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BLOOD-SQUIRT OCCURRENCE IN THE MEXICAN PLATEAU HORNED LIZARD (*PHRYNOSOMA ORBICULARE*)

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ABSTRACT—Blood-squirting from ocular sinuses is a unique defensive behavior widespread in horned lizards. During an ecological study in the state of Mexico, Mexico, we captured 24 males and 23 females of *Phrynosoma orbiculare*, of which three males squirted blood during gentle handling. Two individuals were of juvenile size, suggesting, with data from large adults, that *P. orbiculare* defensive strategy may be employed throughout life.

RESUMEN—Arrojar sangre por los senos oculares es un comportamiento defensivo único ampliamente presente en lagartijas cornudas. Durante un estudio ecológico en el Estado de México, México, capturamos 24 machos y 23 hembras de *Phrynosoma orbiculare*, de los cuales tres machos arrojaron sangre durante la manipulación. Dos individuos fueron juveniles, lo que sugiere, en conjunto con datos de adultos grandes, que esta estrategia defensiva puede emplearse durante toda la vida.

Horned lizards, genus *Phrynosoma*, are among the most distinctive reptiles in North America. The genus contains 17 species (Nieto-Montes de Oca et al., 2014; Leaché and Linkem, 2015) classified into four clades (Leaché and McGuire, 2006; Leaché and Linkem, 2015). Despite differences in species' sizes, modes of reproduction, horn arrays, color patterns, ant and arthropod diets, and geographical distributions, many of their defensive features and appearances are relatively uniform throughout the genus (Pianka and Parker, 1975; Sherbrooke, 2003). Perhaps their most outstanding behavior, reported in most species, is the use of blood-squirting from circumorbital sinuses as a defense against certain mammalian predators (Middendorf and Sherbrooke, 1992; Sherbrooke and Middendorf, 2001, 2004; Sherbrooke et al., 2012).

Elicitation of this response during field encounters with human capture has shown variability in responses by

various species with diverse sample sizes. These inconsistencies have led to questionable interpretations that some species are blood-squirting species and others are non-squirting species (Sherbrooke and Middendorf, 2001; Sherbrooke et al., 2004; Leaché and McGuire, 2006; Sherbrooke and Rodriguez, 2010; Wojnowski et al., 2010). This has led to erroneous conclusions, especially in Mexico, where reports for some species were unavailable until recently (Sherbrooke and Mendoza-Quijano, 2005; García-Vázquez and Canseco-Márquez, 2006; Sherbrooke and Rodriguez, 2010). Significant numbers of human field encounters allowing for calculation of percentage of occurrences of blood-squirting within a population only exist for a few species: *Phrynosoma solare* (Parker, 1971: $n = 65$, 4.6%), *Phrynosoma cornutum* (Lambert and Ferguson, 1985: $n = 118$, 5.9%; Hodges, 2004: $n = 76$, 5%), and *Phrynosoma ditmarsii* (Hodges, 2004: $n = 57$, 12%).

Blood-squirting behavior by *Phrynosoma orbiculare* was known to indigenous people in pre-Colombian times (Gutiérrez-Santillán et al., 2010), was reported by Spanish conquerors in 1651 (Manaster, 1997), and more recently was noted by an early Mexican herpetologist (Cuesta-Terrón, 1932). Here we report the first significant sampling, in the state of Mexico, of blood-squirting in a population of *P. orbiculare*, a widespread Mexican species of diverse lineages (Bryson et al., 2012), and we note the occurrence and significance of this predator-defensive behavior in juvenile individuals.

We studied *P. orbiculare* within the Sierra Morelos State Park, located at Toluca de Lerdo and Zinacantepec, state of Mexico, Mexico (19°20'00"–19°17'47"N, 99°39'00"–99°43'25"W, ~2,700 m altitude; datum WGS 84) on 26 June 2017. This zone exhibits a temperate-humid climate with predominant vegetation of pines and cedars (Gobierno del Estado de México, 2013), including bunchgrass microhabitat that serves as a refuge and perches for *P. orbiculare*. The study area encompasses 14,755 m². By hand we caught 47 individuals. Three males (snout-vent length [SVL] = 34, 38, and 80 mm) squirted blood during gentle handling, representing 6.3% of the sample. These observations occurred between 1350 and 1512 h (Central Standard Time Zone). The sample included 24 males (SVL = 29–80 mm) and 23 females (SVL = 32–95 mm). The percentages of blood-squirting individuals by sex were 12.5% males and 0% females. Nevertheless, during other studies with this population we observed blood-squirting by females (A.G.B., pers. observ.).

In this population of *P. orbiculare*, Hernández-Navarrete (2018) determined SVLs of recently born (females 22–33 mm, males 25–33 mm), juveniles (females 34–65 mm, males 34–64 mm), and adults (females ≥66 mm, males ≥65 mm), within which our sample spread correspondingly was 0, 18.2, and 12.5%. Thus, the two smallest of the three blood-squirting males we encountered were juveniles. The smallest blood-squirting individual (SVL 34 mm) is the smallest horned lizard ever reported to squirt blood. Sherbrooke and Middendorf (2001) reported blood-squirting by three of five *P. cornutum* juveniles (SVLs 37, 38, 39 mm), and by one of three *Phrynosoma hernandesi* juveniles (SVL 62 mm). All responses were during dog trials. Suárez-Rodríguez et al. (2018) report that the offspring of *P. orbiculare* measure up to 33 mm SVL at birth in Sierra Morelos State Park in Toluca. Collectively, these reports of blood-squirting by small juvenile horned lizards suggest that small amounts of blood delivered by juvenile horned lizards may be effective in repelling specific mammalian threats. This is during periods of their early life when the predator spectrum to which they may fall prey is broad. Also, suggesting that blood-squirting by horned lizards continues throughout life, the largest male *P. orbiculare* (SVL 80 mm) to squirt blood is near the largest size at this site (SVL 85 mm; Hernández-Navarrete, 2018) and a broad

spectrum of adult sizes *P. cornutum* squirted blood in trials (Sherbrooke and Middendorf, 2001, 2004).

Further studies of blood-squirting in *P. orbiculare* might encounter geographic differences because of this species' (as currently recognized) distinct phylogenetic populations (Bryson et al., 2012) or other factors, as may well be the case with the also geographically widely dispersed *Phrynosoma douglasii* species complex (Montanucci, 2015). We also note that humans are not a category of predator identity evolved for elicitation of a blood-squirting defensive response by horned lizards, which often exhibit a diversity of specific defenses for different predators (Sherbrooke, 2013). Researchers need to consider this in interpreting blood-squirting responses, or their absence, in horned lizard populations.

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