Amphibians have several morphological, physiological, and behavioural features, which alone or combined provide protection from potential predators (Duellman and Trueb, 1994). When grasped by a predator, frogs may emit distress calls (Bogert, 1960; Hödl and Gollmann, 1986; Toledo and Haddad, 2009). This type of call is characterized by loud, explosive vocalizations emitted by males, females, and juveniles in response to disturbance of potential predators (Wells, 2007). The distress call might also be accompanied by warning displays, like puffing up the body, which is a common defensive behaviour among anurans (Wells, 2007; Toledo et al., 2011; Vargas-Salinas and Aponte-Gutierrez, 2013). Puffing up behaviour consists in filling the lungs with air, enlarging the frog’s size to discourage the predator (Duellman and Trueb, 1994; Toledo et al., 2011).

The genus Proceratophrys is widely distributed in South America (Teixeira-Jr. et al., 2012). However, ecology and natural history of this genus are poorly known. Only stiff-legged behaviour is known as part of the defensive repertory for the genus (e.g. Sazima, 1978; Costa et al., 2009; Weygoldt, 1986; Moura et al., 2010; Peixoto et al., 2013). Herein, we add new types of behaviours to the defensive repertoire of the genus Proceratophrys. We describe the distress call and a sequence of warning displays for Proceratophrys cristiceps from Estação Ecológica do Seridó, municipality of Serra Negra do Norte, Rio Grande do Norte State, Brazil.

We collected a male of P. cristiceps (SVL 46.9 mm) on May 09 2013 at Estação Ecológica do Seridó, Serra Negra do Norte municipality (S 6º 36’ 39.7” W 37º 15’ 04.4”), Rio Grande do Norte State, Brazil. When we positioned the animal to make a photograph, once stressed by the researcher the individual emitted 11 distress calls. The distress calls and the defensive behaviours were recorded with a Canon 60D. The audio was taken from a video file (.mov format) and saved in .wav format using Raven Pro 1.5 (Cornell Lab of Ornithology), at a sampling rate of 48,000 Hz and 16 bit resolution. Sound analyses were performed using Raven Pro 1.5, and the audiospectrograms were produced with the following parameters: FFT = 512, overlap 50, and DFT 512. Call terminologies follow Duellman and Trueb (1994). The frame sequence of the behaviours was extracted using iMovie Version 9.0.9. A voucher specimen (CHUFPB 5528) is deposited at Coleção Herpetológica da Universidade Federal da Paraíba (Collecting permit ICMBio 39288-1).

The distress call of Proceratophrys cristiceps is composed of a single, non-pulsed harmonic note (Figure 1), with a mean duration of 0.27 s ± 0.05 (0.21 – 0.36 s). Mean dominant frequency was 1431.8 Hz ± 421.5 (937.5 – 2062.5 Hz) always on the third harmonic. In the oscillogram, the call is linear-shaped. The distress call was emitted with the mouth open, and followed by other four warning displays. The frog puffed up its body, filling the lungs with air, and elevated the body stretching out its arms. It has been suggested that this behaviour is used to enlarge the size of the frog upon seeing a predator (Stebbins and Cohen, 1995; Williams et al., 2000; Wells, 2007). The individual showed another common defensive posture, lowering the head and elevating the rear part of the body. Lastly, this
sequence of defensive behaviour of *P. cristiceps* was followed by quick and sequential jumps in an attempt to flee away (Figure 2).

*Proceratophrys cristiceps* is characterized by the presence of cryptic coloration resembling fallen leaves, which provides the first line of defence for many adult amphibians (Wells, 2007). This species presented defensive strategies including cryptic coloration, distress call and behavioural displays, which combined probably results in a higher escape chance from potential predators. According to Toledo et al. (2011), multiple signalizations may discourage the action of predators. Likely predators may be intimidated by the defensive scream, or by the gaping display, or even may...
be intimidated only when multiple signals are displayed (Toledo et al., 2011).

This is the first record of distress call in the genus Proceratophrys, and the first description of a defensive behaviour for an individual of P. cristiceps, showing that many aspects of the behaviour and ecology of this genus are still unknown. Another defensive behaviour (stiff-legged) has been shown for the genus (P. appendiculata – Sazima, 1978; P. boiei – Costa et al., 2009; P. moehringeri – Weygoldt, 1986; P. melanopogon – Moura et al., 2010; and P. renalis – Peixoto et al., 2013), so it is possible that P. cristiceps also presents this behaviour.

According to Toledo and Haddad (2009), frog size may be directly related to the success of acoustic defensive strategies. Longer and more powerful vocalizations are emit by larger anurans, which probably enhances the chances of survival (Toledo and Haddad, 2009). They suggest that small species do not use this defensive behaviour because the distress call may be inefficient to most or all of their predators. Proceratophrys cristiceps is considered a medium-sized species, and small (e.g. P. minuta) and larger (e.g. P. laticeps) species are known for the genus Proceratophrys as well. Because distress call and warning display are known for Proceratophrys cristiceps, other species of the genus may have similar behaviours.

Acknowledgements. We thank CNPq and ICMBio for financial support (process #552031/2011-9), along with all the park rangers at the protected area for help during fieldwork.

References


*Accepted by Vinicius Caldart*