

Predation on seven South American anuran species by water bugs (Belostomatidae)

Luís Felipe Toledo

Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Caixa Postal 199, 13500-970, Rio Claro, SP, Brazil. E-mail: toledolf@hotmail.com.

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The risk of predation is one of the many costs related to reproduction in frogs (Howard 1981, Ryan 1985, Pough *et al.* 1992). Although amphibians exhibit a great diversity of defensive strategies (reviews in Duellman and Trueb 1994, Stebbins and Cohen 1997, Pough *et al.* 1998), anurans, in particular, are preyed upon by a great variety of arthropods, such as ants, beetles, water bugs, spiders and crabs, as well as vertebrates (fishes, other amphibians, reptiles, birds, and mammals), and even carnivorous plants (Duellman and Trueb 1994, Pough *et al.* 1998). A considerable amount of information has recently been collected on invertebrate predators of adult anurans (Formanowicz *et al.* 1981, Hinshaw and Sullivan 1990, Schiesari *et al.* 1995, Del-Grande and Moura 1997, Haddad and Bastos 1997, Owen and Johnson 1997, Zuffi 2001, Pramuk and Almillio 2002). Water bugs (Belostomatidae) eat tadpoles (Martins *et al.* 1993, Eterovick and Sazima 2000) and adult frogs (Smith 1980, Hinshaw and Sullivan 1990, Bastos *et al.* 1994, Haddad and Bastos 1997, Mijares-Urrutia *et al.* 1997). Little information is available about predation on adult frogs by Belostomatidae. Here I present new

observations of predation by water bugs, *Belostoma elongatum*, on adult frogs.

Field observations were made at three temporary ponds at the Estação Ecológica de Itirapina (22°13'30"S, 47°54'19"W; 725 m), Municipality of Itirapina, São Paulo state, Brazil, between November 2002 and March 2003. The ponds were no deeper than 15 cm and surrounded by grass and small bushes. A straight transect, 400 m long by 4 m wide was used in one of the ponds, both during the day (from 09:00 to 12:00 h) and at night (from 19:00 to 02:00 h), between 16 and 19 December. Occasional observations were also made at other times. Animals that were being preyed upon, or recently released by the bug on the water surface, identified by the characteristic circular punctures (approximately 1.5 mm in diameter) in the frog's skin caused by the insect's proboscis, were measured with a digital caliper to the nearest 0.01 mm and preserved in 70% alcohol solution. Specimens are deposited at Célio F. B. Haddad collection (CFBH 5937, 5950-60, 5962-68), Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, São Paulo state, Brazil. The belostomatids are deposited at the entomological collection of the Museu de Zoologia of the Universidade de São Paulo, Brazil (without voucher numbers).

During the study, 15 anuran species were found calling at breeding sites: *Hyla*

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Table 1 - Anuran species preyed upon by *Belostoma elongatum* at the Estação Ecológica de Itirapina between November 2002 and March 2003. SVL, snout-vent length; X ± SD, mean ± standard deviation.

SPECIES	N, SEX	SVL (mm)
		X ± SD (range)
<i>Hyla jimi</i>	1, ♂	21.82
<i>Hyla minuta</i>	1, ♂	23.50
<i>Scinax squalirostris</i>	1, ♀	19.53
<i>Scinax</i> sp. (aff. <i>similis</i>)	4, ♂	35.11 ± 1.72 (33.43 - 37.01)
<i>Scinax</i> sp. (aff. <i>similis</i>)	3, ♀ gravid	35.92 ± 1.09 (34.69 - 36.78)
<i>Scinax</i> sp. (aff. <i>similis</i>)	1, ?	27.12
<i>Leptodactylus labyrinthicus</i>	1, ?	—
<i>Physalaemus cuvieri</i>	6, ♂	27.55 ± 1.32 (26.11 - 29.23)
<i>Physalaemus fuscomaculatus</i>	1, ♂	41.66

albopunctata, *H. jimi*, *H. minuta*, *Scinax fuscomarginatus*, *Scinax* sp. (aff. *similis*), *S. squalirostris*, *Leptodactylus furnarius*, *L. fuscus*, *L. labyrinthicus*, *L. ocellatus*, *Physalaemus centralis*, *P. cuvieri*, *P. fuscomaculatus*, *P. nattereri*, and *Elachistocleis* cf. *ovalis*. The 19 predation events by adult and nymphal water bugs (*Belostoma elongatum*) involved seven different species of frogs (Table 1).

Whole predation sequences upon a juvenile *Leptodactylus labyrinthicus* and two adult males of *Scinax* sp. (aff. *similis*) were observed. All three events were similar: the frogs were initially at the edge of the pond and, when they jumped into the water, they were immediately captured by a bug. One of the males of *Scinax* sp. (aff. *similis*) tried to escape by jumping out of the water, after being grasped by an adult *B. elongatum*. However, the water bug was firmly attached to the anuran and did not release it. The three individuals remained alive, but almost immobile, from 25 to 35 minutes after capture. On the other occasions, the frogs were found being preyed upon or just after having been killed by water bugs. All predation events occurred on the water surface and the frogs were

strongly held by the forelimbs of the water bugs. The bugs did not hold the frog in any specific part of the body. *B. elongatum* individuals were found throughout the night and predation events occurred between 21:15 and 00:05 h, coinciding with the peak of calling activity of the frogs. During the day, four dead frogs [two *Scinax* sp. (aff. *similis*) and two *P. cuvieri*] were found floating on the water surface with leptodactylid tadpoles feeding on their internal organs.

Males of the genus *Physalaemus* found at the study site called while floating on the water surface on the edges of temporary ponds. Hence, the production of waves may have attracted aquatic predators such as water bugs (Pough *et al.* 1992) (Figure 1A). Moreover, the proportion of females, in relation to males, in the site was very low (pers. obs.), suggesting why only males were preyed upon. The only *Leptodactylus* sp. preyed upon was a juvenile *L. labyrinthicus* that jumped into the water (Figure 1B). The other species of the genus were observed calling on the ground, strongly reducing the risk of predation by these insects. Hyloid frogs have been also observed calling at dry sites, on the ground [(*Scinax* sp. (aff. *similis*)] or from shrubs



Figure 1 - Adult male *Physalaemus cuvieri* (A) and juvenile *Leptodactylus labyrinthicus* (B) being preyed upon by water bug *Belostoma elongatum* in temporary ponds at Estação Ecológica de Itirapina, São Paulo state, Brazil.

above the ground or the water (all hylid species). However, being highly dependent on water bodies for reproduction, all observed species must have direct contact with water at least during oviposition (Lutz 1973).

Water bugs appear to be the major invertebrate predators of adult frogs in Estação Ecológica de Itirapina as no other predation event was observed during the entire reproductive season at the temporary ponds I studied or other breeding sites I visited occasionally.

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