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**Short Communication**

# Sexual dimorphism of snout–vent length in *Liolaemus nigroviridis* (Squamata: Liolaemidae)

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**Palavras-chave:** América do Sul, Iguana-arborícola-verde-e-preta, Lagarto-de-ilha-do-céu, Tamanho do corpo, Terras altas.

Sexual dimorphism in body size exists in many reptile species (see e.g. Olsson *et al.* 2002, Valdecantos *et al.* 2019, Liang *et al.* 2021, Rodríguez-Rodríguez and Calderón-Espinosa 2024). *Liolaemus* Wiegmann, 1834 is the predominant reptile genus in the southern cone of South America, currently comprising at least 289 recognized species (Uetz *et al.* 2024). For several species of the group, it has been described that males are larger than females (see Cabrera *et al.* 2013, Mella 2017). However, for most species in the genus there are no quantitative studies analyzing size differences between males and females (although see Cabrera *et al.* 2013, Maia-Carneiro and Rocha 2013). Usually, snout–vent length (SVL) is one of the most commonly used characteristics for measuring body size in herpetozoans, which is the measurement from the tip of the snout to the posterior margin of the precloacal scales (Breitman *et al.* 2015).

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*Liolaemus nigroviridis* Müller and Hellmich, 1932 is an endemic Chilean lizard inhabiting the sky islands, distributed from the southern Coquimbo Region (30° S) to the northern O'Higgins Region (34° S) (Cianferoni *et al.* 2013, Mella-Romero *et al.* 2023). *Liolaemus nigroviridis* populations inhabit the Coastal and Andean mountain ranges. The highest concentration of records for the species occurs between 2,000 and 2,800 m a.s.l. (Mella-Romero *et al.* 2023). Although *L. nigroviridis* is considered by the IUCN as Least Concern, this species would be facing threats derived from climate and land-use change (Mella-Romero *et al.* 2024a, Mella-Romero *et al.* 2024b, Moya *et al.* 2024). Natural history observations suggest that males of this species are larger and more robust than females (Donoso-Barros 1966, Mella 2017). However, this has not been quantified nor evaluated.

In this context, we hypothesize that there is sexual dimorphism in size in *L. nigroviridis,* with males of the species having a larger SVL than females.

To obtain data and test our hypothesis, we conducted herpetological sampling in the locality of Farellones (33°21'31.75" S, 70°17'42.40" W), in the Andes mountains in the Metropolitan Region of Chile. On 17 December 2022, we captured 98 specimens (47 females and 51 males) of *L. nigroviridis* between 09:15 h and 19:45 h. The area covered by the study was 9 ha. The captures were performed with the permission of the pertinent national agency (SAG, R.E. N° 5116/2022) and followed the protocol authorized by the Institutional Animal Care and Use Committee (Comité Institucional de Uso y Cuidado de Animales; CICUA) of the University of Chile (Certificado N° 22605-FCS-UCH).

We considered only adult specimens (juveniles were discarded and released). Juveniles were identified by (i) head length < 13 mm (Fuentes 1976), (ii) greyish-brown tone (without greenish scales), and (iii) presence of a discontinuous vertebral line (Donoso-Barros 1966, Mella 2017). We identified adult females and males of *L. nigroviridis* by the shape of the cloaca (rounded in females, square in males), and by the presence of precloacal pores, which are present in males and absent in females (Ruiz de Gamboa 2021). For each individual, we recorded its SVL using a digital caliper (Stainless Hardened, 0.01 mm) (Breitman *et al.* 2015). Measurements were always made by one specialist (JM-R). The lizards were retained in individual cloth bags until all measurements were completed. After the measurements had been taken, *L. nigroviridis* individuals were released at the same capture site.

To determine if there are differences in body size between females and males of *L. nigroviridis* using SVL, we performed data characterization by analyzing the assumptions of normality and homoscedasticity of both data sets (Cabrera *et al.* 2013). Since the distribution of the data for female lizards differed from a normal distribution ($p < 0.05$) and complied with the homoscedasticity principle ($p > 0.05$), we applied the Mann-Whitney U test for differences between two data sets (females and males) for nonparametric data, with the subsequent power test of the analysis. We selected a non-parametric test over data transformation since the distribution and categorization of our data fit the requirements of the Mann-Whitney U test (Conover 1999, Newbold *et al.* 2013). To perform the statistical analysis and elaborate the figures shown below, we used the software RStudio version 3.4.1 (Wickman 2016).

