

UPPER ELEVATIONAL RANGE EXTENSION OF *SCELOPORUS UTIFORMIS* COPE, 1864 (SQUAMATA: PHRYNOSOMATIDAE) IN THE SIERRA DE MANANTLÁN BIOSPHERE RESERVE, MEXICO

EXTENSIÓN DE DISTRIBUCIÓN ALTITUDINAL SUPERIOR DE *SCELOPORUS UTIFORMIS* COPE, 1864 (SQUAMATA: PHRYNOSOMATIDAE) EN LA RESERVA DE LA BIÓSFERA SIERRA DE MANANTLÁN, MÉXICO

FRANCISCO JAVIER MUÑOZ-NOLASCO^{1,2,3}, DANIEL CRUZ-SÁENZ* & FAUSTO ROBERTO MÉNDEZ-DE LA CRUZ²

¹Laboratorio de Interacción Planta-Atmósfera, Departamento de Ecología Funcional, Instituto de Ecología, Universidad Nacional Autónoma de México, Coyoacán, A. P. 70-153, C. P. 04510, Ciudad de México, México.

²Laboratorio de Herpetología, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, A. P. 70-153, C. P. 04510, Coyoacán, Ciudad de México, México.

³Unión de Especialistas en Biodiversidad, Conservación y Sustentabilidad (Unesbio), A. C., C. P. 45178, Zapopan, Jalisco, México.

*Centro de Estudios en Zoología, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, A. P. 1-1919, Zapopan, Jalisco, México.

*Correspondence: dcruzaenz@gmail.com

Received: 2022-07-20. Accepted: 2022-09-13. Published: 2022-10-06.

Editor: Irene Goyenechea Mayer Goyenechea, México.

Resumen.— Las Lagartijas Espinosas del Pacífico (*Sceloporus utiformis*) son endémicas de la vertiente del Pacífico de México. Son ovíparas y es sabido que habitan bosques tropicales y templados desde el nivel del mar hasta los 1800 m s.n.m. Aquí ampliamos este intervalo con base en el hallazgo, en mayo de 2022, de dos individuos de *S. utiformis* en la porción suroriental de la sierra de Manantlán, a 2,154 m de altitud. También proporcionamos datos morfométricos y temperaturas corporales en campo y del microhábitat de estos organismos. Un estudio previo realizado en la misma localidad hace casi tres décadas documentó la especie a altitudes mucho menores, por lo que proponemos la hipótesis de que este podría tratarse de un caso de desplazamiento de distribución ascendente por cambio climático. Además, ya que pocos miembros ovíparos del género *Sceloporus* habitan a más de 2,000 m de altitud, este registro detona muchas interrogantes acerca de las implicaciones ecológicas de la oviparidad a través de gradientes altitudinales.

Palabras clave.— Altitud, herpetofauna, Lagartijas Espinosas del Pacífico, registro.

Abstract.— Cope's Largescale Spiny Lizards (*Sceloporus utiformis*) are endemic to the Pacific slope of Mexico. They are oviparous and are known to inhabit tropical and temperate forests from sea level to 1800 m a.s.l. Here, we expand this range based on the finding, in May 2022, of two individuals of *S. utiformis* in the southeastern portion of the Sierra de Manantlán, at 2154 m elevation. We also provide data on morphometry and field body and microhabitat temperatures of these organisms. A previous study conducted at the same locality almost three decades ago found the species to be present at much lower elevations, so we hypothesize that this could be a case of upward range shifting due to climate change. Moreover, as few oviparous members of the genus *Sceloporus* occur above 2,000 m elevation, this record triggers many questions about the ecological implications of oviparity along elevation gradients.

Key words.— Cope's Largescale Spiny Lizards, elevation, herpetofauna, record.

Cope's Largescale Spiny Lizards (*Sceloporus utiformis* Cope, 1864) are slender-bodied, medium-sized lizards (SVL \approx 70 mm) with a tail more than double their body size and with an oviparous mode of reproduction (García & Ceballos, 1994; Heimes, 2022).

