*Herpetology Notes* 19: 11–14, published on 16 January 2026

# New and recurrent morphological abnormalities in amphibians from northwest Mexico

Héctor A. Castro-Bastidas[1], Carolina Sedano-Camacho[2], Eduardo G. Santos-García[2], Perla M. Meza-Inostroza[1,3], Marcos Bucio-Pacheco[1,2,*], and David R. Aguillón-Gutiérrez[4]

The increasing incidence of abnormalities in amphibians has raised significant concern worldwide (Ouellet, 2000; Henle et al., 2017a). These abnormalities can be classified into two types: malformations and deformities. Malformations are congenital and present from birth due to errors in embryonic development, whereas deformities arise during or after development due to the abnormal deviation of a properly formed structure (Meteyer, 2000). These abnormalities may stem from multiple factors, such as water contamination by heavy metals or agrochemicals (e.g., glyphosate), habitat alteration, exposure to ultraviolet radiation, genetic factors, and infectious diseases associated with parasitism (Haas et al., 2018; Herek et al., 2020; Johnson et al., 2024). Species inhabiting degraded environments, such as polluted water bodies or urbanised areas, exhibit a higher prevalence of these abnormalities (Hayes et al., 2006; Johnson and Hartson, 2009). In Mexico, reports of morphological abnormalities in amphibian species have increased by up to 29% since 2020 (Castro-Bastidas et al., 2025).

Here, we report new and recurring cases of abnormalities in three amphibian species in Sierra Surutato, Badiraguato, Sinaloa, Mexico (25.8303° N, 107.5679° W, elevation ~1500 m). This region has a temperate subhumid climate with summer rainfall, an average annual temperature of 24.8 °C, minimum temperatures reaching as low as −2 °C in winter, and an average annual precipitation of 1156.9 mm, mainly concentrated from June to September (CICESE, 2020). The data were obtained during two non-systematic surveys conducted in the Surutato locality between 13–15 March 2024 and from 1 to 5 May 2025, in a pine-oak forest disturbed by the construction of ecotourism cabins. The captured individuals were photographed and released at the capture site, and the abnormalities were identified according to the criteria of Henle et al. (2017b).

The studied species exhibit wide distributions in Mexico, primarily in mountainous regions and temperate forests. *Dryophytes arenicolor* (Cope, 1866) is found from the southwestern United States to Sonora, Chihuahua, Sinaloa, Durango, and central and southwestern Mexico (Duellman et al., 2016). *Incilius mccoyi* Santos-Barrera & Flores-Villela, 2011 inhabits pine-oak forests in western Chihuahua, eastern Sonora, Sinaloa, and central-southern Durango (Castro-Bastidas, 2022). *Lithobates magnaocularis* (Frost & Bagnara, 1974) occupies central-eastern Sonora, the western foothills of the Sierra Madre Occidental, southwestern Chihuahua, low-elevation Durango, Sinaloa, Nayarit, and central-northern Jalisco (Frost, 2024).

We found an individual of *D. arenicolor* with a reduced finger on its right front leg at 00:20 h on 15 March 2024 (Fig. 1A). We classified this case as brachydactyly, noting that the distal tubercle of the finger appeared developed, with no evidence of lesions suggesting a traumatic origin. Subsequently, we found an individual of *I. mccoyi* that lacked complete development of the right eye at 01:00 h on the same day (Fig. 1C), which we classified as anophthalmia due to the absence of the eyeball and the lack of scars or lesions around the ocular area. Finally, we found an individual of *L. magnaocularis* with a protrusion on the posterior dorsum at 17:41 h on the same day (Fig. 1D). This protrusion, smooth in texture and dark in colouration, may represent an unabsorbed tail remnant from incomplete metamorphosis, though

[1] Centro de Estudios "Justo Sierra", Badiraguato, Sinaloa 80600, Mexico.
[2] Facultad de Biología, Universidad Autónoma de Sinaloa, Culiacán, Sinaloa 80013, Mexico.
[3] Universidad Tecnológica de Culiacán, Culiacán, Sinaloa 80014, Mexico.
[4] Centro de Investigación y Jardín Etnobiológico, Universidad Autónoma de Coahuila, Unidad Laguna, Viesca, Coahuila 27480, Mexico.
[*] Corresponding author. E-mail: ocelotl@uas.edu.mx

