HERPETOLOGÍA MEXICANA No. 9: 37-42
ISSN-e: 2992-7307
2025

Anophthalmia in a juvenile of *Dryophytes plicatus* (Anura: Hylidae), an endemic treefrog of Mexico

Anoftalmia en un juvenil de *Dryophytes plicatus* (Anura: Hylidae), una rana arborícola endémica de México

Rodolfo Guzmán-Ramírez[1], César A. Díaz-Marín[1], Alan Isaac Olvera-Mendoza[1], Aurelio Ramírez-Bautista[1], Tonantzin Carmona-Zamora[1] & Emiliano Hernández-Jiménez[1]*

[1]*Laboratorio de Ecología del Paisaje y Ordenamiento Ambiental, Centro de Investigaciones Biológicas, Instituto de Ciencias Básicas e Ingeniería, Universidad Autónoma del Estado de Hidalgo, km 4.5 carretera Pachuca-Tulancingo, Mineral de La Reforma, Hidalgo 42184, México. *e0312xd@gmail.com*

Recibido/Received: 28-02-2025. Aceptado/Accepted: 28-03-2025.

RESUMEN. Reportamos un caso de anoftalmia en un organismo juvenil de la rana arborícola plegada *Dryophytes plicatus* de Santiago Tulantepec, Hidalgo, México. El espécimen carecía del ojo izquierdo, presentando una cavidad ocular reducida cubierta por piel. Esta rara anomalía podría deberse a factores genéticos o a la exposición a agroquímicos, ya que en los cultivos cercanos se utilizan fertilizantes, lo que resalta la necesidad de realizar más estudios sobre anomalías morfológicas en anfibios y sus principales causas. Este hallazgo amplía el conocimiento sobre las anomalías morfológicas en *D. plicatus* y destaca la importancia de los esfuerzos de conservación.

Palabras clave: anormalidades morfológicas, anoftalmia, anfibios, agroquímicos, conservación.

ABSTRACT. We report anophthalmia in a juvenile of the Ridged Treefrog *Dryophytes plicatus* from Santiago Tulantepec, Hidalgo, Mexico, where the specimen lacked the left eye, presenting a reduced ocular cavity covered by skin. This rare anomaly may result from genetic factors or agrochemical exposure, as fertilizers are used in nearby crops and due to other related cases, highlighting the need for further studies about morphological anomalies in amphibians and the main causes. This finding expands the knowledge of morphological anomalies in *D. plicatus* and emphasizes the importance of conservation efforts.

Key words: morphological anomalies, anophthalmia, amphibians, agrochemicals, conservation.

Cita/Citation: Guzmán-Ramírez, R., C. A. Díaz-Marín, A. I. Olvera-Mendoza, A. Ramírez-Bautista, T. Carmona-Zamora & E. Hernández-Jiménez. 2025. Anophthalmia in a juvenile of *Dryophytes plicatus* (Anura: Hylidae), an endemic treefrog of Mexico. Herpetología Mexicana, 9: 37-42. DOI: https://doi.org/10.69905/gcbbrb42

INTRODUCTION

Morphological anomalies in amphibians have been observed and recorded in different parts of the world (Meteyer, 2000; Rothschild et al., 2012). For instance, Henle et al. (2017) carried out an exhaustive review of studies related to anomalies in amphibians, where Europe and North America show many records in natural populations of these vertebrates. Beltran (2023) conducted a bibliographic review of malformations in amphibians of Latin America, finding that the country with the highest number of studies is Brazil, followed by Argentina, and Mexico. This author also found that 93% of the malformations occurred in the order Anura (frogs and toads with 55.17% and 37.93% of records, respectively), followed by the order Caudata (6.90% of records), and the order Gymnophiona (0% of records). In the three orders, the anomalies with higher frequency records were brachydactyly (reduction in the length of the digits and phalanges), amelia (absence of limbs), and anophthalmia (absence of one or both eyes), which can impact functional attributes related to survival, such as foraging, locomotion and the ability to recognize predators (Henle et al.,

2017).

