SALAMANDRA **62**(3): 249–253
15 August 2026 | ISSN 0036–3375

SALAMANDRA
German Journal of Herpetology

Correspondence

Unexpectedly large nightly movement and extended activity in the endangered coastal desert gecko *Phyllodactylus angustidigitus* (Squamata: Phyllodactylidae)

Carlos Vilca-Alzamora & José Pérez

Universidad Nacional Mayor de San Marcos, Facultad de Ciencias Biológicas, Laboratorio de Ecología Integrativa, Lima, Peru

Corresponding author: Carlos Vilca-Alzamora, ORCID 0009-0004-4646-8490,
e-mail: carlos.vilcaa@unmsm.edu.pe

Manuscript received: 23 April 2026
Accepted: 23 June 2026 by Edgar Lehr

Space use is a fundamental ecological feature because it reflects how individuals obtain resources, locate mates, avoid predators, and respond to environmental constraints (Burt 1943, Nathan et al. 2008). In lizards, spatial behaviour is influenced by energetic (e.g., tail loss), morphological (e.g., size), social (e.g., territoriality) and reproductive factors (e.g., breeding season), which regularly shape the structure of home ranges (Turner et al. 1969, Stone & Baird 2002). Home range estimates provide a cumulative measure of space use, usually derived from repeated observations of individuals over extended periods (Burt 1943, Rose 1982). However, such estimates may obscure fine-scale movement behaviour that reflects behavioural decisions under specific environmental conditions (Levin 1992, Crane et al. 2021). Therefore, continuous tracking approaches could provide valuable insights into short-term spatial behaviour that are not captured by traditional home range estimates.

Despite extensive research on movement ecology in lizards, geckos (Gekkota) remain remarkably understudied. A review of lizard home range literature found only six studies on geckos among 489 sources examined (Perry & Garland 2002), highlighting a persistent taxonomic bias in reptile spatial ecology. Similarly, recent syntheses continue to reveal strong taxonomic biases in reptile movement datasets (Crane et al. 2021). This lack of information is likely caused by gecko-related characteristics – being generally small bodied, nocturnal and cryptic – leading to low detection- and recapture rates in conventional mark-recapture studies (Vitt & Caldwell 2014, Crane et al. 2021). Consequently, spatial behaviour in many gecko species remains poorly understood.

The Paracas Gecko (*Phyllodactylus angustidigitus* Dixon & Huey, 1970) is a small (snout–vent length, SVL: 37–57 mm) nocturnal gecko with terrestrial habits endemic to Peru (Dixon & Huey 1970) and classified as Endangered (EN) by the IUCN (PEREZ et al. 2016). It inhabits a small part of the hyper-arid coastal deserts of Ica Department (Pérez & Balta 2011). There, harsh environmental conditions and limited refuges may influence movement behaviour. Yet no information is currently available regarding its movement ecology. Here we present the first assessment of nightly movement in this species by tracking individuals throughout their nocturnal activity. By quantifying the area covered during a single night, we aimed to characterize short-term spatial behaviour in a poorly known desert gecko. Given its small body size, we expected limited nightly displacement.

Fieldwork was conducted at Laguna Grande within the Paracas National Reserve (14°9'1" S, 76°15'38" W), a hyper-arid coastal desert in southern Peru. The study site corresponds to open sandy beach habitat where *Phyllodactylus angustidigitus* occurs in high abundance (Dixon & Huey 1970). Sampling was carried out during May 2023, February 2024, and May 2024. This corresponds to the non-reproductive season (Goldberg 2016), when reproductive constraints and influences on movement are minimized (Miles et al. 2000). Surveys were performed between 19:00 and 06:00 h. Two HOBO dataloggers (Onset Computer Corporation, USA) were placed on the sandy substrate within the study area as a general characterization of nocturnal substrate conditions during tracking sessions. Dataloggers were programmed to record temperature at 1-min intervals throughout each sampling period. Sampling was conducted during two seasonally distinct thermal conditions: cooler conditions during May 2023 and May 2024 (mean nocturnal substrate temperature: 19.2 °C), and warmer conditions during February 2024 (mean: 24.7 °C).