It is a Mexican endemic species distributed along the Pacific slope in the states of Sinaloa, Nayarit, Zacatecas, Jalisco, Colima, Michoacán, Guerrero, and Morelos, where it can be found in leaf litter, low bushes, and rocks in tropical deciduous, semi-

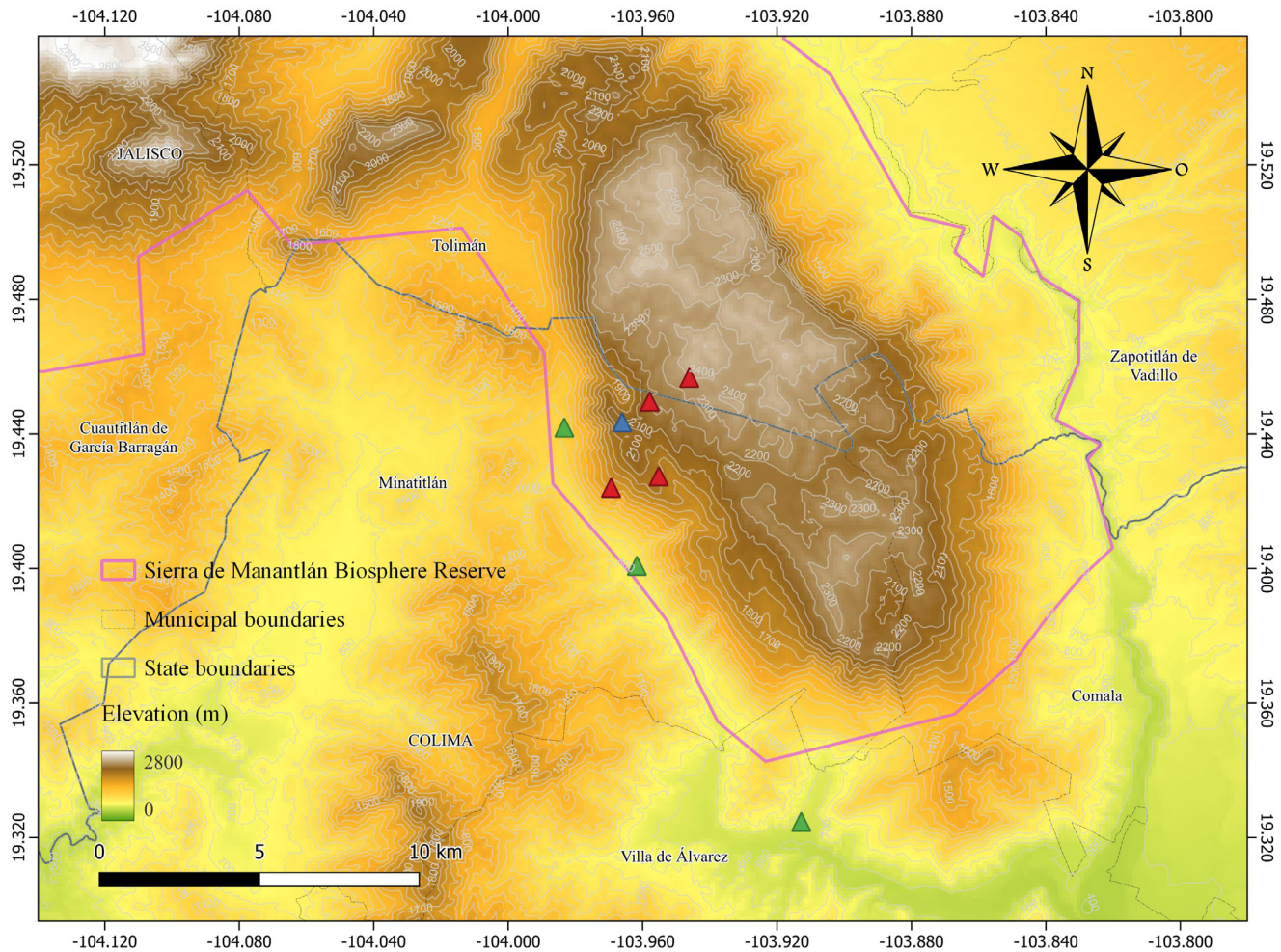


Figura 1. Mapa del área de Cerro Grande que muestra los sitios donde Loeza Corichi (2004) registró *Sceloporus utiformis* (triángulos verdes), sitios donde no registró la especie (triángulos rojos) y el nuevo registro altitudinal (triángulo azul).

