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Original Investigation

# Differential patterns of home-range, net displacement and resting sites use of *Conepatus chinga* in southern Brazil

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ABSTRACT

Studies on the spatial ecology of Molina's hog-nosed skunk were conducted in southern Brazil. Between April 2008 and April 2009, 18 individuals were tagged with radio collars and monitored by radio-telemetry (VHF). The average home-range estimated for 12 skunks was 1.63 km$^2$ ± 1.17 km$^2$. Males had home-ranges 2.5 times larger than females, and also showed significantly larger patterns of displacement. These differences in space probably were related not only to sexual size dimorphism, but also to differential behavior between sexes. We identified six basic types of resting sites, among which holes in the ground were the most common and comprised more than 50% of the total. Reuse of resting sites was high (32%), especially for females, which had a significantly higher rate than males. Although they showed a large proportion of home-range overlap even in the core areas, skunks exhibited a solitary life style, rarely sharing resting sites and maintaining relatively long distances from each other, equivalent to twice the distance of daily movements. The almost strictly nocturnal activity pattern observed in this study is a common characteristic of the family. Among practically all of the ecological features analyzed, males and females showed significant differences, denoting the importance of a sex-specific approach in ecological studies regarding this species.



## Introduction

The Molina's hog-nosed skunk, *Conepatus chinga*, is a small carnivore, measuring ca. 55 cm total length and 2 kg in weight. The geographic distribution of this species ranges from mid-northern Argentina and Chile to Bolivia, Paraguay, Uruguay (Redford and Eisenberg 1992), and southern Brazil (Cheida et al. 2006). The distribution is primarily associated with open and temperate areas, mainly the Pampas biome, and is apparently present in abundant populations in Argentina (Castillo et al. 2011a) and southern Brazil (Kasper et al. 2009). With a diet based on insects and insect larvae, this skunk is able to use fragmented landscapes, even living near urban areas.

One of the central aspects of spatial ecology is home-range area and the overlap between the home-ranges of individuals. These features are determined by foraging and movement patterns, inter-individual relationships, access to sexual partners, and many other factors such access to food and water, population density, and the presence of competitors and predators (Gittleman and Harvey 1982; Sandell 1989; Gompper and Gittleman 1991). Another important aspect is the presence and exploitation of den and resting sites, which are used during resting periods and may confer protection and thermoregulation benefits (Endres and Smith 1993). The availability of this latter resource potentially may limit the distribution and abundance of populations (Crooks 1994). Several studies addressing the use of den or resting sites by North American Mephitidae have been published (e.g., Larivière and Messier 1998; Doty and Dowler 2006; Lesmeister et al. 2008); while only Castillo et al. (2011b) presented some data about *Conepatus* species.

Despite the relatively extensive bibliography regarding North American Mephitidae, especially *Mephitis* and *Spilogale*, little is known about *Conepatus*. Particularly for *C. chinga*, there are only a few published studies, especially in recent years, which describe ecological aspects, such as diet (Travaini et al. 1998; Donadio et al. 2004), home-range (Castillo et al. 2011a), habitat use and activity pattern (Donadio et al. 2001), as well as inter-individual interactions (Reppucci et al. 2009). Most of these studies involved few animals and/or were conducted for short time intervals, not allowing for inferences about the plasticity or variability of ecological requirements. Some of these studies presented conflicting data about different ecological patterns between males and females of *C. chinga*, such as the occurrence of sexual dimorphism reported by Redford and Eisenberg (1992) but not by Castillo et al. (2011a), and

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the differential use of home-ranges related by Castillo et al. (2011a) but not by Donadio et al. (2001). Few carnivore studies, including those on Mephitidae, compare sex-specific behaviors. Analysis of associated behaviors may reveal significant differences between males and females, and may afford a better understanding of their ecological requirements.

Our objective was to test for the existence of differences in the body measurements, home-range area, use of resting sites, movement, and activity patterns between males and females of *C. chinga*, in southern Brazil.

## Material and methods

### *Study area*

Our study area is located in the southernmost region of Brazil, near the border with Uruguay in the municipality of Arroio Grande (32°18′S, 52°54′W). It is a locality of approximately 30 km$^2$ near the coastal plain of Rio Grande do Sul state, in the Lagoa Mirim drainage basin. The area is a mosaic composed of open fields used for cattle ranching, extensive areas of irrigated rice fields, marshes, and some forest patches of native and exotic trees (especially *Eucalyptus* spp.). Rice fields are cultivated between October and April and abandoned the rest of the year. Another important aspect of the rice plantations in this locality is the rotation of cultivated areas, where each patch is cultivated for four to five years and then used for another four to five years for cattle ranching. Thus, practically the whole area is affected by rice crops at some time. The field is usually kept clear (without shrubs) by cattle, and it is dominated by native species such as *Andropogon*, Aristidae, *Paspalun*, *Axonopus*, and *Stipa*, although some exotic species can be found, such as *Anoni* sp. In the wetlands, predominant vegetation is the false screw pine *Eryngium pandanifoliun* Cham. (Umbelliferae). The climate is classified as Cfa by Koeppen's international classification, which characterizes a subtropical wet region, without a dry season. Temperatures vary from −8 °C to 38 °C, with an annual mean from 10 to 15 °C (IBGE 1978).

