Home range of Homonota uruguayensis (Squamata, Phyllodactylidae) at Rio Grande do Sul State, Brazil

Área de Vida do Gecko Homonota uruguayensis (Squamata, Phyllodactylidae)

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ABSTRACT
The home range distribution of the lizard Homonota uruguayensis was studied from May 2010 to January 2011 on a rocky outcrop in the municipality of Rosario do Sul, Rio Grande do Sul State, Brazil. The study was conducted in four seasonal field trips that lasted 13 days each; data was collected in 6-hour shifts, day and night. The area was covered randomly every turn, using the method of capture, mark and recapture. Marking was performed by placing numbered aluminum rings. The individuals’ home ranges were estimated through the Minimum Convex Polygon method and displacements were calculated for individuals which were recaptured only once. There were no differences found between home ranges of non-reproductive and reproductive individuals. Females had greater home ranges and displacement than males, a fact possibly related to the behavior of communal nest building of the species. Information on the ecological aspects of this species is relevant since it is categorized as Vulnerable (VU) in the Brazilian list of species threatened with extinction by the criteria B1ab (iii).
RESUMO
A distribuição da área de vida do lagarto *Homonota uruguayensis* foi estudada de maio de 2010 a janeiro de 2011 em um afloramento rochoso no município de Rosário do Sul, Rio Grande do Sul, Brasil. O estudo foi conduzido em quatro saídas de campo sazonais que duraram 13 dias cada; os dados foram coletados em turnos de 6 horas, durante o dia e a noite. A área foi percorrida aleatoriamente em cada turno, utilizando o método de captura, marcação e recaptura. A marcação foi realizada com anilhas de alumínio numeradas. As áreas de vida dos indivíduos foram estimadas através do método do mínimo polígono convexo e os deslocamentos foram calculados para indivíduos que foram recapturados apenas uma vez. Não foram encontradas diferenças entre áreas de vida de indivíduos reprodutivos e não reprodutivos. As fêmeas apresentaram maiores áreas de vida e deslocamento do que os machos, fato possivelmente relacionado ao comportamento de construção de ninhos comunitários da espécie. As informações sobre os aspectos ecológicos dessa espécie são relevantes, pois está categorizada como Vulnerável (VU) na lista brasileira de espécies ameaçadas de extinção pelos critérios B1ab (iii).

**Palavras-chave:** Geckos, Pampa, afloramentos rochosos, deslocamentos, ninho comunitário.

1 INTRODUCTION

How animals use space is a key issue for ecology and life history of species (Haenel et al., 2003). This information can help to understand how animals use their resources and how these are distributed within the animal’s space (Nicholson & Spellberg, 1989; Guyer, 1991). Some species are active in an area called home range (Burt, 1943), which is defined as an area where an individual carry out its daily activities such as foraging, mate search, sites for oviposition, refuges against predators and adequate thermal conditions (Burt, 1943; Rose, 1982; Stamps, 1983; Huey et al., 1989; Frutos, 2009). Even if the concept is considered simple (Frutos, 2009), its definition and determination become complex when other related factors are considered, such as temporal scale, individual’s sex and age and other biological characteristics (Christian & Waldschmidt, 1984; Perry & Garland, 2002; Frutos & Belver, 2007; Frutos et al., 2007). The home range is not fixed throughout time, it can vary in size or it can be completely modified along the individual’s life (Burt, 1943; Van Sluys, 1997); it is expected to find variations among species, habitats and years (Rose, 1982).

Among lizard species, home ranges distribution patterns observed generally comprise differences in size between reproductive and non-reproductive seasons (Ferner, 1974; Rose, 1982; Van Sluys, 1997). Males often have larger home ranges than females (Ferner, 1974; Ruby, 1978; Schoener & Schoener, 1980; Simonetti & Ortiz, 1980; Rose, 1982; Van Sluys, 1997; Abell, 1999; Rocha, 1999; Haenel, Smith & John-Alder, 2003; Wone & Beauchamp, 2003), probably because females preferably choose males for reproduction with which their home ranges overlap (Ruby, 1978; Haenel et al., 2003). Additionally, active foragers generally have home ranges larger than ambush foragers of equivalent size (Rose, 1982; Silva & Araújo, 2008). The explanation for this is that the
way a species feeds determines its activity level (Huey & Pianka, 1981), affecting, among other things, its migration into new areas (Silva & Araújo, 2008).

