

FIRST RECORD OF THE MEXICAN CAECILIAN, *DERMOPHIS MEXICANUS* (DERMOPHIIDAE), IN COSTA RICA

PRIMER REGISTRO DE LA CECILIA MEXICANA, *DERMOPHIS MEXICANUS* (DERMOPHIIDAE), EN COSTA RICA

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The genus *Dermophis* (Peters, 1879), contains seven currently recognized species of caecilians (*D. costaricense*, *D. glandulosus*, *D. gracilior*, *D. mexicanus*, *D. oaxacae*, *D. occidentalis*, and *D. parviceps*) within Dermophiidae. The genus is a Mesoamerican group, distributed from southern Mexico to northwestern Colombia (Wilkinson et al., 2011; Frost, 2023). The members of *Dermophis* are medium-sized and relatively robust caecilians that share two diagnostic features: the eyes are not covered by bone (and are thus visible) and each tentacle is located between the eye and the nostril (Savage & Wake, 2001; Savage, 2002). Very little is known about the biology of this secretive group of amphibians; all known species are fossorial and uncommon or rarely seen (Savage, 2002).

Savage and Wake (2001) recognized the presence of five species of the genus *Dermophis* in Costa Rica (*D. costaricense*, *D. glandulosus*, *D. gracilior*, *D. occidentalis*, and *D. parviceps*). *Dermophis oaxacae* is endemic to Mexico, while *D. mexicanus* was delineated to those populations from the Isthmus of Tehuantepec, Mexico to the Pacific slope of Nicaragua (Savage & Wake, 2001; Savage, 2002, AmphibiaWeb, 2023). Currently, the known distribution of *Dermophis mexicanus* includes the Atlantic slope of southeastern Mexico, eastern Guatemala and northwestern Honduras. It also occurs discontinuously on the Pacific slope from Oaxaca, Mexico, through Guatemala, El Salvador, and Honduras to central Nicaragua, from sea level to 2,000 m a.s.l. (IUCN SSC Amphibian Specialist Group, 2020). This species is present in dry forests and savanna, inhabits humid to dry soils beneath forest but is adaptable to secondary habitats, such as coffee, sugar o banana plantations (Sunyer, 2009).

On 01 August 2022, a dark, robust, large caecilian (44 cm) was found dead on the road after a night of heavy rains in front of a small patch of sugar cane (*Saccharum officinarum*) plantation in the town of Las Delicias de Cobano, province of Puntarenas (9°39'20" N, 85°06'12" W; WGS 84; 200 m a.s.l.; Fig. 1). The specimen was collected under permits provided by the Sistema Nacional de Areas de Conservacion (permit R-SINAC-SE-DT-PI-007-2022) and the voucher specimen (UCR 23946) was deposited in the Herpetology Collection of the Museo de Zoología, Universidad de Costa Rica (<https://museo.ucr.ac.cr/>). We reviewed the phenotypic characteristics and conducted an analysis of the 16S rRNA (16S) and cytochrome b (cyt b) mitochondrial genes of that specimen to corroborate its identity.

For the voucher specimen we obtained partial sequences of the large subunit ribosomal RNA (16S) and cytochrome b (cytb) mitochondrial genes. The primers 16Sar and 16Sbr (Palumbi et al., 1991) were used for 16S and MVZ15 and MVZ16 (Moritz et al., 1992) for cyt b. The protocols for DNA extraction, amplification, sequencing, and editing followed methods of Arias & Kubicki (2018). We compared the DNA sequences obtained from the voucher specimen with all the 16S and cyt b sequences available on GenBank for members of the genus *Dermophis*. We used a sequence of *Caecilia volceni* as outgroup following Kubicki and Arias (2017). We analyzed concatenated mtDNA using Maximum Likelihood (ML) with Garli 2.01 (Zwickl 2006) and Bayesian phylogenetic analysis with MrBayes 3.2.6 (Ronquist et al., 2012), run on the CIPRES portal (Miller et al., 2010). Detailed protocols for alignment, search of best partition scheme, the best model of sequence evolution for each partition, and phylogenetic

