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Toes, tails, and heads: Morphological anomalies in different lizard species of Central Mexico

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Abstract. Morphological anomalies in reptiles can originate from genetic factors, trauma, infections, or environmental conditions and affect key aspects such as locomotion, behavior, and survival. Here, we document 24 cases of morphological anomalies in the toes, tails, and heads of eight lizard species of three families (Anguidae, Phrynosomatidae, and Scincidae) from Hidalgo, Mexico; which were recorded between January 2023 and August 2025 in different municipalities. Most anomalies occurred in the limbs, identifying cases of brachydactyly, ectrodactyly, and adactyly, alone or in combination. Additionally, three individuals with bifurcated tails and two with head anomalies were identified. The genetic background, environmental factors, or failed predatory events may explain the origin of these anomalies in the wild. This highlights the importance of recording these cases to understand their frequency, potential causes, and effects on the biology and ecology of reptiles.

Keywords. Anguidae, caudal autotomy, ectrodactyly, head anomaly, Phrynosomatidae, predation, Scincidae.

Among squamate reptiles, a great variety of morphological anomalies have been recorded in lizards, which are caused by different factors, such as genetic mutations, trauma, infections, exposure to toxins, and environmental changes (Bishop et al., 2010; Telemeco et al., 2013). These anomalies not only affect the physical appearance of individuals, but in many cases, they also influence their behavior, locomotor performance, survival, and intra-and interspecific signaling capacity (Bishop et al., 2010; Barr et al., 2020).

Recently, some morphological anomalies have been recorded in different lizard species in Mexico, among which the most common occur in the limbs and tail (De la Rosa-Silva et al., 2023; Díaz-Marín et al., 2023 a, b; Suárez-Varón et al., 2024, 2025; Feria-Ortiz et al., 2024; Reyes-Velázquez and Gómez-Benitez, 2025; Sánchez-Manjarrez et al., 2025). The absence of limbs and digits may have resulted from failed predation events or a genetic background. It is well known that many lizard species can undergo caudal autotomy, which is their main defense mechanism; however, an incomplete caudal autotomy or caudal wound might promote the appearance of bifurcated or trifurcated tails (Barr et al., 2020). Nonetheless, anomalies in other body regions, such as the head, have been less frequently recorded (Bellairs, 1965; Díaz de la Vega-Pérez et al., 2015), and even though they are less visible, they can affect important processes, such as chewing and vision.

During the fieldwork of different ecological studies between January 2023 and August 2025, we hand-captured individuals of eight lizard species with morphological anomalies through their typical activity cycle (08:00 to 17:00 h). Captures were conducted under collecting permits SPARN/DGVS/04611/23, SPARN/DGVS/01879/24, and SPARN/DGVS/02351/25 issued by Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). The captures were conducted as part of those studies and not with the specific objective of searching for morphological anomalies. However, during the handling of individuals we detected some specimens that presented visible anomalies, which were recorded photographically and measured their snout-vent length (SVL) with a digital caliper (± 0.02 mm). Lizards were sexed considering the specific characteristics of each species. For phrynosomatid lizards (*Phrynosoma orbiculare*, *Sceloporus mucronatus*, *S. bicanthalis*, *S. variabilis*, *S. grammicus*, and *S. minor*), we considered the presence of enlarged postcloacal scales in males and their absence in females (Ramírez-Bautista et al., 2014). In the anguid *Barisia imbricata*, we considered the presence of uniform dorsal coloration and wide heads in males and banded dorsal coloration and small heads in females (Dashevsky et al., 2013). For the scincid *Plestiodon lynxe*, light blue or brown ventral coloration was considered for females and intense dark blue ventral coloration was considered for males (Huitzil-Mendoza, 2007). After data collection, all lizards were released at the site where they were first observed, except for one specimen of *S. variabilis* that was collected for another study and subsequently deposited in the herpetological collection of the Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, under voucher number CH-CIB-6537.