Studies related to the ecology of nocturnal species, mainly geckos, are scarce (Huey, 1979; Pérez, 2005; Catenazzi & Donnelly, 2007). Perry & Garland (2002) in their review of lizards’ home ranges couldn’t encompass geckos in phylogenetic comparisons due to lack of data for this group. Thus, studies aiming to reveal unknown ecological aspects in certain families should be encouraged to elucidate the fundamental parameters for several species of the same group.

For the 10 species of the genus Homonota currently known (Morando et al., 2014), the studies on ecology published (Vaz-Ferreira & Sierra de Soriano, 1965; Vaz-Ferreira & Sierra, 1973; Gudynas & Gambarotta, 1980; Gudynas, 1986; Aun & Martori, 1994; Autumn et al., 1994; Cruz, 1994; Werner et al., 1996; Renner, 1998; Gomez & Acosta, 2000; Gomez & Acosta, 2001; Cruz et al., 2005; Piantoni et al., 2006; Cacciali et al., 2007; Ibargüengoytía & Casalins, 2007; Ibargüengoytía et al., 2007; Blanco et al., 2009; Godoy & Pinheira-Donoso, 2009; Nunes, 2009; Aguilar & Cruz, 2010; Kun et al., 2010; Etchepare et al., 2011; Vieira et al., 2020) almost don’t encompass spatial ecology or space use. Homonota uruguayensis is the only gecko native to the pampa biome (southern extreme of Brazil and Uruguay) (Lema, 1994) and is categorized as Vulnerable (VU) in the Brazilian list of species threatened with extinction by the criteria B1ab (iii) (Ordinance No. 414/2014 of MMA). It is terrestrial and restricted to sandstone-basalt rocky outcrops of the campanha region (Vaz-Ferreira & Sierra de Soriano, 1973); its habit is both diurnal and nocturnal (Carreira et al., 2005; Vieira et al., 2020), and it uses stones under rocky substrate (Gudynas & Gambarotta, 1980) and rock gaps as refuge. Females lay one or two eggs in communal nests and can produce up to two clutches per reproductive season (Gudynas, 1986; Achaval & Olmos, 2003). This lizard has a feeding strategy both characteristics ambush predator as active predator (Achaval & Olmos, 2003; Nunes, 2009).

The present study aims to analyze the size and distribution of home ranges of Homonota uruguayensis individuals (Squamata, Phyllodactylidae), looking for ontogenetic and intersexual differences, as well as variations between reproductive and non-breeding seasons.

2 MATERIAL AND METHODS

The study was carried out in a locality in the northern portion of the Pampa biome, at the municipality of Rosário do Sul, located in the Midwest region of the state of Rio Grande do Sul, Southern Brazil (30°13’39”S, 55°07’37.1”W). The study site is a 4.13 ha private farm called “Fazenda Casa Branca”, a rural landscape characterized by the presence of rocky outcrops. The climate in the municipality is humid subtemperate (Maluf, 2000), with mean annual rainfall of 1300-1600 mm, well distributed throughout the year, range of mean annual temperature of 16-20 oC, and
well-defined seasons. Maximum altitude in the area is 132 m. The study area has two main vegetation formations: native grasslands (campos) and alluvial deciduous forest (riparian forest) (Boldrini, 1997). More specifically, the study area is characterized by the presence of rocky outcrops in a pasture landscape, measuring 4.13 ha and vegetation composed primarily of shrubs and grasses.

