

The release call of *Dendropsophus sanborni* (Anura: Hylidae), with comments on release calls within *Dendropsophus*

El canto de liberación de *Dendropsophus sanborni* (Anura: Hylidae), con comentarios sobre el canto de liberación entre *Dendropsophus*

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ABSTRACT

Release calls are a non-receptive response to amplexus between different species or conspecific amplexus between males. This call differs between closely related species and can be an important tool for the taxonomy of this group. Here, we describe, for the first time, the release call of *Dendropsophus sanborni* (Schmidt, 1944) from a record during a field trip in a palm grove in southern Brazil. We recorded two release calls from a male individual of *D. sanborni* while handling it. These release calls are simply formed by one note with no modulation. Release calls of *Dendropsophus* are poorly reported in the literature, and comparisons among them are limited. Release calls are possibly much more common than reported in the literature and more description studies are needed.

Keywords: Bioacoustics, communication, vocal repertoire, acoustic signals

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RESUMEN

Los cantos de liberación son una respuesta al amplexo inadecuado entre diferentes especies o entre machos. Este canto es muy diferente entre especies estrechamente relacionadas y puede ser una herramienta importante para la taxonomía de este grupo. Aquí, describimos por primera vez, el canto de liberación de *Dendropsophus sanborni* (Schmidt, 1944) a partir de un registro durante un viaje de campo en un palmeral en el sur de Brasil. Grabamos dos cantos de liberación de un individuo macho de *D. sanborni* mientras se manipulaba. Estos cantos de liberación son simples, formados por una nota sin modulación. Los cantos de liberación de *Dendropsophus* están poco registrados en la literatura y las comparaciones entre ellos son limitadas. Los cantos de liberación son posiblemente mucho más comunes de lo que se informa en la literatura y se necesitan más estudios de descripción.

Palabras clave: Bioacústica, neotrópicos, repertorio vocal, *Dendropsophus*

INTRODUCTION

The production of acoustic signals, through different call types, is the main form of communication in anurans (Ryan 2001). Many frogs are known to have a wide repertoire of call types (Wells 2007, Guerra *et al.* 2017, Boschetti *et al.* 2019). The most common call types are those emitted in a reproductive context, mainly the advertisement call, which serves to attract potential mates and transmit territorial information to conspecifics (Köhler *et al.* 2017, Toledo *et al.* 2015).

A further call type in a reproductive context is the release call. Release calls are emitted by males and females as a non-receptive response to an amplexus attempt (Köhler *et al.* 2017). They generally differ in terms of sound properties even among closely related species, which could act as a mechanism to avoid interspecific amplexus (e.g., Castellano *et al.* 2002). This fact supports the idea that release calls are a possible taxonomic character (Grenat and Martino 2013).

The evolution of release calls is under the forces of sexual selection. On closely related syntopic species, females can use release calls to avoid hybridization. Male release calls, however, could be under stabilizing selection and only taxonomically informative between distantly related species (Köhler *et al.* 2017).

Some individuals emit release calls during amplexus simulations, even when they are held in a manner that creates light pressure on their flanks. These manipulations could

help researchers obtain an important recording of this calling behavior. Amid recent field activities, we recorded the release call of *Dendropsophus sanborni* (Schmidt, 1944) during an opportunistic observation.

Currently, the genus *Dendropsophus* consists of 109 species grouped into nine species groups (Frost 2023, Orrico *et al.* 2021). These species are distributed along South America, from Northern Argentina and Uruguay north through tropical South America and Central America to tropical southern Mexico (Frost, 2023). There is a high variation in morphology (e.g. Duellman and Fouquette 1968; Franco-Belussi *et al.* 2011), vocalizations (e.g. Schwartz and Wells 1985; Martins and Jim 2003; Lingnau *et al.* 2004), and reproductive behavior (e.g. Wogel and Pombal 2007; Touchon 2012). *Dendropsophus sanborni* is an arboreal species that inhabits open areas, especially in lentic, temporary or permanent water bodies (Kwet *et al.* 2010, Zaracho *et al.* 2012). Its advertisement call, composed of two types of notes, was already described by Martins and Jim (2003), but the release call was never formally described. Based on the behavioral, evolutionary and taxonomic importance of release calls, our objectives herein are to (1) describe the release call of *D. sanborni* and (2) provide a review of release calls in the genus *Dendropsophus*.

MATERIALS AND METHODS

During a field trip, we observed a male of *D. sanborni* that was emitting advertisement calls in a palm grove habitat formed by *Butia odorata* (Barb. Rodr.) Noblick. in the

municipality of Tapes (30°31'49.83"S, 51°21'24.62"W), southern Brazil, a landscape of the Pampa biome. When the male was handled with gentle pressure on its flanks, it was possible to hear two calls that differed from the species' advertisement call. Considering the way that the animal was handled and did not call with open mouth, it is plausible to classify the emitted calls as release calls (Köhler *et al.* 2017).

