

New observations of frog and lizard predation by wandering and orb-weaver spiders in Costa Rica

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Abstract

New observations of frog and lizard predation by wandering and orb-weaver spiders in Costa Rica. Studies have suggested that predation by spiders may be an important force regulating life history in neotropical frogs and lizards, but detailed descriptions of predator-prey relationships are few. Here we describe novel observations where spiders contributed to the mortality of frogs and lizards in northeastern Costa Rica, and we corrected or clarified three identification errors of spiders from the literature. The most frequently observed predators were wandering spiders (Ctenidae), which seem to be generalist predators on frogs and lizards. An orb-weaver spider (Araneidae) also contributed to frog mortality, likely after the frog became entangled in the spider's web. More detailed studies are needed to elucidate the role that spider predation contributes to frog and lizard demography in neotropical forests.

Keywords: Anura, Araneidae, Ctenidae, La Selva Biological Station, Neotropics, predators, prey, Squamata, Tirimbina Biological Reserve.

Resumo

Novas observações de predação de anuros e lagartos por aranhas de teia e de vida livre na Costa Rica. Estudos sugeriram que a predação por aranhas pode ser uma força importante na regulação da história de vida de anuros e lagartos Neotropicais, mas descrições detalhadas das relações predador-presa são escassas. Decrevemos aqui novas observações em que aranhas contribuem para a mortalidade de anuros e lagartos no noreste da Costa Rica e corrigimos ou esclarecemos três erros de identificação de aranhas da literatura. Os predadores mais frequentemente observados foram aranhas-andarilhas (Ctenidae), que parecem ser predadoras generalistas de anuros e lagartos. Uma aranha-de-teia-orbicular (Araneidae) também contribuiu para a mortalidade de anuros, provavelmente depois que o animal ficou preso na teia. Estudos mais detalhados são necessários para elucidar o papel que a predação por aranhas exerce sobre a demografia de anuros e lagartos em florestas Neotropicais.

Palavras-chave: Araneidae, aranhas, Ctenidae, Estación Biológica La Selva, predadores, presa, rãs, Reserva Biológica Tirimbina, Squamata.

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Introduction

In the neotropical forests of Central and South America, a diverse assemblage of organisms preys on amphibians and reptiles (Greene 1988), and predation pressure has been hypothesized to affect the life histories of prey species (e.g., Andrews 1979). A relatively large body of research at La Selva Biological Station in Costa Rica has addressed the factors influencing the population and community ecology of frogs and lizards. Observations reported from La Selva and elsewhere in the Neotropics suggest the potential importance of spider predation in regulating abundances of amphibians and reptiles. In particular, the relatively large spiders of the family Ctenidae [i.e., “wandering” spiders that do not construct webs and have low site fidelity (Foelix 1992, Wise 1993)] may be one of the most frequent predators on small anurans and lizards in neotropical forests (Hayes 1983, Guyer 1988, Donnelly and Guyer 1994).

Wandering spiders are common generalist predators that occupy terrestrial, arboreal, and aquatic environments in Costa Rican rainforests. At Tirimbina Biological Reserve, a lowland site 13 km from La Selva, the wandering spider assemblage contains 10 species of three families (Ctenidae, Trechaleidae, Sparassidae). These spiders are large enough to prey on frogs and lizards and they partition habitat among forest, aquatic (streams, swamps), and canopy habitats (Lapinski and Tschapka 2013, Lapinski and Tschapka in press). Observations of wandering spiders in Costa Rica suggest that the spiders indiscriminately consume anurans and lizards across most taxonomic groups (Table 1); however, poisonous frogs (Dendrobatidae) are rejected upon attack (Szelistowski 1985, Murray *et al.* 2016).

Despite the growing body of records of herpetofaunal predation by ctenids in Costa Rica and elsewhere in the Neotropics (Menin *et al.* 2005, Maffei *et al.* 2010, 2014), the predatory spiders reported usually are either unidentified

and/or poorly described. This led us to record observations of anuran and lizard predation by spiders while studying these taxa at localities in Caribbean forests of Costa Rica between 2008 and 2014 (Lapinski and Tschapka 2013, Folt 2017). Herein, we report eight new records of predator-prey interactions in which araneid and ctenid spiders consumed frogs and lizards, and we discuss relevant natural history details associated with these observations.

Materials and Methods

The primary study site was Tirimbina Biological Reserve (TBR). This private conservation reserve is located near the confluence of the Río Sarapiquí and Río Puerto Viejo (10.41° N, 84.12° W) in an area classified as Holdridge's Tropical Wet Forest life zone (McDade and Hartshorn 1994). We also include observations made nearby at the La Selva Biological Station (LSBS; 10.42° N, 84.02° W) and from two, mid-elevation sites—the Rara Avis Rainforest Reserve (Rara Avis; 10.28° N, 84.05° W) and the Costa Rican Amphibian Research Center's Guayacan Rainforest Reserve (CRARC; 10.05° N, 83.55° W).

