

Defensive strategies in three Amazonian hylids (Anura: Hylidae)

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Anurans may adopt different defensive strategies to prevent predation (Duellman & Trueb, 1994; Wells, 2007). A variety of these strategies, either on their own or in combination, have been reported from hylid species and include eye-protection, crouching down, puffing up the body, body raising and feigning death (thanatosis) (Azevedo-Ramos, 1995; Angulo & Funk, 2006; Angulo et al., 2007; Toledo et al., 2011). These behaviours are considered 'defensive strategies' when they are effective in reducing predator attacks, and are a common and diverse survival mechanism employed by many anurans (Toledo & Haddad, 2009; Toledo et al., 2010 & 2011; Humphreys & Ruxton, 2018; Ferreira et al., 2019). In this study we describe defensive strategies of three hylids, *Boana geographica* (Spix, 1824), *Boana lanciformis* (Cope, 1871) and *Boana calcarata* (Troschel, 1848), from the eastern Amazonia region. These species were identified morphologically as detailed in previous studies, *B. geographica* and *B. calcarata* (Silva e Silva & Costa-Campos, 2018) and *B. lanciformis* (Costa-Campos et al., 2014).

On 21 February 2013, at 20.34 h, an adult male *B. geographica* (Fig. 1A) was recorded in the Cancão Municipal Natural Park, municipality of Serra do Navio, Amapá State, Brazil (0.9138° N, 52.9997° W). When handled it displayed eye-protection, and its head remained in an upright position for a few minutes. After its release, it remained in a lower than the habitual sitting posture, exhibiting the 'crouching down' defensive behaviour (Toledo et al., 2011, Fig. 1B).

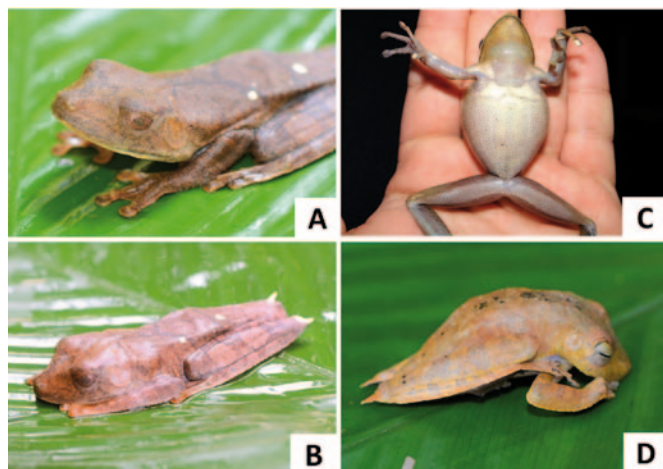


Figure 1. Defensive strategies of Amazonian hylids - **A.** and **B.** *B. geographica* displaying eye-protection and 'crouching down', respectively; **C.** *B. lanciformis* displaying puffing up the body with thanatosis; **D.** *B. calcarata* exhibiting 'crouching down'

On 4 October 2013, at 22.14 h, an adult male *B. lanciformis* was recorded calling on branches above temporary lentic water bodies surrounded by arboreal vegetation inside secondary forest in Santana Island (0.0802° N, 51.1821° W), municipality of Santana, Amapá State, Brazil. When handled it puffed up the body by inflating its lungs, this was followed by thanatosis with limbs outstretched (Fig. 1C).

On 13 October 2017, at 21.53 h, an adult *B. calcarata* was collected in the Cancão Municipal Natural Park, municipality of Serra do Navio, Amapá state, Brazil (0.9138° N, 52.9997° W). When handled, the individual immediately exhibited 'crouching down' behaviour, remaining motionless for three minutes with body arched, arms and legs bent and kept close to the body, and with its eyes partially open (Fig. 1D). After release the individual resumed its initial position, moving slowly.

According to Toledo et al. (2011), eye-protection and crouching are generally associated with puffing up the body and body raising, however, we did not observe this association. Puffing up the body behaviour has been reported in anurans with the accompaniment of other defensive behaviours, such as thanatosis, as was the case for *B. lanciformis* in this study.

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