We recorded this event in a video format using a smartphone (Motorola Moto G5S). The video was originally recorded in MP4, from which we obtained an audio file in WAV format. The individual was released after recording, and resumed calling. The record is deposited at the Foneteca Neotropical Jacques Vielliard, Unicamp, Campinas, Brazil (collection number: FNJV 50058). We analyzed the audio using Raven Pro 1.6, Windows software (Cornell Lab of Ornithology – Bioacoustics Research Program 2019), with FFT (Fast Fourier Transformation) = 512. We did not use filters. We analyzed the following acoustic parameters: minimum frequency (Hz), maximum frequency (Hz), minimum frequency at 5 % of energy (Hz), maximum frequency at 95 % of energy (Hz), dominant frequency (Hz) and call duration (s). We also requested a record of the advertisement call of the species that was deposited at the Foneteca Neotropical Jacques Vielliard (FNJV 0011820) to elaborate a comparative figure between the two call types (Fig. 1). We generated oscillograms and spectrograms using R software (R Core Team 2019), with a window width of 512 samples and 90 % of superposition. We used the package TuneR version 1.0 (Ligges *et al.* 2013) and Seewave version 1.7.3 (Sueur *et al.* 2008).

Since our record was made using a smartphone and in video format, it has low audio quality. This factor makes it hard to precisely determine some acoustic parameters of the call. Therefore, we present results of automatic sound analyses to the minimum frequency at 5 % of energy and

the maximum frequency at 95 % of energy (Köhler *et al.* 2017). These measurements were obtained automatically by Raven Pro 1.6, excluding the lower and higher portions of the call that concentrate 5 % of energy each.

RESULTS

The release call of *Dendropsophus sanborni* is formed by a simple call with a very short note, without modulation, composed of a single pulse (Fig. 1a). The frequency range (bandwidth) of the two release calls was from 4.71 to 11.55 kHz. This frequency range is very different from the range of the analyzed advertisement calls, which is from 4.13 kHz to 5.23 kHz (Fig. 1b). Further acoustic parameters of the calls are included in (Table 1).

DISCUSSION

The present description of the release call of *Dendropsophus sanborni* represents a significant record of an acoustic feature that could be useful to understand the taxonomy and evolution of one of the most diverse genera of neotropical treefrogs. For many years numerous authors warned that the phylogenetic relationships among members of the genus *Dendropsophus* require careful revision (Fouquet *et al.* 2011, Peloso *et al.* 2016), and some groups were even recognized as paraphyletic or polyphyletic (Wiens *et al.* 2010, Fouquet *et al.* 2011). Currently, with the recent publication of a robust phylogeny of *Dendropsophini* (Orrico *et al.* 2021), further studies should obtain more release calls of other *Dendropsophus* species and compare them to the proposed species groups, since male release calls could be taxonomically informative among distantly related species (Köhler *et al.* 2017).

Despite the species richness of *Dendropsophus*, to the best of our knowledge, descriptions of release calls are available only for *D. elegans* (Wied-Neuwied, 1824) (Bastos and Haddad 1995) and *D. werneri* (Lingnau *et al.* 2004). The release call of *D. elegans* consists of 16 pulses, with a duration of 0.05 s and frequency of 2 to 4.1 kHz (Bastos and Haddad 1995). Lingnau *et al.* 2004 described what they call a “distress call” for *D. werneri* (Cochran, 1952) but, as they give the context (the male was stimulated during manipulation), it is clearly a release call since it was emitted with a closed mouth (Lingnau, pers. comm.). The release call of *D. werneri* consists of a single note with one

Table 1. Acoustic and temporal parameters of recorded calls. CD = Call duration, MinF = Minimum frequency, MaxF = Maximum frequency, F 95 % = Maximum frequency at 95 % of energy, F 5 % = Minimum frequency at 5 % of energy, Df = Dominant frequency.

Calls	CD (s)	MinF (kHz)	MaxF (kHz)	F 95 % (kHz)	F 5 % (kHz)	Df (kHz)
Call 1	0.451	4.837	11.559	8.957	5.857	8.268
Call 2	0.429	4.715	10.332	8.785	5.168	7.235