The fieldwork was carried out on four expeditions in the autumn (May 2010), winter (July 2010), spring (September 2010) and summer (January 2011), each field expedition lasting 13 days, with a total effort of 1185 hours, and were posteriorly grouped as non-reproductive season (fall and winter) and reproductive season (spring and summer). Workdays were divided into 6-hour periods: 0:00 h-5:59 h, 6:00 h-11:59 h, 12:00 h-17:59 h and 18:00 h-23:59 h. Data were collected in six work-hours six rest-hours rotations. Thus, it was possible to replicate each rotation six times in each expedition. The area was randomly covered every shift, and for each lizard sighted the following data was recorded: snout-vent length (SVL) using a Mitutoyo caliper of 0.02 mm precision; age class; sex; mass using a Pesola® scale of 10 g and 0.2 g precision; number of the marking and latitude and longitude to the nearest georeferenced stake. Individuals captured received a numbered 2x4 mm ring (Vieira et al., 2020). All lizards larger than 27 mm (SVL) were marked.

Age classes were determined as adults or juveniles. Adults were classified according to the minimum reproductive size of the species (smallest reproductive female: SVL > 35.08 mm; smallest reproductive male: SVL > 37.72 mm); (Lídia Farias Martins, pers. comm., gonadal variation study). Adult specimens were manually sexed, using a cloacal speculum (Fornasiero et al., 2007). The variation analysis related to sex and age was made only for captured specimens.

To obtain the home range of each specimen the method of Minimum Convex Polygon was used, by plotting each point where the animal was sighted and connecting the outer ones to form a polygon with convex angles, therefore constructing a home range map (Rose, 1982; Stone & Baird, 2002). The rocky outcrop was marked by numbered stakes, distant 30 m from each other, and georeferenced by GPS, which served as reference for the location of lizards. From everyone’s point of capture, we measured the longitudinal and transversal distances to the nearest steak, always following a north or south and east or west direction, using a measuring tape (30 m) and a compass for orientation. Through these measurements, the animal’s position was calculated by trigonometry. Individuals captured only twice had their displacements calculated by the distances between the two points of capture. To test if there were differences between the average sizes of males and females home ranges, juveniles and adults, and between seasons, the Mann-Whitney U test (Zar, 2010) was used. To analyze the relationship between the home range size and body size of males and females simple linear regression (Zar, 2010) was used. Differences between the mean displacement between sexes and age classes were tested using T Test (Zar, 2010).
Collections were performed by Instituto Chico Mendes de Conservação da Biodiversidade under (License n°. 23534-1). Research protocols employed in the present study were approved by the Institutional Animal Care and Use Committee of Universidade Federal do Rio Grande do Sul (registration no. 22977).

3 RESULTS

Throughout the study, 710 *H. uruguayensis* individuals were marked and 290 were recaptured (41.04%). The mean SVL of adult females was of 40.16 ± 1.94 mm and the larger specimen measured 49.16 mm. The mean SVL of adult males was of 40.40 ± 1.42 mm and the largest specimen measured 49.68 mm. Juveniles caught had a mean SVL of 30.25 ± 5.41 mm and the smallest individual captured measured 17.9 mm.

Twenty-three home ranges were established in the non-reproductive season (figure 1) and 17 home ranges during the reproductive season (figure 2). The mean home range of this population was of 13.98 ± 32.55 m² in the non-reproductive season and of 34.28 ± 77.28 m² in reproductive season (table 1). There was no significant difference between reproductive and non-reproductive seasons (*Mann-Whitney U test: U’ = 196.00, N = 40, P = 0.0661*).
Figure 1 – Distribution of home ranges and displacements of Homonota uruguayensis males and females in the non-reproductive season at the study area in Rosário do Sul, Rio Grande do Sul State, Brazil, from May/2010 to January/2011. Male home range: erased line; Female home range: white line; Male displacement: dashed line; Female displacement continuous line.
Figure 2 – Distribution of home ranges and displacements of *Homonota uruguayensis* males and females in the reproductive season at the study area in Rosário do Sul, Rio Grande do Sul State, Brazil, from May/2010 to January/2011. Male home range: erased line; Female home range: white line; Male displacement: dashed line; Female displacement continuous line.
Table 1 – Means, standard deviations, amplitude and sample size of Homonota uruguayensis home ranges captured at the study area in Rosário do Sul, Rio Grande do Sul State, Brazil, from May/2010 to January/2011.

