

The Rare Cry For Help: First Record of An Agonistic Call From A Snake In South America

Igor Yuri Fernandes (✉ igor.corallus@gmail.com)

Programa de Pós-graduação em Ecologia, Instituto Nacional de Pesquisas da Amazônia

Esteban Diego Koch

Instituto Nacional de Pesquisas da Amazônia

Alexander Tamanini Mônico

Programa de Pós-graduação em Ecologia, Instituto Nacional de Pesquisas da Amazônia

Research Article

Keywords: behavior, Dipsas catesbyi, vocalization, Amazonia, Serpentes.

Posted Date: January 6th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1204716/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Discussions about auditory systems and sound dynamics in snakes are frequent. The known frequency of sounds produced by snakes ranges from 0.2 - 7.5 KHz, ranging from imperceptible sounds to humans to audible and observable squeaks. The hiss and whistles are the most common sound and are not considered vocalizations. During a nocturnal survey on June 13, 2021, in the northern Brazilian Amazon, we observed the first record of vocalization in a South American snake. Emitted by the individual from *Dipsas catesbyi* has a duration of 0.06 seconds, reaching 3036 Hz in its peak frequency, with an amplitude of 2761 to 4152 Hz of frequency in its main emission. Vocalizations were made during the exhalation of air through the larynx. The modulation differs from all patterns observed for snakes resembling the agonistic call of anuran amphibians, which could characterize an evolutionary mimicry of this behavior. Vocal emission via the larynx can generate internal vibrations perceptible to the auditory system of snakes, which, when vocalizing, vibrate the laryngeal cartilage and vocal cord. Our hypothesis is that structured vocal emission through laryngeal air exhalation may be a characteristic shared by other species of the Colubridae family.

Introduction

The emission of sounds by nonavian reptiles is rare and often associated with defense mechanisms, responses against predators, territorialism or reproduction. This is observed in all Linnaean orders of the group (Crocodylia, Squamata, Testudines and Rhyncocephalia)¹. The sound production in this group is characterized by a modulated, or not modulated, expulsion of air by the larynx or glottis under different levels of contraction (friction of the body scales) or movements of flapping the tail against the substrate (producing an alert sound¹).

Discussions about auditory systems and sound dynamics in snakes are frequent, in which (i) authors claim that the rudimentary structure, as well as the absence of external ears or auditory cavities, make these animals totally deaf². Another side(ii) argues that snakes have more specialized hearing³. The absence of tympanic hearing and an external middle ear were arguments to explain "deafness" for many decades¹⁻⁴. More recently, studies have shown that snakes have an auditory system sensitive to seismic vibrations that can be sensed by jaw contact with the ground or poor perception of differences in air pressure by mechanoreceptors at skin scales (although it is difficult to know whether they can, or cannot, distinguish airborne sounds from seismic sounds). These studies allow us to state that snakes have a somatic auditory system with many aspects to discover^{1,4}.

Usually, the hiss and whistles are the most common sound and are not considered vocalizations because they do not have modularity, amplitude, temporal patterning or composition formed by distinct harmonics. The known frequency of sounds produced by snakes ranges from 0.2 - 7.5 KHz, ranging from imperceptible sounds to humans to audible and observable squeaks. These sounds are associated with body inflation and muscle contraction to expel air and produce sound^{5- 9}. In other cases, the friction of the skin's scalloped scales (a more complex structure, such as a rattle (present in species of the genus

Crotalus L., 1758), in addition to the use of caudal movement over the soil substrate. This species of snake can produce warning sounds audible within walking distance^{4,8}. Here, we describe the first defensive call record of a neotropical snake.

Results

In the video, the individual was caught in the 12th second, and at the 16th second, it unrolled and stayed suspended perched in the researcher's hand. At the 18th second, the individual displayed a short and high-pitched sound. The vocalization emitted by the individual from *Dipsas catesbyi* (snout-to-vent length = 42.8 cm) has a duration of 0.06 seconds, reaching 3036 Hz in its peak frequency, with an amplitude of 2761 to 4152 Hz in its main emission (Figure 1). The agonistic call, designated due to its association with the behavior, can also be observed on video. It is observed in the spectral dimension that there is modularity in the corner, which starts with a higher frequency close to 3700 Hz and decays at its highest point to approximately 3200 Hz. In addition, the corner is composed of a set of five harmonics, which range from 6200 Hz to 12300 Hz, losing their shape modularly and rising in frequency as they lose power (Figure 1). This is the first vocalization record with a single modulated note and harmonics in a South American snake.

