

## Filling gaps on the endangered Cerrado Rocket Frog *Allobates goianus* (Bokermann, 1975) (Anura: Aromobatidae): new distributional record and comments on its daily activity

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Recibida: 18 Septiembre 2019

Revisada: 12 Diciembre 2019

Aceptada: 10 Enero 2020

Editor Asociado: J. Goldberg

doi: 10.31017/CdH.2020.(2019-031)

### ABSTRACT

New data that seeks to fill knowledge gaps about distribution and natural history may improve our knowledge of the status of threatened species. Herein, new distributional record of the endangered species *Allobates goianus* is reported and information on daily activities of a population are provided using an automatic acoustic monitoring recorder. Despite the new distributional record, *A. goianus* has not been recorded in locations where it was previously found, we then discuss the possible causes of decline and how future efforts may help to better understand the species status.

Key Words: Biodiversity shortfalls; Brazilian savanna; Eltonian; Natural history; Wallacean.

Data on the distribution range of species may help to understand biogeographic patterns and processes, as well as help to implement biodiversity conservation strategies at different scales (Oliveira *et al.*, 2019). The lack of knowledge on the distribution range, also known as Wallacean shortfall (see Hortal *et al.*, 2015), is still more problematic when considering endangered or data deficient species (Morais *et al.*, 2013; Pimm *et al.*, 2014; IUCN, 2019). Likewise, in countries with high biodiversity, such as Brazil, there is a lack of data on the natural history of many species (Guerra *et al.*, 2018). These gaps of basic information jeopardize the meaning of threats to biodiversity, mainly in biomes that are facing high environmental degradation, such as the Cerrado (Carvalho *et al.*, 2016; Vieira *et al.*, 2017). Thus, new data that seeks to fill knowledge gaps about distribution and natural history of the species may improve our knowledge of the status of threatened species.

The genus *Allobates* (Zimmermann and Zimmermann, 1988) comprises 55 species distributed throughout Central and South America (Frost,

2019). Twenty-nine species of *Allobates* are known for Brazil (Segalla *et al.*, 2019), but only two species occur in the Cerrado biome (Valdujo *et al.*, 2012). The Cerrado Rocket-Frog *Allobates goianus* (Bokermann, 1975) is an endemic species from Central Cerrado biome, with currently known occurrence restricted to forest environments from four sites in the state of Goiás: Alto Paraíso de Goiás – Parque Nacional da Chapada dos Veadeiros (type locality; Bokermann, 1975), Silvânia – Floresta Nacional de Silvânia (Bastos *et al.*, 2003), Niquelândia and Minaçu (Carvalho, *et al.*, 2016; Frost, 2019). *Allobates goianus* is classified as Endangered (EN) according to the latest Brazilian Red List of Threatened Species (Haddad *et al.*, 2018) and as Data Deficient (DD) according to the criteria of the International Union for Conservation of Nature (Colli *et al.*, 2004).