We found significant differences in SVL between females and males ($W = 2283$; $p < 0.001$) with a statistical power of 0.69 ($d = 0.5$; $p = 0.05$). Females had a mean SVL of 6.07 ± 0.49 cm (SD) with a higher frequency of data between 6.1 and 6.4 cm (min. 4.68 cm; max. 7.01 cm). For males, the mean SVL was 7.37 ± 0.56 cm (SD) with a higher frequency of data between 7.0 and 7.7 cm (min. 5.98 cm; max. 8.42 cm) (Figures 1 and 2). Females had a median of 6.08 cm, and males had a median of 7.43 cm (Figures 1 and 2).

We corroborated our hypothesis of sexual size dimorphism in *L. nigroviridis,* with males of the species having a higher SVL than females.

For some species of the genus *Liolaemus,* it is assumed that males are larger and more robust than females (see Mella 2017). Some studies report SVL, but do not analyze whether this characteristic shows sexual dimorphism (e.g. Campos-Soto *et al.* 2023). Of the studies that analyzed this variable, some do not find differences between females and males (e.g. Mella *et al.* 2023), while others do (e.g. Cabrera *et al.* 2013, Maia-Carneiro and Rocha 2013, Villamil *et al.* 2017). When sexual size dimorphism occurs in *Liolaemus,* there are cases in which males are larger, while in other cases, females are larger (Valdecantos *et al.* 2021). For example, in Cabrera *et al.* (2013), 22 species of *Liolaemus* were analyzed for sexual dimorphism in body size. In 16 of the 22 species, males were larger, while females were the larger sex in only six species. Our results showed that in *L. nigroviridis* males are significantly larger than females.

Sexual dimorphism in body size in species of lizards would be related, in ecological terms, to intra and intersexual selection (Carothers 1984,

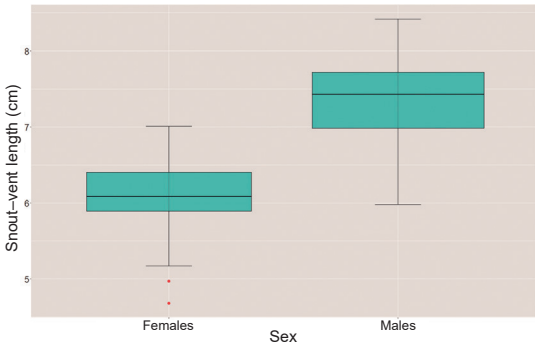


**Figure 1.** Snout–vent length for females and males of *Liolaemus nigroviridis.* Red dots indicate outliers. The horizontal black line in the boxplots indicates the mean.

Olsson *et al.* 2002). Thus, males would be larger because this favors them in aggressive encounters with other males or because larger males are better evaluated by females (Carothers 1984, Carothers *et al.* 1998, Cabrera *et al.* 2013). Since males of *L. nigroviridis* are territorial (see Carothers 1987), it is very likely that having a large body size is useful in intrasexual fights and territorial vigilance, which would provide an ecological explanation for the larger body size of males in the species (Valdecantos *et al.* 2021). Although intersexual selection (e.g. courtships by the males involving physical displays; Dunham and Wilczynski 2014) could be another explanation for sexual size dimorphism in *L. nigroviridis,* this has not been studied.

We should mention that in *Liolaemus* the SVL would not be the only characteristic of the males proposed as a subject of sexual selection, but also the head size (Vanhooydonck *et al.* 2010, Cabrera *et al.* 2013), both having relation with advantages in the territorial encounters between males (Valdecantos *et al.* 2021).

We consider that the relationship between male body size and intra or intersexual selection is an interesting avenue to investigate to answer ecological questions about *Liolaemus* species. Studies such as this one offer quantitative support to natural history observations and fill information gaps about these lizards, which constitute the most diverse reptile genus in the southern cone of South America.

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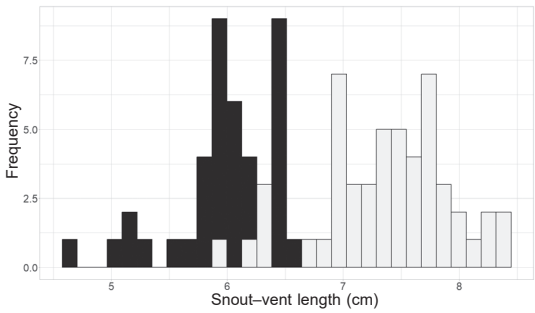


**Figure 2.** Frequencies of snout–vent length data for females (black bars) and males (white bars) of *Liolaemus nigroviridis.*

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