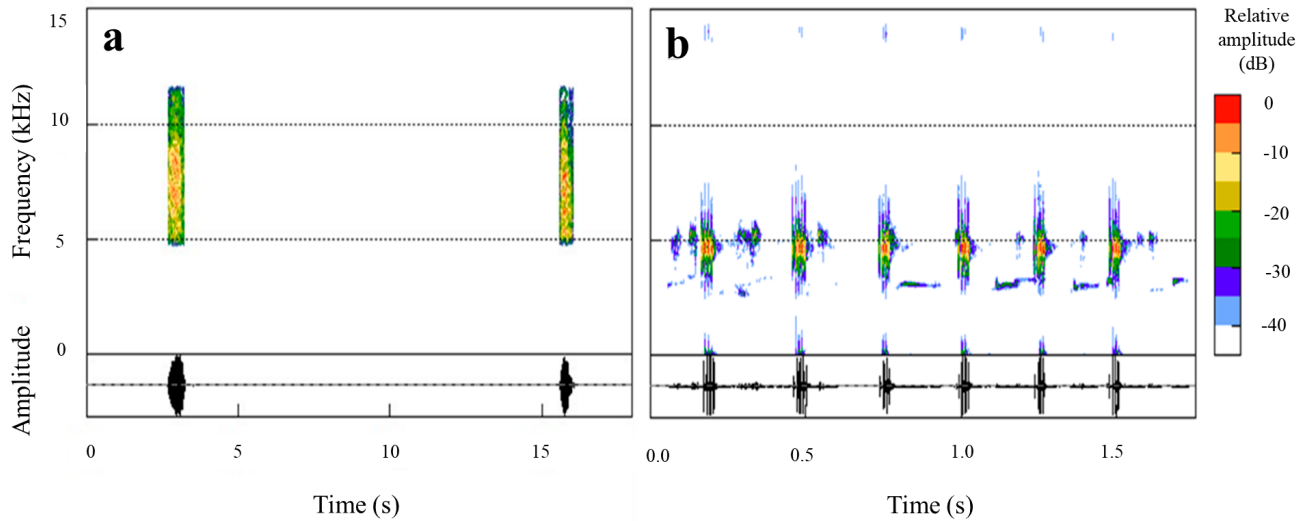


Figure 1. Spectrograms and oscillograms of release and advertisement calls of *Dendropsophus sanborni*. **a.** release call (FNJV 50058), male recorded at 11h12 p.m. on October 7, 2019, in the municipality of Tapes, Rio Grande do Sul, Brazil; Water temperature: 18.8 °C; Air temperature 17.9 °C; Air relative humidity: 88.7 %. **b.** advertisement call FNJV 0011820, male recorded by Adão Cardoso at 10h30 p.m. on December 20, 1982, in the municipality of Cruz Alta, Rio Grande do Sul, Brazil.

to nine pulses, duration of 0.027 to 0.021 s, and a dominant frequency of 5.39 to 6.43 kHz (Lingnau *et al.* 2004). Rivero (1969) depicted a sonogram of a vocalization which he called “perhaps identical with the release call” of *D. luteoocellatus*, without providing a detailed description. A few years later, Duellman and Crump (1974) argued that the release call of *D. luteoocellatus* illustrated by Rivero (1969) may be a series of secondary notes. Even for *D. sanborni*, whose release call we are describing herein, Barrio (1962) already mentioned that he sometimes heard the release call of *D. sanborni* when males were grasped by conspecific males, but he did not provide any sonogram or description of the acoustic parameters.

Release calls usually consist of a series of rapidly repeated broad-spectrum notes (Wells 2007), a pattern also revealed by our recording. The release call of *D. sanborni* is quite different from its advertisement call based on this spectral difference. The advertisement call of *D. sanborni* consists of two different notes and has a frequency bandwidth of 3.6 to 6.45 kHz (Martins and Jim, 2003). The release calls we obtained have a much higher frequency bandwidth and dominant frequency. The release call of *D. sanborni* is quite different from its advertisement call based on this spectral difference. We emphasize the possibility that the recording method, which was not the most appropriate since it was a fortuitous record, may have had some influence on the results. In the other two reports

on release calls, there was no such difference in spectral parameters between advertisement and release calls (see Bastos and Haddad 1995, Lingnau *et al.* 2004). To our knowledge, these are the only species of *Dendropsophus* with described release calls.

Apparently, despite its long-recognized importance, the description of release calls was neglected for a long time. At least for the genus *Dendropsophus*, with more than 100 species (Frost 2023), after our effort in searching for described release calls, this is just the third species of the genus with described release calls. In another genus, *Scinax*, also with high species richness, currently with 129 species (Frost 2023), the first release calls were recently described (Mângia *et al.* 2017).

In addition, release calls can also be an important bioacoustics tool for the taxonomy and definition of different species lineages. Integrative taxonomy, also using bioacoustics, mainly referring to advertisement calls due to their greater availability, has already proved to be efficient in suggesting that some species, considered widely distributed in South America, may actually represent species complexes (Jansen *et al.* 2011). In this way, the inclusion of other types of calls, such as the release call, can help in the taxonomic understanding of the species.

Obtaining release calls through the stimulation of individuals was considered easy (Köhler *et al.* 2017), although

not always the stimulated individuals emit the release calls. Release calls are possibly much more common than reported in the literature. We believe that in the coming years, more descriptions of release calls should emerge and, with the deposit of these recordings in sound collections, new hypotheses may soon emerge about the evolution of these calls and their significance.

PARTICIPATION OF AUTHORS

The authors had equal participation in the entire work.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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