

“Hide and seek”: diurnal refuge and camouflage of two anurans from the Atlantic Forest of Northeastern Brazil

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Over the course of their evolution, anurans have colonized a great diversity of microhabit types (Pertel et al., 2006). Most species of amphibians are nocturnally active, a habit that allows these mesophilic animals to avoid being exposed to higher temperatures and lower atmospheric humidity experienced during the day (Duellman and Trueb, 1994; Pombal, 1997). Diurnal refugia for anurans are generally microenvironments with higher moisture and shaded from sunlight (Duellman and Trueb, 1994). Also, retreat type can differ between species depending on whether the anuran species is terrestrial or arboreal. The former case is exemplified by dendrobatids, most bufonids, and leptodactylids, as these species generally use fallen tree holes (Wells, 1977), ground vegetation (Stewart and Pough, 1983; Stewart and Rand, 1991; Bosman et al., 1996), rock crevices (Wells, 1977; Haddad and Martins, 1994; Seebacher and Alford, 1999), and natural or constructed burrows (see Svihla, 1953; Hoffman and Katz, 1989; Schwarzkopf and Alford, 1996). Anurans will even use burrows constructed by other animals (e.g., Mullally, 1953; Denton and Beebe, 1992, 1993; Bossert et al., 2003), such as those reported for *Leptodactylus labyrinthicus* using burrows of some rodents (e.g. *Clyomis bishop*) and armadillos (e.g. *Cabassous unicinctus*, *Euphractus sexcinctus* and *Dasyppus* spp.) (Tozetti and Toledo, 2005).

Arboreal species, such as hylids and some bufonids species, use bromeliad axils (Peixoto, 1995), crevices and cavities of trees (Leary and Razafindratsita, 1998), as well as leaves, branches, and tree trunks (Feio et al., 1998; Kwet and Di-Bernardo, 1999). Nevertheless, these types of sites have been described or identified in

nature for only a few species (Schwarzkopf and Alford, 1996) and most of studies focused on larval refugia (see Wells, 2007).

While conducting fieldwork during a faunal monitoring program that took place at the Atlantic Rain Forest in the municipality of Estância, state of Sergipe, Northeastern Brazil (11°20'05"S, 37°35'10"W; 90 m.a.s.l.), we observed two anuran species (*Hypsiboas albomarginatus* and *Rhinella granulosa*) hidden in diurnal refugia for the first time. The individuals were not collected and we instead documented them by photos. Herein, we provide details about these natural history observations.

The first observation was made on July 29, 2009, at 15:00 hours. An adult of *Hypsiboas albomarginatus* Spix was found on a leaf of a shrub (Solanaceae; Fig.1). The leaf dimensions were about 10 cm x 20 cm. The individual was 6.3 cm length and occupied half of the leaf's surface. The light-green colour of the frog's dorsum matched very well the coloration of the leaf when exposed to sunlight. Moreover, the supratympanic fold together with the upper eyelid formed a yellow line that was similar in colour to the leaf's network of interconnecting veins, which helped to create the



Figure 1. Gas pipeline at municipality of Estância, state of Sergipe, Northeastern Brazil. Arrows (A) and (B) indicate the diurnal refuge sites, a shrub (*Hypsiboas albomarginatus* site) and the position of the burrow (*Rhinella granulosa* site), respectively.

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Figure 2. Specimen of *Hypsiboas albomarginatus* resting on a leaf of a shrub. Note the similarity between the colour pattern of the treefrog and the leaf.

cryptic effect. Once positioned at the leaf's side where shadows were being projected by other leaves, it would become slightly lighter than the background and, thus, potentially more conspicuous to predators.

The cryptic coloration in colours and patterns of many amphibians are important in their ability to avoid visual recognition by predators (Toledo and Haddad, 2009), especially during the day. Concerning amphibians, especially in tree frogs, the cryptic coloration reflects the uniform colour of the substrate where they are resting on. In the present case, the colour of the specimen of *H. albomarginatus* matches the substrate (leaf) in which it is resting under the daylight.

The second observation occurred on February 08, 2010, at 17:00 hours. An individual of *Rhinella granulosa* Spix was found at the entrance of a natural burrow during

the day (Fig. 2), but still with its body entirely inside the burrow, which was positioned approximately 7 m from a water body (a wide and deep permanent pond) along a deforested gas-pipeline strip. As light conditions darkened late in the day, the specimen gradually moved closer to the entrance until reaching and exiting the burrow once night arrived.

Concerning the burrow's construction, its morphology suggests that it was neither dug by mammals, such as proposed by Tozetti and Toledo (2005), nor by the individual frog we observed. This is in contrast to the report by Silva and Giaretta (2008), which stated that male individuals of *L. labyrinthicus* living in swamps (highly humid soils) could actively excavate the soil. The burrow, which is long and narrow (about 6 cm x 2 cm) and slightly curved on its opening surface, has a sub-elliptical shape and therefore can accommodate the 4.9 cm long frog. Given that the burrow was much narrower than longer also suggests that this opening in the ground merely represented a soil breach, which allowed the specimen to opportunistically utilize this shelter site as a diurnal refuge. Moreover, we believe that the relative long distance to the water body prevents the burrow from being flooded under normal circumstances.

Despite both refuge sites being located in highly disturbed areas, there may be some degree of similarity between the diurnal refuge sites in this study and those used in the habitats where these behaviours evolved. *Rhinella granulosa* is typical of open areas (Narvaes and Rodrigues, 2009), and *Hypsiboas albomarginatus* is largely associated with open areas that are adjacent to forest edges (Lutz, 1973). The deforested strip of the gas pipeline crosses forest fragments and crops, providing open habitats similar to the natural ones.

As previously mentioned, studies of this kind are scarce probably due to the difficulty in finding anurans



Figure 3. (A) Detail of the burrow and (B) the specimen of *Rhinella granulosa* hidden in it.

during daytime. Anurans are primarily acoustic animals and therefore field collectors usually concentrate their collecting efforts during the night when the frogs are calling. Thus, additional fieldwork is required in order better understand on how and why frogs choose and use these shelters.

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