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Observations of Aggressive Behavior in the Palawan Bubble-Nest Frog (*Philautus longicrus*) and Characterization of Its Aggressive Call

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Aggressive behavior between conspecific anuran males has been documented for several species and is usually attributed to territorial defense (Duellman and Savitzky 1976; Wells 1977; Torres-Hernández et al. 2023). Such territorial disputes can be affected by the availability of preferred perching, feeding, or breeding sites, as well as the population density of a species in a given habitat (Duellman and Savitzky 1976; Shepard 2002). On the other hand, some studies suggest that territorial defense in males is exhibited only by species in which males defend oviposition sites (Wells 2007; Valenzuela-Sánchez et al. 2014).

In the genus *Philautus,* territorial disputes between males have been dcumented only in *P. leochorinus* (Arak 1983). *Philautus longicrus* occurs on the island of Palawan in the Philippines (Diesmos et al. 2015), where it inhabits lowland and montane forests in which individuals are usually encountered in shrub vegetation. Little information is available on the reproductive biology of this species, but it is believed to be similar to that of congeners in the Philippines, which lay eggs on leaves of undergrowth vegetation, such as ferns and *Pandanus*, and exhibit direct development (Alcala and Brown 1982). Parental care has not been documented in these frogs.

At about 2000 h on 15 September 2023, about 30 minutes after a downpour and at an ambient temperature of 30.2 °C, during a herpetofaunal survey in Sitio Tambunao, Brgy. Tagusao, Municipality of Quezon, Palawan (9.09500, 117.90840), we encountered two male *P. longicrus* fighting each other (Fig. 1) on decomposing vegetation on the slope a few meters above a stream in a secondary-growth forest. The males were grappling with one another while holding onto the vegetation with their hindlimbs. They used their forelimbs to grasp one another and had inflated their bodies. Both males were vocalizing with what we considered aggressive calls, which we recorded using a cellphone microphone. A comparison of the species' advertisement call and observed aggressive calls (Fig. 2) can be accessed at Philippine Anuran Calls Online Database (https://philippineherps.wixsite.com/pinoyfrogcalls/database). We generated audiospectrograms using Audacity Software version 3.6.1 using the following settings in the frequency analysis: algorithm–spectrum, function–Hann window, size–1024, and axis–linear frequency. Descriptions of calls follow that of Duellman (1970).

Figure 1. Two male Palawan Bubble-Nest Frogs (*Philautus longicrus*) fighting with one another while hanging from a dead twig. Photograph by Jake Wilson B. Binaday.

