

NECROPHAGY IN TWO SNAKE SPECIES OF THE GENUS *LEPTODEIRA* (SQUAMATA: DIPSADIDAE)

NECROFAGIA EN DOS ESPECIES DE SERPIENTES DEL GÉNERO *LEPTODEIRA* (SQUAMATA: DIPSADIDAE)

Edgar Alberto Gamez-Duarte¹, José David Jacobo-González¹, José Martín Manríquez-Soto², Héctor Alexis Castro-Bastidas^{3,4*} & José Manuel Serrano⁴

¹Posgrado en Ciencias Biológicas, Facultad de Biología, Universidad Autónoma de Sinaloa, Culiacán 80013, Sinaloa, México.

²Reserva Ecológica El Mineral de Nuestra Señora Mundo Natural, Universidad Autónoma de Sinaloa, Cosalá 80780, Sinaloa, México.

³Posgrado en Ciencias Aplicadas al Aprovechamiento de los Recursos Naturales, Centro de Estudios “Justo Sierra” (CEJUS), Badiraguato 80600, Sinaloa, México.

⁴Anfibios de Sinaloa, Culiacán 80194, Sinaloa, México.

*Correspondence: salamander@cejus.edu.mx

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Resumen.— Las serpientes del género *Leptodeira* son conocidas por ser depredadoras con una amplia variedad de presas conocidas en su dieta. Las observaciones de depredación reportadas aquí se realizaron en el estado de Sinaloa, en el noroeste de México. Nuestro estudio presenta el primer registro de *L. splendida* y *L. septentrionalis* consumiendo sapos muertos de la especie *Incilius mazatlanensis*. Además, reportamos el avistamiento de *L. splendida* alimentándose de un sapo vivo de *Rhinella horribilis*. Por lo tanto, este es el primer informe de necrofagia para ambas especies de *Leptodeira*. Se discuten las posibilidades de señales quimiosensoriales para la detección de las presas en estas serpientes y la depredación oportunista cuando las presas vivas son escasas.

Palabras clave.— Carroñero, depredación, dieta, serpiente ojo de gato, Sinaloa.

Abstract.— Snakes of the genus *Leptodeira* are known to be predators with a wide variety of prey known in their diet. The predation observations reported here were made in the state of Sinaloa, in northwestern Mexico. Our study reports the first record of *L. splendida* and *L. septentrionalis* consuming dead toads of the species *Incilius mazatlanensis*. In addition, we report the sighting of *L. splendida* feeding on a live toad of *Rhinella horribilis*. Therefore, this is the first report of necrophagy for both *Leptodeira* species. The possibilities of chemosensory signals for prey detection in these snakes and opportunistic predation when live prey is scarce are discussed.

Key words.— Cat eye snake, diet, predation, scavenging, Sinaloa.

Despite the complexity of their feeding behavior, snakes have independently adopted a wide variety of dietary preferences (insects, mammals, birds, crustaceans, etc.; see Colston et al., 2010). Additionally, snake species exhibit this wide range of feeding behaviors in association with their dental morphology and prey abundance variation (Segall et al., 2023). Although snakes are characterized by the ingestion of whole prey, for which they implement different capture and immobilization strategies, such as venom inoculation, constriction or simply ingesting prey alive, they can also consume carrion (Sazima & Strüssmann, 1990). This behavior of feeding on tissues or fluids exuded from carrion is known as necrophagy and has been described for various vertebrate species (Berkovitz & Shellis,

2017; Selva et al., 2019; Székely et al., 2019; Barberá, 2020; Bartel et al., 2023). Although necrophagy in snakes has been reported in the literature (DeVault & Krochmal, 2002; Selva et al., 2019), it is possible that necrophagy is an under-observed behavior since the typical method of analyzing diet in reptiles is through examination of stomach contents, which does not reveal the initial state in which the prey was consumed (Gloyd, 1933; Lillywhite, 1982; Shine, 1986). However, it remains an unexplored question what sensory mechanisms enable carrion consumption in snakes.

