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Review of the diet of *Leptodeira rhombifera* (Colubridae) and new case to attempt predation of *Rhinella horribilis* (Bufonidae) in Nicaragua.

Lester Fonseca-González, Ariel Salinas & Ronier Francisco Rugama Montoya.

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Foto de portada: *Leptodeira rhombifera* (Foto © Lester Fonseca).

Review of the diet of *Leptodeira rhombifera* (colubridae) and new case to attempt predation of *Rhinella horribilis* (Bufonidae) in Nicaragua.

Lester Fonseca-González[1], Ariel Salinas[2] & Ronier Francisco Rugama Montoya[3].

Resumen

Revisión de la dieta de *Leptodeira rhombifera* (Colubridae) y nuevo caso de intento de depredación de *Rhinella horribilis* (Bufonidae) en Nicaragua.

Las interacciones presa-depredador son importantes para comprender la dinámica de especies, por lo cual aportamos datos relevantes de la dieta de *Leptodeira rhombifera* a través de la búsqueda exhaustiva de publicaciones concerniente a sus presas, conjuntamente reportamos por primera vez el intento de depredación de *Rhinella horribilis* por *Leptodeira rhombifera* en el pacifico de Nicaragua. Corroboramos que la dieta de *L. rhombifera* está dirigida hacia anfibios, sin embargo, los reptiles y peces forma parte sustancial de su alimentación, los reportes sugieren que los hábitos alimenticios de la especie están estrechamente relacionados con su historia natural. Por último, mencionamos que *R. horribilis* podría representar una alternativa en los hábitos alimenticios del género *Leptodeira*.

Palabras claves: Anfibios, Dieta, Dinámica ecológica, Presa, Serpientes.

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Abstract

Prey-Predator interactions are important to understand species dynamics, therefore, we provide relevant data on the diet of *Leptodeira rhombifera* through an exhaustive literature review of its diet. We also report for the first time the attempt predation of *Rhinella horribilis* by *L. rhombifera* in the Pacific region of Nicaragua. We corroborate that the diet of *L. rhombifera* primarily targets amphibians, however, reptiles and fish also are substantial part of its diet, reports suggest that the feeding habits of the species are closely related to its natural history. Finally, we mentioned that *R. horribilis* could represent an alternative in the feeding habits of the genus *Leptodeira*.

Keywords: Amphibians, Diet, Ecological dynamics, Prey, Snakes.

Introduction

Tropical habitats are characterized by high biodiversity and complex biotic interactions such as predation (Freestone *et al.*, 2011; Brown, 2014). Predation is an integral part of the ecological dynamics of living organisms and is based on the effort made by one animal to find and feed on another (Curio, 1976), it is fundamental for better understand the ecology of living organisms (Rosenberg and Cooper, 1990), as documenting predation interactions provides valuable information to increase the understanding of the dynamics of structure and function within communities and ecosystems (Rosenberg & Cooper, 1990).

In this sense, anurans are a crucial component in the trophic dynamics of communities and ecosystems (Whiles *et al.*, 2006); they are secondary consumers in the food chain, as they consume insects and other invertebrates, while also serving as prey for other species.

Leptodeira is a genus of snakes known to base its diet mainly on amphibians and small lizards, in *L. rhombifera*, it probably consists mainly of adult or juvenile anurans (Espinoza, 2021; Duellman, 1958; Solórzano, 2004). However, the species has been documented feeding on other groups such as fish (Solórzano, 2022), birds and small mammals (unspecified), (Köhler 2008; Solórzano, 2004). Additionally, there are records that mention other important aspects of the species diet such as scavenging (Fuentes & Quiroz-Espinoza, 2024; Knight, 2016) and ophiophagy (Köhler 2008; Solórzano, 2004).

L. rhombifera, has an established distribution from southern Mexico to Panama and is found in dry to humid lowland tropical environments (Barrio-Amorós, 2019).

In Nicaragua, it is present in almost the entire national territory, associated wetlands (HerpetoNica, 2015) and is primarily terrestrial and nocturnal, according to Leenders (2019) it is more common in seasonally dry areas. The species possesses a certain amount of venom and enlarged, striated posterior maxillary teeth that they use to immobilize their prey before consuming them (Leenders, 2019).