We recorded 24 individuals with morphological anomalies in eight lizard species (Table 1). These anomalies were present on forelimbs or hind limbs, the tails, and the heads. Considering the records of the eight species in all sample sites, the prevalence (number of individuals with anomalies *100 / total number of individuals examined) varied among species. For instance, 18% for *B. imbricata* (n = 11), 6% for *P. orbiculare* (n = 34), 4% for *S. bicanthalis* (n = 80), 1% for *S. grammicus* (n = 93), 3% for *S. minor* (n = 79), 6 % *S. mucronatus* (, n = 176), 1% for *S. variabilis* (, n = 91), and 7% for *P. lynxe* (0.066, n = 30).

We recognize that several of the recorded anomalies could be associated with injuries or predation attempts. For this reason, we consider the use of this terminology appropriate to describe the observed anomalies. According to Rothschild (2012), most lizards showed toe anomalies that correspond to brachydactyly (abnormally short fingers or toes), ectodactyly (absence of one or more digits), and adactyly (absence of all digits). Specifically, seven individuals (four *S. mucronatus*, one *S. bicanthalis*, one *P. lynxe*, and one *B. imbricata*) exhibited brachydactyly in at least one limb (Fig. 1A), whereas five individuals (three *S. mucronatus* and two *S. bicanthalis*) showed ectrodactyly (Fig. 1B). Two *S. mucronatus* individuals had both anomalies (brachydactyly and ectodactyly), one *P. lynxe* individual showed adactyly (Fig. 1C), one *S. mucronatus* showed adactyly and brachydactyly (Fig. 1D), and other individuals of *S. mucronatus* showed these three anomalies (brachydactyly, ectodactyly, and adactyly; Fig. 1B), where one limb had no toes and the others had incomplete or lacked toes.

In contrast, one *S. variabilis* (Fig. 2A), one *S. grammicus* (Fig. 2B), and one *B. imbricata* (Fig. 2C) exhibited bifurcated tail. In each case, one tail was the original, actively growing and regenerating, while the second tail featured new tissue developing from the original. Two individuals of *P. orbiculare* showed cranial anomalies, one of which consisted of a cleft parietal zone of the skull covering the base of the first and second left horns, where these two horns were absent. Hence, a cleft was evident at the base of the third horn (Fig. 3A). The cranium of the second horned lizard lacked the fourth left and third right horns and had a scar on the fourth right horn (Fig. 3B). Both horned lizards were found on the ground and did not show apparent behavioral modifications. However, we could not determine whether these cranial anomalies had an environmental or genetic origin. In oviparous species, cranial developmental anomalies may prevent hatchlings from breaking the egg and hatching (Bellairs, 1965); however, the functional consequences of such anomalies remain uncertain in viviparous species such as *P. orbiculare*. Nevertheless, we could not rule out the possibility that this cranial anomaly was a byproduct of physical trauma originating during a failed predation event.

Morphological anomalies in lizards are a topic that has gained greater interest in recent years (Barr et al., 2020), and most of the cases are occasional records of tail anomalies (Feria-Ortiz et al., 2024; Suárez-Varón et al., 2024; Sánchez-Manjarrez et al., 2025), while few of them are records of limb anomalies (Díaz-Marín et al., 2023 b; De la Rosa-Silva et al., 2023; Suárez-Varón et al., 2025), and in some other body regions, such as the cranium (Díaz de la Vega-Pérez et al., 2015). Currently, there is no knowledge about the frequency of these distinct anomalies, and it is possible that they have an environmental or genetic origin (specifically those in limbs and the head). However, previous studies have shown that individuals can suffer injuries during predation events and agonistic fights (Vervust et al., 2009). Recently, Díaz-Marín (2024) recorded a lizard finger in the stomach content of a male *S. grammicus*, which might have been ingested during a male agonistic fight.

