

SHORT COMMUNICATION

## Visual communication in *Hypsiboas curupi* (Anura: Hylidae) at Parque Estadual do Turvo, southern Brazil

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**Keywords:** communication, visual repertoire, visual signals.

**Palavras-chave:** comunicação, repertório visual, sinais visuais.

Acoustic communication plays a fundamental role in anuran communication (Wells 1977) because most species are active at night and vocalizations are not light-dependent (Duellman and Trueb 1994). However, many studies have demonstrated that some species display remarkable and stereotyped visual signals used in different social contexts (Lindquist and Hetherington 1996, 1998, Haddad and Giaretta 1999, Preininger *et al.* 2009), indicating that visual signalling in anurans is diverse, widespread, and has evolved independently in several families (Hödl and Amézquita 2001).

Most recently, visual displays have been documented even for nocturnal species (Bertolucci 2002, Hartmann *et al.* 2005, Giasson and Haddad 2006, Toledo *et al.* 2007, Barros and Feio 2011), suggesting that nocturnal anurans have visual acuity for visual stimulus, possibly dependent on

the optimum ambient illumination of the species (Hartmann *et al.* 2005). Thus, data on the repertoire of visual signals of different species, including information on the behaviors and the social context in which they are performed, constitute a primary source of information to understand the evolution of visual communication in anurans (Amézquita and Hödl 2004).

*Hypsiboas curupi* Garcia, Faivovich, and Haddad, 2007 is a recently described species from the *Hypsiboas pulchellus* Group, previously referred as *Hypsiboas semigutattus*. Its distribution includes localities in the province of Misiones, Argentina (Garcia *et al.* 2007), in the departments of Caazapá and Itapúa, Paraguay (Brusquetti and Lavilla 2008), and in the Brazilian states of Santa Catarina (Lucas and Garcia 2011) and Rio Grande do Sul (Iop *et al.* 2009). Despite these new population records, little is known about the ecology and behavior of the species. This study aimed to describe the visual repertoire used by *H. curupi* and to identify the context in which the visual signals were performed.

Received 3 October 2011.  
Accepted 3 April 2012.  
Distributed June 2012.

The study was conducted with populations from Parque Estadual do Turvo, located in the municipality of Derrubadas, in the northwestern region of the state of Rio Grande do Sul, southern Brazil (27°14'34.08" S, 53°57'13.74" W). The park covers an area of 17,491.4 ha, representing the largest remnant of preserved Mesophytic Semideciduous Forest (sensu Oliveira-Filho *et al.* 2006) in the state, and is bordered by the province of Misiones, Argentina, and the state of Santa Catarina, Brazil (SEMA 2005). The local climate is classified as subtropical sub-humid with dry summer, with an annual mean temperature of 18.8°C (ST SB v type of Maluf 2000) and rainfall evenly distributed throughout the year, with an annual mean of 1.665 mm (SEMA 2005).

We conducted monthly observations from November 2009 to March 2010 (except in December 2009) in four streams in the park in which we had confirmed the occurrence of populations of *Hypsiboas curupi*. We divided observations into non-regular, sporadic visits to the streams in November 2009 and March 2010, and regular visits in January and February 2010, in which we observed individuals in the streams for eight consecutive days each month. Although the reproductive biology of *H. curupi* has not yet been studied, the period of our observations included months in which males were found in calling activity in localities from Misiones, Argentina (Carrizo 1991, Garcia *et al.* 2007), and in localities from the west of Santa Catarina, Brazil (Lucas and Garcia 2011).

We made observations following the *ad libitum* method (Lehner 1996), always by the same observer, starting at dusk and extending between 00:00 and 04:00 h, depending on the presence and activity of individuals. We only used flashlights to locate individuals, and once observations started, we used the night-shot device of a video camera (Handycam SONY MiniDV DCR-HC52) to avoid influencing an individual frog's behavior with artificial light; many of the observed behaviors were videotaped for further analysis. Background noise at the observation

sites was not measured. Considering non-regular and regular visits, the total time employed in observations was 2.620 min. With respect to the social context in which visual signals were performed, we considered signal use in short-or long-distance interactions between conspecific males to be agonistic, and signaling by males or females toward one another as courtship. All visual signals were assigned according to the descriptions provided by Hödl and Amézquita (2001) and Hartmann *et al.* (2005).