Figure 1. Map of the area of Cerro Grande displaying locations where *Sceloporus utiformis* were recorded (green triangles) and were not recorded (red triangles) in Loeza Corichi (2004), as well as the new elevational record (blue triangle).

deciduous, oak, oak-pine, and pine-oak forests (Saldaña de la Riva & Pérez Ramos, 1987; García & Ceballos, 1994; Castro-Franco & Bustos Zagal, 2004; Uetz et al., 2022). This species is known to occur from sea level up to nearly 1,800 m a.s.l. (Saldaña de la Riva & Pérez Ramos, 1987; Köhler & Heimes, 2002; Heimes, 2022). Here, we expand this range based on the finding of two individuals of *S. utiformis* in the southeastern portion of the Sierra de Manantlán, known as Cerro Grande. This area, spanning from ca. 650 to 2,460 m elevation, differs from the rest of the Manantlán mountain massif by its primarily karstic composition (Martínez et al., 1998). Along its elevational gradient, Cerro Grande harbors six main vegetation types (tropical deciduous forest, tropical sub-deciduous forest, gallery

forest, montane cloud forest, oak forest, and pine forest), as well as areas of mixed and secondary vegetation (Vázquez & Givnish, 1998; INEGI, 2021).

On May 20th, 2022, between 12:57 and 13:34 h (GMT-5), while conducting a herpetological survey at the western slope of Cerro Grande, we found two female individuals of *S. utiformis* along a trail that takes to the viewpoint known as El Filete, in the locality of El Terrero, Minatitlán, Colima (19.443° N, 103.966° W; datum = WGS84; 2,154 m a.s.l.; Fig. 1). Habitat at this site consisted of oak forest with a relatively shallow layer (< 50 cm) of leaf litter, herbaceous elements, and rocky outcrops (Fig. 2). We recorded snout-vent length (SVL) and tail length of the organisms, using a



Figura 2. Individuo hembra de *Sceloporus utiformis* documentado en este estudio (izquierda) y su hábitat en la localidad de El Terrero, Minatitlán, Colima (derecha). Fotos: Francisco J. Muñoz-Nolasco.

Figure 2. Female individual of *Sceloporus utiformis* herein documented (left) and its habitat at the locality of El Terrero, Minatitlán, Colima (right). Photos: Francisco J. Muñoz-Nolasco.

digital caliper (± 0.01 mm), body mass, with a digital scale (± 0.1 g), as well as field body (cloacal) temperatures (T_b), air temperatures (T_a , 3 cm above perching site), and substrate temperatures (T_s) where the organisms were first spotted, using a Fluke 51-II digital read-out thermometer with a K-type thermocouple (± 0.01 °C). Both individuals were found in leaf litter.

The first individual had a SVL of 37 mm, a tail length of 65.9 mm, and a body mass of 1.6 g, with a T_b of 33.8 °C, a T_a of 28.2 °C, and a T_s of 31 °C. The second one had a SVL of 39 mm, a tail length of 68.6 mm, and a body mass of 1.6 g, with a T_b of 34.1 °C, a T_a of 22 °C, and a T_s of 25.8 °C. Neither of them showed indications of caudal autotomy or regeneration. After taking

these measurements, we released back the individuals at the point where we caught them.

Ours represents the highest known record of *S. utiformis* so far (Table 1). Previously, the uppermost record consisted of that of Saldaña de la Riva and Pérez Ramos (1987), who reported the species to be present in the vicinity of Coatepec de la Escalera, in Guerrero, at 1,775 m a.s.l. Hence, our finding extends the known elevational range of *S. utiformis* by 380 m. Notably, Loeza Corichi (2004) carried out, from 1994 to 1995, monthly samplings to study the structure of the herpetofaunal assemblage of Cerro Grande along its elevation gradient. She found this species to be present up to 1110 m. Therefore, the occurrence of *S. utiformis* over 1,000 m above where it was found almost three decades ago

Tabla 1. Registros altitudinales mayores de la lagartija *Sceloporus utiformis*. Vegetación: OF = bosque de encino; OPF = bosque de pino-encino; POF = bosque de pino-encino; TDF = bosque tropical caducifolio.

Table 1. Highest elevational records of the lizard *Sceloporus utiformis*. Vegetation: OF = oak forest; OPF = oak-pine forest; POF = pine-oak forest; TDF = tropical deciduous forest.

