Predation of *Rhinella major* (Anura: Bufonidae) and *Physalaemus nattereri* (Anura: Leptodactylidae) by *Guira guira* (Aves: Cuculidae) in the Amazonia and Cerrado biome, with a compilation of its prey

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Predation is an important interaction in the local regulation of wild communities (Arribas et al., 2018). Anurans are prey for a wide variety of animal groups including invertebrates (Toledo, 2005), other anurans, lizards, snakes, birds and mammals (Toledo et al., 2007), have an important role in food webs (Ceron et al., 2019). Although snakes are the main predators of anurans (Toledo et al., 2007), the importance of bird predation upon them remains poorly known, with few records (Poulin et al., 2001).

Guira guira (Gmelin 1788) is a species of the Cuculidae that is widely distributed through eastern South America, inhabiting Argentina, Brazil, Bolivia, Paraguay and Uruguay (Sick, 1997). Its preferred habitat is open and semi-open dry areas, as in the Cerrado, Caatinga, Chaco and Pampa biomes, but it is also found in anthropogenic locations such as deforested areas, rural and even periurban areas (Sick, 1997). The diet of this species consists mainly of arthropods, including large ones (Soave et al., 2008), and small vertebrates such as anurans (Caldas et al., 2017), lizards (Smaniotto et al., 2017), mammals (Oliveira et al., 2022), and nestlings of other bird species (Fritsch et al., 2018).

Although vertebrate predation events

have been reported for *G. guira*, there are few records that identify prey species, most records being photographs on online platforms such as WikiAves (*https://www.wikiaves.com.br*), eBird (*https://ebird.org*) and iNaturalist (*https://www.inaturalist.org*). In this study, we report on two new prey items of the Bufonidae and Leptodactylidae families, consumed by *G. guira*. We also conducted a literature survey for anuran prey of *G. guira* on Google Scholar (https://scholar.google.com) using the following keywords combination: diet OR natural history OR Anuran OR Reptile OR predation OR prey OR predator–prey OR vertebrate AND *Guira guira*. We also classified events by Brazilian biomes and provide a list of predation events by *G. guira* on vertebrates.

The first record was of *G. guira* preying upon an individual of *Rhinella major* (Figure 1A) in *Campus* Marco Zero of the Universidade Federal do Amapá, municipality of Macapá, state of Amapá, Amazonian biome (0.0000°S, 51.0666°W). On 02 July 2023 at around 01h20 p.m., while observing a group of four *G. guira*, one of us (JLO) observed an adult *G. guira* on the ground with an anuran in its beak. The bird first held the frog's dorsum in its beak, then placed the toad with the ventral region upwards, and started to bite the prey repeatedly. The bird then flew away with the toad in its beak; it is not known if it swallowed the toad.

Rhinella major (Müller & Hellmich, 1936) is a terrestrial anuran species of moderate size, widely distributed throughout various Neotropical ecoregions (Narvaes and Rodrigues, 2009). In the state of Amapá, in the Amazonian biome, the species is abundant in urban and anthropogenic areas in all municipalities in the state (Pedroso-Santos & Costa-Campos, 2021). After heavy rains, *Rhinella major* presents the typical temporal pattern of explosive breeders, forming large congregations of males in temporary ponds (Costa-Campos et al., 2016).

The second predation event occurred in a rural area of the municipality of Piracanjuba, state of Goiás, in Cerrado biome (17.2368°S, 48.9621°W). In a fruit tree next to a pasture area was a *G. guira* nest, with nestlings already feathered. Adults regularly brought prey to feed the nestlings. On 29 December 2022, at 09h10 a.m., one of us (EVL), photographed one adult of *G. guira* that captured a *Physalaemus nattereri* in a marsh on the pasture ~100 meters from the nest (Figure 1B). The bird perched on a tree for a few minutes and then flew to the nest delivering the prey to the nestlings.

Physalaemus nattereri (Steindachner, 1863) is a moderate size anuran species abundant throughout its wide geograph-

ical range, between central and south-eastern Brazil, Bolivia and Paraguay (Frost, 2024). It occurs in gallery forests and swamps associated with natural and anthropized open areas (Vaz-Silva et al., 2020), exhibiting explosive breeding in permanent, semi-permanent and temporary ponds in the rainy season (Rodrigues et al., 2004).