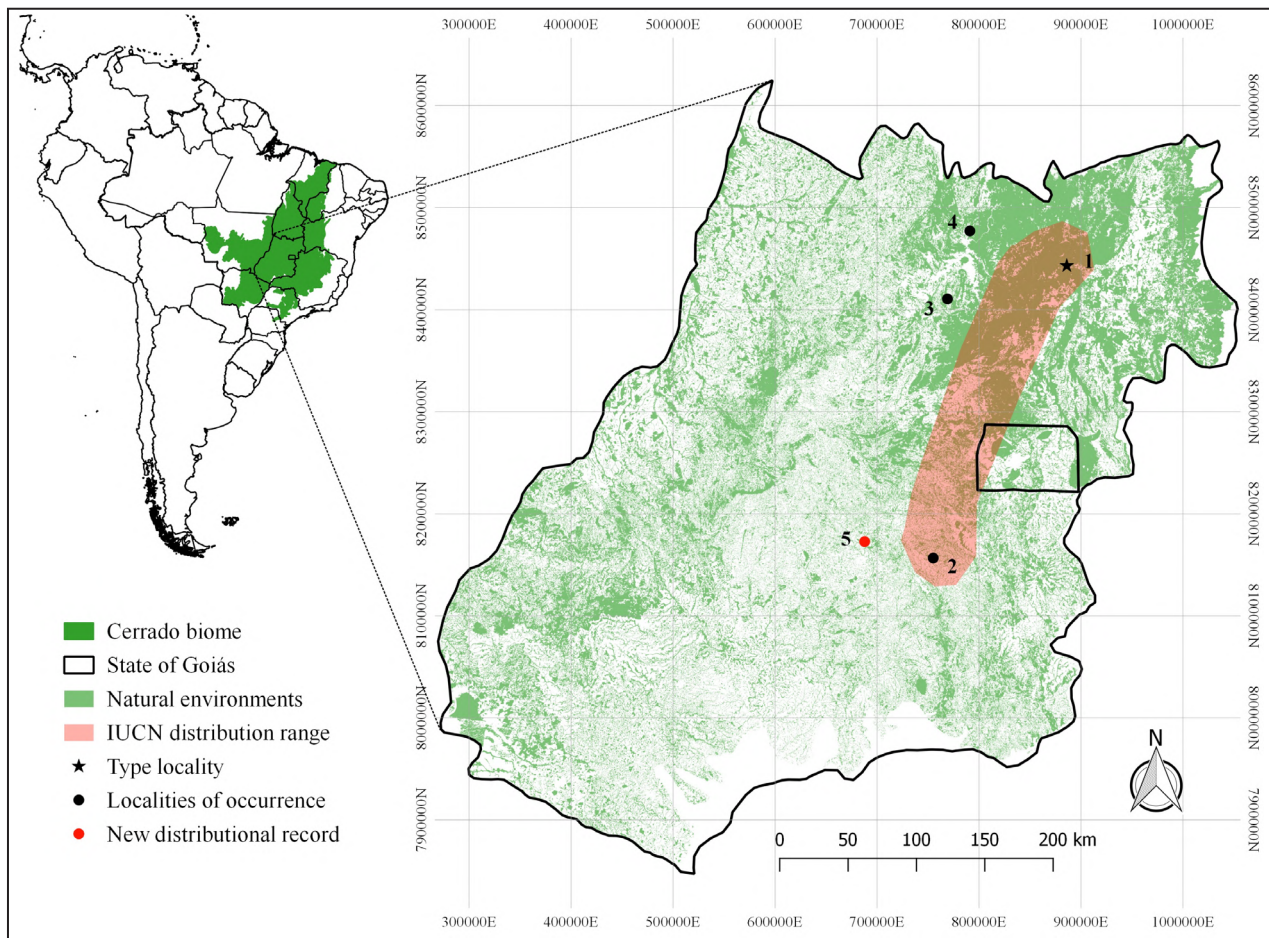
The threat status of *A. goianus* is attributed to the knowledge gaps in its geographical distribution, ecology, and natural history, as well as the habitat loss and fragmentation of their occurrence localities (Colli *et al.*, 2004; Carvalho *et al.*, 2016; Haddad *et*

*al.*, 2018). Small frogs from genus *Allobates* are an important component of the diurnal amphibian community in the leaf litter of forest ecosystems (Simões *et al.*, 2019), but the daily activity pattern is still poorly known for many of these frogs. Herein, we report a new and westernmost distribution record of the endangered species *A. goianus*, and information on daily activities of a population registered with an automatic acoustic monitoring recorder.

We obtained occasional records of *A. goianus* during field works carried out in December 2017 (from 09 to 18) and January 2018 (from 17 to 29) in the municipality of Goiânia, state of Goiás, Central Brazil (Fig. 1), a new locality of occurrence for this species (Fig. 2). The study area is covered by remnants of Cerrado forest vegetation (Ribeiro and Walter, 2008), including seasonal forest (16°31'11.43"S; 49°14'22.94"W, 787 m a.s.l.) and gallery forest (16°31'11.27"S; 49°14'21.65"W, 785 m a.s.l.), fragmented by pasture matrices. The climate is type Aw

according to the classification of Köppen-Geiger, which characterizes the region as tropical with hot and rainy summer, and cold and dry winter (Peel *et al.*, 2007).

