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THE PASSAGE OF DEATH: ROADKILL OF THE PINE TOAD (*INCILIUS OCCIDENTALIS*) IN TLAXCALA, MEXICO

EL PASO DE LA MUERTE: ATROPELLAMIENTO DEL SAPO DE LOS PINOS (*INCILIUS OCCIDENTALIS*) EN TLAXCALA, MÉXICO

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Resumen.— Las carreteras son una amenaza para los anfibios, especialmente durante la temporada de lluvias, cuando aumenta su movilidad. En México se han documentado algunos estudios de atropellos de ranas y sapos, pero en Tlaxcala no existe ningún reporte. Nosotros registramos por primera vez el atropellamiento masivo del sapo de los pinos (*Incilius occidentalis*) en el tramo carretero Ixtacuixtla-Nanacamilpa, lo que resalta la necesidad de implementar medidas de conservación de anfibios en esta región.

Palabras clave.— Anura, carretera, México, conservación, sapo, Tlaxcala.

Abstract.— Roads are a threat to amphibians, especially during the rainy season when their mobility increases. There are some studies documenting frog and toad roadkills in Mexico, but none in the state of Tlaxcala. We recorded, for the first time, a mass roadkill of the pine toad (*Incilius occidentalis*) on the Ixtacuixtla-Nanacamilpa highway in southeastern Tlaxcala in central Mexico. This report highlights the need to implement amphibian conservation measures in this region.

Keywords.— Anura, highway, México, conservation, toad, Tlaxcala.

Roads facilitate connections between communities and promote economic growth, but they also pose a significant threat to wildlife (González-Suárez et al., 2018). Several studies have documented roadkill incidents involving various groups of terrestrial vertebrates (Fuellhaas et al., 1989; Nahuat-Cervera et al., 2021; Briceño-Méndez et al., 2025). Amphibians are among the most threatened vertebrate groups globally, and traffic-related mortality on roads is a significant factor in their population's decline (Stuart et al., 2004; Zhang et al., 2018). They are especially vulnerable because their small body size and slow movement, make them difficult for drivers to see and, consequently, increases the risk of vehicle collisions (Arévalo et al., 2017). This danger intensifies during the rainy season, when amphibians increase their activity by moving to temporary bodies of water to reproduce, feed, or avoid predation (Anđelković & Bogdanović, 2022).

In Mexico, population declines of various amphibian species have been observed due to road accidents on multiple highways. For example, mortality of several toad and frog species has been reported on highway sections that cross natural areas in Campeche and Oaxaca, where species such as the Mesoamerican cane toad (*Rhinella horribilis*), the cane toad (*R. marina*), and Brown's tree frog (*Lithobates brownorum*) are found (Grosselet et al., 2008; Briceño-Méndez et al., 2025). Similarly, mortality of the Gulf toad (*Incilius valliceps*) and the cane toad has been documented on highways crossing the coastal plain of the Gulf of Mexico, particularly in Veracruz, as well as on Pacific

highways in Michoacán (Delgado-Trejo, 2018). On the Kinchil–Celestún highway in Yucatán, the common valley toad (*I. valliceps*), the Mesoamerican cane toad (*R. horribilis*), and several tree and terrestrial frog species (*Trachycephalus vermiculatus, Scinax staufferi, Leptodactylus fragilis, L. melanonotus, Hypopachus variolosus, Smilisca baudinii, Triprion petasatus*, and *L. brownorum*) have been reported as roadkill victims (Nahuat-Cervera et al., 2021). Meanwhile, on the Villahermosa–Zacatal highway, amphibians represented the third most common vertebrate among roadkill, though the Mexican green frog (*L. brownorum*) was the only species that was identified (Pozo-Montuy et al., 2021). Despite these roadkill studies in other Mexican states, no cases of amphibian mortality due to vehicle collisions have been reported in the central Mexico state of Tlaxcala.

As part of a herpetofauna monitoring project in Tlaxcala, Mexico (SEMARNAT; SGPA/DGVS/03662; August 2022), we conduct annual systematic censuses along the Ixtacuixtla–Nanacamilpa highway section, specifically between the communities of Espíritu Santo and Atotonilco (see map; Fig. 1). The predominant vegetation in this area is juniper forest (*Juniperus deppeana*), with a temperate subhumid climate characterized by a rainy season that runs from May to September. These environmental conditions favor the reproductive activity of toads and frogs, increasing their mobility and, consequently, their exposure to the risk of road collisions.