The absence of digits is not considered to affect the physiology or locomotor performance of individuals (Perry et al., 2011), but extreme cases, such as the absence of digits in all limbs, might influence some of these traits. The observation and recording of these morphological anomalies are important for understanding the endurance and adaptation of different species, as well as how lizards with morphological anomalies perform different activities during their life cycles. Future studies could evaluate how such anomalies affect individual performance and fitness by comparing locomotor performance, body condition indices, growth rates, and survival rates, between individuals with and without anomalies. These comparisons would help to determine whether morphological anomalies have measurable consequences on the ecological performance, behavior, or overall fitness of affected individuals in natural populations.

Acknowledgements

Fieldwork was approved under collecting permits SPARN/DGVS/04611/23, SPARN/DGVS/01879/24, and SPARN/DGVS/02351/25 issued by the government of Mexico through Secretaría del Medio Ambiente y Recursos Naturales. Handling of live specimens was conducted according to the 2004 "Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research" (Second Edition, Herpetological Animal Care and Use Committee of the American Society of Ichthyologists and Herpetologists), and the national Mexican law NOM-051-ZOO-1995 (Norma Oficial Mexicana NOM-051-ZOO-1995).

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Table 1. Records of the eight lizard species with morphological anomalies in the toes, tails, and heads found in the municipalities of Zacualtipán de Ángeles (ZA), Mineral El Chico (MC), Santiago Tulantepec de Lugo Guerrero (ST), San Agustín Metzquititlán (SA), and Acaxochitlán (AC) in Hidalgo, Mexico. The snout-vent length (SVL) of each record is shown for reference of body size.