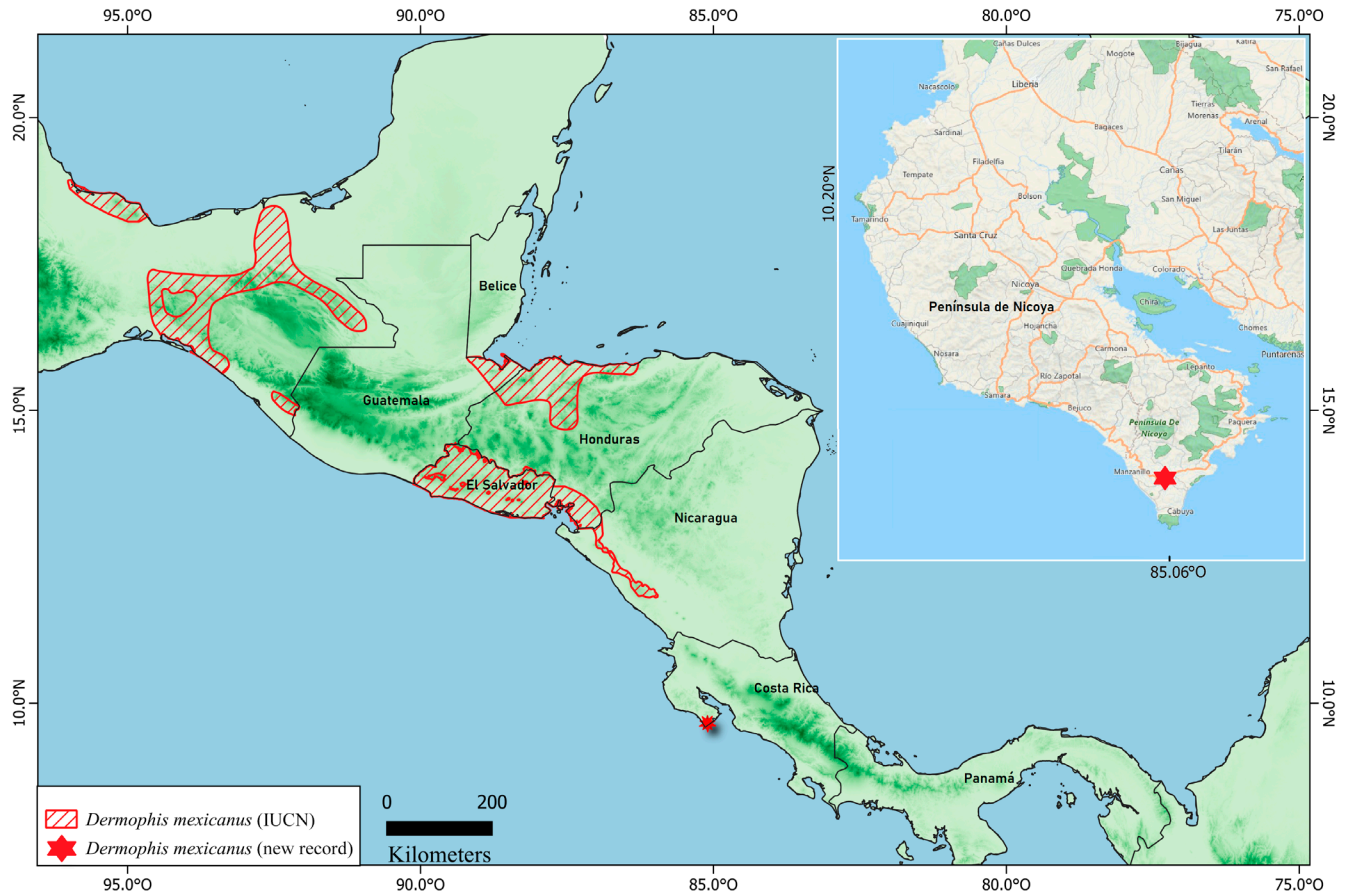


Figura 1. Distribución geográfica conocida de *Dermophis mexicanus* (sombra roja), incluido el nuevo registro en Las Delicias, Puntarenas, Costa Rica (estrella roja). Fuente: Lista Roja de la IUCN, descarga de datos el 20 de septiembre de 2022. <https://www.iucnredlist.org/species/59545/53988419>

Figure 1. Known geographic distribution of *Dermophis mexicanus* (red stripped pattern), including the new record from Las Delicias, Puntarenas, Costa Rica (red star). Source: The IUCN Red List, data download on 2022-09-20. <https://www.iucnredlist.org/species/59545/53988419>

inference using Garli and MrBayes are provided by Arias et al. (2019). The sequences obtained are available under GenBank accession numbers PPO69939 and PPO70415.