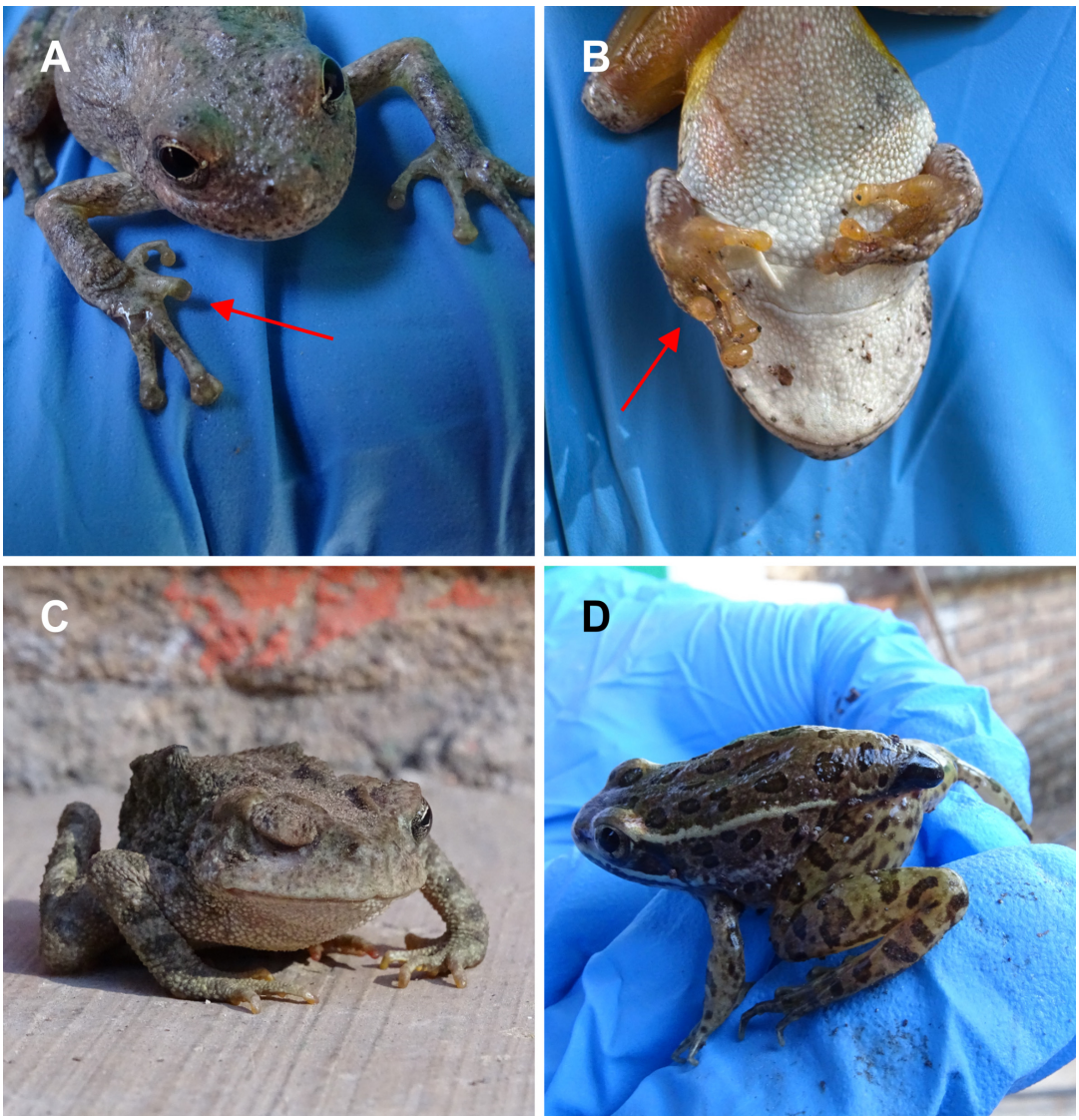


**Figure 1.** Morphological abnormalities in amphibians from Sierra Surutato, Sinaloa, Mexico. (A and B) *Dryophytes arenicolor* exhibiting brachydactyly (shortened digits), displaying a distal tubercle in both cases. (C) *Incilius mccoyi* with anophthalmia, evidenced by the absence of the right eyeball. (D) *Lithobates magnaocularis* with a protrusion on the posterior dorsum. Photos by Walfredo Ávila Chancellor (A, C, D) and Marcos Bucio-Pacheco (B).

its exact origin could not be confirmed without histopathological analysis, and thus, we consider it to be a deformity. During the second sampling period in the same area, we found another individual of *D. arenicolor* with brachydactyly at 15:17 h on 2 May 2025 (Fig. 1B), similar to the one described previously, but with the abnormality in the left front leg.