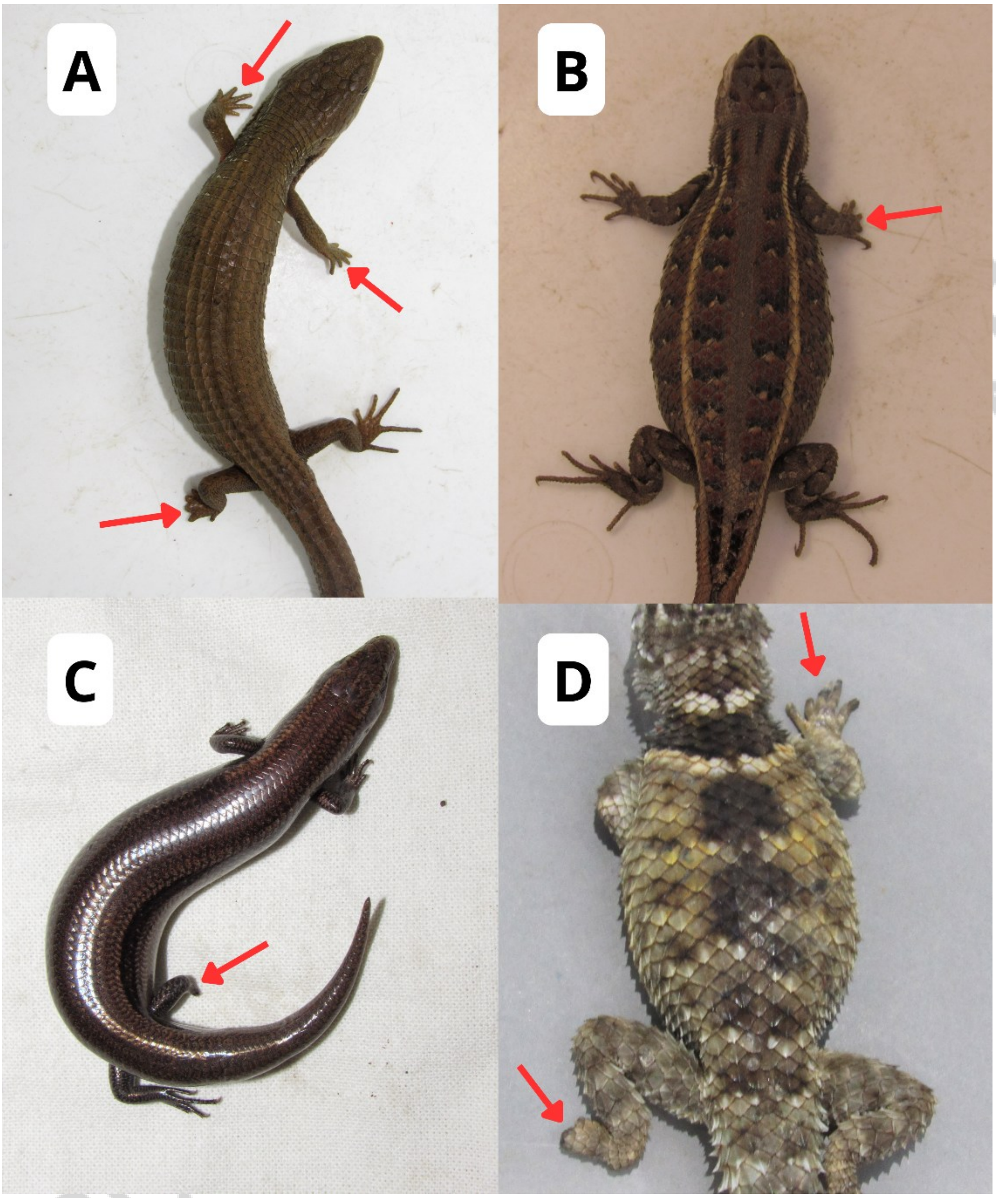
Family / Species	Study site	Morphological anomalies	Date	Sex	SVL (mm)
Anguidae					
Barisia imbricata	ZA	Brachydactyly	5 July 2024	Female	84.87
B. imbricata	MC	Tail bifurcation	6 July 2024	Female	82.12
Phrynosomatidae					
Phrynosoma orbiculare	MC	Absence of horns	22 November 2024	Female	68
P. orbiculare	MC	Cleft skull	17 August 2024	Male	60.85
Sceloporus bicanthalis	MC	Brachydactyly	27 September 2024	Female	46.41
S. bicanthalis	MC	Ectrodactyly	22 February 2025	Female	51.94
S. bicanthalis	MC	Ectrodactyly	27 April 2023	Female	51.48
S. grammicus	MC	Tail bifurcation	20 July 2023	Male	47.1
S. minor	SA	Brachydactyly and ectrodactyly	22 August 2025	Female	53.45
S. minor	SA	Brachydactyly and ectrodactyly	23 August 2025	Female	59.23
S. mucronatus	MC	Adactyly and brachydactyly	17 August 2024	Male	51.29
S. mucronatus	ST	Adactyly, brachydactyl and ectrodactyly	29 October 2023	Female	62.9
S. mucronatus	MC	Brachydactyly	22 February 2023	Male	88.94
S. mucronatus	MC	Brachydactyly	24 August 2024	Male	76.2
S. mucronatus	MC	Brachydactyly	29 September 2023	Female	69.1
S. mucronatus	MC	Brachydactyly	27 September 2024	Female	58.1
S. mucronatus	MC	Brachydactyly and ectrodactyly	22 February 2023	Female	80.21
S. mucronatus	ST	Brachydactyly and ectrodactyly	12 April 2024	Male	65.44
S. mucronatus	MC	Ectrodactyly	24 February 2024	Female	68.99

S. mucronatus	MC	Ectrodactyly	20 March 2024	Female	67.25
S. mucronatus	ST	Ectrodactyly	29 August 2023	Male	68.3
S. variabilis	AC	Tail bifurcation	17 November 2013	Female	57.89
Scincidae					
Plestiodon lynxe	MC	Adactyly	23 November 2025	Female	56.6
P. lynxe	MC	Brachydactyly	26 January 2024	Female	63.32

Fig. 1. Evidence of diverse morphological anomalies found in the toes of different lizard species from Hidalgo, Mexico. The red arrows indicate the anomalies in A) *Barisia imbricata* with brachydactyly (short digits), B) *Sceloporus bicanthalis* with ectrodactyly (absence of one or more digits), C) *Plestiodon lynxe* with adactyly, and D) *S. mucronatus* with adactyly and brachydactyly. Photographs of César A. Díaz-Marín (A, B, C) and Alexis M. Leonardo-González (D).

