

Defensive behaviors of *Leptodactylus chaquensis* (Anura: Leptodactylidae)

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The evolution of toxic and distasteful skin secretions, cryptic and aposematic coloration, and a wide variety of defensive behaviors in amphibians have been attributed to predator-prey interaction (Wells, 2007). Due to selective pressure of predation, numerous defensive behaviors evolved in amphibians, such as death feigning, stiff-legs, puffing-up the body, mouth-gaping, biting, and body raising (Duellman and Trueb, 1994; Toledo et al., 2011). Knowledge on such behaviors has been mostly reported from field observations or laboratory tests (e.g., Ferreira et al., 2013). Nevertheless, defensive behaviors remain poorly known for most Neotropical anurans.

The Neotropical genus *Leptodactylus* includes 76 species and occurs throughout Southern North America, South America, and the West Indies (Frost, 2014). *Leptodactylus chaquensis* is included in the *Leptodactylus latrans* group (Frost, 2014). This median-sized species (males 58.2 - 82 mm and females 60.7-80.1 mm; Prado et al., 2000) reproduces in permanent and temporary water bodies (Uetanabaro et al., 2008). This species exhibits the defensive behavior of head hitting, biting, and mouth-gaping (Toledo et al., 2011).

We observed a sequence of defensive behaviors displayed by an adult of *L. chaquensis*, readily identified by brownish dorsal coloration, double vocal sac, snout truncate, and posterior surface of the thighs with a uniform dark green coloration (Cei, 1950; Santos and Cechin, 2008). This observation occurred on 10 August

2011 at 18:00h in São Joaquim da Barra (- 20.58, - 47.85, Datum SAD 69, 118 m elevation), São Paulo, Brazil (Figure 1). The individual was exposed to an artificial stimulus produced by the observer.

We recorded four defensive behaviors in the species: motionless, fleeing, thanatosis, and secretion of greenish-skin substance. Firstly, the frog remained motionless after being touched. It jumped and fled away when the observer lightly squeezed and touched the frog's dorsal, chin, and lateral regions with the fingertips. After a few seconds without any disturbance, the frog was touched and squeezed again. At this time, the frog displayed thanatosis. Finally, the frog in thanatosis slowly rubbed their legs and secreted a greenish adhesive substance, and with odor, after being released and tapped with the fingertips (Figure 1). These behaviors were observed for about 3 minutes. After a few seconds, the frog returned to normal posture.

We did not observe *L. chaquensis* exhibiting some of those defensive behaviors reported previously, such as head hitting, biting, and mouth-gaping (Toledo et al., 2011). It is noteworthy that those behaviors were displayed by females of *L. chaquensis* during egg and tadpole guarding (Prado et al., 2000; Heyer and Giaretta, 2009).

Motionless and fleeing are the two opposite extremes of defensive behaviors and are considered widespread in anurans (Toledo et al., 2011). Most species remain motionless to avoid visualization; if touched, the frog tends to flee away from the predator. Thanatosis is a strategy to avoid subjugation after being captured (Toledo et al., 2010). The congener *Leptodactylus latrans* also displays thanatosis (Toledo et al., 2010). Skin secretion has also been reported in the genus. *Leptodactylus latrans* produces noxious and slippery skin secretions (Toledo et al., 2011; Haddad et al., 2013). Species of the group *L. latrans* (*L. macrosternum* and *L. viridis*) and species of the group *L. pentadactylus* (*L. flavopictus*, *L. labyrinthicus*, and *L. vastus*) also secrete poisonous substances through the skin (Haddad

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Figure 1. *Leptodactylus chaquensis* rubbing the legs for skin secretion in São Joaquim da Barra, São Paulo, Brazil.

et al., 2013). These similar observations across different species suggest that more congeners may exhibit such defensive behaviors.

Our observation of rubbing legs followed by substance secretion further indicates that leptodactylids produce toxic or unpalatable substance to predators. To our knowledge, this is the first report of thanatosis and skin secretion in synergy for *L. chaquensis* (Figure 1). The lack of knowledge on anti-predator behaviors in *Leptodactylus* prevents evolutionary understanding of its defensive strategies.

Acknowledgments. RLM thanks CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for scholarship (140710/2013-2). VGB thanks CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) for scholarship. RBF thanks Ecology Center at Utah State University for providing a PhD assistantship. We thank Diogo Provete and Iuri Dias for comments on the manuscript.

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