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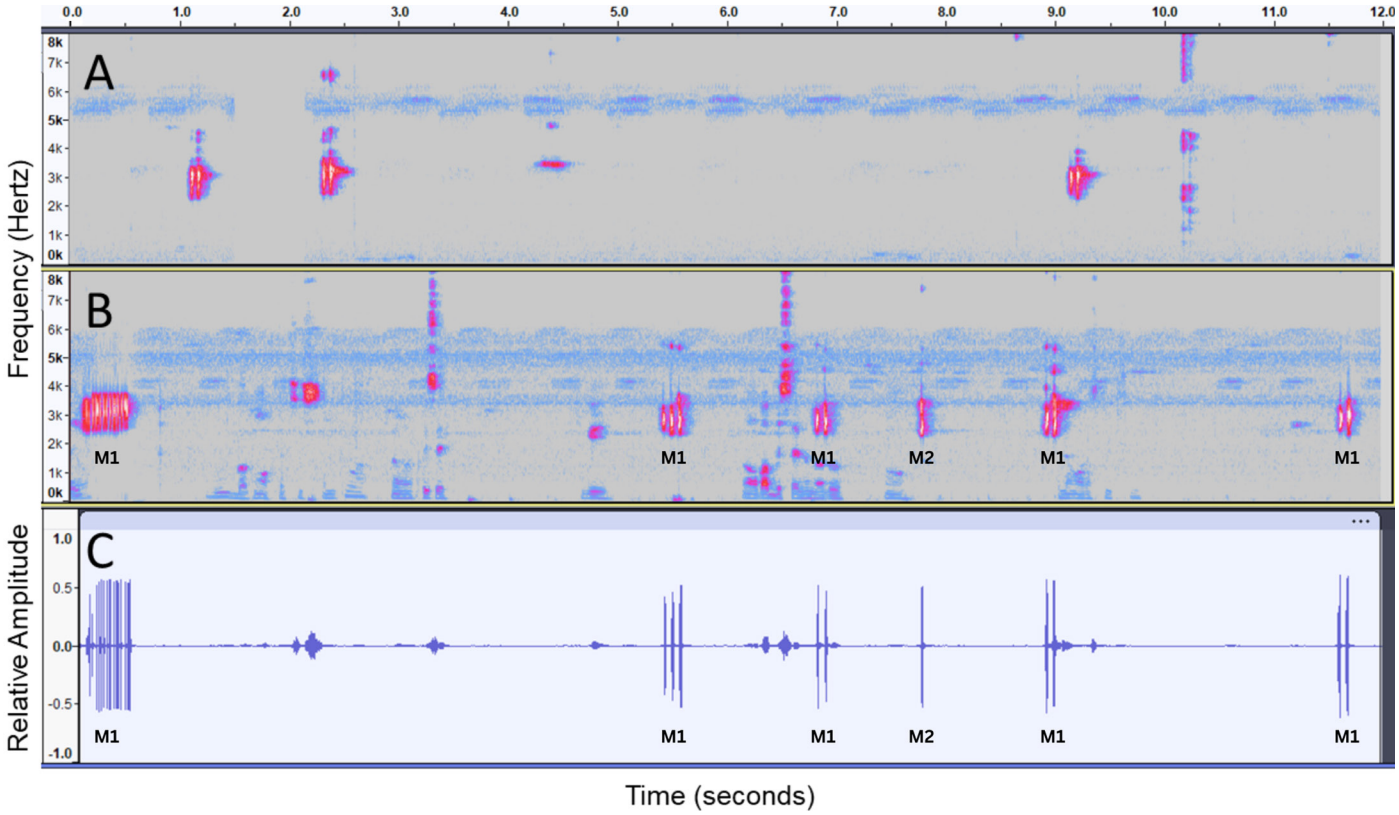

Figure 2. Spectrograms of vocalization by the Palawan Bubble-Nest Frogs (*Philautus longicrus*): An advertisement call (A) is characterized by double-clicks, whereas the aggressive call (B) is characterized as a compound call comprising clicks and rattles, with the number of clicks varying from single-, double-, and triple-clicks. One male (designated M1) called more frequently than the other (M2), although both individuals produced the same compound call structure. A waveform of the aggressive call (C) also is illustrated. Spectograms were generated using Audacity Software version 3.6.1.

The advertisement call of *P. longicrus* is characterized by double-click notes with a duration of 0.31–0.34 sec (mean = 0.32 sec) and a dominant frequency of 3.04–3.269 kHz (mean = 3.12 kHz; n = 5 calls, one male). The first note of the call is lower in amplitude when compared to that of the second note. This call was by a male perched on a twig in a primary-growth forest on Mt. Bulanjao, Palawan, at ~1800 h. The aggressive call can be characterized as a compound call composed of clicks and trills. The trills comprising 16–18 pulses (mean = 17 pulses) lasted 0.39–0.41 sec (mean = 0.41 sec) with a dominant frequency of 2.74–3.28 kHz (mean = 3.05 kHz, n = 3 calls, two males). The amplitude of the trill starts low, increases within three pulses, and subsequently remains relatively constant. Between trills, single-click notes lasted 0.03–0.06 sec (mean = 0.04 sec) with a dominant frequency of 2.48–3.48 kHz (mean = 2.80 kHz; n = 13 calls, two males); double-click notes lasted 0.11–0.13 sec (mean = 0.12 sec) with a dominant frequency of 2.74–3.30 kHz (mean = 2.97 kHz, n = 21 calls, two males); and triple-click notes lasted 0.19–0.21 sec (mean = 0.20 sec) with a dominant frequency of 2.84–3.28 kHz (mean = 2.99 kHz; n = 7 calls, two males). One male called more frequently than the other, although both individuals produced the same compound call structure.

To the best of our knowledge, this is the first time that aggression between male *P. longicrus* has been documented, and the first time that the species' aggressive call has been characterized. Few studies have been done on the vocal communication of Philippine frogs, even though such information is important in understanding their social behavior. This observation adds to our understanding of the natural history of *P. longicrus* and could be a basis for further vocal behavioral studies of the species.

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