Individuals were located by active search and captured by hand. SVL and tail length (TL) were measured using a digital caliper (± 0.1 mm). Body mass was recorded using a spring balance (± 0.1 g). The presence of a regenerated tail was noted. Sex was determined by the presence of hemipenal bulges at the base of the tail (Dixon & Huey 1970).

Each individual was marked with fluorescent powder (Dayglo) and released at the capture site. Fluorescent tracking methods have proven useful for documenting movements of small cryptic lizards under natural conditions (Roseno et al. 2024). Observers maintained a distance of approximately 3 m whenever possible to minimize interference during tracking. Individuals were then tracked throughout the night using a UV flashlight (UVBeast) (Supplementary Video S1). The UV flashlight was used intermittently every 3–5 minutes to verify the position of individuals while observers remained stationary whenever possible. Geographic positions were recorded every 3–5 minutes using a handheld GPS (Garmin GPSMAP 66i). Tracking continued until individuals ceased activity and returned to a refuge. No obvious behavioural alterations, such as repeated body rubbing or attempts to remove the fluorescent powder, were observed during tracking sessions (Supplementary Video S2). Individuals occasionally moved close to observers without apparent interruption of locomotor activity.

Because individuals were relocated at 3–5 minute intervals rather than continuously tracked position-by-position, cumulative linear distances between successive lo-