| Season       | Mean ± Standard Deviation (m²) | Amplitude (m) | Sample size |
|--------------|--------------------------------|----------------|-------------|
| Reproductive |                                |                |             |
| Adults       | 32.84 ± 80.74                  | 0.09 - 299.61  | 15          |
| Juveniles    | 86.33 ± 58.28                  | 3.91 - 86.33   | 2           |
| Males        | 19.22 ± 42.06                  | 0.09 - 129.98  | 9           |
| Females      | 61.17 ± 133.30                 | 0.29 - 299.61  | 5           |
| Total        | 34.28 ± 77.03                  | 0.09 - 299.61  | 17          |
| Non-Reproductive |                          |                |             |
| Adults       | 106.83 ± 211.80                | 0.59 - 868.36  | 19          |
| Juveniles    | 40.40 ± 74.56                  | 1.46 - 152.19  | 4           |
| Males        | 23.65 ± 51.88                  | 0.95 - 159.56  | 9           |
| Females      | 197.98 ± 283.66                | 0.59 - 868.36  | 9           |
| Total        | 95.28 ± 195.25                 | 0.59 - 868.36  | 23          |

In relation to displacements, 135 were established (68 in non-reproductive season and 67 during the reproductive season) (table 2). The mean displacement of the population was of 13.98 ± 32.55 m in the non-reproductive season and of 34.14 ± 19.29 m in the reproductive season. There was no significant difference between the displacement in non-reproductive and reproductive seasons (Mann-Whitney U test: $U' = 0.714$, $N = 40$, $P = 0.4752$).

Table 2 – Means, standard deviations, amplitude and sample size of displacements of Homonota uruguayensis captured at the study area in Rosário do Sul, Rio Grande do Sul State, Brazil, from May/2010 to January/2011.

| Season       | Mean ± Standard Deviation (m²) | Amplitude (m) | Sample size |
|--------------|--------------------------------|----------------|-------------|
| Reproductive |                                |                |             |
| Adults       | 14.63 ± 34.55                   | 0.57 - 190.38  | 59          |
| Juveniles    | 9.21 ± 8.30                    | 1.35 - 22.06   | 8           |
| Males        | 8.39 ± 8.28                     | 0.87 - 33.61   | 29          |
| Females      | 22.08 ± 48.78                   | 0.70 - 190.38  | 28          |
| Total        | 13.98 ± 32.55                   | 0.57 - 190.38  | 67          |
| Non-Reproductive |                          |                |             |
| Adults       | 19.39 ± 35.14                   | 0.32 - 182.52  | 59          |
| Juveniles    | 18.58 ± 28.45                   | 0.60 - 85.38   | 9           |
| Males        | 12.63 ± 20.13                   | 0.46 - 81.83   | 32          |
| Females      | 27.48 ± 45.95                   | 0.32 - 182.52  | 28          |
| Total        | 19.29 ± 34.14                   | 0.32 - 182.52  | 68          |

Females showed larger home ranges than males (table 1) in both seasons; however, this difference was significant only in the non-reproductive season (Mann-Whitney U test: $U' = 2.075$, $N$
= 23, P < .05). Apparently, females also move further in the rocky outcrops, but this difference wasn’t significant (Mann-Whitney U test: U’ = 0.8183, N = 57, P = 0.4126).

It was not possible to compare home ranges between age classes due to the low value of the juveniles’ home ranges; however, comparison of displacements of adults and juveniles did not show significance in any season (Mann-Whitney U test: U’ = 0.3287, N = 68, P = 0.7424).

Since there were no significant differences in comparing reproductive and non-reproductive seasons, all data were grouped to compare body size and home range. There is no increase of home ranges following body size (simple linear regression, F = 0.0054, N = 80, P = 0.8149).

