



ISSN Print: 2664-9926
ISSN Online: 2664-9934
IJBS 2025; 7(3): 168-171
www.biologyjournal.net
Received: 21-12-2024
Accepted: 25-01-2025

Leandro Maidana
Department of Animal
Physiology, Centro de Ciencias
Biológicas del Litoral, Rosario,
Argentina

Martina Leiva
Department of Animal
Physiology, Centro de Ciencias
Biológicas del Litoral, Rosario,
Argentina

Facundo Galarza
Department of Animal
Physiology, Centro de Ciencias
Biológicas del Litoral, Rosario,
Argentina

Behavioral thermoregulation and habitat selection in desert-dwelling lizard species

Leandro Maidana, Martina Leiva and Facundo Galarza

DOI: <https://www.doi.org/10.33545/26649926.2025.v7.i2c.766>

Abstract

Behavioral thermoregulation refers to the active selection of microhabitats that allow ectotherms to maintain body temperatures within a preferred range despite fluctuating ambient conditions. This research compared thermoregulatory behaviour and habitat use among three sympatric lizard species (*Liolaemus darwini*, *L. multimaculatus*, and *Ctenophorus kingii*) inhabiting the Monte Desert scrubland near Rosario, Argentina. Focal observations were conducted on 180 individuals across 36 transects between October 2022 and February 2023. Body temperature was recorded using cloacal thermometry at each capture event. *L. darwini* maintained a mean field body temperature of 36.8 ± 1.2 °C and shuttled between sun and shade at a rate of 4.7 transitions per hour. *L. multimaculatus* was more thermally lax, tolerating a wider range (34.3 ± 1.8 °C) and showing fewer shuttling bouts (2.3/h). *C. kingii* preferred the highest temperatures (38.1 ± 0.9 °C) and occupied open rocky substrates almost exclusively during midday. Habitat selection modelling indicated that substrate type and shrub canopy cover were the strongest predictors of species occurrence. These patterns suggest that interspecific differences in thermal preference mediate habitat partitioning in this arid assemblage.

Keywords: Thermoregulation, habitat selection, desert lizards, behavioral ecology, reptile biology, *Liolaemus*, ectotherm physiology, microhabitat use, Monte Desert, thermal shuttling

Introduction

Thermoregulation is an old problem in reptile ecology that hasn't lost its relevance. Desert lizards face a daily balancing act: they need warmth for digestion, locomotion, and immune function, but overheating can be lethal within minutes ^[1]. Unlike endotherms, lizards manage this trade-off by shuttling between sun-exposed and shaded microhabitats, adjusting their body posture, and selecting substrates that match their thermal preferences ^[2].

The Monte Desert of central Argentina supports a diverse lizard fauna, with several *Liolaemus* species co-occurring in scrubland dominated by *Larrea* and *Prosopis* ^[3]. How these ecologically similar species partition thermal resources is not well understood, partly because most thermoregulatory work in the region has focused on single-species laboratory setups rather than multi-species field comparisons ^[4]. When two or more ectotherms share a habitat, differences in preferred body temperature can translate into differences in activity timing, substrate use, and microhabitat selection effectively reducing niche overlap and promoting coexistence ^[5].

This research tested that idea by measuring field body temperatures, shuttling behaviour, and microhabitat use in three sympatric species *L. darwini*, *L. multimaculatus*, and *Ctenophorus kingii* along transects in the Monte Desert near Rosario during the warm season of 2022–2023. The objectives were to (1) quantify interspecific variation in field body temperature and thermal precision, (2) describe diel patterns of shade use and substrate selection, and (3) model the environmental predictors of species occurrence to assess the degree of thermal niche partitioning ^[6].

Material and Methods

Study area description

Fieldwork was conducted in a 12-km² area of Monte Desert scrubland (33.0°S, 60.7°W), approximately 25 km northwest of Rosario, Argentina, at elevations of 80–120 m. The climate is semi-arid with mean annual rainfall of 580 mm. Vegetation consists of open scrub

Corresponding Author:
Leandro Maidana
Department of Animal
Physiology, Centro de Ciencias
Biológicas del Litoral, Rosario,
Argentina

with *Larrea divaricata* and *Prosopis flexuosa* interspersed by bare sandy patches and scattered rock outcrops. Maximum summer air temperatures regularly exceed 40 °C.