Fig. 2. Tail bifurcation in A) *Sceloporus variabilis*, B) *S. grammicus*, and C) *Barisia imbricata* from Hidalgo, Mexico. Photographs of César A. Díaz-Marín (A and C) and Alexis M. Leonardo-González (B).

Fig. 3. Cranium anomalies in *Phrynosoma orbiculare* from Mineral El Chico, Hidalgo, Mexico, showing A) a cleft in the parietal zone of the cranium, considering the base of the first and second left horns and B) the absence of the fourth left horn and the third right horn. Photographs of César A. Díaz-Marín.



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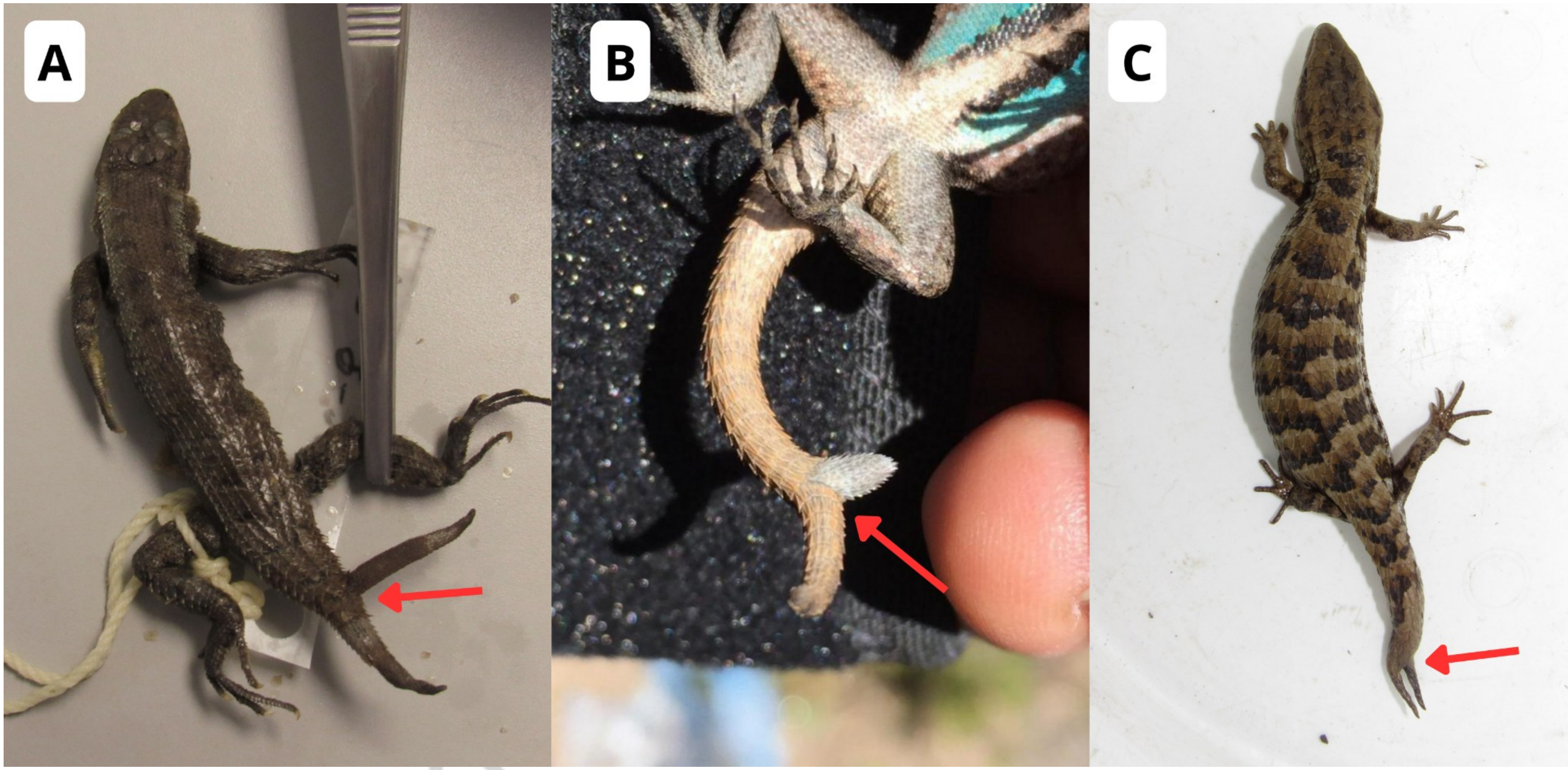