Dryophytes plicatus Brocchi, 1877, also known as Ridged Treefrog, is an endemic species of Mexico that occurs in the states of Hidalgo, Tlaxcala, and Veracruz, covering the regions of the Transmexican Volcanic Belt and Mexico Valley (Duellman, 2001; Wilson & Johnson, 2010). Here, *D. plicatus* inhabits pine and pine-oak forests, as well as temporary bodies of standing water (Duellman, 2001; Ramírez-Bautista et al., 2009). This small species (snout-vent length [SVL]: 38.8 ± 4.2 mm) reproduces between June and August during the rainy season (Ramírez-Bautista et al., 2009). According to the Mexican protection law NOM-059-SEMARNAT-2010 (SEMARNAT, 2019), *D. plicatus* is considered a threatened species, while the IUCN red list classifies it as Least Concern (IUCN SSC Amphibian Specialist Group, 2020).

A WILDLIFE RECORD

On October 14, 2024, during a fieldwork of amphibians, at the 1454 h, a juvenile of *D. plicatus* (SVL: 17.65 mm) was found perched near a lentic body water (Fig. 1) in the locality of Santiago Tulantepec (20.039722 °N, -98.3575 °W, WGS 84), Hidalgo, Mexico, where the vegetation types are pine-oak forest and grasslands (INEGI, 2002; Rzedowski, 2006). The specimen lacked the left eye, showed a reduced ocular cavity, and was