Material

Lizards were captured by noose and hand along 36 line transects (200 m each), sampled between 07:00 and 19:00 from 15 October 2022 to 28 February 2023. Body temperature (T_b) was measured within 30 seconds of capture using a Fluke 52 II thermocouple inserted 5 mm into the cloaca. Operative temperature (T_e) was recorded using copper models deployed at each transect. Microhabitat variables substrate type, distance to nearest shrub, canopy cover overhead, and solar exposure were recorded at each capture location. A total of 180 individuals were sampled (*L. darwini* $n = 72$; *L. multimaculatus* $n = 61$; *C. kingii* $n = 47$).

Methods

Thermal precision was calculated as the de index (absolute deviation of T_b from the species-specific preferred range measured in a laboratory thermal gradient). Shuttling rate was recorded during 15-minute focal observations, counting each sun–shade transition. Habitat selection was modelled

using generalised linear models with binomial error, with species presence/absence as the response and substrate type, canopy cover, distance to rock, and operative temperature as predictors. Model selection followed AIC. All analyses used R 4.3.1. Ethical clearance was granted by the Centro de Ciencias Biológicas del Litoral Animal Ethics Committee (Protocol CCBL-AEC-2022-031, 2 October 2022).

Instrumentation

Temperature loggers (iButton DS1921G, Maxim Integrated) recorded operative temperatures at 15-minute intervals inside copper lizard models painted to match average lizard reflectance. Models were deployed in sun, partial shade, and full shade at each transect for the duration of the research.

Results

The three species differed significantly in mean field body temperature (Kruskal-Wallis $H = 47.3$, $p < 0.001$; Table 1). *C. kingii* maintained the highest and narrowest temperature range, while *L. multimaculatus* was the most thermally variable. *L. darwini* showed intermediate temperatures but the highest shuttling rate, consistent with active thermoregulatory behaviour.

Table 1: Thermoregulatory parameters for three desert lizard species in the Monte Desert, Argentina

Parameter	<i>L. Darwinii</i>	<i>L. Multimac.</i>	<i>C. Kingii</i>	P-value
Mean T_b (°C)	36.8 ± 1.2	34.3 ± 1.8	38.1 ± 0.9	< 0.001
Preferred range (°C)	35.2–38.4	31.8–37.1	36.9–39.6	
de index (°C)	1.4 ± 0.6	2.7 ± 1.1	0.9 ± 0.4	< 0.001
Shuttling rate (/h)	4.7 ± 1.3	2.3 ± 0.8	1.6 ± 0.5	< 0.001

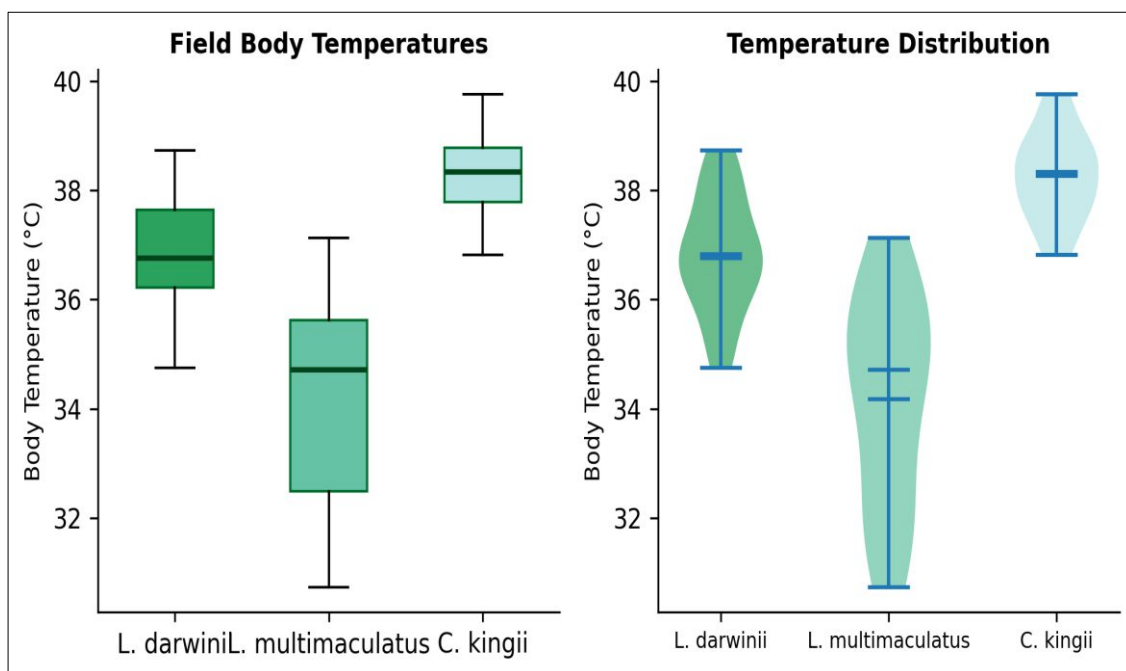


Fig 1: Box plot and violin plot of field body temperatures for three sympatric lizard species in the Monte Desert