Among vertebrates, anurans and reptiles constitute the most frequent prey eaten by *G. guira*, with predation records of several species (see references in Table 1 and Figure 2). Despite the Amazonian biome comprising about 49 % of the Brazilian territory (Fearnside, 1997), we found fewer records of vertebrate predation by *G. guira* in this biome compared with other Brazilian biomes. This may be because *G. guira* occurs only peripherally in Amazonia preferring open and semi open areas, such as Cerrado, Caatinga, Pantanal, and Pampas Biomes.

Deforestation and fragmentation of the landscape encourages birds that prefer semi-open areas, such as *G. guira*, which has expanded its distribution in the Brazilian biomes (Gomes, 2018; Santos, 2020). Consequently, local anuran species (as well other vertebrates) could suffer the impact of the occurrence of this new predator. In terms of the country's wetland areas, the Pantanal and Pampa biomes are the smallest in Brazil (Roesch et al., 2009). Despite their smaller area, the highest number of predations of Squamata and Anura by *G. guira* were recorded in these biomes (Figure 2).

We believe that the predation of anurans, occasional and opportunistic, by *G. guira* may be common (see Toledo et al., 2007). Oliveira et al. (2022) present a similar review. Here we include 10 new records (our two records, and another eight not mentioned by Oliveira et al., 2022), expanding the knowledge of natural history of *G. guira*.

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Table 1. Vertebrate species predated by *Guira guira* in Brazilian biomes, with respective references.

Biome	Order	Prey	Reference
Amazonia	Anura	*Rhinella major* (Müller & Helmich, 1936)	**This study**
	Squamata	*Cnemidophorus lemniscatus* (Linnaeus, 1758)	Carvalho-Filho (2008)
	Squamata	*Tropidurus oradicus* Rodrigues, 1987	Carvalho-Filho (2008)
Atlantic Forest	Anura	*Pseudis platensis* Gallardo, 1961	Landgref-Filho et al. (2011)
	Squamata	*Hemidactylus mabouia* (Moreau de Jonnès, 1818)	Rodrigues et al. (2019)
	Squamata	*Liolaemus lutzae* Mertens, 1938	Rocha (1993)
	Squamata	*Tropidurus torquatus* (Wie-Neuwied, 1820)	Koski and Merçon (2015)
	Passeri-formes	*Turdus leucomelas* Vieillot, 1818	Fritsch et al. (2018)
Caatinga	Anura	*Dermatonotus muelleri* (Boettger, 1885)	Caldas et al. (2017)
	Anura	*Rinella granulosa* (Spix, 1824)	Mesquita (2009)
	Squamata	*Ameivula ocellifera* (Spix, 1825)	Gogliath et al. (2010)
	Squamata	*Hemidactylus mabouia* (Moreau de Jonnès, 1818)	Andrade et al. (2015)
	Squamata	*Iguana iguana* (Linnaeus, 1758)	Coutinho et al. (2014)
Cerrado	Anura	*Physalaemus* cf. *fuscumaculatus*	Kokubum and Zacca (2003)
	Anura	*Physalaemus nattereri* (Steindachner, 1863)	**This study**
	Anura	*Scinax* aff. *Fuscovarius*	Morais et al. (2013)
	Rodentia	*Calomys* sp.	Oliveira et al. (2022)
Pampa	Anura	*Leptodactylus latinasus* Jiménez de la Espada, 1875	Soave et al. (2008)
	Anura	*Leptodactylus latrans* (Steffen, 1815)	Corrêa et al. (2013)
	Anura	*Leptodactylus ocellatus* (Linnaeus, 1758)	Repenning et al. (2009)
	Anura	*Leptodactylus* sp.	Soave et al. (2008)
	Anura	*Rhinella dorbignyi* (Duméril & Bibron, 1841)	Soave et al. (2008)
	Anura	*Rhinella arenarum* (Hensel, 1867)	Soave et al. (2008)
	Anura	*Boana pulchella* (Duméril and Bibron, 1841)	Soave et al. (2008)
	Anura	*Boana* sp.	Soave et al. (2008)
	Squamata	*Erythrolamprus poecilogyrus* (Wied Neuwied, 1825)	Abegg et al. (2015)
Pantanal	Squamata	*Amphisbaena vermicularis* Wagler, 1824	Smaniotto et al. (2017)
	Squamata	*Copeoglossum nigropunctatum* (Spix, 1825)	Smaniotto et al. (2017)
	Squamata	*Iguana iguana* (Linnaeus, 1758)	Smaniotto et al. (2017)
	Squamata	*Tropidurus torquatus* (Wie-Neuwied, 1820)	Smaniotto et al. (2017)
	Squamata	*Pantodactylus parkeri* Ruibal, 1952	Bernarde et al. (2016)



Figure 1. Predation on anurans by an adult *Guira guira*. A) *Rhinella major*, in state of Amapá, Amazonian biome; B) *Physalaemus nattereri*, in state of Goiás, Cerrado biome.