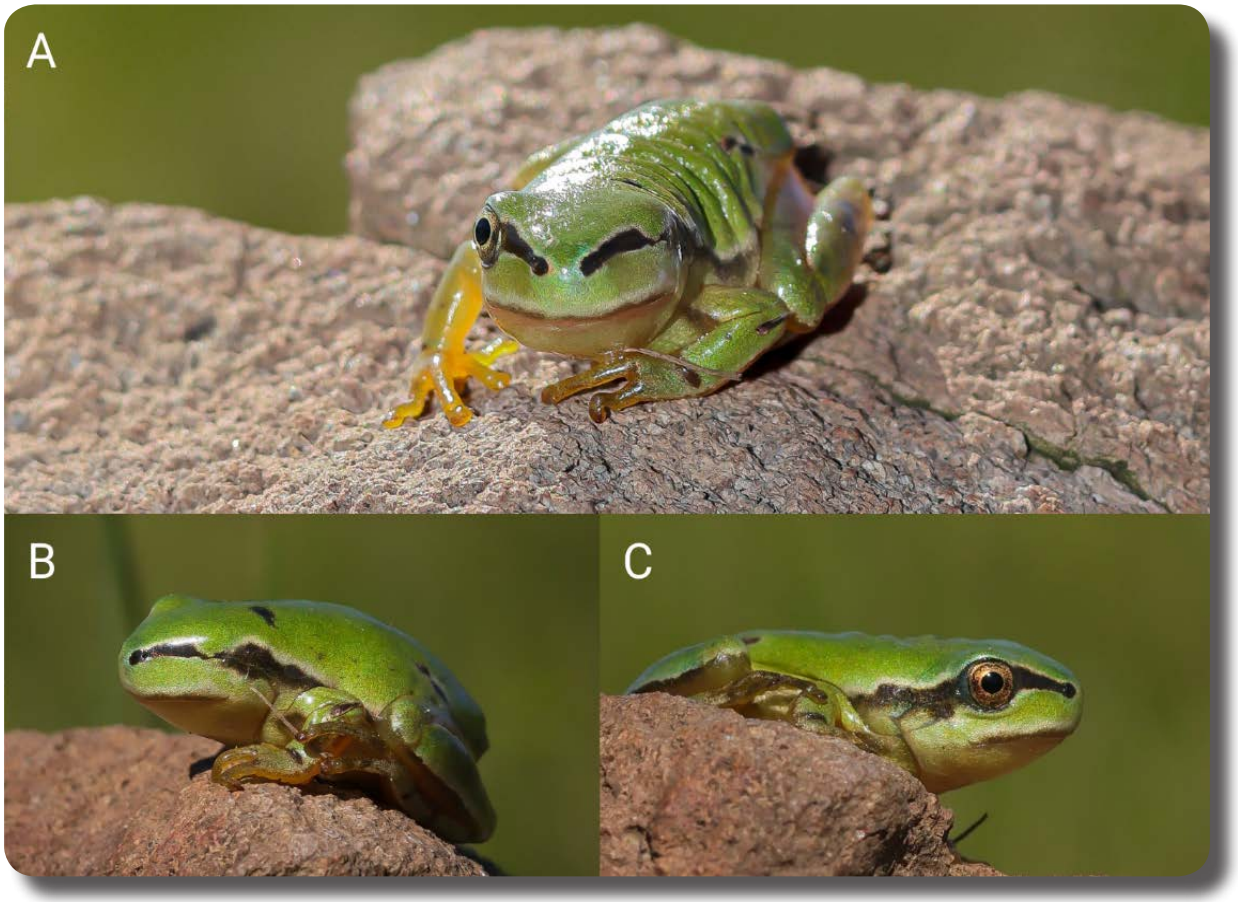

Figure 1. Juvenile of the Ridged Treefrog *Dryophytes plicatus* with anophthalmia in the left eye, recorded in its natural habitat in the state of Hidalgo, Mexico. Showing frontal view (A), left lateral view (B), and right lateral view (C), where the absence of the eye is evident.

completely covered by skin tissue. According to Henle et al. (2017), this ocular anomaly is known as anophthalmia, and along with cysts, constitutes the most frequent morphological anomaly in anurans.

Anophthalmia is an ocular defect resulting from alterations in eye organogenesis, triggered by genetic and environmental factors (Mejía & Cardenas, 2022; Rojas et al., 2016). It has been suggested that anophthalmia could also be a congenital malformation due to inbreeding (Morales-Flores et al., 2021) or exposure to inorganic compounds such as pesticides and herbicides that affect the embryonic development of amphibians, which subsequently produces high rates of ocular anomalies (Lajmanovich et al., 2003; Hayes, 2005; Fort et al., 2006; Reves et al., 2010; Paganelli et al., 2010; Lajmanovich et al., 2012).

Cases of anophthalmia in Mexican amphibians are scarse in the literature, but the most outstanding are those recorded in caudates such as *Bolitoglossa platydactyla* (Venerozo-Tlazalo et al., 2022) and *Pseudoeurycea leprosa* (Cante-Bazán & Ramírez-Bautista, 2023), and anurans such as *Smilisca baudini* (Hernández-Jaúregui et al., 2021; Hernández-Vázquez et al., 2023), and *Incilius occidentalis* (Castro-Torreblanca & Blancas-calva, 2021).

AGROCHEMICALS AS A POSSIBLE CAUSE

Although the causes of ocular anomaly in our record are unknown, landowners in the study area acknowledge using fertilizers and pesticides on crops near water bodies. Studies indicate that glyphosate-based herbicides used in agriculture can cause neuronal teratogenic effects and craniofacial malformations related to anophthalmia during embryonic and larval development in amphibians such as *Xenopus laevis*, *Scinax nasicus*, and other vertebrates, including humans (Lajmanovich et al., 2003; Paganelli et al., 2010).

This highlights the need for further studies to assess their effects on the health of local amphibian populations. Additionally, at the same study site, Olvera-Mendoza et al. (2023) reported a case of ectromelia (complete missing limb segment) in the mountain treefrog (*D. eximius*), while Hernández-Jiménez et al. (2024) found a bifurcated tail (a tail with two or more points) in the plateau tiger salamander (*Ambystoma velasci*), both of which are endemic to Mexico. If confirmed as in other regions of the world, this suggests that sensitivity to agrochemicals is similar among these amphibian species (Oullet, 2000; Peltzer et al., 2011; Ramírez-Jaramillo, 2019).

Undoubtedly, good environmental conditions of the habitat are of key importance for the healthy amphibian life cycle. A better understanding of the causes and effects of anomalies related to the amphibians could help provide fragile points of natural development of these organisms during their life histories, their survival behaviors, their interaction with the elements of the environment, and the impact that anthropogenic activities have had on them (Aguillón-Gutiérrez, 2018). Thus, conservation strategies could be implemented to protect this vertebrate group that requires good environmental quality (mainly water bodies and vegetation cover) of the habitats where they live and reproduce, which also has a positive effect on humans.