On six occasions during the study time, WPR observed a maximum recorded abundance of five males vocalizing between 09:00 and 11:00 a.m. in a semideciduous seasonal forest and eight males at the same time in a gallery forest, always in the ground on moist leaf litter. No female was found. The specimens were assigned to *A. goianus* based on the combination of the following characteristics provided by Carvalho *et al.* (2016): finger III not swollen; dorsal coloration sorrel with a distinctive dark brown hourglass-shaped blotch; dorsolateral stripe absent; ventrolateral stripe present, whitish, with no distinctive dark blotches ventrolaterally; throat coloration yellow; and belly coloration cream to yellow. Two males were collected and anesthetized with Xylocaine 5%, fixed with formaldehyde



**Figure 1.** Distribution map of *Allobates goianus* in the Brazilian Cerrado, state of Goiás, Brazil. Star (1) Alto Paraíso de Goiás, Chapada dos Veadeiros (type locality; Bokermann, 1975); 2. Silvânia (Bastos *et al.*, 2003); 3. Niquelândia; 4. Minaçu (Carvalho *et al.*, 2016). Red circle (5) is a new locality of occurrence from the municipality of Goiânia, state of Goiás, Brazil. Geographical range distribution (in red) according to Colli *et al.* (2004).



**Figure 2.** Adult male of *Allobates goianus* (SVL 17.80 mm; ZUFG15052) from the new locality of occurrence in municipality of Goiânia, state of Goiás, Central Brazil.

10% and housed in the Zoological Collection of the Universidade Federal de Goiás (ZUFG 15052 and ZUFG 15053).

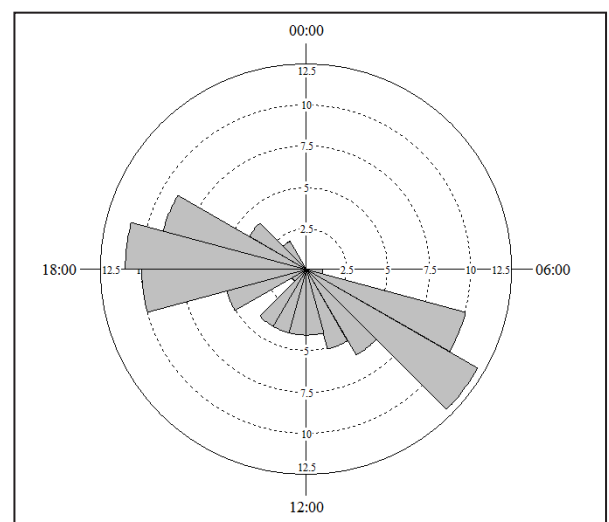
We used two automatic recorders (Sony ICD-PX320) to evaluate the daily acoustic activity of this *A. goianus* population, based on calls emitted by the males. The first recorder was installed in a gallery forest, in the edge of a stream, and another was installed thirty meters away from the first, in a semi-deciduous seasonal forest. Both automatic recorders were installed at 1 meter high from the ground and recorded for a continuous period of 24 hours, totaling eight sampled days and 192 hours of recording. To evaluate the daily activity of calling males (phenology), two minutes were randomly analyzed for every 10 minutes, accounting 12 minutes for an hour and 288 minutes per day. The recordings were analyzed in the Audacity® program through listening and visual analysis of the sonogram, totalizing 2304 minutes of listening. For each analyzed hour, we rank categorized calling male activity considering: 1= when calling males were recorded in only once (each time was considered 2 of every 10 minutes analyzed); 2= when calling males were recorded twice or three times; and 3= when calling males were recorded more than three times throughout the hour.

Using automatic recorders and further frequency distribution of vocalizations over days and nights (Fig. 3), we identified that males of *A. goianus* exhibit daytime and twilight calling activity. Vocalizations were concentrated mainly after sunrise, when it begins to warm up (~8:00-9:00h), and at sunset (~18:00-19:00h). Some individuals presented

a sporadic calling activity throughout the day or after sunset on rainy days (Fig. 3).

