

Short Note

Predation attempts on large *Rhinella* toads (Bufonidae) by *Paleosuchus* caimans (Alligatoridae) in artificial ponds

Depredación de sapos grandes de *Rhinella* (Bufonidae) por caimanes *Paleosuchus* (Alligatoridae) en estanques artificiales

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ABSTRACT

Predation on bufonid toads can be perilous due to the presence of paratoid glands, which can poison and even lead to the death of the predator. Some crocodilians avoid contact with the toad's poison or are probably tolerant to the venom of the toad species they feed on. Herein, we report predation events on the toads belonging to the *Rhinella marina* species group (*R. marina* and *R. diptycha*) by the caimans *Paleosuchus trigonatus* and *P. palpebrosus*, respectively. Our observations represent the first record of *Rhinella* species in the diet of *P. palpebrosus* and reveal strategies used by *Paleosuchus* individuals to avoid or minimize toxin ingestion. Both observations involved caimans in disturbed habitats, where lower prey availability likely promotes this interaction during the toad's reproductive activity.

Keywords: Amazon, caimans, cane-toads, Cerrado, trophic interactions.

RESUMEN

La depredación de sapos bufónidos puede ser peligrosa debido a la presencia de glándulas que producen veneno, lo que puede provocar envenenamiento e incluso la muerte de sus depredadores. Algunos cocodrilos evitan el contacto con las glándulas venenosas o son probablemente tolerantes al veneno de los sapos que consumen. Reportamos dos eventos de depredación de grandes sapos del género *Rhinella* de grupo *marina* (*R. marina* y *R. diptycha*) por caimanes *Paleosuchus trigonatus* y *P. palpebrosus*, respectivamente. Las observaciones presentadas constituyen el primer registro de especies de *Rhinella* en la dieta de *P. palpebrosus* y revelan estrategias utilizadas por individuos de *Paleosuchus* para evitar o minimizar la ingestión de toxinas. Ambas observaciones involucraron caimanes en hábitats alterados, donde la menor disponibilidad de presas probablemente fomenta esta interacción durante los eventos reproductivos de los sapos.

Palabras clave: Amazonía, caimanes, Cerrado, interacciones tróficas, sapos de caña.

Trophic interactions between anurans and crocodilians have received increasing attention since declines in populations of the *Crocodylus johnstoni* (Krefft, 1873) were reported, related to the arrival and spread of the invasive cane-toad *Rhinella marina* (Linnaeus, 1758) in Australia (Letnic *et al.*, 2008; Fukuda *et al.*, 2016). Crocodilian mortality related to the ingestion of *Rhinella* species is influenced by factors such as watercourse characteristics, local climate, crocodile size, prey handling, and prey avoidance (Fukuda *et al.*, 2016). This mortality can impact aquatic biodiversity, as top-order predators play a crucial role in maintaining ecosystem balance (Somaweera *et al.*, 2012). Therefore, understanding how crocodilians that evolved alongside *Rhinella* species manage this toxic prey can provide valuable insights into the management of trophic relationships between crocodilians and toads in regions where invasive toads threaten native crocodilians.

The *Rhinella marina* group (*sensu* Pereyra *et al.*, 2021) comprises 11 large-sized species, which bear several large poison glands in the cephalic region and dorsum. Although

the cane-toad *Rhinella marina* has been introduced worldwide aiming to control beetles that act as cane pests, in Brazil, it occurs naturally in the Amazon region (Frost, 2024). The cururu-toad *Rhinella diptycha* (Cope, 1862) occurs throughout Brazil (Frost, 2024), mainly in open biomes. Both species use natural and anthropogenic habitats, often forming large choruses during the rainy season (Arantes *et al.*, 2020).

The genus *Paleosuchus* comprises two species of small crocodilians naturally found in South America (Magnusson, 1985). *Paleosuchus palpebrosus* (Cuvier, 1807) can occupy flooded forests, rivers, lakes, and even roadside ditches throughout Brazil (Campos *et al.*, 2010; Vasconcelos *et al.*, 2020), while *Paleosuchus trigonatus* (Schneider, 1801) occurs only in forest habitats of rivers in the Amazon Basin (Campos *et al.*, 2019).

Caimans are opportunistic and diet-generalist predators that occasionally prey on anurans (e.g., Toledo *et al.*, 2007). However, reports of predation on species belonging to the *Rhinella marina* group have become more frequent, largely due to increased fieldwork efforts (Peixoto-Couto *et al.*,