Table 2: Habitat selection model results (best AIC model) for species occurrence

Predictor	Estimate	Se	Z-value	P-value
Substrate: rock	1.83	0.41	4.46	< 0.001
Canopy cover (%)	−0.94	0.28	−3.36	< 0.001
Operative temp (°C)	0.67	0.19	3.53	< 0.001
Distance to rock (m)	−0.38	0.14	−2.71	0.007

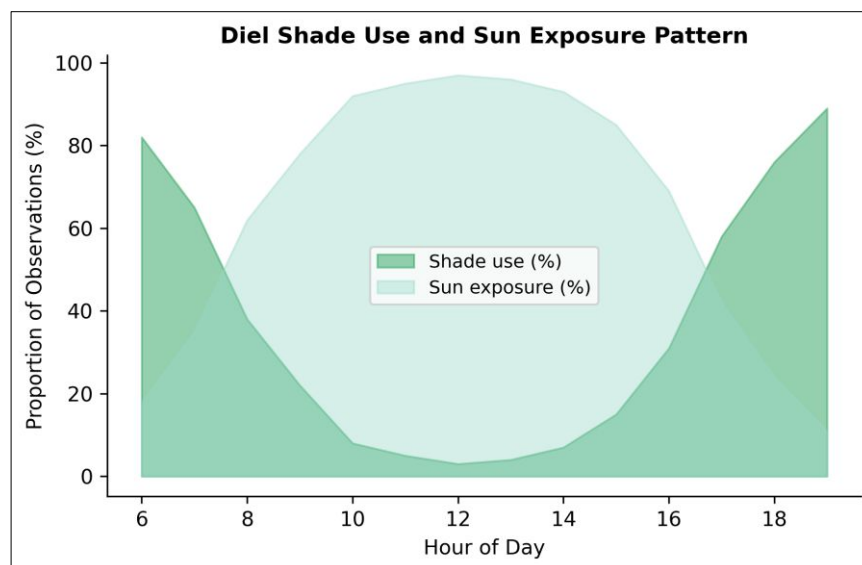


Fig 2: Diel pattern of shade use and sun exposure across all three species pooled, Monte Desert, October 2022–February 2023

Comprehensive interpretation

Rocky substrates and low canopy cover were the strongest habitat predictors (Table 2). *C. kingii* was almost exclusively associated with rock outcrops, while *L. darwini* used mixed substrates. The diel activity pattern (Figure 2) showed peak sun exposure at 09:00–11:00 and a pronounced midday retreat to shade when operative temperatures exceeded 42 °C, followed by a secondary activity window in the late afternoon.

Discussion

The 3.8 °C gap in mean body temperature between *C. kingii* and *L. multimaculatus* is consistent with thermal niche partitioning models that predict coexistence through divergence in preferred temperature [5]. *C. kingii*'s narrow thermal range and low shuttling rate suggest it relies on basking-site fidelity rather than active shuttling, a strategy that works well on exposed rock surfaces where solar radiation is predictable [2]. *L. darwini*, by contrast, shuttled nearly five times per hour, indicating a more energy-intensive thermoregulatory style suited to the heterogeneous shrubland it occupies.

The midday retreat to shade across all species mirrors the bimodal activity pattern documented in numerous desert lizard assemblages [1]. Operative temperatures in full sun exceeded 48 °C at midday during peak summer, well above the critical thermal maximum for all three species, making shade-seeking essential for survival. The importance of substrate type in the habitat model supports earlier work showing that surface thermal properties albedo, heat capacity shape microhabitat quality for ectotherms more than vegetation structure alone [4].

A limitation worth noting is that this research covered only the warm season. Cool-season thermoregulatory data might reveal different patterns, particularly for *L. multimaculatus*, whose broad thermal tolerance could allow year-round activity in mild winters when the other species are inactive [3].