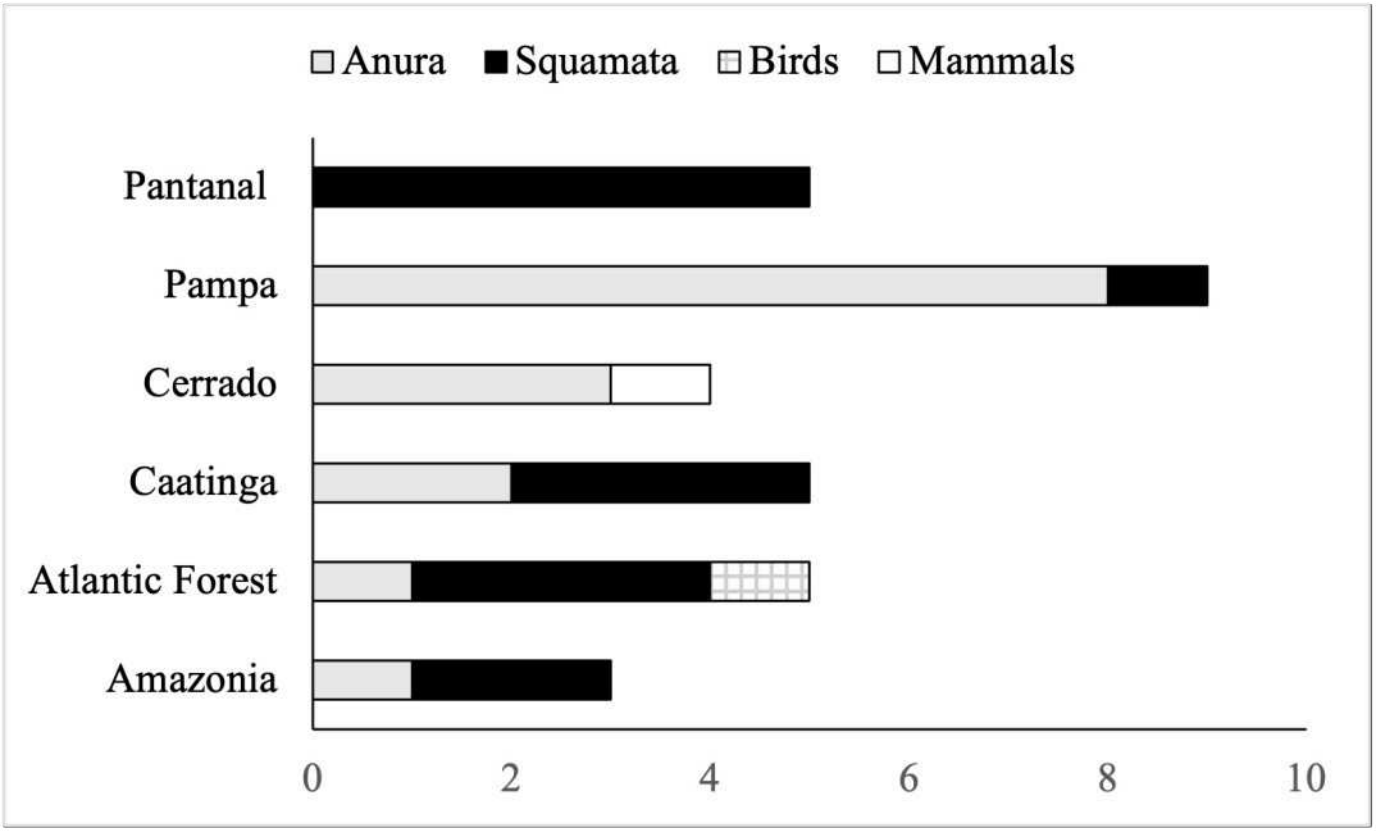

Figure 2. Vertebrate species predated by *Guira guira* in Brazilian biomes indicating the respective number of species reported as prey. Values used to draw this graph are presented in Table 1.