



Predation attempt of *Hypsiboas boans* (Anura: Hylidae) by *Helicops angulatus* (Squamata: Dipsadidae) with notes on defensive behavior

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Anurans have evolved a wide array of defensive strategies to augment their survival probability when attacked by predators. Herein, we report a predation attempt of *Helicops angulatus* (Linnaeus, 1758) (Dipsadidae: Xenodontinae) upon *Hypsiboas boans* (Linnaeus, 1824) (Anura: Hylidae), in Central Amazon, Brazil and present details on the defensive behavior exhibit by the attacked frog. This note reports the first observed trophic interaction between both species and the first evidence of distress calls emitted by *H. boans* upon attack by a natural predator.

Helicops angulatus (Linnaeus, 1758) is a mildly venomous snake (Estrella *et al.*, 2011) that inhabits still or slow flowing waters of Venezuela, Guiana, Suriname, Colombia, Brazil, Bolivia, Peru, Trinidad, Ecuador and French Guiana (Roberto *et al.*, 2009). Despite being widely distributed there have been few studies of its natural history and consequently information about its prey items and feeding behavior is still scarce. The species is known to feed generically upon amphibian eggs, tadpoles, adult anurans, aquatic lizards and fish (Martins & Oliveira, 1998); however, specific information about which species are preyed by *H. angulatus* is limited to the reference of tadpoles of the genera “*Hyla*”, *Osteocephalus* (Martins & Oliveira, 1998), *Rhinella marina* (Kaefer & Montanarin, 2011) and a post-metamorphic *Hypsiboas crepitans* (Silva Jr. *et al.*, 2003).

The tree frog *Hypsiboas boans* is an arboreal nocturnal hylid widely distributed in the subtropical and tropical moist lowland forests of the Amazon basin and found in association with ponds, rivers and streams (Lima *et al.*, 2005). Its reproductive activity takes place mainly in the dry season between July and December and eggs are laid in nest basins constructed by the male near streams or in backwaters of streams (Lima *et al.*, 2005).

Hypsiboas tadpoles are vulnerable to a multitude of predators such as coleopteran and odonate insects, as well as fish and other amphibian tadpoles (Caldwell, 1989; Magnusson & Hero, 1991). Adults have also been found to be preyed by invertebrates (Menin *et al.*, 2005) and several vertebrate taxa such as snakes (Kluge, 1981), birds (Toledo *et al.*, 2005) and primates (Canale & Lingnau, 2003). When unable to escape from predators, adult *Hypsiboas* try to enhance their survival chances by using different defensive strategies that range from distress calls (Lima *et al.*, 2005) to death feigning, open arm display and odor production (Angulo *et al.*, 2007).

Herein, we report the first observed trophic interaction between *H. boans* and *H. angulatus* and provide details of defensive behavioral strategies displayed by the hylid immediately following the attack.

Our observation took place on 27 July 2012 in continuous, terra firme closed canopy forest at km 41 field camp,

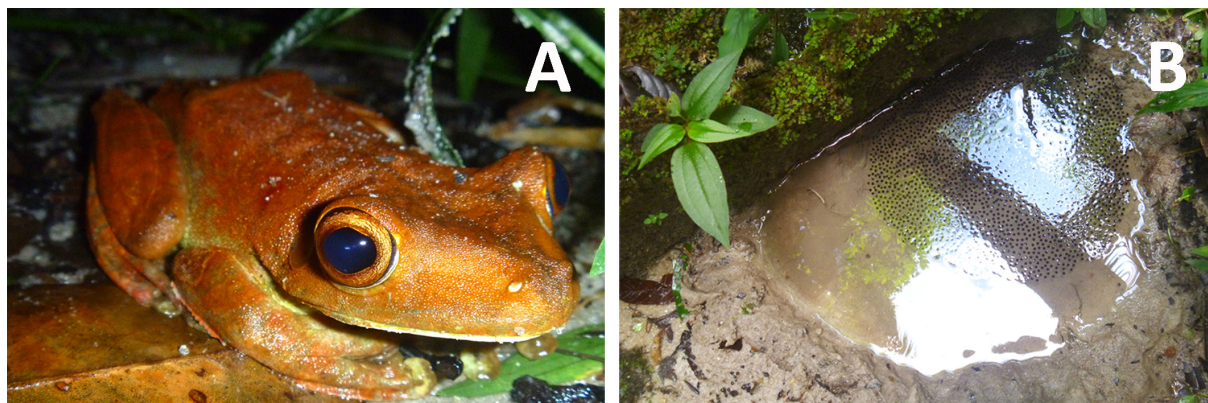


Figure 1. A. adult *Hypsiboas boans* prior to attack; B. mud nest where the *H. boans* was first observed.