In another order, Cane toads are the most widely distributed and abundant new world amphibians around the world (Lever 2001), within this group we find *Rhinella horribilis*, which is naturally distributed from southern Texas to the central Amazon. Particularly, this species is one of the most cosmopolitan anurans and inhabits diverse types of ecosystems (Acevedo *et al.*, 2016; Bonett *et al.*, 2017). In Nicaragua, it is present throughout the national territory, in urban areas, livestock areas and altered natural habitats (HerpetoNica, 2015). It is terrestrial and nocturnal (Savage, 2002) although arboreal behavior has been reported (Berra, 2020).

This toad has a generalist diet, feeding on a wide variety of invertebrates, small vertebrates and in some cases, plants (Botero-Trujillo 2006; Escudero & Ortega 2009; Sampedro-Marín *et al.*, 2011), essentially consuming different species that it can capture in its mouth.

In this note, we describe a case attempted predations of *R. horribilis* by *L. rhombifera* in the pacific region of Nicaragua, and discuss relevant aspects of the diet of *L. rhombifera*.

Materials and Methods

The event of predation occurred in the central Pacific region of Nicaragua, department of Managua, in "Natura" Reserve, located at the following coordinates: N. 11.86756°, W. 086.51387°. This zone corresponds to Central American dry forests and secondary regenerations was present locally.

Information gathering

To document the in-situ observation and identification of both species involved, the organisms were photographed using a Sony Ciber-shot H-400 and Nikon 3500 camera, without interrupting the event from a distance of one meter.

An exhaustive review of publications concerning to *L. rhombifera* prey was conducted using the Google Scholar search engine and Scopus. We also reviewed the metadata of 15 specialized herpetology journals, as well as the repository of CSUCA (Consejo superior de Universidades Centroamericanas) and other academic institutions, primarily in North America.

During the search we delimited the cases explicitly documented for *L. rhombifera* and employed field operators (Gómez, 2017) with the key terms: Alimentación /Dieta / Depredación / Nota / *Leptodeira rhombifera* / *Rhinella horribilis* / Registro / Nota, as well as their English equivalents.

The compiled information was carefully reviewed and selected from its source and was organized chronologically and by taxonomic group.

Figure 1. Location of predation case.

Results and Discussion

On August 20, 2024, during a night hike in the vicinity of the "Los Lagartos" reservoir, Ronald Bermudez, Francisco Flores, Junior Baltodano, Carlos Corea, Lester Fonseca, Ariel Salinas y Ronier Rugama observed a juvenile individual of *L. rhombifera* on the side of the "Guardabarranco" trail, feeding on a specimen of juvenile *R. horribilis*. The event took place at 18:05 hours, we proceeded to photograph the predation for no more than four minutes during which the snake attempted to swallow the frog (figure 2). At the time of the observations, the snake was holding its prey by the right flank, the prey showed no signs of resistance.

Afterwards, it was not possible to remain at the site for more time, so we moved to other locations within the reserve. Upon returning to the exact point of observation, we noticed that the snake abandoned its prey, the anuran exhibited lacerations on its shoulders as a result of the snake's subjugation.

Figure 2. Event of predation of *R. horribilis* by *L. rhombifera*. (photos © Lester Fonseca and Ariel Salinas).

We cannot assume that the colubrid did not consume the prey due to our presence or because it could not swallow it, as such cases have been previously recorded in snakes of the Colubridae family, which do not complete their feeding for different reasons (Heinen & Hammond, 1997; Engeman & Engeman, 2015; Teles *et al.*, 2018; Hernández & Guevara, 2022). This case may be related to the relative sizes of the predator and prey or by secretions on the frogs' skin, as well as physical resistance on the part of the prey (Costa & Trevelin, 2020).

Figure 3. *Post mortem* state of *R. horribilis* (photos © Ariel Salinas and Lester Fonseca).

Both the prey and the predator (approximately 29 cm) were juveniles, so it is not clear whether the predation was not fully developed because of the size of the prey relative to the snake, the human presence or some other factor.

The result was the lifeless body of the prey, with torn shoulders and symptoms of having been poisoned (figure 3).

Rhinella horribilis has been documented as prey for other species of the genus *Leptodeira*, such as *L. maculata* and *L. splendida* (García-Mata *et al.*, 2017; Gámez-Duarte *et al.*, 2024), also, other reptiles such *Ctenosauria similis* (Pasachnik & Corneil, 2011), even data provided by Pasachnik & Corneil, (2011) and Okada-Aguiar & Costa-Campos (2018), specify that *R. horribilis* is a feeding alternative even in the post-mortem state.

