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First description of sound emission of *Rhaphiptera affinis* Thomson, 1868 (Cerambycidae: Lamiinae: Pteropliini)

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Cerambycidae is one of the largest families of beetles, containing about 38,000 described species (Tavakilian & Chevillotte 2018). In most species of this family, adults possess a stridulatory device that allows them to produce squeaking sounds (Wang 2017). In the subfamilies Prioninae and Parandrinae, individuals stridulate by rubbing their ridged hind femora against elytral margins (Švácha & Lawrence 2014). In the other subfamilies, including Lamiinae, the stridulation is produced by friction between the ventral face of the posterior pronotal margin (*plectrum*) and a striated plate on the mesoscutum (*pars stridens*) (Švácha & Lawrence 2014). Although some adults produce sounds during courtship and copulation, this sound production occurs mainly when individuals are disturbed, being considered a defensive mechanism that might act as a startle response against predators (Dumortier 1963; Švácha & Lawrence 2014; Wang 2017).

Despite being a characteristic and conspicuous behavior in Cerambycidae, there are a few works that study in detail the sound produced by these beetles (e.g., Alexander *et al*. 1963; Finn *et al*. 1972; Hernández *et al.* 1997; Hernández 2007, 2011). Herein, we describe for the first time the sound of *Rhaphiptera affinis* Thomson, 1868, the first bioacoustical study conducted for the tribe Pteropliini Thomson, 1860.

A single male specimen (Fig. 1A) was collected in the district of Lumiar, municipality of Nova Friburgo, state of Rio de Janeiro, Brazil (22°19'00.6"S 42°17'26.2"W; datum WGS84; 910 m a.s.l.), on 1 April 2017 (air temperature = 15ºC). The specimen started to produce chirps while in captivity inside a transparent plastic bag. We recorded these sounds with an Olympus LS-10 Linear PCM digital recorder, using the built-in microphones, at sample rate of 48,000 Hz and sample size of 24 bits. The specimen was preserved and deposited in the entomological collection of the Museu de Zoologia da Universidade de São Paulo (São Paulo, Brazil) and the recording was deposited in the Fonoteca Neotropical Jacques Vielliard (FNJV) under the number FNJV 39025.

We analyzed 75 chirps with Raven Pro 1.5 (64-bit version) (Bioacoustics Research Program, 2014). Temporal measurements were made on oscillograms, while spectral measurements were made on sonograms and power spectra with Window Type = Hann, 3 dB Filter Bandwidth = 50 Hz; Window Size = 1381 samples, and Time Grid Overlap = 99%. Quantitative features are given as range followed by mean, standard deviation (SD), and sample size (n) in parenthesis.

The sounds were frequently emitted after manipulation, and consisted of a series of chirps. The chirp repetition rate is around four chirps per second and the envelope of the chirps is highly variable, but it usually has rectangular or triangular shape (Fig. 1B). The duration of the chirp varies from 0.008 to 0.200 s (0.092 ± 0.039; 75), and its dominant frequency varies from 375.0 to 3843.8 Hz (1347.3 ± 909.3; 64). Chirps with higher dominant and fundamental frequencies were frequently emitted alternating with chirps with lower dominant and fundamental frequencies (Fig. 1C). Each chirp is composed of a pulse series, which is usually emitted at high repetition rates resulting in clear harmonic series with around four visible harmonics (Fig. 1C, D). These bands present irregular frequency modulations, but most chirps have at first an upward followed by a downward modulation, resembling a boomerang or arc shape (Fig. 1C, D). Sometimes this modulation sequence is repeated within a single chirp resulting in two connected boomerang shapes ("M" shape; Fig. 1D). The repetition rate of the pulses (= fundamental frequency of the harmonic series) is usually ca. 2000 Hz, varying from 279.6 to 4273.5 pulses per second (2133.1 ± 659.3; 284 measurements and three chirps). When

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the pulse repetition rate is low, it is not possible to see the harmonic series; on the other hand, the individual pulses are clearly visible in sonograms (Fig. 1E). Even in chirps with clear harmonics, the pulse repetition rates can irregularly vary in some parts of the emission resulting in noise traits in the sonogram and power spectrum (Fig. 1C).