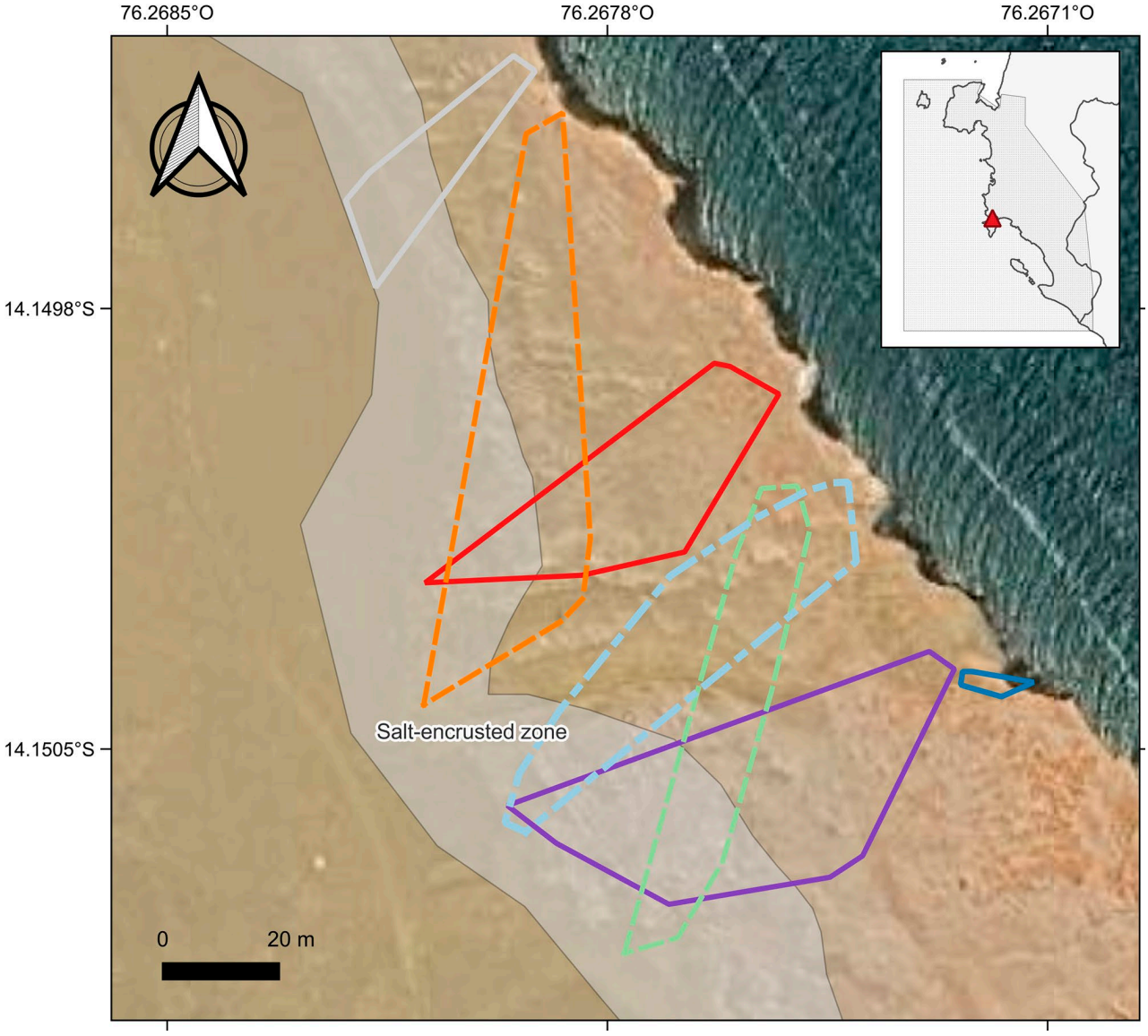

Figure. 1 Representative NMAs of *Phyllodactylus angustidigitus* at Laguna Grande, Paracas National Reserve, Peru. Each polygon corresponds to a different individual. The gray shaded polygon indicates the salt-encrusted zone. Inset shows the study location within Paracas National Reserve.

cations were not considered reliable estimates of total distance travelled. Individuals frequently exhibited irregular movements between observations, which could underestimate actual movement distances. Consequently, movement was quantified as nightly movement area (NMA), defined as the area covered by an individual during a single night based on all sequential coordinates obtained during tracking. Spatial data were processed in QGIS (v3.40.7), and NMAs were estimated using minimum convex polygons constructed from all recorded GPS positions. Differences in NMA between sexes, thermal conditions, and presence of regenerated tail were evaluated using t-tests. Relationships between NMA and SVL, TL, or body mass were assessed using Pearson correlation coefficients (r). All statistical analyses were performed in RStudio.

A total of 21 individuals (12 females, 9 males) were successfully tracked throughout their nocturnal activity. NMA varied widely among individuals, ranging from 31 to 1707.01 m^2 (mean: 850.86 ± 525.10 m^2). Tracking began near the shoreline, with movement trajectories mostly extending between the shoreline and inland salt-encrusted zones (Fig. 1, Online Resource 3). Considerable individual variation was evident, with some individuals moving only short distances while others covered large areas within a single night. Similarly, activity duration was highly variable, with some individuals remaining active until nearly dawn. The hour of retreat to refuges ranged from 00:12 to 05:45 h, indicating a broader nocturnal activity window than previously reported for the species.

Although most individuals ended their activity within the salt-encrusted zones, four individuals (two males and two females) retreated beneath rocks instead, which were identified as their daytime refuges. No significant differences in NMA were detected between sex, thermal condition, or presence of regenerated tail (Table 1). However, a tendency towards larger movement under warmer conditions was observed (Fig. 2). No correlation was detected between NMA and SVL, TL, or body mass (Table 1).