It is worth mentioning that according to HerpetoNica (2015), the Bufonidae family is considered the most common family in the Pacific region of Nicaragua and is present throughout the country. Within this group, it is important to note that *R. horribilis* is the most frequently observed species. This statement is consistent with the relative abundance of *R. horribilis* in the "Nature" Reserve, as it tends to be the most commonly observed amphibian. Therefore, this species could represent an alternative resource in the diet of terrestrial snakes due to its common character.

The diet of *L. rhombifera* is well documented, however, records documenting its prey at the species level are rare. For example, (Savage, 2002) mentions that it consumes aquatic prey such as crabs and fish, other authors include lizards, amphibians, tree frog eggs, and small mammals (Duellman, 1958, Solórzano, 2004; Köhler, 2008), although without precision about species.

In this regard, we compile the cases that specifically document the species (some up to family level) that are part of the diet of *L. rhombifera*.

According our documentary review, the diet of *L. rhombifera* is more focused on amphibian, this data suggests that the feeding habits by *L. rhombifera* are closely related to its natural history; being a nocturnal and terrestrial species, it relies on species that can be easily found on the ground or in not so high places. On the other hand, these characteristics may explain why there are almost no literary resources documenting the predation of birds and mammals. In addition, these particular characteristics of L. rhombifera justify the fact that the species has been reported to feed on fish and scavenging, which it is likely to resort to more frequently than previously thought.

The consumption of dead prey in *L. rhombifera* is important, as it alludes to an ability of the species to select a broader diet when anurans are less abundant (Céspedes, & Abarca, 2014).

Of the 20 cases collected of predation by *L. rhombifera*, 60% correspond to amphibians, while 20% correspond to reptiles and 20% to fish and we include in their diet small mammals, which have been mentioned without specifying the species.

Table 1. Compilation the diet (Preys) of *Leptodeira rhombifera*.

Documented prey of *Leptodeira rhombifera*				
Taxonomic group	**Prey**	**Documented attack**	**Country**	**Sources**
Amphibians	*Engystomops pustulosus*	Yes (Individuo)	Barra Colorado, Panama	Ryan (1985)
Amphibians	*Engystomops pustulosus*	Yes (Individuo)	Gamboa, Panama.	Dougherty & Lisondro (2023)
Amphibians	*Boana rosenbergi*	Yes (Individuo)	Panama	Kluge (1981)
Amphibians	*Boana rosenbergi*	Yes (Individuo)	Gamboa, Panama.	Dougherty & Lisondro (2023)
Amphibians	*Engystomops pustulosus*	Yes (Individuo)	Gamboa, Panama.	Dougherty & Lisondro (2023)
Amphibians	*Incilius coccifer*	Not (Individuo)	Guanacaste, Costa Rica	Área de Conservación de Guanacaste
Amphibians	*Lithobates vallianti*	Yes (Scavenging)	Guanacaste, Costa Rica	Mora-Benavides (1999)
Amphibians	*Rhinophrynus dorsalis*	Yes (Individuo)	Guanacaste, Costa Rica	Céspedes *et al*. (2018)
Amphibians	*Anaxyrus americanus*[*1]	Yes (Experiment)	Arrived in New York, EEUU	Skeha (1959)
Amphibians	*Lithobates pipiens*[*2]	Yes (Experiment)	Arrived in New York, EEUU	Skeha (1959)
Amphibians	*Pseudacris regilla*	Yes (Experiment)	EEUU	Busack (2018)
Amphibians	*Hylidae*	Yes (Scavenging)	Los Santos, Panama	Knight (2016)
Reptiles	*Leptodactylus labialis*	Yes (Scavenging)	Panama	Fuentes & Quiroz-Espinoza (2024)
Reptiles	*Lampropeltis triangulum*	Yes (Experiment)	Arrived in New York, EEUU	Skeha (1959)

Reptiles	*Anolis spp*	Yes (Experiment)	Arrived in New York, EEUU	Skeha (1959)
Reptiles	*Iguana rhinolopha*	Yes (Scavenging)	Panama	Fuentes & Quiroz-Espinoza (2024)
Fish	*Rhamdia guatemalensis*	Yes (2 Individuo)	Guanacaste, Costa Rica.	Rojas-Carranza & Anderson (2023)
Fish	*Rhamndia spp*	Yes (Individuo)	Alajuela, Costa Rica	Céspedes & Abarca (2014)
Fish	*Characidae*	Yes (Individuo)	Los santos, Panama	Knight & Shervette (2022)
Fish	*Rhamdia laticauda*	Yes (Individuo)	Francisco Morazán, Honduras	Solis & Guerrero (2016)

Note: * indicates update in the scientific name of some documented species: *Bufo americanus*[*1], *Rana pipiens*[*2].