Discussion

This record contributes to the discussion about calling behaviors of snakes, since it was previously stated that their sounds were composed only of vocal emissions without temporal structure, amplitude, or spectral modulation. As it is a widely distributed Amazonian species, the record of this behavioral act highlights the importance of careful observations on the behavior of snakes, given that vocalization appears to be highly costly to these animals that are devoid of developed vocal cords, which are rare to be observed due to other passive defensive behaviors with lower energetic cost (e.g., hiding the head and curling up)¹.

The hissing, common to many families, is characterized by not having a temporal or spectral structure, which can be considered broadband white noise². The vocalization in our records was made during the exhalation of air through the larynx, similar to the vocalization of other snakes, such as *Pituophis melanleucus* (Daudin, 1803) (Colubridae); *P. melanleucus* presents a modulated temporal series corresponding to the time and number of exhalations, issuing a defensive call with a frequency of 2000-9500 Hz³. Young et al. (1995) described the structures of the larynx of *P. melanleucus* corresponding to vocal cords, allowing controlled and modulated sound emission in this species. This observance raises the hypothesis that the same could be observed in *D. catesbyi*, in which the specialization of body structures allows for a complex call.

However, the modulation observed in *D. catesbyi* differs from all patterns observed for snakes resembling the agonistic call of anuran amphibians, which could characterize an evolutionary mimicry of this behavior. Evolutionary convergence and acoustic mimicry are observed in different groups, mainly in the

context of defensive behaviors, which can be described between snakes⁴. Some species of birds and snakes⁵ in this study demonstrate a possible mimetic character with the agonistic vocalization of anurans by *D. catesbyi*, which must be confirmed with more studies.

The audible frequency perceptible by snakes is low, in which sound perception occurs mainly through seismic vibrations or, according to some authors, through the detection of sound waves in the air by mechanoreceptors in the skin scales⁶. However, the evolution of a trait related to sound production may have arisen through the selection of this characteristic. Despite the deafness of snakes, there is possibly a way in which the vocalization frequency is selected by predator pressure. In addition, intraspecifically, vocal emission via the larynx can generate internal vibrations perceptible to the snakes' auditory system, which, when vocalizing, vibrate the laryngeal cartilage and vocal cord. Our hypothesis is that structured vocal emission through laryngeal air exhalation may be a characteristic shared by other species of the Colubridae family and that sound emission through different pathways may be correlated with different families of snakes, requiring more knowledge on the subject.

Methods

Record

We unpretentiously recorded a male individual of *Dipsas catesbyi* (Colubridae) during a nocturnal survey on June 13, 2021, 20h43 (GMT -4), in Presidente Figueiredo municipality, Amazonas state, northern Brazil (S 1°45'30.2, W 60°08'25.4, 100 a.s.l.). The specimen was foraged and perched in vegetation 30 cm above the ground. When handled to measurements, the individual displayed the typical movements of rolling and head hiding¹. We recorded a short video (21 s) of this behavior and started to stimulate this display to gently touch the individual (available at <https://youtu.be/3FMJc4jlkys>). During the video, we recorded the behavior described here. We declare that all methods performed are in accordance with the guidelines, regulations through the license of the Research Ethics Committee of the National Research Institute of the Amazon (license n° 01280.000036 / 2021-90) and collection license from the Authorization and System Biodiversity Information (license n° 75441-1).

Acoustic analysis

The video was recorded by a smartphone (iPhone 7 Plus model, Apple brand), and the audio was later converted on an online platform to WAVE (.wav) format. We analyzed the following temporal parameters (call duration), spectral parameters (maximum, minimum, and peak frequencies of the main vocalization), and structural parameters (number of harmonics, modularity and frequency range of harmonics). Acoustic analysis was performed at 20 dB below to reduce the effect of background noise without losing the properties of the analyzed vocalization. All measured analyses were performed using the Raven Pro Software program.

Declarations

Acknowledgments

This work was financed in part by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - PROEX n. 0742/2020 and by Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM) - PAPAC n. 005/2019. IYF thanks FAPEAM for the scholarship. EDK and ATM thank Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for scholarships (132131/2020-0; 142153/2019-2). We thank Amazon Emotions and Vanessa Marino for structural support and Lauren Hamilton for grammar revision and philosophical comments.

Author contributions

IYF recorded the video, analyzed the acoustic parameters and wrote the manuscript. EDK wrote the manuscript and translated the text. ATM wrote the manuscript.

Additional Information

The authors state that there are no conflicts of interest in the manuscript.