Locality	Latitude	Longitude	Elevation (m)	Vegetation	Source
Cerro Grande, Minatitlán, Colima	19.4435	-103.9661	2154	OF	This study.
Coatepec de la Escalera, Leonardo Bravo, Guerrero	17.74	-99.85	1775	OF, OPF, POF	Saldaña de la Riva & Pérez Ramos (1987)
Agua Zarca, Mixtlán, Jalisco	20.6444	-104.5556	1654	POF	Williams & Arce (2021)
Sierra Los Huicholes, Bolaños, Jalisco.	21.8747	-103.8206	1615	OF	Ahumada-Carrillo et al. (2020)
Uruapan, Michoacán.	19.38	-102.06	1600	OF	Smith (1939)
Cerro Frío, Tilzapotla, Morelos	18.4519	-99.2688	1411	OF	Castro-Franco & Bustos Zagal (2004)
Mezquital del Oro, Zacatecas	21.2277	-103.3700	1230	TDF	Ahumada-Carrillo et al. (2011)
Cerro Grande, Minatitlán, Colima	19.4419	-103.9833	1110	TDF	Loeza Corichi (2004)

at the same locality poses a remarkable finding, as it would imply a mean upward shift of almost 40 m per year.

Across its range, *S. utiformis* is a rather conspicuous element within lizard assemblages (García & Cabrera-Reyes, 2008; Sicileo-Cantero et al., 2016), so it is unlikely that the species has passed undetected during previous samplings. As elevational range shifts are expected to happen due to increasing global temperatures (Bonino et al., 2014; Sillero, 2021), it is not unreasonable that this new record could be a case of such phenomenon. If so, the upslope change observed for this species at Cerro Grande would be one of the highest recorded among amphibians and reptiles (Raxworthy et al., 2008).

Moreover, few oviparous members of the genus *Sceloporus* are found at elevations above 2,000 m (Méndez-de la Cruz et al., 1998, 2013; Díaz de la Vega-Pérez et al., 2022), due to thermal and metabolic constraints on reproduction (Domínguez-Guerrero et al., 2022). In this regard, a comparison of the life-history traits, physiological ecology, and reproductive biology of lowland and highland populations of *S. utiformis* might provide valuable insights into the implications of oviparity along elevation gradients and on the effects of climate change on reptiles.

Acknowledgements.- We thank to the Comisión Nacional de Áreas Naturales Protegidas (Conanp), in particular to

director Fernando R. Gavito Pérez, and to Marcelina Alejandres Rodríguez, Lino Sánchez Rodríguez, and Juan Pablo Alejandres Sosa, from the community of El Terrero, Minatitlán, for allowing us to conduct research at the reserve and for their hospitality and assistance in the field. Also, we are grateful to Gerardo Ramos-León, Edgar Ramón Gómez-Vega, and David Lazcano for providing us with some of the literature cited. Finally, we thank Ricardo Palacios-Aguilar for a thorough review and feedback on this manuscript. This research was conducted under collection permit SGPA/DGVS/00962/22, issued by the Dirección General de Vida Silvestre, Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

CITED LITERATURE

- Ahumada-Carrillo, I.T., C.I. Grünwald, M.A. López Cuellar & J.M. Jones. 2020. Some records of amphibians and reptiles from the Wixarica region in the state of Jalisco, Mexico. *Herpetological Review* 51:277-281.
- Ahumada-Carrillo, I.T., O. Vázquez-Huizar, J. Vázquez-Díaz & U.O. García-Vázquez. 2011. Noteworthy records of amphibians and reptiles from Zacatecas, México. *Herpetological Review* 42:397-398.

