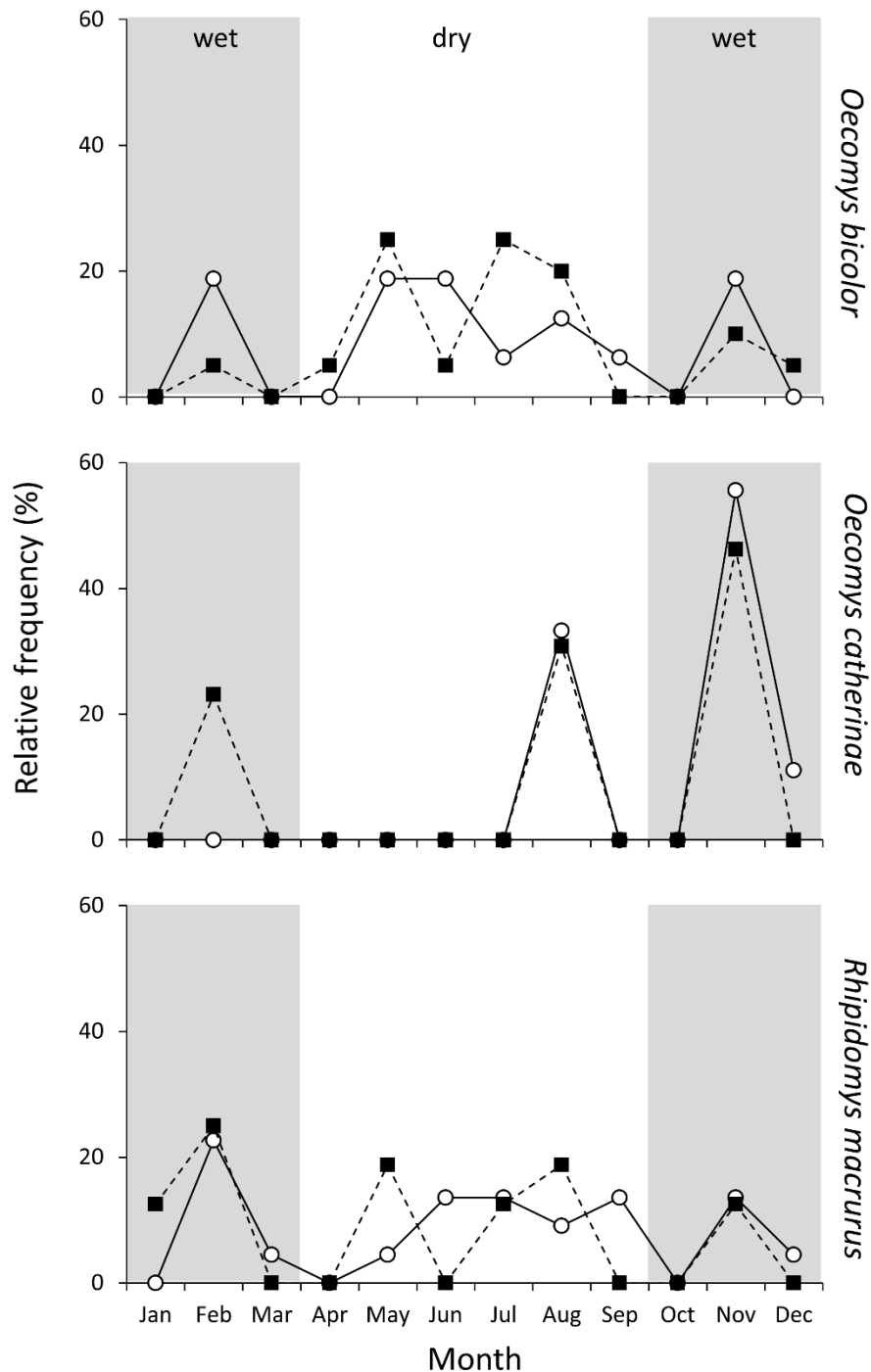
We sampled small mammals monthly between November 2012 to September 2014, and January to December 2015 (see, Hannibal et al. 2015; 2018 for methodological details), and more recently in January, May, August, and November 2020, in a fragmented landscape of southern Goiás state, totaling 14,312 trap-nights and 1,680 bucket-nights. We made the captures under the collection licenses SISBio (nº 37519-1/2013, nº 37519-2/2014, nº 46985-1/2015) according to the guidelines of the American Society of Mammalogists (Sikes et al. 2016). To evaluate the litter size, we counted the number of young found in the pouch when the specimen was captured in the field and the number of embryos in the uterus. For this second approach, we sectioned the abdominal region of all females deposited at the Mammal Collection of the Universidade Estadual de Goiás [CMUEG], to check the presence of embryos in their uterus (Figure 1). To evaluate their reproductive condition, we recorded the presence of well-developed teats (teats eruption in the reproductive period) for females (Figure 2), and the presence of evident scrotum for males of three small rodents (*Oecomys bicolor* [♀ = 16, ♂ = 20], *Oecomys catherinae* [♀ = nine, ♂ = 13], and *Rhipidomys macrurus* [♀ = 22, ♂ = 16]), which presented more than five individuals sampled. Then, we tested the interaction between sex with seasonality on the relative frequency (number of individuals of each species divided by the total of individuals and multiplied by 100) of reproductive conditions through Pearson's Chi-square test.

