Caldasia 47: e107014 | 2025
http://www.revistas.unal.edu.co/index.php/cal

CALDASIA
Fundada en 1940

ISSN 0366-5232 (impreso)
ISSN 2357-3759 (en línea)

ECOLOGÍA

Activity pattern of the Lorenz's tree iguana *Liolaemus lorenzmuelleri* in Coquimbo, Chile

Patrón de actividad de la lagartija de Lorenz Müller *Liolaemus lorenzmuelleri* en Coquimbo, Chile

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- **Received:** 11/Sep/2023
- **Accepted:** 20/Mar/2025
- **Online Publishing:** 21/04/2025

Citation: Chávez C, Lozada-Piña A, Tabilo-Valdivieso E. 2025. Activity pattern of the Lorenz's tree iguana *Liolaemus lorenzmuelleri* in Coquimbo, Chile. 47:e107014. doi: https://doi.org/10.15446/caldasia.v47.107014

ABSTRACT

Liolaemus lorenzmuelleri is a lizard endemic to Chile. Some authors indicated that its activity pattern was unimodal; however, no evidence was found to support this statement. The objective of this study was to verify the unimodal activity pattern of *L. lorenzmuelleri*, based on quantitative data. Thirty-five videos recorded between August and December 2022 of an individual of the species were examined. The times and dates of recording were analyzed with the Kernel density function. It was concluded that the species exhibited a unimodal activity pattern for the study period.

Keywords: Bimodal, Camera trap, Diurnal activity, Kernel, Unimodal

RESUMEN

Liolaemus lorenzmuelleri es un lagarto endémico de Chile. Algunos autores indicaron que su patrón de actividad fue unimodal; sin embargo, no se encontró evidencia que respalde esta afirmación. El objetivo de este estudio fue comprobar el patrón de actividad unimodal de *L. lorenzmuelleri*, a partir de datos cuantitativos. Se examinaron 35 videos grabados entre agosto y diciembre de 2022, de un individuo de la especie. Las horas y fechas de registro se analizaron con la función de densidad de Kernel. Se concluyó que la especie presentó un patrón de actividad unimodal, para el periodo del estudio.

Palabras clave: Actividad diurna, Bimodal, Cámara trampa, Kernel, Unimodal

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INTRODUCTION

Activity patterns in animals are associated with behaviors such as escape from predators, foraging, or thermoregulatory sites (Gibbons y Semlitsch c1987, Labra *et al*. c2008). These activities are concentrated in a time interval that depends on the weather, sunlight, photoperiod length, environmental temperature, and the activity time of their prey (Díaz and Cabezas-Díaz 2004, Labra *et al*. c2008). There is evidence that species of the genus *Liolaemus* Wiegmann, 1834 presented bimodal activities in spring and summer, and unimodal activities in autumn and winter. *Liolaemus alticolor* Barbour, 1909 and *Liolaemus jamesi* (Boulenger, 1891) (species that live at elevations higher than 4000 m above sea level) concentrate their activities at midday (unimodal activity), a time with greater availability of thermal resources (Marquet *et al*. 1989). Other species showed bimodal activity, such as *Liolaemus curis* Núñez and Labra, 1985 and *Liolaemus constanzae* Donoso-Barros, 1966 (Núñez 1996, Labra *et al*. 2001). The activity pattern of *Liolaemus wiegmannii* (Duméril & Bibron, 1837) and *Liolaemus darwinii* (Bell 1843) varies seasonally, being bimodal in warm periods with a decrease at midday; and unimodal in warmer months, concentrated at midday (Videla and Puig 1994, Martori *et al*. 1998). There are even species such as *Liolaemus fabiani* Núñez and Yáñez, 1983, whose individuals are active throughout the day (Labra *et al*. 2001).

