REPTILES & AMPHIBIANS

Male-Male Agonistic Interaction in the Four-Lined Ameiva, *Holcosus quadrilineatus* (Squamata: Teiidae), in Costa Rica

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The family Teiidae comprises 173 species in 18 genera, the most diverse of which are the racerunners and whiptails in the genera *Ameiva*, *Aspidoscelis*, *Cnemidophorus*, *Pholidoscelis*, and *Holcosus* (Uetz et al. 2025). Species in these genera are diurnally active and exhibit consistently high activity levels, a trait driven largely by their foraging and thermo-

Figure 1. Male-male physical aggression in Four-lined Ameivas (*Holcosus quadrilineatus*) in Costa Rica: (A) The larger male (white arrows) with a regenerated tail biting the neck of the smaller male (black arrows) with an intact tail; (B) two males with jaws locked and spinning; (C–E) larger male attempting to immobilize the smaller male; (F) the smaller male manages to break free from the larger male, flees, and is chased by the larger male. Photographs by Denis Padilla-Raudales.

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regulatory strategies (Carpenter 1960; Savage 2002). Less well documented are agonistic behaviors, the intensity of which can vary geographically in at least some species (Grassman et al. 1991). These are involved in establishing and maintaining territories and dominance hierarchies crucial for feeding and reproductive success (Anderson and Vitt 1990; Costa et al. 2010). Despite the relative scarcity of detailed behavioral studies, observations have revealed social interactions that include mating, courtship, and agonistic encounters in several species (e.g., Pianka 1966; Anderson and Vitt 1990; Censky 1995; Rudman et al. 2009; Ribeiro et al. 2011). Although observations of behavioral displays such as courtship, mating, and agonistic interactions in nature often are opportunistic (e.g., Costa et al. 2010), evidence suggests that several teiid species exhibit territoriality and engage in frequent agonistic encounters, during which larger males experience greater competitive success, thus driving sexual selection pressures (Fitch 1967; Gorman et al. 1977; Anderson and Vitt 1990; Censky 1995; Imparato et al. 2007; Rudman et al. 2009; Winck et al. 2011).

The Four-lined Ameiva, *Holcosus quadrilineatus* (Hallowell 1861), is distributed in humid lowlands at elevations from sea level to 1,375 m along the Atlantic Slope from southeastern Nicaragua to northwestern Panama and along the Pacific slope from central and northwestern Costa Rica to central Panama (Savage 2002; Vargas Álvarez et al. 2013; Leenders 2019). Reproduction is continuous throughout the year, with peak egg-laying during the rainy season from May to June (Fitch 1973; Savage 2002). Contrary to patterns of male territoriality and aggression observed in other species, Hirth (1963) proposed that male Four-lined Ameivas are not territorial. We herein present the first detailed account of aggression between two male *H. quadrilineatus* in Costa Rica.

At 1030 h on 1 April 2021, after a very rainy night, we observed and documented an agonistic interaction between two male *Holcosus quadrilineatus* on sandy substrate in the parking lot of the Isla Inn Hotel, Cocles Beach, Limón Province, Costa Rica (Fig. 1; video available at: https://www.youtube.com/watch?v=14F2RoRE93w) (9.65184°N, -82.73891°W; WGS84; elev. 13 m asl). Lizards initially were observed at the base of three palm trees, approximately 3–4 m apart. The larger male with a regenerated tail initiated non-physical agonistic behaviors. A slightly smaller male with an intact tail responded immediately. The larger male lunged at the smaller one but the smaller individual evaded and countered with a powerful bite to the jaw. The skirmish lasted about 15 s. The larger male then tried and eventually freed itself using jerky movements. The smaller male reacted with two bites, but the larger male immobilized its opponent by biting its jaw (Fig. 1A). Both then circled one another while attempting to bite the other's neck. They grappled, each gripping the other's jaw before twisting their bodies in an effort to break free (Fig. 1B). These rotational movements were similar to those documented in some species of lizards and many crocodilians during agonistic interactions or when subduing prey (e.g., Beck and Ramírez-Bautista 1991; Fish et al. 2007; Krebs and Wünstel 2019). Throughout this period, which lasted about 2 min, the larger male maintained a firm grip on the smaller male's neck in an effort to immobilize it (Figs. 1C–D). The larger male then released its opponent, who had ceased to resist. The respite, however, was brief as the larger male renewed its pursuit and bit the smaller male's left thigh, inflicting a bleeding wound. This continued for approximately 5 min until the smaller male freed itself (Fig.1E). The larger male again attempted to grasp the smaller male but failed to secure a grip. The smaller male then escaped and sought refuge under a wooden platform in the restaurant, followed closely by the larger male (Fig. 1F), at which time we lost sight of both lizards. The entire encounter lasted 7–8 min.

Unlike anoles (*Anolis* spp.), which are known to be highly territorial (e.g., Ortiz and Jenssen 1982; Deckel 1995; Antúnez-Fonseca et al. 2022), agonistic interactions appear to be comparatively rare in teiids (Pianka 1966; Stamps 1983). However, some studies suggest these encounters might be more common than previously thought (e.g., Anderson and Vitt 1990). During social interactions, lizards often display visual cues involving head movements as precursors to physical aggression (Grassman et al. 1991; Losos 2009). Frequently attributed to reproductive overtures, such displays also can arise from territoriality and dominance (Stamps and Barlow 1973; Ribeiro et al. 2011). Our observation of agonistic interactions in *H. quadrilineatus* likely stemmed from males defending territories or establishing dominance hierarchies to secure mating opportunities with nearby females. Further research, needed to fully elucidate the frequency and underlying causes of such encounters, should investigate the role of factors including temperature and sex ratios (e.g., Censky 1995; Sales and Freire 2021).

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