Our results show that *Phyllodactylus angustidigitus* exhibits unexpectedly large NMAs and prolonged activity hours despite its small body size and the extreme conditions of coastal deserts. Previous studies have reported positive relationships between body size and home range extent in lizards (Perry & Garland 2002), and therefore, relatively limited movement would be expected in a small-bodied gecko such as *P. angustidigitus*. Nevertheless, several individuals covered remarkably large areas in a single night. Individuals were most frequently encountered near the shoreline, where the species has been reported as particularly abundant (Dixon & Huey 1970). Movement trajectories generally followed a pattern extending from the shoreline towards inland salt-encrusted zones, suggesting a non-random use of space rather than undirected wandering. Such displacement may be associated with either foraging or dispersal processes between spatially separated habitat features (Clobert et al. 2012). However, the ecological drivers underlying the substantial variation in NMAs among individuals remain unclear and deserve further investigation. Even though our metric captures short-term movement rather than long-term home range, the sizes of NMAs observed in *Phyllodactylus angustidigi-*

Table 1. Statistical analyses of variables associated with NMA. Summary statistics values represent mean ± SD for categorical variables and Pearson's r for continuous variables.

	Summary statistic	p
Temperature		0.0535
Warmer (n = 8)	1129.77 ± 424.21	
Cooler (n = 13)	679.22 ± 520.38	
Sex		0.6513
Male (n = 9)	788.87 ± 569.21	
Female (n = 12)	897.36 ± 510.08	
Regenerated tail		0.2793
Yes (n = 9)	704.38 ± 495.35	
No (n = 12)	960.73 ± 540.51	
SVL (mm)	-0.1129	0.6259
TL (mm)	0.0229	0.9214
Body mass (g)	-0.1059	0.6478

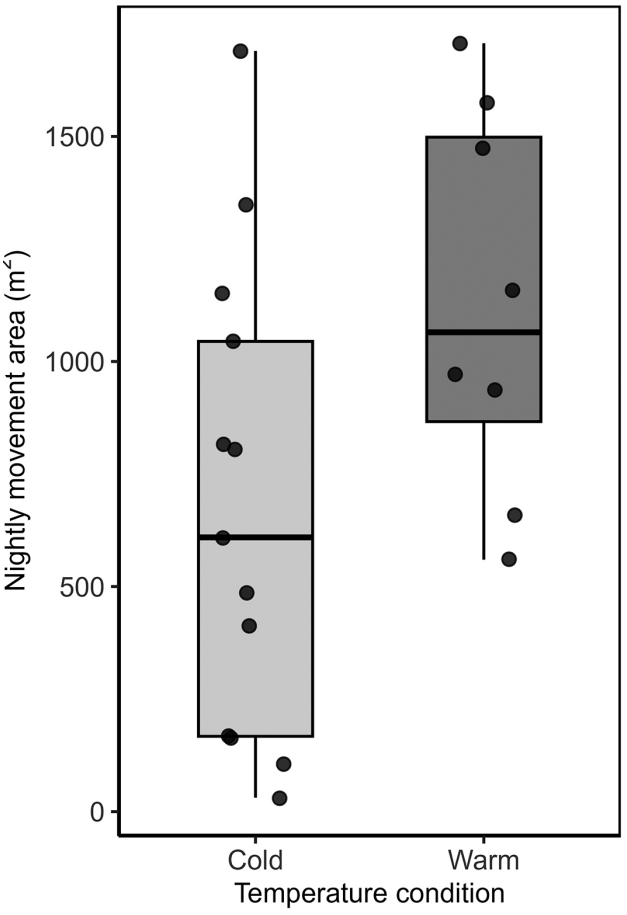

Figure. 2 Boxplot showing NMAs of *Phyllodactylus angustidigitus* under contrasting thermal conditions within the non-reproductive season.

tus are remarkable when contextualized with other desert geckos. Mean reported home range sizes in desert gecko species are within similar or even smaller spatial scales despite being estimated over longer time periods: *Teratoscincus przewalskii* (1345.3 ± 384.3 m^2, estimated over a five-year period, Semenov & Borkin 1992) and *Ptenopus garrulus garrulus* (10.4 ± 1.5 m^2, based on individuals observed for at least 10 days, Hibbitts et al. 2007). This may suggest that individuals of *P. angustidigitus* cover a substantial proportion of their activity space within a single night. Still, direct comparisons should be interpreted cautiously due to methodological differences. Nevertheless, the evidence reinforces the idea that movement extent in this species is greater than expected for a small-bodied desert gecko.