Our new distributional record of *A. goianus* in the municipality of Goiânia extends the distribution of this species in about 70 km west from Silvânia, with a distance of 335 km south-west from its type locality (Fig. 1). *Allobates goianus* was described by Bokermann (1975), based on specimens collected at Chapada dos Veadeiros, State of Goiás, Brazil. However, this species has no long been found in its type locality, it was extinct in sites that were flooding by Serra da Mesa hydroelectric power plant, and the population from Silvânia has been reduced significantly (Carvalho *et al.*, 2016; Haddad *et al.*, 2018). Nevertheless, although the populations are decreasing, this new record reveals that the distribution range of *A. goianus* seems to be more widespread than previously expected (Carvalho *et al.*, 2016) and that the species is still present close (less than 7 kilometers) to the major urban center (municipality of Goiânia) in the State of Goiás in landscapes dominated by agriculture. However, specimens of *A. goianus* were found only in forested matrix, indicating that fragmentation and edge effect by altering the relative humidity of the air and soil may negatively influence the presence of the species.

Although the most recent records of *A. goianus*, provided by Carvalho *et al.* (2016), discuss the advertisement call and some new data on the morphology of this species, few natural history data are available. Our recordings confirm that *A. goianus* presents a daytime and twilight reproductive activity, with a peak of activity at dawn and dusk. Most of the



**Figure 3.** Frequency distribution of daily male vocalization activity of *Allobates goianus* recorded in the municipality of Goiânia, state of Goiás, Brazil.



studies with amphibians in the Cerrado is carried out using active searches at night because there are few species with diurnal habit in this biome (V.G. pers. obs.). Therefore, the lack of knowledge on occupancy areas and extent of occurrence of *A. goianus* may be an effect of under sampling or natural low abundances in the nature.

Data on the species' phenology can help us to improve the knowledge about its natural history and activity peak, which facilitates further studies (see Hudson and Keatley, 2010). Males of *A. goianus* from Goiânia emitted a multi-note call with a continuous calling pattern, such as record for males from Niquelândia and Minaçu (Carvalho *et al.*, 2016). In our acoustic records no more than two males were found vocalizing at the same time, which could be interpreted that the males have a great territorial area or that the population has a low abundance. This implies the need for an extensive area for the *A. goianus* populations persistence and aggravates our concerns about the conservation status of the species, especially because the known populations are isolated in forest fragments with a high degree of anthropization (Carvalho *et al.*, 2016). For instance, in a parallel work of herpetofaunistic survey in the Floresta Nacional de Silvânia (I.F.M. pers. obs.), a previously reported locality of occurrence for *A. goianus* (Bastos *et al.*, 2003), we carried out three expeditions (September–November 2017 and May 2018). Each expedition lasted 10 days, totaling 30 days of sampling and a total of 540 observer hours in active searches and 14,400 hours with 60-liter pitfalls in 20 localities of Cerrado, cultivation or Seasonal Forest. Despite this high sampling effort, we did not find individuals of *A. goianus* in this locality.

Conservation status assessments mainly use species presence data. However, for endangered species all efforts to search for previously known or new populations are important. Therefore, we indicate that researchers who make specific efforts to search for these species, such as *A. goianus*, include in their data and reports the absence of these species, since these anecdotal reports may help evaluators to define details about population status in specific localities. Thus, we emphasize that is extremely necessary to find and monitor populations of *A. goianus* in localities where this species was already reported. Additionally, the development of potential distribution maps (with validation in field) to update their range of distribution can help the implementation of conservation strategies for this species.

## Acknowledgements

We thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for providing scholarship to I.F.M. and W.P.R., and the Fundação de Amparo à Pesquisa do Estado de Goiás for providing scholarship to D.F. We also thank the National Institutes for Science and Technology (INCT) in Ecology, Evolution and Biodiversity Conservation, supported by MCTIC/CNPq (proc. 465610/2014-5), which provides a fellowship to V.G. (CNPq grant number: 380320/2018-5). V.H.M.P. was financed by the Support Program for University Research and Scientific Production of the Universidade Estadual de Goiás (PROBIP/UEG) and CNPq (proc. 431012/2016-4). Specimen collection permits granted by the MMA/ICMBio N° 55420-1.

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