Six visual displays were performed by *Hypsiboas curupi* (Table 1). Males performed all six visual signals, whereas females performed two types of display. Four signals were performed exclusively by males, while females did not perform none visual signal exclusively. The four visual signals performed by males were used in agonistic contexts toward other males, which could explain the differences in the visual repertoire between the sexes. Although the literature lacks information about visual signals performed by frogs relative to their sex, it is probable that males have a more diverse visual repertoire than females, especially in species in which males defend territories and compete to attract females. Moreover, *vocal sac display* is a signal performed specifically by males, as reported for the hylid *Aplastodiscus eugenioi* (Hartmann *et al.* 2004, Hartmann *et al.* 2005), for the ranid *Staurois latopalmaris* (Preininger 2009), and the phrynobatrachid *Phrynobatrachus krefftii* (Hirschmann and Hödl 2006).

Visual signals such as *upright posture* and *mouth opening* were performed by males of *Hypsiboas curupi* exclusively toward other males in agonistic contexts. Many hylid species use visual signals when engaging in agonistic behaviors. Giasson and Haddad (2006) observed males of *Hypsiboas albomarginatus* performing five visual signals, and Amézquita and Hödl (2004) observed two visual signals displayed in agonistic contexts by the Amazonian hylid *Dendropsophus parviceps*. Toledo *et al.* (2007) presented information on visual signals performed by males of *Aplastodiscus perviridis*, *Hypsiboas*

**Table 1.** Visual signals performed in courtship or agonistic contexts by male and female *Hypsiboas curupi* at Parque Estadual do Turvo, Rio Grande do Sul, Brazil. Descriptions of the visual signals follow those of Hartmann *et al.* (2005).

Visual signals	Description	Agonistic	Courtship
Vocal sac display	Vocal sac inflates without vocalization	♂	♂
Throat display	Pulsation of the throat without vocalization	♂	♂
Face wiping	Lifting an arm and touching the head with the hands, passing the hands on the eyes and snout, returning to the normal position	—	♂ ♀
Leg stretching	Stretching a single leg rapidly at the substrate level; leg may or not remain extended for some time	—	♂ ♀
Upright posture	Extending the angled arms and raising the anterior part of the body	♂	—
Mouth opening	Opening and closing the mouth slowly or rapidly, or individual remaining with mouth opened for some time	♂	—

*albopunctatus*, and *H. bischoffi*, also during agonistic behaviors or after playback of conspecific advertisement calls. Nevertheless, it is interesting to note that none of the signals reported for these species was performed by *H. curupi*.

In relation to the visual signals performed exclusively in a courtship context, *Hypsiboas curupi* performed *face wiping* and *leg stretching*, both of which were performed by both sexes. In contrast to other species, Hartmann *et al.* (2004) reported males of *Aplastodiscus eugenioi* employing visual signals only during courtship, including *face wiping*. Males of *Hylodes asper* (Haddad and Giareta 1999) and males of *Hylodes phyllodes* (Hartmann *et al.* 2005) are known to perform *leg stretching* during courtship. Our results with *H. curupi* provide new information on females performing *face wiping* and *leg stretching* in a courtship context. Considering that most studies on visual signals focus on males and on the interactions between them, further studies including information on visual signals employed by females are necessary.

*Hypsiboas curupi* seems to have a repertoire of visual signals composed of signals performed by other species that also inhabit streams, such as *Hylodes phyllodes* (Hartmann *et al.* 2005) and *Hylodes nasus* (Wogel *et al.* 2004), rather than of visual signals reported for species in the genus *Hypsiboas*. In fact, *H. curupi* does not share any

visual signal in common with *Hypsiboas albomarginatus* (Giasson and Haddad 2006), *H. albopunctatus*, and *H. bischoffi* (Toledo *et al.* 2007), although there are some similarities with the visual signals of *Aplastodiscus eugenioi* (Hartmann *et al.* 2005). Because *H. curupi* inhabits streams (syntopically with *Crossodactylus schmidtii* at Parque Estadual do Turvo and in localities from Misiones), it is plausible to hypothesize that the communication system of this species may be constrained by the selective pressures of lotic habitats. Species of *Crossodactylus* and *Hylodes* are subject to these same pressures, in contrast to those associated with the lentic habitats inhabited by many species of *Hypsiboas*. Although our results with *H. curupi* are insufficient to support this hypothesis, future studies on the visual communication of other species from the *Hypsiboas pulchellus* Group that inhabit forested streams may clarify this.

### Acknowledgments

We are grateful to SEMA-RS for granting access to the Parque Estadual do Turvo (license no. 302). We also thank Tiago Gomes dos Santos, Rafael Márquez and an anonymous reviewer for their critical suggestions on the manuscript, and Tiago R. N. Bertaso and Marcelo Carvalho da Rocha for their help in fieldwork. 🐸

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