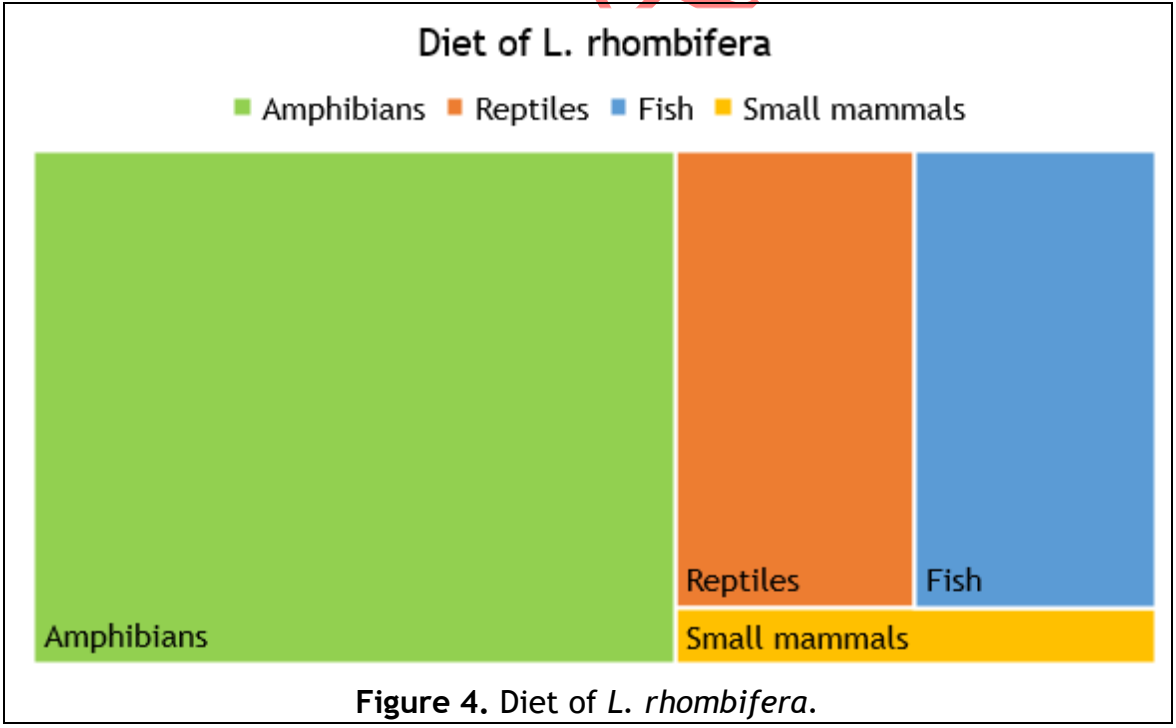

Figure 4. Diet of *L. rhombifera*.

It should be noted that five cases come from experiments, some of which were conducted outside the natural habitat of the species, and four species were documented as cases of scavenging. (figure 4).

Our prey collection for *L. rhombifera* suggests a higher degree of plasticity than previously reported (Espinoza, 2021; Duellman, 1958; Solórzano, 2004; Dougherty & Lisondro, 2023).

Conclusion

We confirm that anurans are the main food item of *L. rhombifera*, but this review suggests that fish and reptiles could be an essential part of its diet. In addition, it is important to mention that the species exhibits some behaviors that are little known or sometimes overlooked, such as ophiophagy (Köhler 2008; Solórzano, 2004) and scavenging (Fuentes & Quiroz-Espinoza, 2024; Knight, 2016).

Finally, we emphasize that due to the frequency and abundance of *R. horribilis*, this species could represent an alternative in the feeding habits of many predators, including snakes of the genus *Leptodeira* (García-Mata *et al.*, 2017; Gámez-Duarte *et al.*, 2024) and other terrestrial snakes. Further focal studies of *Rhinella horribilis* predators and a deeper analysis of their ecological role are needed.

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