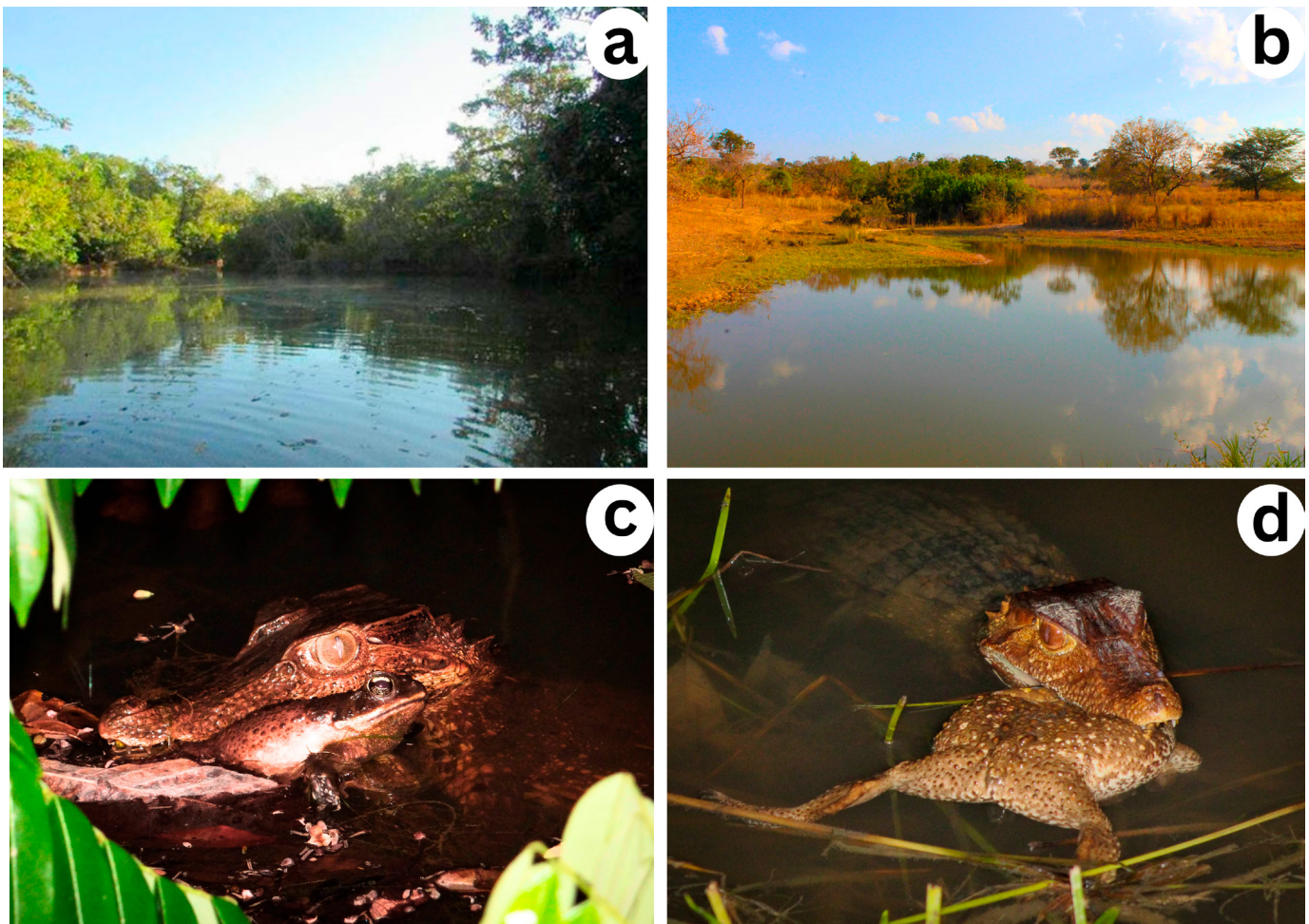


Figure 1. Predation attempts of *Rhinella* toads by *Paleosuchus* caimans. a) The artificial pond where predation of *R. marina* by *P. trigonatus* was recorded. b) The artificial pond where predation of *R. diptycha* by *P. palpebrosus* was recorded. c) Individual of *P. trigonatus* holding an adult male of *R. marina*. d) Individual of *P. palpebrosus* holding an adult male of *R. diptycha*. Photos by KRAS (a, c) and MAC (b, d).

2020; Oda *et al.*, 2022). These observations include small-sized crocodilian species of the genus *Paleosuchus* (Rivas *et al.*, 2023).

During fieldwork, we observed two predatory attempts on *Rhinella* toads by *Paleosuchus caimans*. The first observation occurred in the municipality of Novo Progresso, state of Pará, Brazil (7°32'36" S; 55°2'7" W) on July 25, 2016, in an artificial pond formed by damming a small stream (Fig. 1a). KRAS observed three individuals of *P. trigonatus* and one of them, with approximately 120 cm in total length, captured an adult *R. marina*. The caiman remained motionless throughout the observation, holding the toad by its hind limb and posterior part of its body (Fig. 1c). After approximately 20 minutes of observation, the ingestion was not yet complete. Remnants of the toad were found on the following day, indicating that the caiman had ingested parts of it.

The second observation was documented on August 23, 2019, in the municipality of Santa Fé de Minas, state of Minas Gerais, Brazil. The area was characterized by an artificial pond of approximately 0.23 ha (16°34'6" S; 45°43'22" W), formed by damming a small tributary of the Urucuia River, and located in a pasture for goat farming (Fig. 1b). MAC noticed a chorus of *Rhinella diptycha* around the margins of the artificial pond at 8:00 PM. The author observed an individual of *Paleosuchus palpebrosus* (approximately 110 cm in total length) holding an adult male *R. diptycha* close to the pond edge (Figure 1d). The *P. palpebrosus* captured the toad head-first, while submerging the toad's head. The following day, we did not observe remnants of *R. diptycha* at the site, suggesting its complete ingestion by the caiman.