The resulting data matrix had a total sequence length of 1329 bp, including gaps; 545 bp for 16S, and 784 for cyt_b. Three partitions were identified with the following substitution models: GTR+I for 16S + cyt_b codon position 2, HKY+I for codon position 1 of cyt_b, and HKY for cyt_b codon position 3. The phylogenies from Garli and MrBayes were almost identical in topology (Fig. 2). The phylogeny showed the voucher specimen to be conspecific with *Dermophis mexicanus*, confirming the presence of this taxon in Costa Rica.

The voucher specimen closely matched the diagnostic characters provided by Savage and Wake (2001) for *Dermophis*

mexicanus. Specifically, the voucher specimen agrees with the following characters: tentacle lying about halfway between eye and nostril; externally visible eye (Fig. 3); annular grooves marked with dark pigment ventrally, sharply contrasting with lighter venter (Fig. 4) and counts of primary (99) and secondary folds (50).

No previous reports had placed the species in Costa Rica, with the nearest reliable record found on Volcán Mombacho National Reserve, Depto. Granada, Nicaragua (Spencer, 2022), approximately 260 km northwest of Las Delicias de Cobano (Fig. 1). Las Delicias de Cobano occurs in the Tropical lowland moist forest life zone (Holdridge, 1967), is bordered by the Tropical dry forest to the north and is flanked by the Pacific Ocean on all other sides. The presence of *D. mexicanus* in this area may be explained because this species can survive drier environments, such as the

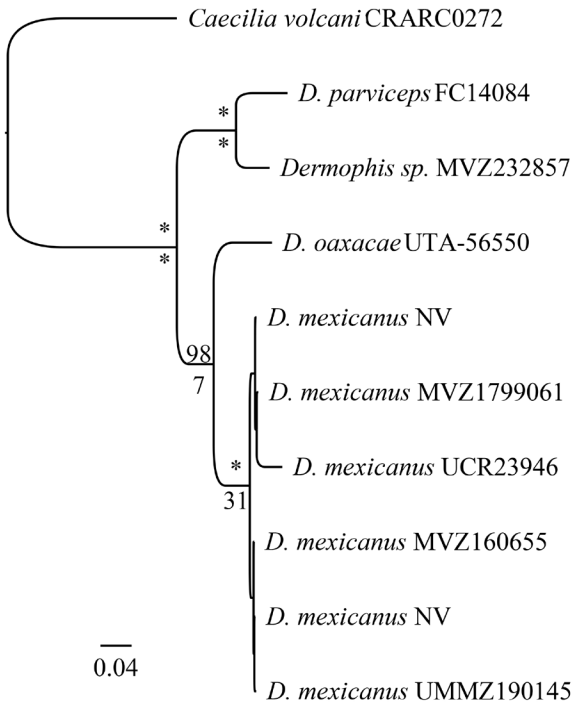


Figure 2. Inferencia filogenética bayesiana mostrando la relación del espécimen costarricense de *Dermophis mexicanus* (UCR23946) entre miembros del género *Dermophis* basándose en los fragmentos de los genes de ADN mitocondrial 16S y cyt b. Probabilidades posteriores (multiplicadas por 100) del análisis de MrBayes se muestran arriba de las ramas. Las proporciones de Bootstraps se muestran debajo de las ramas. La barra de escala se refiere a las sustituciones estimadas por sitio. Los asteriscos representan un soporte de 100. N.V. = sin voucher.

Figure 2. Bayesian phylogenetic inference shows the relationship of the Costa Rican specimen of *Dermophis mexicanus* (UCR23946) among members of the genus *Dermophis* based on the 16S and cyt b mitochondrial DNA gene fragments. Posterior probabilities (multiplied by 100) from MrBayes analysis are shown above branches. Bootstraps proportions are shown below branches. The scale bar refers to the estimated substitutions per site. The asterisks represent support of 100. N.V. = no voucher.

dry forest and savannas found in Nicaragua and northwestern Costa Rica (Sunyer, 2009). Savage (2002) suggested that absence of caecilians in Nicoya Peninsula might be explained by the lack of rainforest, however, it is possible that other species of caecilians might occur in this region in low densities, inhabiting humid patches inside dry areas.