These records are particularly significant, as they document abnormalities not previously reported for some of these species. In *D. arenicolor*, the documented cases of brachydactyly constitute the fourth record of this type of malformation in the species in the country (Castro-Bastidas et al., 2024, 2025). For *I. mccoyi*, the case of anophthalmia is the first reported for this species, although deformities and protrusions in its limbs have previously been described (Castro-Bastidas et al., 2025). In turn, the individual of *L. magnaocularis* with a smooth, dark bodily protrusion (potentially a

retained tail remnant from incomplete metamorphosis; Henle et al., 2017b) represents the first report of this abnormality in the species, which until now had only exhibited structural malformations and a rare case of ocular abnormality (Castro-Bastidas et al., 2025).

Given that the records are incidental and we lack a representative sample size, it was not possible to estimate the incidence of these abnormalities as proposed by Castro-Bastidas et al. (2025). Although brachydactyly in *D. arenicolor* is the most frequently reported abnormality in this species in Mexico with all four cases originating from Sierra Surutato (Castro-Bastidas et al., 2024, 2025) this recurrent pattern in a single locality highlights a potential hotspot for such malformations, underscoring the value of continued monitoring. This recurrence in a single locality suggests the potential influence of local environmental or anthropogenic factors, such as habitat disturbance or pollution (e.g., Hayes et al., 2006; Johnson and Hartson, 2009; Haas et al., 2018), which warrants further investigation. In a broader context, *D. arenicolor* ranks as the second species with the highest number of reported abnormalities in Mexico, with a total of ten cases, while *L. magnaocularis* is also among the most affected, with six cases (Castro-Bastidas et al., 2025). This elevated reporting likely reflects their relative abundance, ease of detection during field surveys (Tepos-Ramírez et al., 2021), and frequent occurrence in anthropogenically altered environments (Camarena-Hernández et al., 2023).

In Mexico, brachydactyly and anophthalmia are the most frequently documented malformations in amphibians (Castro-Bastidas et al., 2025) and are typically associated with factors such as trauma, parasitic infections, exposure to ultraviolet radiation, and unknown causes (Ouellet, 2000; Johnson and Hartson, 2009; Henle et al., 2017a). Although anophthalmia may be related to these same factors, the exact cause of the reduction or absence of the eyeball in natural populations remains uncertain (Henle et al., 2017a). Bodily protrusions, such as the one reported in *L. magnaocularis*, may represent a retained tail remnant from incomplete metamorphosis. This is evidently a malformation probably caused by disruption in thyroid hormone-mediated tail resorption, where increasing concentrations of this hormone are essential for the process but can be suppressed by abiotic or xenobiotic factors (potentially endocrine disruptors; Murthy and Murthy, 2012; Thambirajah et al., 2019). Although it may also involve a tumoural, cystic, or infectious process (Henle et al., 2017b) that requires histopathological analysis to confirm its origin.

These four cases reinforce Sinaloa's position as the state with the highest number of reported abnormalities in amphibians in Mexico, totalling twenty-one cases (Castro-Bastidas et al., 2025). This prominence likely arises from a combination of factors: the region's burgeoning tourism sector, which has intensified habitat disturbances through the construction of recreational infrastructure (e.g., ecotourism cabins) and associated activities; and the recent surge in herpetological studies and exploration efforts in Sierra Surutato (Castro-Bastidas, 2024; Castro-Bastidas et al., 2024). These findings underscore the need for more extensive and systematic research to identify the environmental, genetic, and anthropogenic factors that may be contributing to the development of these abnormalities in the Sierra Surutato region.

**Acknowledgments.** To the Facultad de Biología at the Universidad Autónoma de Sinaloa for sponsoring the field practise from which these reports were obtained. We also thank the Centro de Estudios "Justo Sierra" (CEJUS) for providing food and accommodation during our stay in Surutato. Likewise, we acknowledge Walfredo Ávila Chancellor for his assistance in taking some of the photographs. Additionally, we thank Jorge Guillermo Sánchez Zazueta (UAS) for his support in translating and verifying the British English. We thank Juan Manuel Díaz García (Universidad Autónoma de Tlaxcala) for kindly providing a previous review of the manuscript.

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*Accepted by Vinicius Guerra*