During the monitoring process (6 June 2024), we estimated an approximate mortality of 1120 toads along a 2 km transect attributed to vehicle collisions observed exclusively between kilometers six and eight of the Ixtacuixtla-Nanacamilpa highway in southeastern Tlaxcala in central Mexico. This estimate corresponds to a mortality rate of 560 toads/km/day, calculated following López et al. (2022). This roadway consists of two lanes with bidirectional traffic. The survey was conducted by two observers who walked both directions of the road segment, recording the incidence of toads roadkills at the onset of evening twilight, between 18:30 and 20:30 h (Fig. 2A, B).

Figura 1. Ubicación geográfica del municipio Espíritu Santo en el estado de Tlaxcala, México. Sitio donde se reportó el atropellamiento masivo del sapo de pino (*Incilius occidentalis*).

Figure 1. Geographic location of the Espíritu Santo municipality in the state of Tlaxcala, Mexico. This is the site where the mass killing of the pine toad (*Incilius occidentalis*) was reported.

We identified the species as *Incilius occidentalis* using the guide for amphibians of central Mexico published by Santos-Barrera et al. (2014). For this purpose, and so as not to disturb the integrity of the population, we captured only three healthy individuals (body mass: 3.4 g; SVL: 30.3 mm) in the early postmetamorphic stage. These individuals were not sexed, as their SVL and body mass were smaller than those of adults (Santos-Barrera et al., 2014) (Fig. 2C, D).