Snakes of the genus *Leptodeira* belong to the family Dipsadidae with 11 species distributed from the United States to central



Figure 1. A) y B) Individuo adulto de *Leptodeira septentrionalis* consumiendo un cadáver de *Incilius mazatlanensis*. Fotos: JDJG.

Figure 1. A) and B) Adult individual of *Leptodeira septentrionalis* consuming a cadaver of *Incilius mazatlanensis*. Photos: JDJG.

Argentina (Costa et al., 2022). This genus has a wide variety of prey that make up its diet (Mora et al., 2020; Nuñez-Escalante & Garro-Acuña, 2020; Dueñas & Báez, 2023; Rojas-Carranza & Anderson, 2023), including necrophagy as a characteristic of dietary components of *L. annulata* and *L. ashmeadii* (Mora-Benavides et al., 1999; Oliveira et al., 2023). Currently, the report of this type of behavior raises the questions of whether carrion feeding is a common behavior of this genus *Leptodeira* and what role the snakes' sensory perception plays during feeding.

In the state of Sinaloa, located in northwestern Mexico, four species of the genus *Leptodeira* are distributed: *L. maculata*, *L. punctata*, *L. splendida*, and *L. septentrionalis* (Hardy & McDiarmid, 1969; Aguirre-Zazueta et al., 2023; Jacobo-González et al., 2023), which are found together at elevations below 1,500 m a.s.l. in pine-oak habitats and in tropical dry forests along the entire coastal plain (Uetz et al., 2023). Here we report new prey items in the diet of two *Leptodeira* snakes. Additionally, we highlight the consumption of carrion in two species, not previously reported. The discovery of these predatory events comes from non-systematic samplings.

On July 17, 2023, at 20:23 h, during rainy weather at the Reserva Ecológica El Mineral de Nuestra Señora Mundo Natural

of the Universidad Autónoma de Sinaloa (UAS), municipality of Cosalá in Sinaloa, Mexico (24°24'5.04"N, 106°36'29.88"W; WGS84; Elevation 570 m a.s.l.) an adult individual of *L. septentrionalis* was observed by one of us (JDJG) consuming the carcass of an adult individual of *Incilius mazatlanensis* (Fig. 1A). Upon detection, the snake abandoned the prey and moved a few meters away, allowing photographs to be taken of the toad carcass (Fig. 1B). After capturing images (for approximately 5 min), the second author left the location and upon returning around 40 minutes later, the remains of the toad were no longer present, leading us to infer that it was consumed by the snake, given the absence and low probability of being eaten by another scavenger on a rainy night.

In the same area, on a rainy night but on July 22, 2023 at 21:16 h, another similar event was observed. An adult individual of *L. splendida* was attempting to ingest a road killed toad, of the species *I. mazatlanensis*. In both the previous case and the present one, this species was identified by the presence of distinctive cranial ridges with dark borders, and small slightly oval paratoid glands (Taylor, 1940 [1939]). In this case, the first author (EAGD) proceeded to take photographs of the snake as it fed (Fig. 2A) but left the site to avoid interrupting the individual. Two hours later, EAGD returned to the site where both individuals, prey