Liolaemus lorenzmuelleri Hellmich, 1950 inhabits central-northern Chile (Chávez-Villavicencio 2022). Although it is a well-known species, its activity pattern has not been systematically studied. Cortés et al. (1995) indicated that *L. lorenzmuelleri* presented a period of unimodal activity, probably from direct observations of the specimens. Lobos (2022) contributed to the knowledge of the activity pattern of this species, reporting that the highest number of records was made between 13:00 and 17:00 hours, coinciding with the highest temperatures of the day. Since the references to the activity pattern of this species were descriptive, we proposed to prove the unimodal activity pattern of *L. lorenzmuelleri*.

MATERIAL AND METHODS

We conducted the study in the Cordillera of the municipality of La Higuera, in the north of the Coquimbo region. We collected data between August and December 2022. In one day, we selected two sites to place camera traps, after confirming the presence of individuals of the species. These individuals were observed in situ between 13:00 and 17:00 h. During this time, the presence of other species was not observed. The sites are located on Route D-115, which departs from Route 5 North towards the Andean Cordillera (Fig. 1). We located the first trap camera (29°27'56 "South and 70°34'17 "West, 2665 m above sea level) in a substrate composed of soil, sand, stones, and scattered bushes. The second camera (29°24'23 "South and 70°29'14 "West, 3210 m above sea level) is located on a rocky slope with rocky soil, scattered stones, and very sparse herbaceous vegetation. The cameras (Browning Strike Force HD Pro X) were set to record 20-second

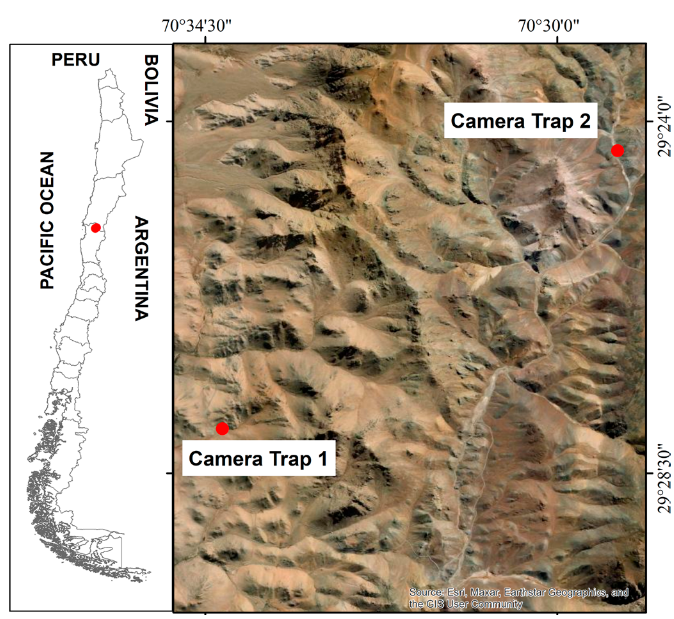

Figure 1. Location of the camera traps used in this study.

Figure 2. a: *Liolaemus lorenzmuelleri* observed at the first site. **b:** *L. lorenzmuelleri* observed at the second site. **c:** Screenshots of the video of *L. lorenzmuelleri* at the second site with the second camera. The individual corresponds to the one in (fig. 1b).

videos in 1600 x 900p HD quality and were always active. To be certain that the individuals recorded on video by the camera traps corresponded to *L. lorenzmuelleri*, we photographed each one (Fig. 2) and compared them *in situ* with the individuals captured on video.

The activity pattern of the individual was calculated with the date and time records obtained from the camera trap videos. The analysis was performed with the Kernel density function of the "camtrapR" package (Niedballa *et al.* 2016) of R v4.2.1 (R Core Team c2021).

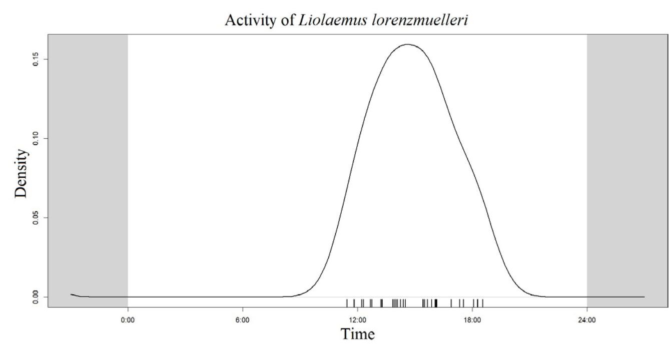

Figure 3. Kernel densities function of the activity pattern in *Liolaemus lorenzmuelleri* between August and December 2022.