Figura 3. Ejemplar de Cecilia mexicana (*Dermophis mexicanus*) de Las Delicias, Distrito de Cóbano, Cantón de Puntarenas, Provincia de Puntarenas, Costa Rica. (A) Vista ventral (B) vista dorsal (C) vista lateral de la cabeza (D) tamaño total. Fotografías de Juan G. Abarca (A,B) y Juan Pinto (C,D).

Figure 3. A specimen of the Mexican caecilian (*Dermophis mexicanus*) from Las Delicias, Distrito de Cóbano, Cantón de Puntarenas, Provincia de Puntarenas, Costa Rica. (A) Ventral view (B) dorsal view (C) lateral view of the head (D) total size. Photographs by Juan G. Abarca (A,B) and Juan Pinto (C,D).

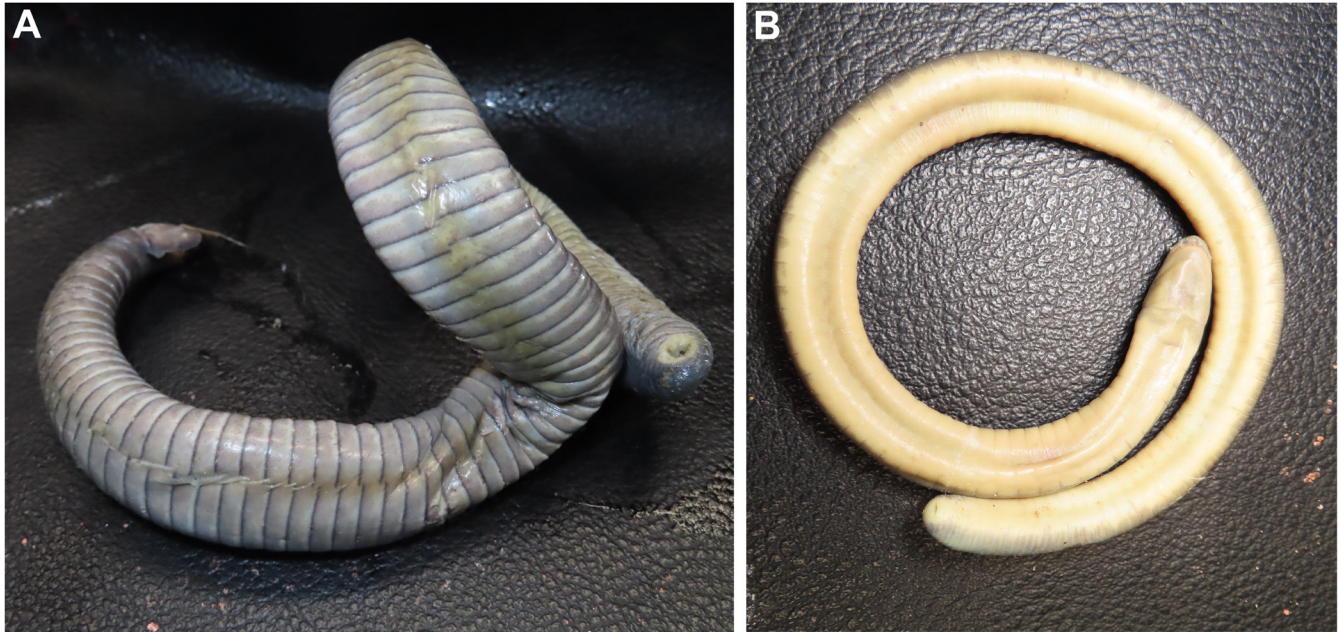


Figura 4.Detalle del vientre en especies del género *Dermophis*. A) *Dermophis mexicanus*, nótese los surcos anulares marcados con pigmento oscuro ventralmente B) *Dermophis glandulosus*, los surcos anulares no contrastan en color con el vientre más claro. Fotografías de Juan G. Abarca.

Figure 4. Detail of the belly in species of the genus *Dermophis*. A) *Dermophis mexicanus*, note the annular grooves marked with dark pigment ventrally B) *Dermophis glandulosus*, annular grooves not contrasting in color with lighter venter. Photographs by Juan G. Abarca.

