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The advertisement call of *Physalaemus ephippifer* (Anura: Leiuperidae) from Brazilian Amazonia

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Physalaemus is recognized as an important system for the study of mechanisms and evolution of animal communication, especially because of studies involving the *P. pustulosus* species group. *Physalaemus ephippifer* is considered, together with *P. fischeri* (*enesefae*) and an undescribed species, to be the most similar species to the *P. pustulosus* group in external morphology, osteology, and characteristics of the call. Because of this, *P. ephippifer* has been included as an outgroup in studies to interpret patterns of signal-receiver evolution in the genus. Whereas details of the advertisement call structure of *P. fischeri* have been described (Tárano 2001), information (e.g., detailed graphic representation and range of variation) on *P. ephippifer* calls remains unavailable.

We recorded calls of 18 *P. ephippifer* in the riverine Maracá Island, Roraima State, Brazil (3°15'–3°35'N; 61°22'–61°54'W). Individuals from this locality were previously identified as *P. ephippifer* by Nascimento *et al.* (2005). We used a Marantz PMD-660 digital recorder and a Sennheiser K6/ME66 directional microphone, and analyzed three calls per male with the software Raven 1.2 (Blackman window, DFT 4080). Call traits were based on Ryan and Rand (1999), with five additional traits (number of pulses: pulses added after the whine component of the call; call rate: mean number of calls per minute; intercall interval: silence interval between two consecutive calls; initial frequency: first harmonic frequency at the call beginning; and peak frequency: frequency of higher intensity of the first harmonic) (Fig. 1). Mean air temperature was 24.95 °C ± 0.59 (23.7–25.7) and mean male SUL was 29.5 mm ± 0.88 (27.8–30.8). Voucher specimens (26502–26512) were deposited at INPA-H, Manaus, Brazil.

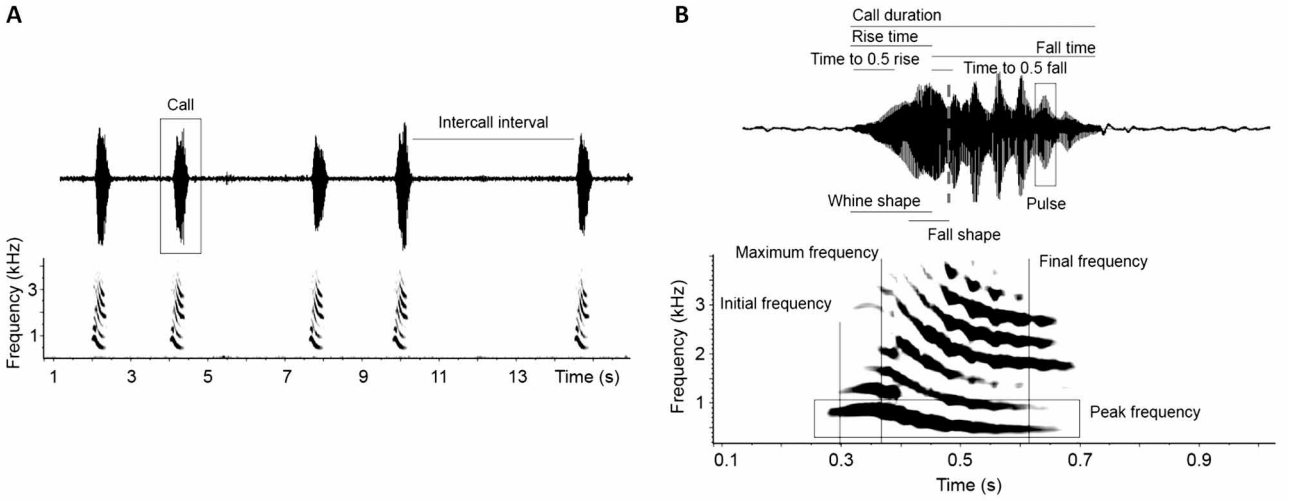

FIGURE 1. Oscillogram and spectrogram of (A) a sequence of five calls and of (B) a representative call of *Physalaemus ephippifer* from Brazil. The vertical dashed line represents the beginning of the pulsed portion of the call.

The whine-like advertisement call of *P. ephippifer* has a harmonic structure in which the fundamental harmonic is modulated from 818.17 Hz to 443.2 Hz over a period of ca. 0.3 s. Hence, the call has a descending frequency modulation, with an ascending modulation at its beginning. A representative call is 0.41 s long (± 0.08; 0.27–0.62) and reaches its maximum amplitude at ca. 0.1 s (± 0.02; 0.07–0.13), after which it declines steadily. Rise 0.5 (s): 0.06 ± 0.02 (0.02–0.09); Fall 0.5 (s): 0.05 ± 0.04 (0.02–0.13); Intercall interval (s): 4.65 ± 7.65 (2.2–26.6); Call rate: 11.75 ± 6.44 (2.23–

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23.09); Whine shape (%): 33.25 ± 4.2 (27.3–41.8); Rise shape (%): 14.46 ± 3.6 (6.5–20.2); Fall shape (%): 13.67 ± 8.2 (3.75–31.14); Initial frequency (Hz): 818.27 ± 26.37 (760.83–861.3); Maximum frequency (Hz): 839.8 ± 25.58 (775.2–872.1); Final frequency (Hz): 443.2 ± 25.17 (423.5–516.8); Peak frequency (Hz): 839.8 ± 77.56 (592.17–940.3).

We found a whine + pulses structure, in which the whine component, i.e., the frequency sweep, is immediately followed by a series of pulses (4.83; ± 1.41; 3.67–8) that continuously decrease in frequency. We refrain from calling this a suffix, because it is continuous and pertains to the fall time. This pulsed portion has a mean duration of 0.29 s (± 0.07; 0.19–0.47) and was also identified by us in recordings of *P. ephippifer* from Monte Alegre, Pará, Brazil (01°16'56"S, 54°07'47"W; ca. 628 km westward from Belém; data not shown).

We considered the call duration as the whine + pulses, whereas Ryan and Rand (1999) considered the call of *P. ephippifer* from the region of Belém (Brazil) as a simple whine, without mentioning the presence of a pulsed portion. The suffix nature of these pulses may resemble the chucks and squawks, which are secondary components emitted by *P. pustulosus* and *P. petersi*, respectively, both in the *P. pustulosus* group. Although the whine is necessary and sufficient for mate recognition, the chucks further enhance the attractiveness of the call to females (Ryan & Rand 1999). The presence of complex calls (whines + additional components) has been proposed for other species of this genus (Ron *et al*. 2005), while *P. fischeri* lacks any kind of additional component in its structure (Tárano 2001). However, it is unclear if the acoustic components found in other *Physalaemus* species are homologous to chucks/squawks, since they lack the characteristic intermediate harmonics of "true chucks/squawks". These spectral structures arise as these secondary components are produced by large fibrous masses that are attached to the vocal cords. Besides this, a crucial difference between these systems is that the pulsed portion of the *P. ephippifer* call is present in all analyzed calls, while the chucks and squawks are facultative. Therefore, further studies should evaluate the significance of the acoustic structures found in these species in order to better comprehend the evolution of signal complexity in *Physalaemus*.

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