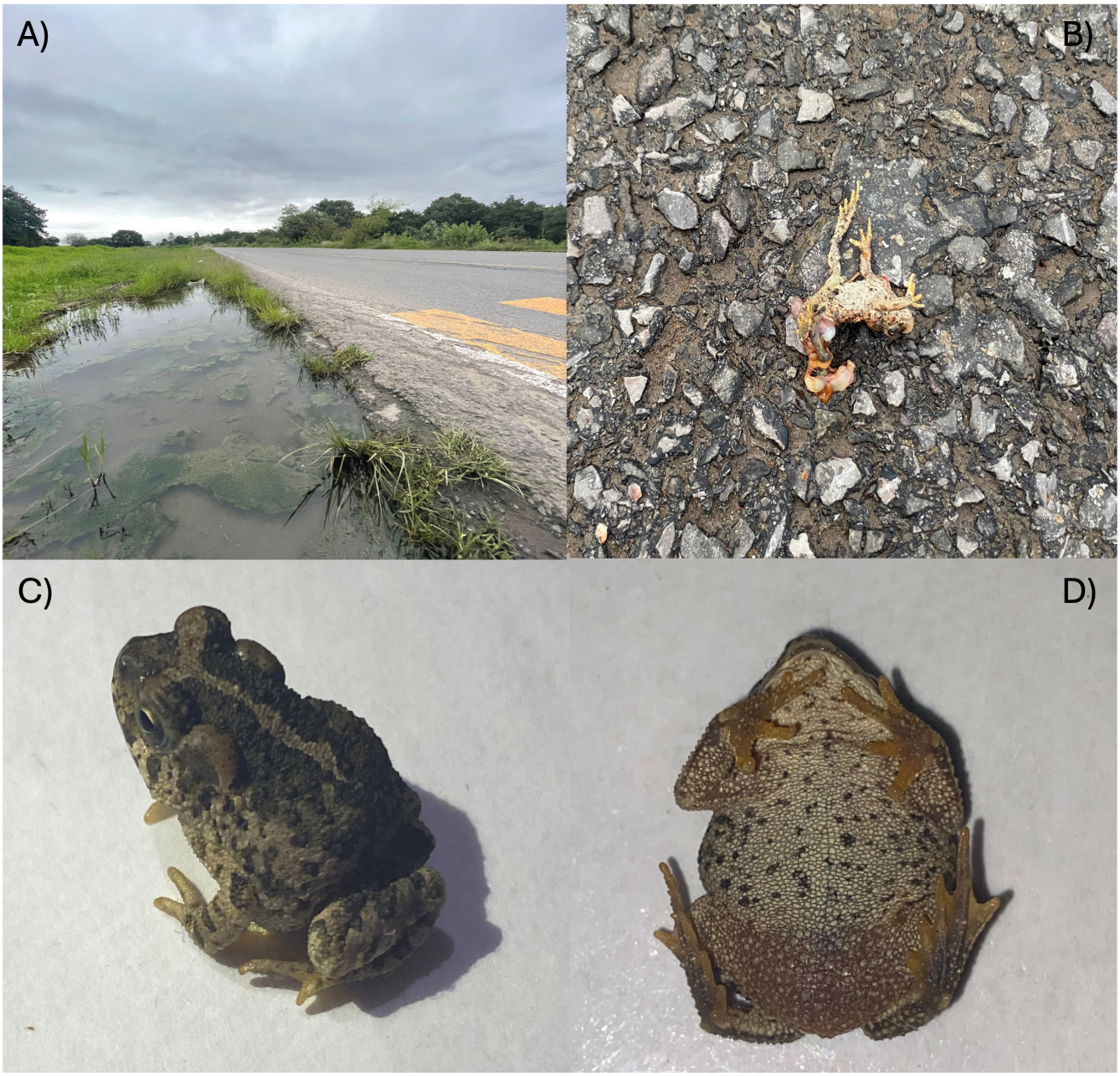

Figura 2. A) Vista general de la carretera Espíritu Santo, ubicada en una zona predominantemente de vegetación de bosque de sabino y charcos de agua. B) Ejemplar de *Incilius occidentalis* encontrado muerto por atropellamiento sobre la vía. C y D) Fotografías de un individuo vivo *Incilius occidentalis* en vista lateral y ventral. Fotos: Maribel Méndez Tepepa y Erika Xochicale Rodríguez.

Figure 2. A) General view of the Espíritu Santo Highway, located in an area predominantly covered with juniper forest and puddles of water. B) An *Incilius occidentalis* specimen found dead after being run over on the road. C and D) Photographs of a live *Incilius occidentalis* in lateral and ventral views. Photos: Maribel Méndez Tepepa and Erika Xochicale Rodríguez..

The pine toad (*Incilius occidentalis*) is endemic to Mexico, distributed from Durango and San Luis Potosí to the Isthmus of Tehuantepec and central Veracruz. It inhabits diverse ecosystems such as oak forests, pine–oak forests, scrublands, arid and semi-arid zones, and cloud forests, between 150 and 2600 m a.s.l. (Canseco-Márquez & Gutiérrez-Mayén, 2010; Santos-Barrera et al., 2014). Adult females are larger (snout–vent length [SVL]: 76.42–91.93 mm) and have broader heads than males (SVL: 52.37–84.15 mm), which typically have more visible tympana (Santos-Barrera et al., 2014).

This new record of amphibian roadkill in Tlaxcala, Mexico, is likely due to high traffic pressure. The Ixtacuixtla–Nanacamilpa highway section experiences heavy daily traffic, which may contribute to recurring wildlife mortality, especially during the rainy season. Vehicular flow increases on this road because it is one of the main routes to ecotourism destinations in the region and is located near an industrial zone approximately 5 km from the site where the collisions were recorded. To date, this report constitutes the first formally documented case of vehicle-related anuran mortality in central Mexico. Several studies have reported that amphibian roadkill is closely associated with periods of intense rainfall, particularly during the breeding season (Anđelković & Bogdanović, 2022).

The formation of small puddles near the road may act as an ecological driver of toad movement, as temporary aquatic environments attract individuals seeking breeding or foraging sites (Anđelković & Bogdanović, 2022). In this context, habitat modification and the disconnection between refuge and breeding areas may have long-term negative demographic effects, such as a decrease in effective population size, reduced gene flow, and eventual loss of viability of local populations (Colino-Rabanal & Lizana, 2012; Beebee, 2013). In the study area, we also observed the absence of nearby water bodies such as rivers, lakes, streams, or ponds that could serve as breeding or refuge sites. As a conservation strategy, the construction of underpasses is a common technical solution to prevent amphibian road mortality (Schmidt et al., 2008), contributing to the conservation of local populations and reducing the risk of roadkill in the area. Urbanization in the vicinity of the species' habitat may further exacerbate the problem. This stretch of road is located near inhabited areas, which likely increases vehicular traffic and, consequently, the risk of collisions. Another important factor is the small body size of this species, which makes it difficult for drivers to detect, thereby reducing the chances of avoidance (Arévalo et al., 2017). In this context, we also recommend the installation of road signs to alert drivers to the presence of wildlife and to encourage cautious driving.

Roadkill mortality does not always cause significant population-level impacts, due to the high population density or resilience of certain species to anthropogenic disturbances (Vargas-Salinas et al., 2012). Although no local extinctions or resilience of anurans due to roadkill have been documented in Mexico to date, mass predation events have been reported that could pose a threat to *I. occidentalis* (Hernández-Gallegos et al., 2019). *Incilius occidentalis* is classified as Least Concern on the International Union for Conservation of Nature (IUCN) Red List and is not included in other national conservation lists (IUCN, 2012; Santos-Barrera et al., 2014). However, we consider it essential to implement continuous monitoring for species currently considered at low risk.

Finally, the persistence of these amphibian mortality events may represent a direct threat to the population density of various species. Therefore, implementing mitigation measures is essential to reduce the impact of vehicle traffic on herpetofauna and to support amphibian conservation in Mexico. Our documentation of road-killed *I. occidentalis* highlights the urgent need to establish local monitoring programs to assess the impact of road traffic on other amphibian populations in Tlaxcala, Mexico.

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