The Nicoya Peninsula has suffered the loss of dry and humid forests for many centuries, mainly due to their conversion to pastures for cattle (Hilje et al., 2022). However, in the current century the country's economic model has focused on ecotourism, improving the conditions of natural ecosystems, and potentially allowing the growth of populations of rare species such as *D. mexicanus*. In Costa Rica, the Nicoya Peninsula, together with the North Caribbean zone and the Cordillera de Talamanca, remains highly unexplored in terms of biodiversity and more efforts are needed to quantify biodiversity in those regions.

CITED LITERATURE

- AmphibiaWeb. 2023. AmphibiaWeb: Information on Amphibian Biology and Conservation [web application]. https://amphibiaweb.org/cgi/amphib_query?where-scientific_name=Dermophis&rel-scientific_name=contains&include_synonymies=Yes Berkeley, California. [Consulted in 23 September 2023]
- Arias, E & B. Kubicki. 2018. A new moss salamander, genus *Nototriton* (Caudata: Plethodontidae), from the Cordillera de Talamanca, in the Costa Rica-Panama border region. *Zootaxa* 4369:487-500.
- Arias, E., A. Hertz & G. Parra-Olea. 2019. Taxonomic assessment of *Craugastor podiciferus* (Anura: Craugastoridae) in lower Central America with the description of two new species. *Amphibian & Reptile Conservation* 13:173-197.
- Frost, D.R. 2023. Amphibian Species of the World: An Online Reference. Version 6.1. <https://amphibiansoftheworld.amnh.org/Amphibia/Gymnophiona/Dermophiidae/Dermophis>. American Museum of Natural History, New York, USA. [Consulted in 23 September 2023]
- Hilje, L, R.F. Arias, B. Hilje, & W. Solórzano. 2022. Santa Rosa, Paraje de Diversidad y Escenario de Libertad. Editorial UTM. San José, Costa Rica.
- Holdridge, L.R. 1967. Life Zone Ecology. Tropical Science Center, San José, Costa Rica, 206 pp.
- IUCN SSC Amphibian Specialist Group. 2020. *Dermophis mexicanus*. <https://www.iucnredlist.org/species/59545/53988419> The IUCN Red List of Threatened Species 2020: e.T59545A53988419. [Consulted in 13 September 2023]

- Kubicki, B. & E. Arias. 2017. Vulcan's slender caecilian, *Caecilia volcani*, Costa Rica. *Mesoamerican Herpetology* 4:488-492.
- Miller M.A., W. Pfeiffer & T. Schwartz. 2010. Creating the CIPRES Science Gateway for inference of large phylogenetic trees. Proceedings of the Gateway Computing Environments Workshop November 2010:1-8.
- Moritz, C., C.J. Schneider & D.B. Wake. 1992. Evolutionary relationships within the *Ensatina eschscholtzii* complex confirm the ring species interpretation. *Systematic Biology* 41:273-291.
- Palumbi, S., A. Martin, S. Romano, W.O. McMillan, L. Stice & G. Grabowski. 1991. The simple fool's guide to PCR, version 2.0. Special Publication, Department of Zoology and Kewalo Marine Laboratory, University of Hawaii, Honolulu, Hawaii, USA.
- Ronquist, F., M. Teslenko, P. Van Der Mark, D.L. Ayres, A. Darling, S. Höhna, B. Larget, L. Liu, M. Suchard & J.P. Huelsenbeck. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* 61:539-542.
- Savage J.M. 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. The University of Chicago Press, Chicago, Illinois, USA.
- Savage J.M. & M.H. Wake. 2001. Reevaluation of the status of taxa of Central American caecilians (Amphibia: Gymnophiona), with comments on their origin and evolution. *Copeia* 2001:52-64.
- Sunyer, J. 2009. Taxonomy, zoogeography, and conservation of the herpetofauna of Nicaragua. Department of Biology, Goethe University, Frankfurt am Main, Germany.
- Wilkinson, M., D. San Mauro, E. Sherratt, & D.J. Gower. 2011. A nine-family classification of caecilians (Amphibia: Gymnophiona). *Zootaxa* 2874:41-64.
- Zwickl, D.J. 2006. Genetic algorithm approaches for the phylogenetic analysis of large biological sequence datasets under the maximum likelihood criterion. Ph.D. Dissertation, The University of Texas, Austin, Texas, USA. 125 p.