Acknowledgements. We thank Brisa Almaraz-Najera for her help during fieldwork. To Telésforo Emiliano Vera, authorities and landowners in the study area for giving permission to access their land. To Joel Hugo Hernández-Peralta, Ariadna Jiménez-Islas, and their family for

providing accommodation and assistance during fieldwork. Fieldwork was conducted under the collecting permit SPARN/DGVS/01879/24 issued by Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

LITERATURE CITED

Aguillón-Gutiérrez, D. 2018. Anomalías macroscópicas en larvas de anfibios anuros. Revista Latinoamericana de Herpetología, 1 (1): 8-21.

Beltrán, A. S. V. 2023. Malformaciones en anfibios de Latinoamérica: una revisión bibliográfica. Tesis de licenciatura. Universidad Autónoma del Estado Morelos. 37 pp.

Cante-Bazán, E. A. & A. Ramírez-Bautista. 2023. Ocular abnormalities in two sympatric salamanders (Caudata: Plethodontidae) in a pine-oak forest of La Malinche National Park, Mexico. Phyllomedusa, 22 (2): 181-184.

Castro-Torreblanca, M. & E. Blancas-Calva. 2021. Anophthalmia in a Juvenile Pine Toad (*Incilius occidentalis*) from Laguna de Tixtla, Guerrero, México. Reptiles & Amphibians, 28 (1): 22-23.

Duellman W. E. 2001. The Hylid frogs of Middle America. Society for the Study of Amphibians and Reptiles. Ithaca, New York. 2 Vols. 1180 pp.

Fort, D. J., R. L. Rogers, B. O. Buzzard, G. D. Anderson & J. P. Bacon. 2006. Deformities in cane toad (*Bufo marinus*) populations in Bermuda: Part III. Microcosm-based exposure pathway assessment. Applied Herpetology, 3 (3): 257-277.

Hayes, T. B. 2005. Welcome to the revolution: Integrative biology and assessing the impact of endocrine disruptors on environmental and public health. Integrative and Comparative Biology, 45 (2): 321-329.

Henle, K., A. Dubois & V. Vershinin. 2017. A review of anomalies in natural populations of amphibians and their potential causes. Mertensiella, 25: 57-164.

Hernández-Jiménez, E., A. I. Olvera-Mendoza, C. A. Díaz-Marín & A. Ramírez-Bautista. 2024. First record of bifurcated tail in *Ambystoma velasci* (Caudata: Ambystomatidae) within an agroecosystem in Central Mexico. Sonoran Herpetologist, 37 (3): 132 -133.

Hernández-Jaúregi, M. & F. Chacón-Juárez 2021. *Smilisca baudinii* (Mexican Treefrog). Anophthalmia. Herpetological Review, 52 (4): 839.

Hernández-Vázquez, M. E., M. A. García-Jiménez & R. Montejo-Hernández. 2023. Anomalies in three species of anurans in the state of Chiapas, Mexico. Reptiles & Amphibians, 30 (1): e20113.

INEGI. 2002. Instituto Nacional de Estadística, Geografía e Informática. Singuilucan Estado de Hidalgo. Cuaderno estadístico municipal. Edición 2002. México.

IUCN SSC Amphibian Specialist Group. 2020. *Dryophytes plicatus*. The IUCN Red List of Threatened Species 2020: e.T55608A53957401. DOI: https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T55608A53957401.en [Acceso: febrero, 2025]

Lajmanovich, R., M. Sandoval & P. Peltzer. 2003. Induction of Mortality and Malformation in *Scinax nasicus* Tadpoles Exposed to Glyphosate Formulations. Bulletin of Environmental Contamination and Toxicology, 70: 612-8. DOI:

https://doi.org/10.1007/s00128-003-0029-x

Lajmanovich, R. C., P. M. Peltzer, A. M. Attademo, M. Cabagna-Zenklusen & C. M. Junges. 2012. Los agroquímicos y su impacto en los anfibios: un dilema de difícil solución. Química Viva, 11 (3): 184-198.

Mejia, E. L. F. & M. F. Cárdenas. 2022. Anoftalmia bilateral congénita: a propósito de un caso. Recimundo, 6 (3): 284-290.