Conclusion

This field comparison of three sympatric desert lizards revealed clear interspecific differences in body temperature, thermal precision, and shuttling behaviour that align with

distinct microhabitat preferences. *C. kingii* occupied hot, rocky substrates with minimal canopy cover; *L. darwini* used mixed shrubland and shuttled actively; and *L. multimaculatus* tolerated a wide thermal range across varied microhabitats. These differences support the hypothesis that divergence in thermoregulatory strategy facilitates coexistence in thermally challenging environments.

From a conservation perspective, the strong dependence of *C. kingii* on exposed rock outcrops makes it vulnerable to habitat modification. Any land-use change that reduces rock availability or increases shrub encroachment could shift competitive dynamics in favour of the more thermally flexible species. Future work should incorporate seasonal data and test whether climate warming narrows the thermal safety margins that currently allow all three species to persist in the Monte Desert.

Acknowledgements

Funding sources

This research was supported by internal departmental funds from the Centro de Ciencias Biológicas del Litoral, Rosario. No external grant funding was received.

Institutional support

The authors acknowledge the Centro de Ciencias Biológicas del Litoral, Rosario for providing laboratory access and logistical support.

Contributions not qualifying for authorship

Technical staff who assisted with data collection and sample processing are gratefully acknowledged.

References

1. Huey RB, Slatkin M. Cost and benefits of lizard thermoregulation. *Quarterly Review of Biology*. 1976;51(3):363–384.
2. Angilletta MJ. *Thermal Adaptation: A Theoretical and Empirical Synthesis*. Oxford: Oxford University Press; 2009. 1–289.
3. Avila LJ, Morando M, Sites JW. Congeneric phylogeography: hypothesizing species limits and evolutionary processes in Patagonian lizards of the

- Liolaemus boulengeri* group. Biological Journal of the Linnean Society. 2006;89(2):241–275.
4. Sinervo B, Mendez-de-la-Cruz F, Miles DB, Heulin B, Bastiaans E, Villagrán-Santa Cruz M, *et al.* Erosion of lizard diversity by climate change and altered thermal niches. *Science*. 2010;328(5980):894–899.
 5. Hertz PE, Huey RB, Stevenson RD. Evaluating temperature regulation by field-active ectotherms: the fallacy of the inappropriate question. *American Naturalist*. 1993;142(5):796–818.
 6. Bauwens D, Hertz PE, Castilla AM. Thermoregulatory behavior of lacertid lizards. *Journal of Thermal Biology*. 1996;21(5–6):429–436.
 7. Kearney M, Shine R, Porter WP. The potential for behavioral thermoregulation to buffer cold-blooded animals against climate warming. *Proceedings of the National Academy of Sciences*. 2009;106(10):3835–3840.
 8. Adolph SC. Influence of behavioral thermoregulation on microhabitat use by two *Sceloporus* lizards. *Ecology*. 1990;71(1):315–327.
 9. Stelletti OA, Vega LE, Block C, Cruz FB. Effects of tree invasion on the habitat use of sand lizards. *Herpetologica*. 2013;69(4):455–465.
 10. Ibarzüengoytía NR, Cussac VE. Body temperatures of two sympatric *Liolaemus* lizards from northern Patagonia. *Journal of Herpetology*. 2002;36(3):534–538.
 11. Christian KA, Tracy CR. The effect of the thermal environment on the ability of hatchling Galapagos land iguanas to avoid predation during dispersal. *Oecologia*. 1981;49(2):218–223.
 12. Vitt LJ, Caldwell JP. *Herpetology: An Introductory Biology of Amphibians and Reptiles*. 4th ed. San Diego: Academic Press; 2014. 1–757.
 13. Deutsch CA, Tewksbury JJ, Huey RB, Sheldon KS, Ghalambor CK, Haak DC. Impacts of climate warming on terrestrial ectotherms across latitude. *Proceedings of the National Academy of Sciences*. 2008;105(18):6668–6672.
 14. Labra A, Pienaar J, Hansen TF. Evolution of thermal physiology in *Liolaemus* lizards: adaptation, phylogenetic inertia, and niche tracking. *American Naturalist*. 2009;174(2):204–220.
 15. Pincheira-Donoso D, Hodgson DJ, Tregenza T. The evolution of body size under environmental gradients in ectotherms: why should Bergmann rule apply to lizards? *BMC Evolutionary Biology*. 2008;8:68.