RESULTS

We obtained 35 activity records of the species in 36 videos from the second camera trap (Supplementary File 1). No video was recorded from the first one. In all the videos, we observed the individual walking or running. The minimum activity temperature was 8°C on two occasions: September 8 at 13:16 h and September 23 at 18:16 h. The maximum observation temperature was 30°C at 17:32 h on December 15. The earliest activity was 11:26 h (November 23, 22°C), while the latest was 18:32 h (November 10, 12°C). Additionally, we recorded the individual entering under a layer of ice (August 29, 11:48 h, 16°C; and 12:18 h, 17°C) and ingesting it at another time (September 5, 12:13 h, 23°C). The activity pattern of the individual was unimodal, concentrating its activity between 12:00 and 18:00 h (Fig. 3). The highest activity record (ten) coincided with 17°C, between 14:00 and 16:00 h (Fig. 3).

DISCUSSION

The activity pattern observed in *L. lorenzmuelleri* aligns with what has been reported for other species within the genus *Liolaemus* that inhabit similar environments. The unimodal activity concentrated between 12:00 and 18:00 h corresponds with the availability of thermal resources, which is crucial for ectothermic reptiles that rely on external heat sources to regulate their body temperature (Marquet *et al.* 1989). This behavior is consistent with other species of *Liolaemus* found at high altitudes, where the thermal window for activity is limited. For instance, *Liolaemus alticolor* and *Liolaemus jamesi*, which inhabit elevations above 4000 m, also exhibit a unimodal activity pattern concentrated around midday when temperatures are more favorable (Marquet *et al.* 1989). The concentration of activity during the warmest part of the day is likely a strategy to optimize thermoregulation and metabolic efficiency, allowing these lizards to perform essential behaviors such as foraging and reproduction.

The research site's elevation likely plays a significant role in shaping the activity pattern of *L. lorenzmuelleri*. At higher altitudes, temperatures fluctuate more drastically, and the day when temperatures are suitable for activity is narrower (Omura 2012). In our study, the temperatures during observed activity ranged from 8°C to 30°C, indicating that *L. lorenzmuelleri* is active across a relatively broad thermal range. However, the peak activity recorded between 14:00 and 16:00 h, with the highest frequency of observations at 17°C, suggests that this species may have a preferred temperature range for optimal activity.

The analysis of the videos provides additional insights into the behavior of *L. lorenzmuelleri* during the study period. The individual was highly active during the observation times, but we did not record any clear thermoregulatory or feeding behaviors, suggesting these activities may occur outside the camera trap's range. To capture a more comprehensive picture of the species' activity, future studies should consider increasing the number of camera traps, strategically placing them in locations where thermoregulatory behaviors, such as basking or feeding, are likely to occur. The record of the individual moving under a layer of ice could be related to the search for food or escape from a predator. However, it was novel that an insectivorous species (Mella 2017) consumed ice, which led to the question: Could ice be a source of water (hydration) or is it a mechanism to reduce body temperature?

Our study confirmed that the activity pattern of *L. lorenzmuelleri* was unimodal, as suggested by Cortés *et al.* (1995). By employing a more systematic and exhaustive methodology, we not only validated these earlier observations but also highlighted the importance of using appropriate statistical tools to analyze activity patterns. Future research should continue to explore the ecological and behavioral implications of this activity pattern, including how it influences predator-prey dynamics, reproductive success, and survival in such a challenging environment.

AUTHOR´S CONTRIBUTION

CCV, ALP and ETV planned and designed the study, participated in the field sampling, conducted data analysis, wrote, and discussed the manuscript

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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