NMAs were not significantly affected by thermal conditions, but a tendency to larger movement under warmer conditions was observed. Temperature is an important driver of locomotor performance in ectotherms, so some degree of thermal dependence would be expected (Huey & Kingslover 1989, Angilletta et al. 2002). However, because body temperatures and fine-scale thermal conditions were not measured, the mechanisms underlying this pattern remain unclear. Nonetheless, extensive movement was observed under both nocturnal thermal conditions, suggesting that *Phyllodactylus angustidigitus* could be capable of sustained activity across a relatively broad range of nocturnal substrate temperatures.

In addition, intraspecific interactions can strongly influence movement patterns, as territoriality and competition frequently constrain space use and activity (Schoener & Schoener 1977, Perry & Garland 2002). Nevertheless, the lack of marked sexual dimorphism (Dixon & Huey 1970) and the absence of published and observed territorial interactions during tracking, suggest that agonistic interactions may be weak or absent. If so, these low levels of social interactions could further facilitate extensive nightly movements.

The inland salt-encrusted zone appeared to be consistently used as a refuge area by most tracked individuals. In structurally simple desert systems, localized structural features are known to have a disproportionate influence on reptile spatial ecology and persistence (Webb & Shine 2000, Michael et al. 2021). The repeated return of individuals to inland refuges suggests that these areas may represent an important component of habitat use in *Phyllodactylus angustidigitus*.

We provide novel insights into the fine-scale movement behaviour of a poorly known threatened gecko. The use of continuous tracking allowed us to capture short-term spatial dynamics that are often overlooked in traditional home range studies. Overall, our results suggest that movement capacity in small-bodied desert geckos may be underestimated and highlight the need to incorporate fine-scale approaches when evaluating movement ecology in arid environments. For *Phyllodactylus angustidigitus*, the recurrent use of shoreline and inland refuge zones suggests that conservation planning should consider the spatial connectivity between complementary habitats. Protecting structurally simple coastal deserts may therefore require preserving the microhabitats that sustain both nocturnal activity and daytime refuge use.

Acknowledgements

We thank M. Castillo, V. García, A. Miranda, F. Ludeña, and D. Serrano for fieldwork assistance. We also thank the Paracas National Reserve administration for the respective authorization (Resolution N°030-2021-SERNANP-RNP/J). This research was supported by Universidad Nacional Mayor de San Marcos – RR N°05557-2022-R, Project N°B22100451–PCONFIGI 2022.

References

Angilletta, M. J., P. H. Niewiarowski & C. A. Navas (2002): The evolution of thermal physiology in ectotherms. – Journal of Thermal Biology, **27**: 249–268.

Burt, W. H. (1943): Territoriality and home range concepts as applied to mammals. – Journal of Mammalogy, **24**: 346–352.

Clobert, J., M. Baguette, T. G. Benton & J. M. Bullock (2012): Dispersal ecology and evolution. – Oxford University Press, Oxford.

Crane, M., I. Silva, B. M. Marshall & C. T. Strine (2021): Lots of movement, little progress: a review of reptile home range literature. – PeerJ, **9**: e11742.

Dixon, J. R. & R. B. Huey (1970): Systematics of the lizards of the gekkonid genus *Phyllodactylus* of mainland South America. – Contributions in Science, **192**: 1–72.

Goldberg, S. R. (2016): Note on reproduction of *Phyllodactylus angustidigitus* (Squamata: Gekkonidae) from Peru. – Bulletin of the Chicago Herpetological Society, **51**: 45–46.

Hibbitts, T. J., M. J. Whiting & D. M. Stuart-Fox (2007): Shouting the odds: vocalization signals status in a lizard. – Behavioral Ecology and Sociobiology, **61**: 1169–1176.

