

# A BRIEF REVIEW OF LIMB ANOMALIES IN LIZARDS AND PRESENCE OF ECTRODACTILY IN *ASPIDOSCELIS COSTATUS* (SQUAMATA: TEIIDAE)

## UNA BREVE REVISIÓN DE LAS ANOMALÍAS DE LAS EXTREMIDADES EN LAGARTIJAS Y PRESENCIA DE ECTRODACTILIA EN *ASPIDOSCELIS COSTATUS* (SQUAMATA: TEIIDAE)

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**Resumen.**– Las lagartijas cola de látigo sobreviven a heridas graves infligidas durante la colecta por el ser humano y ataques de depredación fallidos. Así, parece que estas lagartijas pueden sobrevivir a una variedad de lesiones específicas a sus extremidades, aún cuando el movimiento rápido es una adaptación clave para muchos teiidos. Examinamos el tema poco conocido de anomalías en las extremidades de lagartijas, estimulado en parte por el descubrimiento de la primera anomalía natural en un individuo de entre cientos de lagartijas del género *Aspidoscelis* y *Cnemidophorus* (Familia Teiidae, Orden Squamata) examinados en América. Es plausible que un deterioro tan severo afectaría negativamente la supervivencia al reducir la movilidad; sin embargo, esa suposición requiere más estudios. Aunque nombramos a la condición descrita aquí como ectrodactilia severa en una hembra adulta de *Aspidoscelis costatus* (Huico Llanero), es posible que la condición resultara de un intento de depredación o un fenómeno ambiental.

**Palabras clave.**– Huico Llanero, pérdida de dígitos, lagartija, México, anomalía morfológica.

**Abstract.**– Whiptail lizards have been reported to survive serious wounds inflicted during collection by humans and failed predation attacks. Thus, it appears that these lizards can survive a variety of limb-specific injuries, though rapid movement is a key adaptation in many teiid lizards. We herein review the little-known subject of extremity abnormalities in lizards, stimulated in part by the discovery of the first profound naturally occurring limb anomaly among hundreds of lizards of the genera *Aspidoscelis* and *Cnemidophorus* (Family Teiidae, Order Squamata) examined from the Americas. It seems likely that such a severe impairment would negatively affect survival by reducing mobility; however, that assumption requires further study. Although we term the condition described herein as severe ectrodactily within an adult female of *Aspidoscelis costatus* (Western México Whiptail), it is possible that the condition resulted from either a predation attempt or another environmental occurrence.

**Keywords.**– Western México Whiptail, loss of digits, lizard, Mexico, morphological anomaly.

Naturally occurring limb anomalies are rarely reported in lizards. Such conditions may result from either genetic or environmental factors (e.g., predation attempts or developmental problems arising from the effects of temperature, humidity levels, toxins, etc.; Rothschild et al., 2012; Kolenda et al., 2017; Mora et al., 2020). Such morphological departures from the usual body plan may present themselves in different forms, with some, but not all, being described in the next paragraph. Brachydactyly is the development of digits that are shorter than normal, ectrodactily

is a condition when one or more digits are absent from an extremity, aphyalangia is the term applied when there is skin but a lack of phalanges or finger bones, and adactyly denotes the absence of all phalanges or finger bones from a sole digit (Rothschild et al., 2012; Martínez et al., 2017; Sánchez-Manjarrez et al., 2022). In addition, as Kolenda et al. (2017) and Rothschild et al. (2012) discuss, there are conditions that affect a significant section or the whole limb, including ectomely, where a portion of the limb is missing, particularly where it pertains to the



**Figure 1.** Leg anomaly in an adult female of *Aspidoscelis costatus*, found within the municipality of Tonicato, Estado de México, Mexico. (A) Ventral view of the specimen lacking the distal section of the right hind limb. Note the presence of the sole fifth digit and the reduction in musculature. (B) Close-up of the right hind limb, seen through a dorsal view.

**Figura 1.** Anomalía en la pierna en una hembra adulta de *Aspidoscelis costatus*, encontrada al interior del municipio de Tonicato, Estado de México, Mexico. (A) Vista ventral del espécimen al cual le falta la sección distal de la extremidad posterior derecha. Nótese la presencia de un solo quinto dígito y la reducción en la musculatura. (B) Acercamiento de la extremidad posterior derecha vista de forma dorsal.

more distal parts. This is further subdivided into amely when the entire limb is absent, hemimely when the tibia or fibula are either reduced or not present, though the distal parts still may be seen, and meromely when all digits are missing. Such limb abnormalities to varying degrees have been observed in various squamate families, including Corytophanidae (Mora et al., 2020), Gymnophthalmidae (Tipantiza-Tuguminago et al., 2021), Lacertidae (Gkourtsouli-Antoniadou et al., 2017; Kolenda et al., 2017), Mabuyidae (Martínez et al., 2017), and Phrynosomatidae (Díaz-Marín et al., 2023a; b).

*Aspidoscelis costatus* (Western México Whiptail) is the available name for an assemblage of Whiptail lizards in western Mexico, which, according to genetic analyses, are paraphyletic (Reeder et al., 2002; Barley et al., 2019). It has been reported in Estado de México within different habitats and elevations (Granados-González et al., 2020), reaching an average snout-vent length (SVL) of  $101.8 \pm 14.5$  mm for males and  $89.5 \pm 10.4$  mm for females (Aguilar-Moreno et al., 2010). It is oviparous, with the largest mean clutch size (7.7 eggs) thus far documented for the genus *Aspidoscelis* (López-Moreno et al., 2016). Rapid movement is a characteristic of Whiptail lizards; thus, it is not surprising that *A. costatus* has an active foraging mode and a speedy retreat from threats of all kinds (Hernández-Gallegos & Domínguez-Vega, 2012). The alternative to rapid locomotor performance is crypsis, as the dorsal color pattern is subject to ontogenetic (Gómez-Benitez et al., 2020) and seasonal variations (Hernández-Gallegos & Domínguez-Vega, 2012). Therefore, the anomaly reported herein would likely have seriously reduced the ability to move rapidly.