Our observations document the strategies used by *Paleosuchus caimans* to avoid or minimize the ingestion of toxins. We also provide the first record of *Rhinella* species in the diet of *P. palpebrosus*. Predators of true toads may either tolerate the toxins or learn strategies to avoid them (Oda *et al.*, 2022). For instance, *Caiman latirostris* has been observed consuming *R. diptycha* entirely (Peixoto-Couto *et al.*, 2020), whereas *C. crocodilus* typically consumes only the limbs of *R. marina* (Oda *et al.*, 2022). The selective ingestion of limbs, by avoiding contact with the parotoid glands, suggests that some crocodilian populations have developed learned behaviors for handling toxic prey (Britton *et al.*, 2013). Additionally, juveniles may rapidly learn to avoid unpalatable or potentially lethal prey (Somaweera *et al.*, 2012), particularly when cane toads are involved, as observed in *Caiman crocodilus* (Batista *et al.*, 2011). Tolerance to toad toxins has also been reported in some caiman populations (Batista *et al.*, 2011; da Costa and dos Santos-Nunes, 2019; Peixoto-Couto *et al.*, 2020; Rivas *et al.*, 2023, see Table 1).

Predation events on bufonids by crocodilians may be more frequent in anthropogenically modified environments, as reduced prey availability in artificial ponds likely promotes such events (Britton *et al.*, 2013). We found that trophic interactions between crocodilians and large bufonids are influenced by environmental conditions, predator experience, and historical predator-prey interactions (Somaweera *et al.*, 2012; Fukuda *et al.*, 2016). Future observations of anuran predation by crocodilians should be documented, particularly those involving toxic species or interactions

Table 1. A synopsis of trophic interactions between South American alligatorids and *Rhinella* toads. Ecoregions following Dinerstein *et al.*, (2017) (Available at <https://ecoregions.appspot.com/>).

Caiman species (age)	<i>Rhinella</i> species	Location (Ecoregion)	Habitat	Interaction characteristics	Reference
<i>P. trigonatus</i> (Adult)	<i>R. marina</i>	Curionópolis, Pará, Brazil (Amazon Forest)	A lake near the municipality	Caiman captured the prey, slammed it repeatedly against the lake margin, tore off body parts (limbs), and ingested them, then consumed the rest.	de Assis and dos Santos (2007)
<i>C. crocodilus</i> (Juvenile)	<i>R. marina</i>	Oriximiná, Pará, Brazil (Amazon Forest)	The Sapucaá Lake	Caiman was observed biting the parotoid glands, then released the prey and fled.	Batista <i>et al.</i> (2011)
<i>C. latirostris</i> (Juvenile)	<i>R. diptycha</i>	Ilha Solteira, São Paulo, Brazil (Atlantic RainForest)	An artificial pond	Caiman bit the toad's head and swallowed it whole. Rested for ~2 hours afterward.	Peixoto-Couto <i>et al.</i> (2020)
<i>C. crocodilus</i> (Adult)	<i>R. marina</i>	Manaus, Amazonas (Amazon Forest)	A lagoon in Reserva Florestal Adolpho Ducke	Caiman was recorded holding the toad by its left hind leg. The next day, the toad was observed missing both its forelimbs and hind limbs.	Oda <i>et al.</i> 2022
<i>R. trigonatus</i> (Juvenile)	<i>R. major</i>	Riberalta, Vaca Díez, Bolivia (Amazon Forest)	An artificial pond	Caiman held prey by its flank, avoiding parotoid glands. Outcome unknown.	Rivas <i>et al.</i> (2023)
<i>P. trigonatus</i> (Adult)	<i>R. marina</i>	Novo Progresso, Pará, Brazil (Amazon Forest)	An artificial pond	Caiman captured prey's hind limbs. Prey remains were found the next day, indicating partial ingestion.	This study
<i>P. palpebrosus</i> (Adult)	<i>R. diptycha</i>	Santa Fé de Minas, Minas Gerais, Brazil (Cerrado)	An artificial pond in a pasture	Caiman held the prey by the head. No prey remains were found the next day, suggesting complete ingestion.	This study

favoured by human-induced habitat changes. Such records should include details on aquatic habitat characteristics, the number of prey and predator individuals, the antipredator responses, the observed feeding strategy, the duration of the event, and the digestion period to identify any carcasses of the individuals involved.

AUTHOR'S PARTICIPATION

MAC, KRAS, IP, LFL, MJMD, RAB – Manuscript conception; MAC, KRAS, IP, LFL, MJMD, RAB – Manuscript writing; MAC, KRAS – field observations; MAC, KRAS, IP, LFL, MJMD, RAB – Manuscript approval.

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CONFLICT OF INTEREST

The authors declare no conflict of interest

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