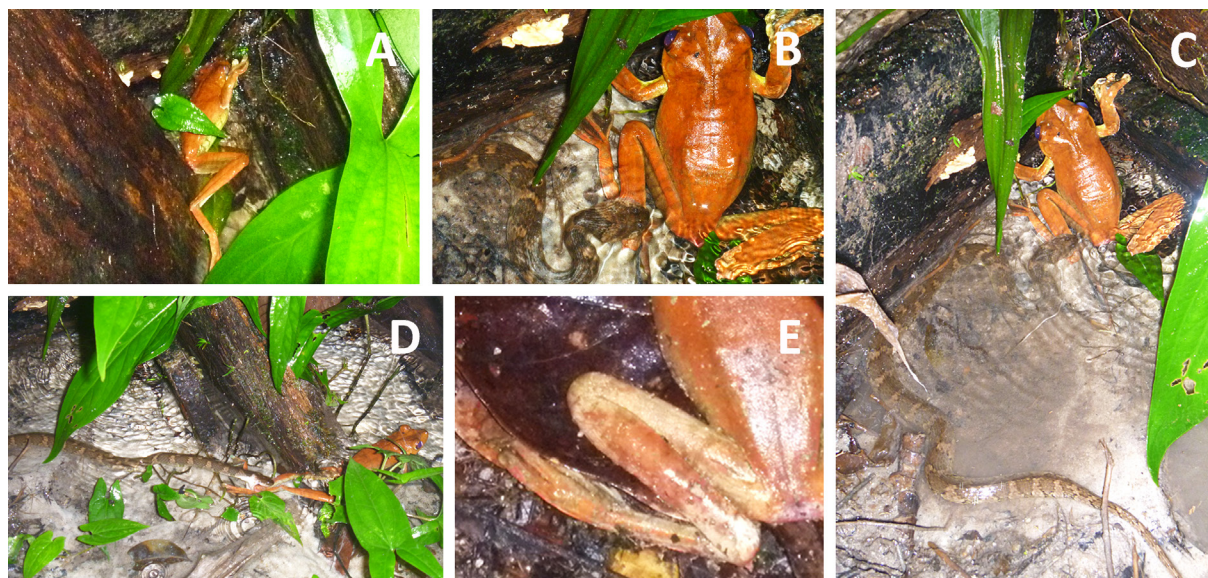


Figure 2. Predation attempt of *Helicops angulatus* upon *Hypsiboas boans* in Central Amazon, Brasil: A. Initial stage of the attack during which the frog was emitting loud distress calls while keeping its limbs partly extended; B. and C. *H. angulatus* biting *H. boans* on its tibiofibula and calcaneum leg portions; D. *H. boans* crawling into the opposite direction of the *H. angulatus*; E. *H. boans* after the attack presenting slight swelling around the bitten area and evident discoloration around the bitten area and the upper third of the affected leg.

Biological Dynamics of Forest Fragments Project (BDFFP) (2°26'54.8"S, 59°46'13.2"W) (see Gascon & Birregaard, 2001) for a detailed description of the site) in Central Amazon, Brazil. At 1:20 am an adult *H. boans* (SVL approx. 120 mm) was observed at the edge of a mud nest filled with *H. boans* eggs, at the periphery of small stream (fig. 1.A and B). When approached by the observers, the frog jumped into the direction of the stream and immediately opened its mouth emitting distress calls (*sensu* Bogert, 1960) while keeping its legs and arms partly extended (fig. 2.A). Upon close inspection, a *H. angulatus* (SVL approx. 600 mm) was observed biting the hylid on its tibiofibula and calcaneum leg portions (fig. 2.B and fig. 2.C). The frog kept emitting distress calls for over a minute (always keeping its limbs partly extended) then went silent, relaxed its legs and gave small leaps for about five minutes. After that the frog slowly started to crawl into the opposite direction of the snake and eight minutes after the start of the attack, the frog managed to move roughly 30 cm away from the initial point of contact (fig. 2.D). At this point one of the observers (RR) tried to capture the snake; however, after releasing the frog, the snake managed to escape underneath an artificial dam and the frog jumped into dense vegetation on the margin of the stream. At 02:00 am the frog was last observed amongst the riparian vegetation presenting a slight swelling around the bitten area and evident discoloration both around the bitten area and the upper third of the affected leg (fig. 2.E).

Although no vouchers have been collected, species identification was possible given that in the BDFFP study area the only hylid similar in size and color to *H. boans* is *Osteocephalus taurinus* (Zimmerman & Rodrigues, 1990) and the later can be easily distinguished by a golden iris with radiating lines (Lima *et al.*, 2005). The identification of *H. angulatus* was based on the distinct banded dorsal color pattern as *Helicops hagmanni*, the only other snake of the genus *Helicops* to be known to occur across the BDFFP study landscape (Zimmerman & Rodrigues, 1990), can be easily distinguished by presenting spots instead of strips on the dorsum (Ri-

beiro-Kawashita *et al.*, 2013).

During the observed predation attempt the frog displayed several potential defensive behaviors. Immediately upon attack, partial stretching of both legs and arms and distress calls were used together, probably in order to avoid subjugation. Distress calls emitted by *H. boans* upon human grasping had already been recorded (Hödl & Gollmann, 1986); however, to date the species have not been recorded emitting acoustic signals upon capture by a natural predator. Defensive vocalizations have been suggested to be useless against snakes, which are suspected to be unable of hearing a prey's screams (Toledo & Haddad, 2009). However, distress calls can act as attracting stimuli to guide snake predators to home in on a potentially easy meal (either prey, primary predator, or both) and interrupt the predation process, giving the screaming frog a chance to escape (Hödl & Gollmann, 1986). The use of two defensive strategies concomitantly (partial stretching of limbs and distress calls) may achieve a superior net benefit than the simple sum of the isolated behaviors, enhancing the frog's survival probability (Toledo *et al.*, 2011).

Despite limited by morphological constrains, snakes are capable of capturing and consuming prey relatively large in relation to their own body size (Sazima & Martins, 1990). However, handling excessively large prey can represent an energy waste and even if the prey is subdued the snake might be unable to successfully ingest it (e.g. Font *et al.*, 2013) and in extreme cases the swallowing of too large prey might result in death of both predator and prey (e.g. Cavalcanti *et al.*, 2012). In the event here reported, the large size of the seized *H. boans* might have prevented the snake from successfully ingesting the hylid.

For most species, especially in remote, largely unexplored places like Central Amazon, witnessing wild interactions between predator and amphibian prey are rare events that should be properly reported in order to allow a better understanding of prey defense behaviors and trophic relations between anurans and their predators.

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