- Bonino, M.F., D.L. Moreno Azócar, J.A. Schulte II & F.B. Cruz. 2014. Climate change and lizards: changing species' geographic ranges in Patagonia. *Regional Environmental Change* 15:1121-1132.
- Castro-Franco, R. & M.G. Bustos Zagal. 2004. Additional records and range extensions of reptiles from Morelos, México. *Herpetological Review* 35:196-107.
- Díaz de la Vega-Pérez, A.H., O. Ramírez-Icaza, J.E. Gómez-Campos, R.A. Lara-Resendiz & M.A. Domínguez-Godoy. 2022. New highest elevation records of two mexican endemic spiny lizards: *Sceloporus megalepidurus* and *Sceloporus spinosus* (Squamata: Phrynosomatidae). *Revista Latinoamericana de Herpetología* 13:6-10.
- Domínguez-Guerrero, S., F. Méndez-de la Cruz, N. Manríquez-Morán, M. Olson, P. Galina-Tessaro, D. Arenas-Moreno, A. Bautista-del Moral, A. Benítez-Villaseñor, H. Gadsden, R. Lara-Reséndiz, C. Maciel-Mata, F. Muñoz-Nolasco, R. Santos-Bibiano, J. Valdez-Villavicencio, G. Woolrich-Piña & Martha Muñoz. 2022. Exceptional parallelisms characterize the evolutionary transition to live birth in phrynosomatid lizards. *Nature Communications* 13:2881.
- García, A. & A. Cabrera-Reyes. 2008. Estacionalidad y estructura de la vegetación en la comunidad de anfibios y reptiles de Chamela, Jalisco, México. *Acta Zoológica Mexicana* 24:91-115.
- García, A. & G. Ceballos. 1994. Field Guide to the Reptiles and Amphibians of the Jalisco Coast, Mexico. Fundación Ecológica de Cuixmala, A. C./ Instituto de Biología, UNAM, México, D.F.
- Heimes, P. 2022. Herpetofauna Mexicana, Volume 2: Lizards of Mexico, Part 1: Iguanian Lizards. Edition Chimaira, Frankfurt Contributions to Natural History.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática). 2021. Conjunto de datos vectoriales de uso del suelo y vegetación. Escala 1:250 000. Serie VII. Conjunto Nacional. <https://www.inegi.org.mx/app/biblioteca/ficha.html?upc=889463842781> [accessed June 2022].
- Köhler, G. & P. Heimes. 2002. Stachelleguane: Lebensweise, Pflege und Zucht. Herpeton-Verlag, Offenbach.
- Loeza Corichi, A. 2004. Caracterización altitudinal de la herpetofauna en la región de Cerro Grande, Reserva de la Biosfera Sierra de Manantlán, Jalisco-Colima. MSc. Thesis. Facultad de Ciencias, Universidad Nacional Autónoma de México.
- Martínez, L.M. & J.M. Ramírez. 1998. Unidades fisiográficas de la reserva de la biósfera Sierra de Manantlán bajo un sistema de información geográfica. *Terra* 16:195-203.
- Méndez-de la Cruz, F.R., M. Villagrán-Santa Cruz, M.L. López-Ortiz & O. Hernández-Gallegos. 2013. Reproductive cycle of a high elevation, oviparous lizard (*Sceloporus spinosus*: Reptilia: Phrynosomatidae). *The Southwestern Naturalist* 58:54-63.
- Méndez-de la Cruz, F.R., M. Villagrán-Santa Cruz & R.M. Andrews. 1998. Evolution of viviparity in the lizard genus *Sceloporus*. *Herpetologica* 54:521-532.
- Raxworthy, C.J., R.G. Pearson, N. Rabibisoa, A.M. Rakotondrazafy, J.-P. Ramanamanjato, A.P. Raselimanana, S. Wu, R.A. Nussbaum & D.A. Stone. 2008. Extinction vulnerability of tropical montane endemism from warming and upslope displacement: a preliminary appraisal for the highest massif in Madagascar. *Global Change Biology* 14:1703-1720.
- Saldaña de la Riva, L. & E. Pérez Ramos. 1987. Herpetofauna del Estado de Guerrero, México. BSc. Thesis. Facultad de Ciencias, Universidad Nacional Autónoma de México.
- Siliceo-Cantero, H.H., A. García & Y. Gao. 2016. Abundance and habitat use of the lizard *Sceloporus utiformis* (Squamata: Phrynosomatidae) during the seasonal transition in a tropical environment. *Revista Mexicana de Biodiversidad* 87:1301-1307.
- Sillero, N. 2021. Climate change in action: local elevational shifts on Iberian amphibians and reptiles. *Regional Environmental Change* 21:101.
- Smith, H.M. 1939. The Mexican and Central American lizards of the genus *Sceloporus*. *Field Museum of Natural History Zoological Series* 26:1-397.
- Uetz, P., P. Freed, R. Aguilar & J. Hošek (eds.). 2022. The Reptile Database. <http://www.reptile-database.org>, [accessed June 2022].
- Vázquez G., J.A. & T.J. Givnish. 1998. Altitudinal gradients in tropical forest composition, structure, and diversity in the Sierra de Manantlán. *Journal of Ecology* 86:999-1020.
- Williams, S. & J.A. Arce. 2021. New distributional records from Mixtlán, an undersampled municipality in Jalisco, Mexico. *Herpetological Review* 52:359-361.