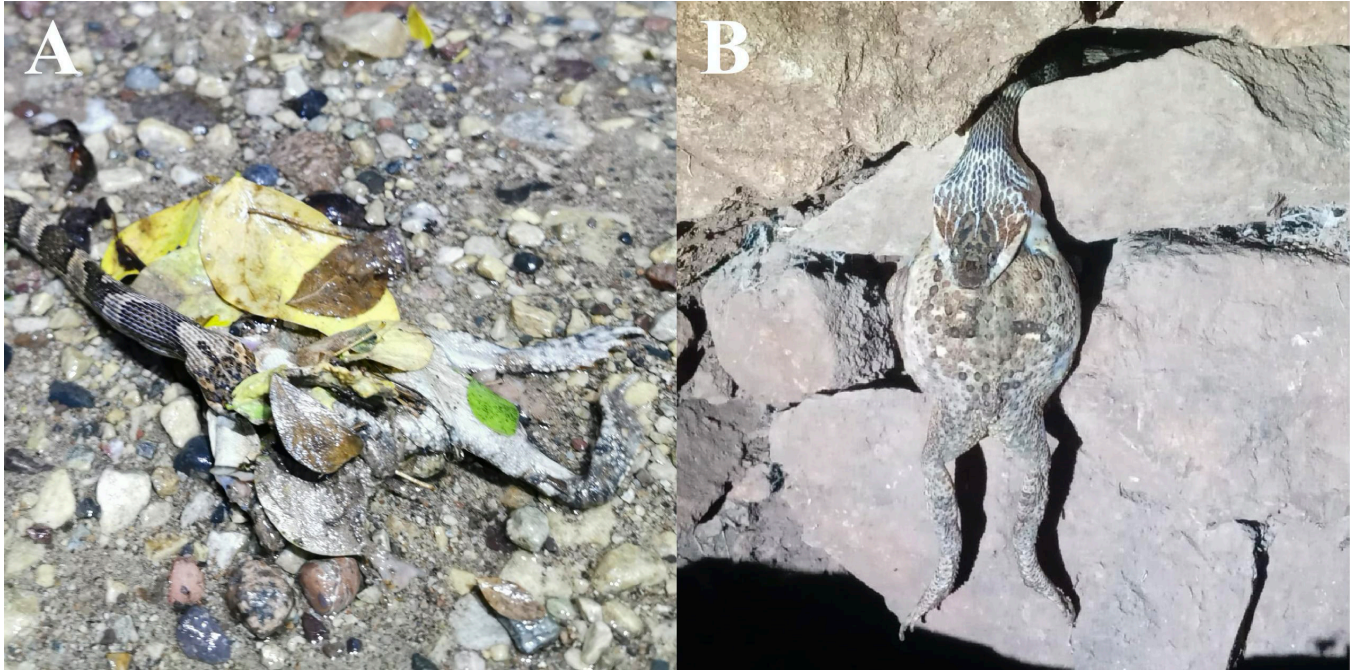


Figura 2. A) Individuo adulto de *Leptodeira splendida* depredando un animal atropellado de *Incilius mazatlanensis* (EAGD alcanzó a percatarse de las crestas craneales que distinguen a este sapo antes de tomar las fotografías). Fotografía tomada por EAGD. B) Otro individuo de *L. splendida* depredando un individuo adulto vivo de *Rhinella horribilis*. Foto: JMMS

Figure 2. A) Adult individual of *Leptodeira splendida* preying a roadkill of *Incilius mazatlanensis* (EAGD noticed the cranial crests that distinguish this toad before taking the photographs). Photograph by EAGD. B) Another individual of *L. splendida* preying on an adult living individual of *Rhinella horribilis*. Photo: JMMS.

and predator, were no longer present. It is important to mention that EAGD noticed the cranial crests that distinguish this toad before taking the photographs.

A third observation in the same area occurred on September 17, 2023 at 23:07 h. Another feeding event was observed, with an adult individual of *L. splendida* feeding on a live adult individual of *Rhinella horribilis* (Fig. 2B). This species is mainly characterized by its large size, well marked cranial ridges, prominent paratoid glands with subtriangular shape, tubercles and conspicuous warts on the dorsum (Pereyra et al., 2021). This scene was observed by one of us (JMMS) from the Reserva Ecológica UAS, therefore, only photographs were taken since JMMS left the site and did not return. We assume that the snake was successful in ingesting its prey because the event was not interrupted.