Hernandez *et al*. (1997) and Hernandez (2011) use the term "hemisyllable" as synonymous with "chirp". According to these studies, a single syllable would be composed of two hemisyllables (= two chirps), one produced during the flexion and the other during the extension of the prothorax in relation to the mesoscutum (Hernandez 2011; see also Finn *et al.* 1972). One hemisyllable has significantly lower pulse repetition rate than the other (Hernandez *et al.* 1997) likely a consequence of velocity differences during the two stridulation movements (Hernandez 2011 and references within). This seems to explain the alternation pattern of chirps with different dominant and fundamental frequencies observed here for *Rhaphiptera affinis* (see Finn *et al*. 1972). The up-downward frequency modulation patterns of *R. affinis* are similar to those found by Finn *et al*. (1972) for species of Lamiinae. Nevertheless, the dominant frequency measured for some chirps of *R. affinis* (< 1000 Hz) are the lowest values when compared with the other studies on sound description of cerambycid species so far (e.g., Alexander *et al*. 1963; Finn *et al.* 1972; Hernández *et al.* 1997; Hernández 2007, 2011). Descriptions and comparisons of acoustic features within the Cerambycidae family are rare. However, these features reflect particular behavioral and morphological traits of the taxa (e.g., Finn *et al.* 1972; Hernandez *et al*. 1997; Hernandez 2011) and, as well as for other insect groups (see Alexander 1957; Gerhardt & Huber 2002), they can be useful as additional characters for taxonomic studies in the family.

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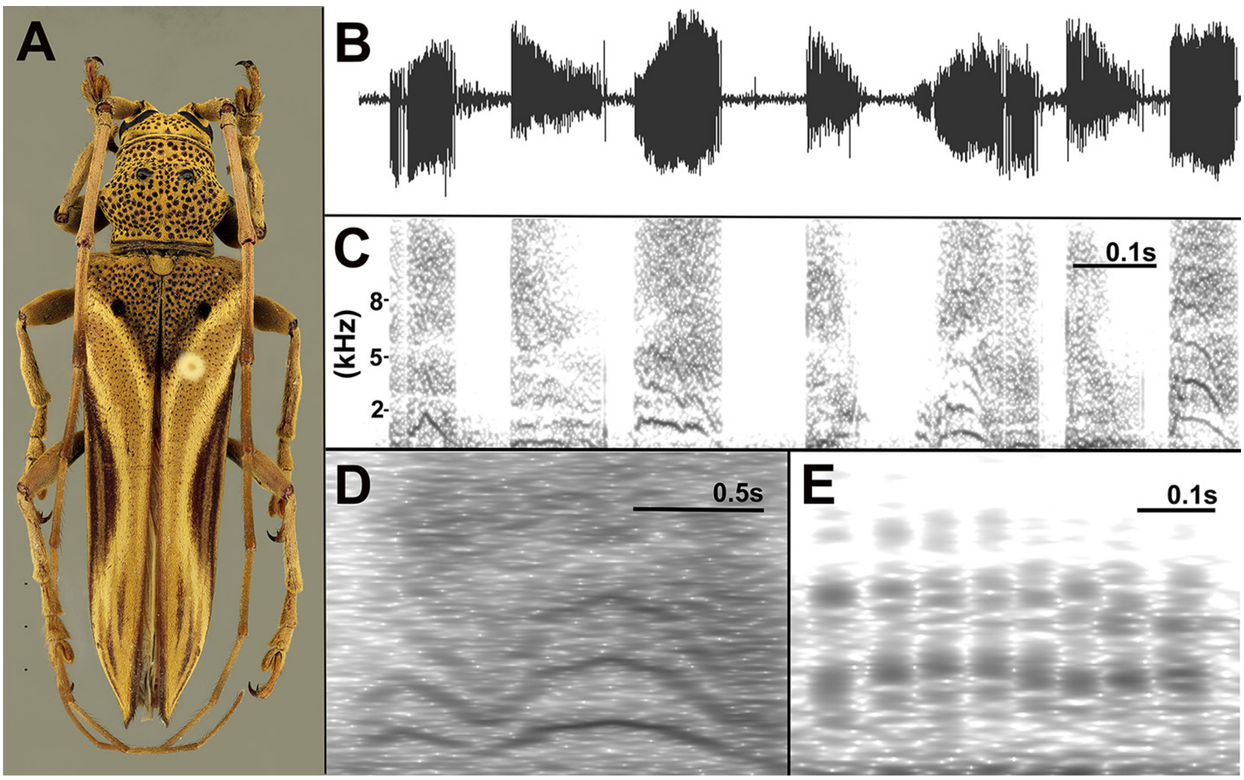

FIGURE 1. *Rhaphiptera affinis*: (A) recorded male; (B) oscillogram and (C) spectrogram of a sequence with seven chirps; (D) spectrogram of a single chirp with harmonic series and frequency modulation; and (E) spectrogram of a single chirp with low pulse rate. Spectrograms with window function Hann, overlap 99%, and 3 dB Filter Bandwidth 270 Hz (C) and 135 Hz (D–E).

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