Meteyer, C. U. 2000. Field guide to malformations of frogs and toads with radiographic interpretations. Biological Science Report. U. S. Dept. of the Interior and U. S. Geological Survey and National Wildlife Health Center. 16 pp.

Morales-Flores, R. A., K. Muñoz-Arosemena, G. R. X. Pérez & J. L. Medina-Madrid. 2021. Primer reporte de anoftalmia en *Isthmohyla graceae* (Myers y Duellman, 1982) (Anura: Hylidae) en la serranía de Tabasará, comarca Ngäbe-Buglé, Panamá. Revista Latinoamericana de Herpetología, 4 (2): 165-172.

Olvera-Mendoza, A. I., E. Hernández-Jiménez, C. A. Díaz-Marín & A. Ramírez-Bautista. 2023. First record of ectromelia in *Dryophytes eximius* (Anura: Hylidae) of central Mexico. Revista Latinoamericana de Herpetología, 6 (3): 746-176.

Ouellet, M. 2000. Amphibian deformities: Current state of knowledge. In: Sparling, D. W., G. Linder & C. A. Bisop, Pp. 617–661, Ecotoxicology of Amphibians and Reptiles. Society of Environmental Toxicology and Chemistry (SETAC) Press, Pensacola, Florida, USA.

Paganelli, A., V. Gnazzo, H. Acosta, S. L. López & A. E. Carrasco. 2010. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signaling. Chemical Research in Toxicology, 23: 1586-1595.

Peltzer, P. M. R. C. Lajmanovich, L. C. Sanchez, A. M. Attademo, C. M. Junges, C. L. Bionda, A. L. Martino & A. Bassó. 2011. Morphological abnormalities in amphibian populations from the mid-eastern region of Argentina. Herpetological Conservation and Biology, 6 (3): 432-442.

Ramírez-Bautista A., U. Hernández-Salinas, U. O. García-Vázquez, A. Leyte-Manrique & L. Canseco-Márquez. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. UAEH. CONABIO. Pp. 210.

Ramírez-Jaramillo, S. M. 2019. Primer reporte sobre la presencia de malformaciones en siete especies de ranas (Amphibia, Anura) de bosque húmedo tropical en el Ecuador. Revista Latinoamericana de Herpetología, 2 (2): 34-40. DOI: https://doi.org/10.22201/fc.25942158e.2019.2.90

Reeves, M., P. Jensen, C. Dolph, M. Holyoak & K. Trust. 2010. Multiple stressors and the cause of amphibian abnormalities. Ecological Monographs, 80 (3): 423-440. DOI: https://doi.org/10.1890/09-0879.1

Rothschild, B. M., H. P. Schultze & R. Pellegrini. 2012. Herpetological Osteopathology: annotated bibliography of amphibians and reptiles. Springer. 450 pp.

Rojas, R. I., P. H. Turiño, G. L. Ramírez, C. D. Duperet, C. Y. Michel, A. Pérez & M. S. Rodríguez. 2016. Manejo clinicoquirúrgico de la anoftalmia y de la microftalmia congénitas. Revista Cubana de Oftalmología, 29 (4): 663-673.

Rzedowski, J. 2006. In: Vegetación de México, Pp. 200-214. Rzedowski, J. (ed.). Ciudad de México, México, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad/Limusa.

SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). 2019. Modificación

del Anexo Normativo III, Lista de especies en riesgo de la Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-lista de especies en riesgo, publicada el 30 de diciembre de 2010. Diario Oficial de la Federación.

Venerozo-Tlazalo, D., V. Vásquez-Cruz & D. Medina-Nogueira. 2022. Lista actual de anomalías morfológicas en anfibios mexicanos, con dos casos nuevos en el centro oeste del estado de Veracruz. Revista Latinoamericana de Herpetología, 5 (1): 15-21.

Wilson, L. D. & J. D. Johnson. 2010. Distributional patterns of the herpetofauna of Mesoamerica: a biodiversity hotspot. In: Wilson L D., J. H. Townsend, J. D. Johnson (eds.), Pp. 31-235, Conservation of Mesoamerican Amphibians and Reptiles. Eagle Mountain Publishing, Eagle Mountain, Utah.