The prey recorded for *L. septentrionalis* from different geographic areas consist in 16 species of amphibians and five reptiles: *Smilisca baudinii*, *S. phaeota*, *S. cyanosticta*, *Incilius valliceps*, *Rhaebo haematiticus*, *Rhinella humboldti*, *Lithobates warschewitschi*, *Leptodactylus melanonotus*, *Agalychnis callidryas* eggs, *A. moreletii*, *Craugastor loki*, *Dendropsophus ebraccatus*, *D. microcephalus*,

Tlalocohyla loquax, *Bolitoglossa* spp., *Scinax staufferi*, *Ameiva* spp., *Anolis* spp., *A. zapotecorum*, *Lepidophyma tuxtlae*, and *Ninia sebae* (Duellman, 1963; Henderson & Hoevers, 1977; Campbell, 1998; Savage, 2002; Solórzano, 2004; Cabrera-Guzmán et al., 2009; Vargas-Salinas & Aponte-Gutiérrez, 2013; González-Hernández et al., 2015; Bello-Sánchez et al., 2018; Tepos-Ramírez et al., 2019; Carbajal-Márquez et al., 2022). Therefore, this is the first record that includes *I. mazatlanensis* in the diet of *L. septentrionalis* as well as the first report of necrophagy of this snake.

On the other hand, nine species of amphibians and four reptiles have been recorded for the diet of *L. splendida*: *Incilius* spp., *I. valliceps*, *Engystomops pustulosus*, *L. melanonotus*, *Smilisca baudinii*, *S. staufferi*, *Sphaerodactylus lineolatus*, *A. callidryas* eggs, *Lithobates psilonota*, *Anolis* spp., *A. lineatus*, *Ameiva undulata*, and *Ctenosaura pectinata* (Duellman, 1958; Huerta-García et al., 2015). It is the first time that *I. mazatlanensis* and *R. horribilis* are reported in its diet of *L. splendida*, in addition to the behavior of feeding on carrion.

Snakes of the genus *Leptodeira* are nocturnal, semi-arboreal and elusive snakes that usually hide in rock crevices. For the

location of dead prey, vision may be of little use, as snakes depend largely on other means to detect the food that represents carrion. This is based on observations of other snake groups (Viperids or Colubrids) that use chemical cues for prey detection, whereas arboreal snakes rely on both chemical and visual cues (Shivik et al., 1997). On the other hand, Sharma et al. (2016) reported the consumption of inanimate objects by *Ptyas mucosa* following chemical cues.

It is likely that snakes of the genus *Leptodeira* are dependent on chemo-sensory signals to find food where olfaction plays an important role. However, these species possess venom glands, so understanding how these snakes administer venom to capture their prey remains unclear (Sazima & Strüssmann, 1990; DeVault & Krochmal, 2002). Some snakes may need to minimize energy expenditure for venom production during prolonged periods of severe drought (Berriozabal-Islas et al., 2021; Becerra-López et al., 2022). For example, the non-venomous colubrid *Natrix natrix* has been observed consuming carrion when common prey species become scarce, likely due to drought-induced climatic stress (Muszyńska et al., 2022). Although our observations on the feeding behavior of the two *Leptodeira* snakes were made during the rainy season for the region's dry forest, irregular rains and high temperatures occurred in 2023 due to a strong ENSO in the northern Pacific (CONAGUA, 2024).

Another possible explanation for the carrion-eating behavior of the genus *Leptodeira* is that these snakes are simply opportunistic. Consuming dead prey seems to be an easy alternative, as carrion is not defended unlike live prey and can be predictably found along roadsides (Gomes et al., 2017; Marques et al., 2017; Moleón et al., 2019; Sales et al., 2019). We suggest that scavenging in snakes is likely much more common than literature indicates, with roads in particular serving as reliable food sources. However, if snakes use roadkill as a food source, it increases their chances of being killed by road traffic, potentially an underestimated cause of snake mortality (Degregorio et al., 2011).

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