We recorded litter size from specimens captured in the wild for: five *Didelphis albiventris* (mean =  $5.8 \pm 3.03$  SD pouch young in August, September, and November), one *Caluromys philander* (five pouches young in August), one *Gracilinanus agilis* (six pouch young in August), and one *Marmosa murina* (11 pouches young in October). We also recorded embryos for *G. agilis* (11 in October), *Cerradomys scotti* (five in August), *Hylaeamys megacephalus* (four in January), *O. bicolor* (one in November), and *R. macrurus* (three in June). We found no interaction between sex and seasonality regarding the relative frequency of reproductive condition ( $\chi^2 = 0.13$ ,  $p = 0.72$ ). However, *O. bicolor* and *R. macrurus* showed a continuum frequency during all the months of the year for both sexes, while *O. catherinae* showed only two peaks, in August and November.

The litter size found in our study is similar to the reported for these species in South America. Litter size for *D. albiventris* ranged from four to nine pouch young in Argentina (Regidor & Gorostiague 1996) and a mean of around 9 pouches young in Brazil (Câceres 2000). *Caluromys philander* and *H. megacephalus* showed a litter size range of one to six, respectively; while *O. bicolor* showed ranges of one to four in the Guiana region (Catzefflis et al. 2018), agreeing with our findings. *Cerradomys* and *R. macrurus* also presented a similar result with litter sizes ranging around three and three to four young, respectively, in the Brazilian savanna (Silva et al. 2015). However, we found 11 pouch young for *M. murina* compared to one to ten in the Guiana region (Catzefflis et al. 2018), and we found no information about *G. agilis* litter size. For reproductive conditions, *O. bicolor* females have been found pregnant during seven months of the year in the Guiana region (Catzefflis et al. 2018), different from our result. To the best of our knowledge, we present here the first information about the reproductive condition of *O. catherinae*, *R. macrurus*, and *G. agilis* species. Studies on litter size are scarce in central Brazil.

The exclusive use of external morphological characters may be a misleading method for determining the reproductive activity of males and females of small neotropical rodents, as some studies show that such characteristics are not indicative of a real reproductive condition (Couto & Talamoni 2005; Villamizar-Ramírez et al. 2017 e 2019). Future

investigations should use combined methods such as vaginal smears and the estrous cycle with external morphology observation



**FIGURE 2.** Relative frequency of females with well-developed teats (white circle) and males with evident scrotum (black square) for three small rodents in a fragmented landscape in Goiás, central Brazil. These frequencies are based on following total: *Oecomys bicolor* [♀ = 16, ♂ = 20], *Oecomys catherinae* [♀ = nine, ♂ = 13] and *Rhipidomys macrurus* [♀ = 22, ♂ = 16].

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