### *Animal capture*

Skunks were captured with hand nets covered by plastic to avoid the defensive spray. Individuals were located at night with spotlights, during their activity period, along the periphery of secondary roads traveled by car at ca. 10–15 km/h. Once located, the animal was captured and immediately transferred to a containment box. Chemical immobilization was made by intramuscular administration of a combination of 10 mg/kg ketamine and 2 mg/kg xylazine (Dopalen and Anasedan, VetBrans). Each animal was fitted with VHF radio collars (model 1930, Advanced Telemetry Systems, Isanti, USA). Skunks were measured and aged based on a combination of tooth wear, body mass, and overall condition. Only adult individuals, identified by yellowish or brownish teeth and well developed genitals, were fitted with collars. After recovery from the anesthetic, individuals were released at the capture site. All procedures were in accordance with the guidelines of the American Society of Mammalogists (Gannon et al. 2007) and were approved by the Brazilian Ministry of the Environment's enforcement agency (IBAMA, license no. 13573-1 of November 7, 2007).

### *Data collection and analysis*

We tested whether males and females showed differences in body measurements by a MANOVA and Principal Component Analysis. We then performed a *t*-test to determine which variable had the greatest influence on the first canonical axis. The tests were performed using the software PAST version 1.87 (Hammer et al. 2001).

Field data were collected in monthly campaigns of 8–12 days, between April 2008 and April 2009. In each campaign, we recorded two locations per day for each marked individual: one during daytime (resting period) and one at night (activity period). Location data were collected preferentially by the homing technique, and occasionally by triangulation (White and Garrot, 1990).

To calculate home-range area, we used all recorded locations of each individual in an analysis of fixed kernel 95%, to generate the estimates used within this study. For this analysis we adopted a fixed smoothing parameter of 0.8*href (following Kie et al. 2002). To test if males and females present similar smoothing parameters, we compared the variance with ANOVA in the software BioStat. With this, we avoided over-smoothing caused by the use of crude href (too large for the animals with big areas) and under-smoothing caused by the use of least square cross validation. For the purpose of comparison with a larger number of studies, we estimated the Minimum Convex Polygon. The core area was calculated by kernel 50%. All analyses were performed using the software Biotas 2.0 (Ecological Software Solutions). We compared the home-ranges areas of males and females by Monte Carlo *t*-test, using the Software PAST. The overlap between home-ranges was analyzed with the software Biotas for all contiguous animals. Also, the distance between simultaneous locations of different animals was calculated, and was arbitrarily defined as the distance between the locations of two individuals having contiguous or overlapping home-ranges obtained within 2 h. The significance of the differences in home-range overlap was tested by the Kruskal–Wallis test with the software BioStat (Ayres et al. 2007). Simultaneous distances between male–male, female–female, and male–female pairs were tested by ANOVA with the software PAST.

Diurnal locations permitted us to identify den and resting sites. Because we recorded only two females with cubs during the entire study, the term "resting site" will be used as a synonym of "den site." All resting sites were described and monitored in order to investigate reutilization by the same or different individuals. Patterns of reutilization by males and females were compared through the use of Student's *t*-test, with the proportion of resting sites reused in relation to the total number of resting sites described (data transformed by the arcsine of the square root of the proportion). These analyses were performed with Microsoft Excel version 2007 for Windows and the statistical software PAST.

To evaluate displacement patterns, we calculated the mean straight-line distances moved: (1) between resting sites used on consecutive days; (2) between resting site and the location where the individual was observed in activity, during consecutive periods (day to night and night to the following day); (3) between consecutive nights. The displacement patterns of males and females were compared by Mann–Whitney tests, followed by Tukey's test with the software BioStat.

Activity pattern data were taken from nocturnal and crepuscular periods. Daytime activity patterns were inferred during the monitoring of resting-site use. Activity record was taken during the survey for locations of individuals by an activity sensor incorporated in the collars that generates a constant 40 pulses per minute when inactive, or variable pulse rates when the animal is moving. We recorded the status of each individual within an interval of 30 min, when the signal was in range.

## Results

Twenty-two skunks were captured, and 18 of them (11 females and 7 males) were fitted with radio collars. We found a significant difference between male and female sizes ($F_{6,11} = 8.312$, $P = 0.001$)