4 DISCUSSION

Home range is considered an important indicator of resource requirements in relation to availability in the environment and the characteristics of animal behavior, it is important to understand which factors determine the size and distribution of an individuals’ area (Perry & Garland, 2002). For H. uruguayensis, the average size of home ranges varied in both periods considered, the largest areas occurring in the non-reproductive season than in the reproductive season, although these differences were not significant. Home ranges diminish along warmer seasons (Wone & Beauchamp, 2003) what may be a consequence of partners getting closer in the reproductive season. This was reported for Phrynosoma beauchamp in California (Wone & Beauchamp, 2003). On the other hand, in colder seasons, individuals need to accumulate energetic resources, what results in larger home ranges because of the increasing foraging area (Wone & Beauchamp, 2003).

Apparently, home ranges of male lizards depend on the presence and dispersal of females; on the other hand, selection of females’ home ranges does not depend on the presence of males (M’Closkey et al., 1990; Guyer, 1994). The size of females’ home ranges is determined by energetic needs (Perry & Garland, 2002), while the size of males’ home ranges is defined mainly by social factors, such as the number of females present (Frutos, Camporro & Ávila, 2007). In this study, females showed larger home ranges than males and a great area overlap and displacement between males and females on both seasons (figures 1 and 2).

For H. uruguayensis females, the factor that appears to be decisive for displacement and definition of home ranges is the presence of communal nests (Gudynas, 1986); the same is true for other species of the genus (H. borelli – Godoy & Pinheira-Donoso, 2009). A hypothesis that would explain such characteristic would be that females cover greater distances in order to increase genetic variability within the population, once the gene flow among populations could be low due to environment specificity – specific isolated rocky outcrops (Felappi et al., 2015). However, during nesting period, females would have to return to where the communal nests are. It was observed that
females of some lizard species choose sites that were already used and where incubation was successful; thus, disputes for nesting sites may occur sometimes (Espinoza & Lobo, 1996). Evidence of this dispute is the presence of the species eggs in its diet (Nunes, 2009).

For some lizard genera body size is strongly associated to the home range size (Turner, Jennrich & Weintraub, 1969; Christian & Waldschmidt, 1984; Rocha, 1999). Several authors have explained this strong relation based on factors such as energetic requirements and foraging costs (Schoener, 1968). Other studies build a relation between home range and sexual dimorphism, showing that species with greater body size dimorphism have greater differences between male and female home ranges (Stamps, 1983; Rocha, 1999). For example, when males are larger than females, one can predict that males have greater home ranges than females. However, for species like *H. uruguayensis*, which has no sexual dimorphism (Felappi et al., 2015) and does not share feeding niches according to sex (Nunes, 2009), one would expect that this would be reflected on the size of home ranges found; our data showed that there are no differences of home range size and individual body size.

The low number of juvenile recaptures made impractical to calculate the differences between adults and juveniles home ranges. This low number of recaptures may be a consequence of the study area’s complexity and size, what made difficult to visualize individuals. Nevertheless, it was possible to estimate juveniles displacements, demonstrating that they move a lot within the study area. A large juvenile displacement may reflect dispersal movements to establish new home ranges (Van Sluys, 1997). The study area also influences the lack of territoriality, with areas and displacement of individuals overlapping (Ferner, 1974). This is because the concentration of lizards on rocky outcrops is uneven; fewer lizards occupy plain areas, and this concentration may reflect a different territoriality social structure (Ferner, 1974).

Due to the lack of knowledge about the ecological aspects of *Homonota uruguayensis* and other South American Gekkotas, long-term studies should be encouraged. In the present study, the geckos showed the existence of higher home ranges in females than in males, even though there is no sexual dimorphism by size for the species, which may suggest that this characteristic is linked to reproduction and community nests. The study of *H. uruguayensis* home ranges makes clear the need to expand research to include distribution parameters for geckos and to make possible comparisons within the group and among other groups.
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