References

1. Russell, A. P. & Bauer, A. M. Vocalization by extant nonavian reptiles: A synthetic overview of phonation and the vocal apparatus. *Anat. Rec.* **304**, 1478–1528 (2021).
2. Pope, C. H. *Snakes alive and how they live*. (Viking Press, 1937).
3. Taylor, E. H. & others. The serpents of Thailand and adjacent waters. *Kansas Univ. Sci. Bull.* **45**, 609–1096 (1965).
4. Young, B. A. Snake bioacoustic: Toward a richer understanding of the behavioral ecology of snakes. *Q. Rev. Biol.* **78**, 303–325 (2003).
5. Colafrancesco, K. C. & Gridi-Papp, M. *Vocal Sound Production and Acoustic Communication in Amphibians and Reptiles*. (2016). doi:10.1007/978-3-319-27721-9_3
6. Young, B. A. Morphological basis of “growling” in the king cobra, *Ophiophagus hannah*. *J. Exp. Zool.* **260**, 275–287 (1991).
7. Young, B. A., Sheft, S. & Yost, W. Sound production in *Pituophis melanoleucus* (Serpentes: Colubridae) with the first description of a vocal cord in snakes. *J. Exp. Zool.* **273**, 472–481 (1995).
8. Kinney, C., Abishahin, G. & Young, B. A. Hissing in rattlesnakes: Redundant signaling or inflationary epiphenomenon? *J. Exp. Zool.* **280**, 107–113 (1998).
9. Moller, A. P., Gil, D. & Liang, W. Snake-like calls in breeding tits. *Curr. Zool.* 1–7 (2021). doi:10.1093/cz/zoab001

Figures

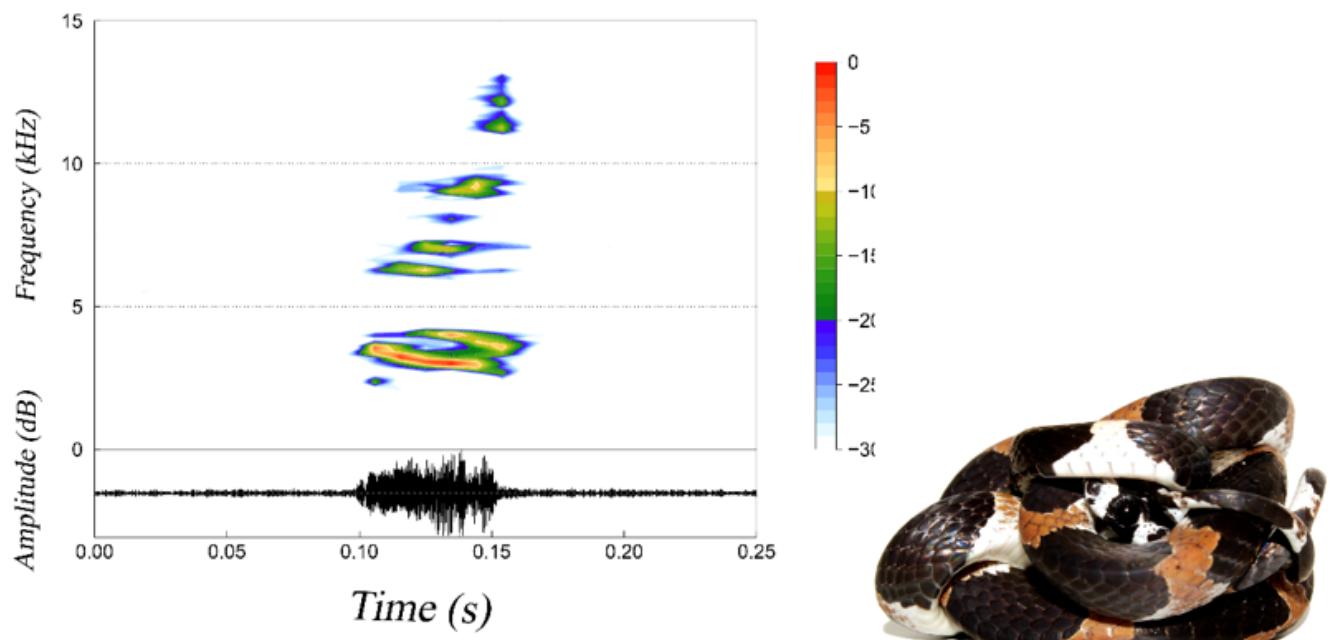


Figure 1

First record spectrogram (frequency) and oscillogram (amplitude) of the defensive call of *Dipsas catesbyi* and distribution of the parameters.