

First account of *Rhinella mirandaribeiroi* (Anura: Bufonidae) as prey of the giant water bug *Lethocerus annulipes* (Hemiptera: Belostomatidae), with additional observations of predation on *Physalaemus nattereri* (Anura: Leptodactylidae)

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As prey to numerous vertebrates, invertebrates, and even carnivorous plants, amphibians play a critical role in food webs across many ecosystems (Duellman and Trueb, 1994; Toledo, 2005; Ceron et al., 2019). Invertebrates stand out as key amphibian predators, being present in both terrestrial and aquatic environments, and in their role as consumers across all amphibian life stages (Toledo, 2005; Wells, 2007; Gambale et al., 2014). Many aquatic invertebrates are opportunistic predators that exploit reproductive activity as amphibians move to, breed, and develop, in temporary or permanent ponds (Toledo, 2005; Ceron et al., 2019). Among these aquatic predators, belostomatids (giant water bugs) are considered one of the most significant (Toledo, 2005; Batista et al., 2013; Gambale et al., 2014).

Rhinella mirandaribeiroi (Gallardo, 1965) is widely distributed across the Brazilian Cerrado and Cerrado enclaves of the Amazonian biome in Brazil and Bolivia (Narvaes and Rodrigues, 2009; de Pina et al., 2015; Frost, 2019). Found in open areas, *R. mirandaribeiroi* exhibits explosive breeding in both ephemeral and permanent ponds after heavy summer rains (Narvaes and Rodrigues, 2009; Valdujo et al., 2011). Here we report a novel predation of *R. mirandaribeiroi* by the giant water bug *Lethocerus annulipes* (Herrich-

Schaeffer, 1845), a large (54–75 mm) South American member of the Belostomatidae (Leach, 1815) known to occur from Venezuela to the north of Argentina (Perez-Goodwyn, 2006). Additionally, we report supplemental observations of predation by *L. annulipes* on *Physalaemus nattereri* (Steindachner, 1863).

At 1931 hrs on 02 November 2018 in the Campina region, municipality of João Pinheiro, state of Minas Gerais, Brazil (17.4633°S, 46.2282°W), in a temporary pond that had formed after heavy rain, we observed a partially submerged (vent-side up) adult male *R. mirandaribeiroi* (Fig. 1A). Clamped to the right hind limb of the toad by its raptorial appendices, and with the proboscis inserted near the cloaca, was a partially emergent giant water bug (*L. annulipes*) (Fig. 1A). The toad was alive at the point of our initial observation but expired approximately two minutes hence.

In adjacent temporary ponds we observed four other incidences of anuran predation by individual *L. annulipes*, all of which were upon adult male *P. nattereri*, a previously recorded prey species of *L. annulipes* (Batista et al., 2013). We documented and collected interacting individuals (predator and prey) of one of these incidences at the edge of a temporary pond (Fig. 1B). In this example, the giant water bug was positioned above the already dead anuran, clamping the anterior dorsal region of the frog with raptorial appendices, and with its proboscis inserted in the central-right of the dorsal region.

Anuran vouchers from both reported observations were fixed (10% formalin), preserved (70% ethanol), and deposited in the herpetological collection of the Universidade Federal de Goiás (ZUFG) (collection permit 21643-2: *R. mirandaribeiroi* voucher – ZUFG 14783, snout-vent length [SVL] 55.41 mm, mass 15 g; *P. nattereri* voucher – ZUFG 14790, SVL 50.91 mm, mass 17 g). The two exemplars of *L. annulipes* were donated

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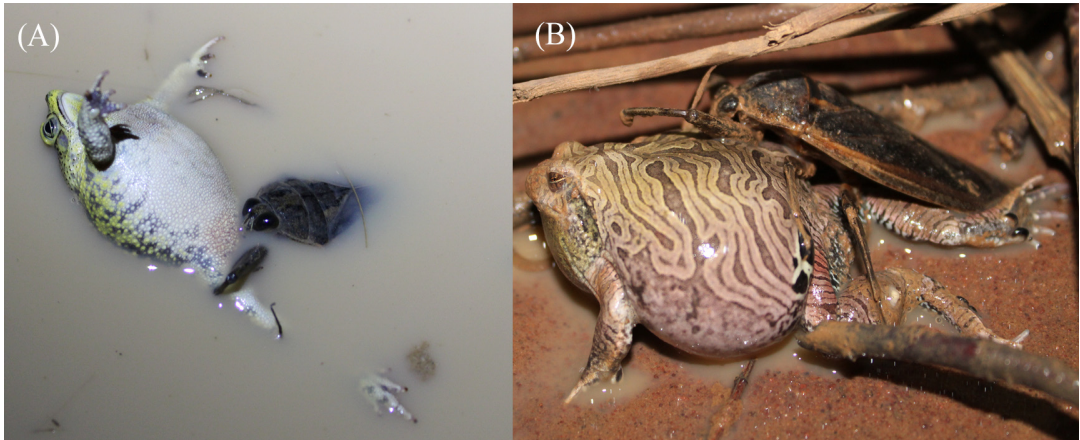


Figure 1. Predation by the giant water bug *Lethocerus annulipes* on (a) *Rhinella mirandaribeiroi* and (b) *Physalaemus nattereri* in the municipality of João Pinheiro, state of the Minas Gerais, Brazil.

to the invertebrate collection of the Universidade Federal do Pampa where taxonomy and sex of both specimens (adult females) was confirmed.

Lethocerus annulipes feeds mainly on anurans (Carlo, 1938; Pezzuti *et al.*, 2008; Nenda *et al.*, 2008; Figueiredo-de-Andrade *et al.*, 2010; Zaracho, 2012; Gobel *et al.*, 2013; Batista *et al.*, 2013; Batista *et al.*, 2014; Taffarel *et al.*, 2019) but snakes may also be taken (Piñeiro *et al.*, 2015). Prior to our observation, to the best of our knowledge only the anuran *Leptodactylus podicipinus* (Cope, 1862) (Guimarães *et al.* 2004), the snakes *Helicops angulatus* (Linnaeus, 1758) (Oliveira *et al.*, 2017) and *Leptodeira annulata* (Linnaeus, 1758) (Ferraz *et al.*, 2018), and the crab-eating raccoon *Procyon cancrivorus* (Cuvier, 1798) (Costa, 2006) had been documented as predators of *R. mirandaribeiroi*.

Water bugs may disperse between permanent and ephemeral water bodies in response to prey availability, or changes in environmental conditions such as heavy rains, drying, or the lunar cycle (Goula, 2008). Such movements may be an important factor influencing predation pressure on amphibians during their reproductive periods (Batista *et al.*, 2013). Our novel observation shows that *L. annulipes* dispersal is a feature of the predator–prey interactions of *R. mirandaribeiroi*.

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