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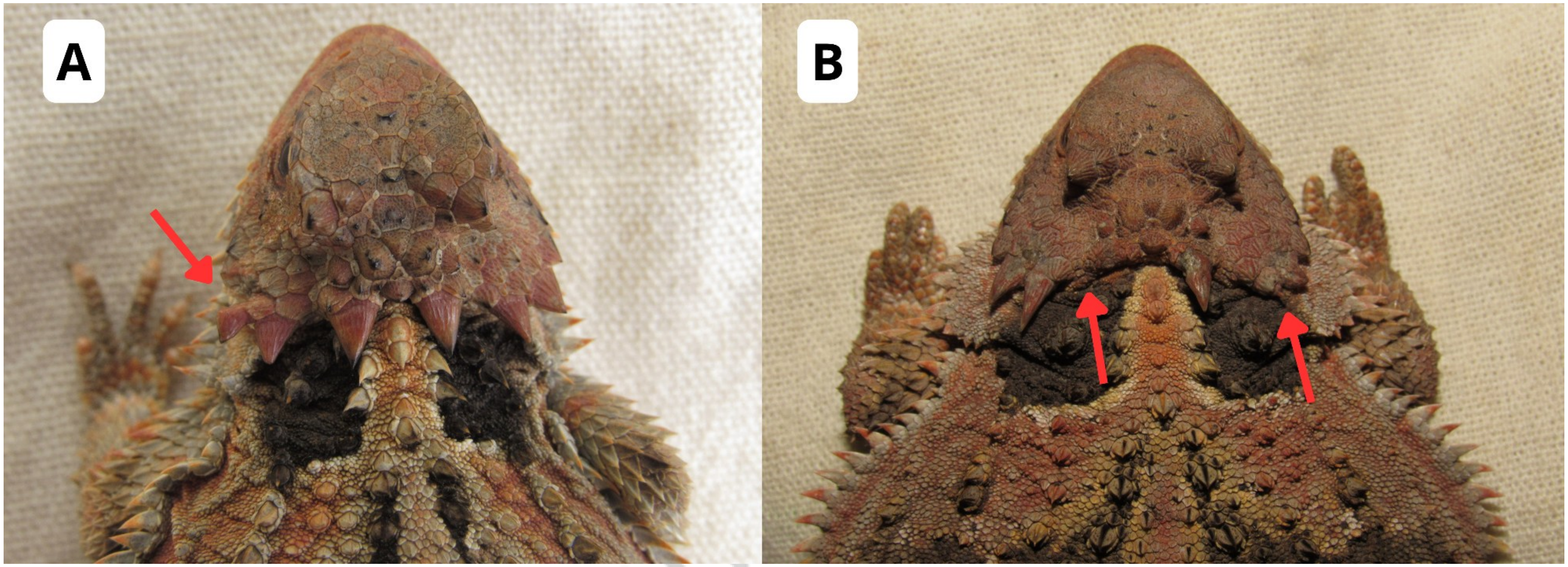

Fig. 3.