Huey, R. B. & J. G Kingsolver (1989): Evolution of thermal sensitivity of ectotherm performance. – Trends in Ecology & Evolution, **4**: 131–135.

Levin, S. A. (1992): The problem of pattern and scale in ecology: the Robert H. MacArthur award lecture. – Ecology, **73**: 1943–1967.

Michael, D. R., H. Moore, S. Wassens, M. D. Craig, R. Tingley, D. G. Chapple, J. O'Sullivan, R. J. Hobbs & D. G. Nimmo (2021): Rock removal associated with agricultural intensification will exacerbate the loss of reptile diversity. – Journal of Applied Ecology, **58**: 1557–1565.

Miles, D. B., B. Sinervo & W. A. Frankino (2000): Reproductive burden, locomotor performance, and the cost of reproduction in free ranging lizards. – Evolution, **54**: 1386–1395.

Nathan, R., W. M. Getz, E. Revilla, M. Holyoak, R. Kadmon, D. Saltz & P. E. Smouse (2008): A movement ecology paradigm for unifying organismal movement research. – Proceedings of the National Academy of Sciences, **105**: 19052–19059.

Pérez J., A. Quiroz & K. Balta (2016): *Phyllodactylus angustidigitus*. The IUCN Red List of Threatened Species 2016: e.T48442719A48442730. – https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T48442719A48442730.en. Accessed on 27 March 2026.

Pérez, J. & K. Balta (2011): Ecología de *Phyllodactylus angustidigitus* y *P. gerrhopygus* (Squamata: Phyllodactylidae) de la Reserva Nacional de Paracas, Perú. – Revista Peruana de Biología, **18**: 217–223.

Perry, G. & T. Garland (2002): Lizard home ranges revisited: effects of sex, body size, diet, habitat, and phylogeny. – Ecology, **83**: 1870–1885.

Rose, B. (1982): Lizard home ranges: methodology and functions. – Journal of Herpetology, **16**: 253–269.

Roseno, R. S., D. Pareja-Mejia, L. S. Dos Santos, L. M. Diele-Viegas, L. M. Carilo, P. R. Nascimiento, G. G. Eidenberger & M. Solé (2024): Tracking the little ones: use of fluorescent powder to follow a leaf litter lizard (*Coleodactylus meridionalis*, Squamata: Sphaerodactylidae) in the Atlantic Forest of southern Bahia, Brazil. – Anais da Academia Brasileira de Ciências, **96**: e20230728.

Schoener, T. W. & A. Schoener (1982): Intraspecific variation in home-range size in some *Anolis* lizards. – Ecology, **63**: 809–823.

Semenov, D. V. & L. J. Borkin (1992): On the ecology of Przewalsky's gecko (*Teratoscincus przewalskii*) in the Transaltai Gobi, Mongolia. – Asiatic Herpetological Research, **4**: 99–112.

Stone, P. A. & T. A. Baird (2002): Estimating Lizard Home Range: The Rose Model Revisited. – Journal of Herpetology, **36**: 427–436.

Turner, F. B., R. I. Jennrich & J. D. Weintraub (1969): Home ranges and body size of lizards. – Ecology, **50**: 1076–1081.

Vitt, L. J. & J. P. Caldwell (2014): Herpetology: an introductory biology of amphibians and reptiles. – Academic Press, London.

Webb, J. K. & R. Shine (2000): Paving the way for habitat restoration: can artificial rocks restore degraded habitats of endangered reptiles? – Biological Conservation, **92**: 93–99.

Supplementary data

The following data are available online:

Supplementary Video S1. *Phyllodactylus angustidigitus* individual marked with fluorescent powder and illuminated with UV light during nocturnal tracking.

Supplementary Video S2. Tracked *Phyllodactylus angustidigitus* individual exhibiting no apparent behavioural disturbance during observation.

Supplementary Figure S3. Complete nightly movement areas (NMA) of all tracked individuals of *Phyllodactylus angustidigitus*.