There are virtually no reports of limb anomalies in lizards within Mexico in general, except for a pair of recent scientific notes by Díaz-Marín et al. (2023a; b), which describe the presence of ectrodactily and brachydactily in individuals of the Graphic Spiny Lizard (*Sceloporus grammicus*), as well as ectomely in a female Mountain Horned Lizard (*Phrynosoma orbiculare*). To our knowledge, no information on such a condition has been published concerning *Aspidoscelis* or *Cnemidophorus*, even though hundreds of individuals belonging to both genera have been examined from the Americas. That said, it has been noted that Whiptail lizards housed in the laboratory for extended periods of time often develop malformed digits on the hindlimbs, and in the field, Whiptail lizards are apparently able to endure significant damage caused by unsuccessful predator attacks and capture by investigators (Walker J.M., *com. pers.*). Thus, here we discuss the first natural occurrence of missing digits and part of the foot, discovered in an individual of *A. costatus*.

At 12:45 h, on 16 June 2022, we encountered an adult female of *A. costatus*, which possessed a SVL of 77 mm, a tail length of 155 mm, and mass of 13 g. We determined its sexual development in accord with López-Moreno et al. (2016). This, while we were sampling an area of approximately 22,000 m<sup>2</sup>, in the municipality of Tonicato, Estado de México, Mexico (18.794167° N, 99.611944° W; 1646 m a.s.l.). The vegetation within the study site mainly consisted of grasses and herbaceous plants, though we noted the presence of thorny bushes (*Acacia* sp.) and a few corn plants (*Zea mays*). The lizard was captured manually with the assistance of a drift fence trap as it tried to escape once it detected our presence. After taking its biometric data: temperature with a cloacal thermometer, SVL via a ruler, mass through a spring scale, and sexing it according to the number and morphology of the scales underneath the cloaca, as per Ashton (2003), along with stimulating it to vocalize (the individual produced a total of two vocalizations in a span of three minutes), which was the goal of our project, we released the adult female back to its habitat where we found it. While we examined the specimen, we discovered it was missing a significant section of its right hind limb, lacking all digits and metatarsals except for the fifth one (Fig. 1). A noticeable stump could be seen near the end of the tarsals, with the scales at this zone being tightly clumped together, lacking a regular shape, and with a darker coloration compared to the normal scalation of the extremity. Also, in contrast to the healthy left hind limb, the right one had a reduced diameter, which most likely stemmed from a loss in musculature due to a lack of activity from that leg.

Based on this, we classify the condition as severe ectrodactily, according to the definition provided by Rothschild et al. (2012). However, it is difficult to assert with certainty if the condition was caused by a predatory event or if it is a malformation related to genetic factors. However, we would argue that the former is more likely based on the presence of asymmetric, grey-black scales that covered the stump. It was similar to the outgrowths described by Alibardi (2017), seen after the amputation of a lizard's limb, and characterized by being short or flat as well as having a dense, hard, and scaled structure. It is also difficult to determine what may have caused the possible injury. There is little knowledge about probable predators for *A. costatus*, though recent evidence suggests that both Coachwhip snakes (*Masticophis* spp.; Hernández-Gallegos & Domínguez-Vega, 2012) and the Thornscrub Vine Snake (*Oxybelis* spp.; Bucio-Jiménez & Flores-Loyola, 2021) may feed on several species of *Aspidoscelis*. Another likely culprit is the Ringtail (*Bassariscus astutus*), as this mammal also preys upon diverse species of lizards (Rodríguez-Estrella et al., 2000; Herrera-Flores, 2018), or perhaps feral dogs or cats, though we saw none of these predators in the study site.

Of course, we wish to reiterate that without x-rays or a way to examine the area of the affected extremity more closely, the nature of the ectrodactily seen in the specimen remains as a hypothesis.

From the six individuals of *A. costatus* we captured that day, this female was the only one that presented the described condition. Though it may seem as if the lack of a fully functional limb could impact the fitness of an individual (Díaz-Marín et al., 2023a), we consider that overall, the specimen was not seriously adversely affected by its loss. The development of scar tissue and a stump, along with the noticeable lack of musculature on the limb, is evidence that it survived for some time before we encountered it. Indeed, we captured a healthy adult male with similar proportions (SVL of 76 mm, tail length of 144 mm, and mass of 12.8 g) to the previously described female. This discovery indicates that an individual with ectrodactily was able to properly forage for food, as it seemingly was not underweighted. The vocalizations produced by the female could also indicate that the specimen was in good condition, as *A. costatus* does not tend to vocalize when infirm, as we saw with an extremely thin male found in a population within Ixtapan de la Sal (De La Rosa-Silva E., *com. pers.*). Furthermore, it proved to be quite elusive, and we struggled to capture it on site, something that may indicate its rapid locomotor performance was not substantially hindered by its condition. More studies are required to determine how limb anomalies in lizards affect the behavior of individuals who possess such disabilities and to what extent they alter their behavior to persist.

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