To verify that our predation observations were novel, we reviewed the literature by querying: (1) online research databases Google Scholar and the Thomson Reuters Web of Science Core Collection (keywords: “amphibians,” “reptiles,” “Ctenidae,” “predation,” “Costa Rica”); and (2) Thomson Reuters Web of Science Zoological Record (keywords: “new record,” “predation,” “anura,” “Costa Rica”). We then read relevant citations from these searches to determine which predator-prey interactions had been described between ctenids and amphibians and reptiles in Costa Rica (Table 1). Identification of Central American wandering spiders can be difficult (e.g., Ctenidae), because a user-friendly taxonomic key is absent. In three reports, we noted that researchers had: (1) identified spiders only to the family level although identification to lower

Table 1. A review of predation records of amphibians and reptiles by ctenid spiders and tarantulas at La Selva Biological Station and other comparable nearby sites in Costa Rica and Panama. “Ctenid” = unidentified member of the family Ctenidae. Sites abbreviations are LSBS (La Selva Biological Station), TBR (Tirimbina Biological Reserve), Guanacaste NP (Guanacaste National Park). ¹Two predation observations of *Craugastor stejnegerianus* initially identified the predators as *Cupiennius coccineus*. However, we re-examined the photographs and verified those spiders to be *Ctenus curvipes* (females). ²This note did not identify the spider beyond family level; after examining the available materials, it seems most likely to be a *Cupiennius* sp. (juvenile), but we indicate slight uncertainty. ³This observation of a “jumping spider” preying on an adult female *Norops limifrons* was first reported by Losos (2009); we verify the spider’s identity to be the wandering spider *Cupiennius getazi* (female).

Vertebrate species	Spider	Site	Source
ANURA			
Centrolenidae			
<i>Espadarana prosoblepon</i>	<i>Cupiennius</i> sp.	Monteverde	Hayes (1983)
Craugastoridae			
<i>Craugastor</i> sp.	<i>Cupiennius coccineus</i>	LSBS	Szelistowski (1985)
<i>Craugastor bransfordii</i>	<i>Cupiennius coccineus</i>	LSBS	Murray <i>et al.</i> (2016)
<i>Craugastor ranoides</i>	<i>Ancylometes bogotensis</i>	Guanacaste NP	Zumbado-Ulate <i>et al.</i> (2009)
<i>Craugastor stejnegerianus</i>	<i>Ctenus curvipes</i> *	Puntarenas	Ervin <i>et al.</i> (2007)
<i>Pristimantis cerasinus</i>	<i>Nephila clavipes</i>	LSBS	Ganong and Folt (2015)
<i>Pristimantis ridens</i>	<i>Cupiennius</i> sp.**	Monteverde	Jablonski (2015)
Dendrobatidae			
<i>Dendrobates auratus</i>	<i>Sericopelma rubronitens</i>	Taboga Island, Panama	Summers (1999)
Hylidae			
<i>Agalychnis callidryas</i>	<i>Cupiennius coccineus</i>	LSBS	Stynoski <i>et al.</i> (2014)
<i>Dendropsophus ebraccatus</i>	Ctenid	LSBS	Donnelly and Guyer (1994)
<i>Scinax elaeochroa</i>	Ctenid	LSBS	Donnelly and Guyer (1994)
<i>Smilisca sordida</i>	<i>Ancylometes bogotensis</i>	Golfito	Dehling (2007)
<i>Tlalacohyla loquax</i>	Ctenid	LSBS	Ugarte and Briggs (2007)
SQUAMATA			
Dactyloidae			
<i>Norops humilis</i>	Ctenid	LSBS	Guyer (1988)
<i>Norops limifrons</i>	<i>Cupiennius getazi</i> ***	LSBS	Losos (2009)

taxonomic levels was possible (Losos 2009, Jablonski 2015); or (2) identified the spiders to species, but incorrectly (Ervin *et al.* 2007). We emend these identifications in Table 1.

Results

Anura: Centrolenidae.—On 04 November 2011 at 2200 hr, an adult *Teratohyla spinosa*

(Taylor, 1949) (Spiny Cochran Frog) was found trapped in the web of an adult female *Eriophora* sp. (Araneidae) by W. Lapinski at TBR. The dead frog was being consumed by the spider (Figure 1A). The spider's web was about 2 m above the ground near a small forest creek. We presume that the frog somehow became ensnared in the web, where it was eaten by the spider.

On 17 August 2014 at about 1930 hr, an adult male *Teratohyla spinosa* was attacked and killed by a subadult male *Ancylometes bogotensis* (Keyserling, 1877) (Ctenidae; Figure 1B). The glassfrog was calling on leafy vegetation above a small stream at La Selva and was briefly detained as part of an ongoing study of the species' population ecology (B. F., in prep.). After being measured (snout–vent length SVL = 20 mm; mass = 0.5 g), we released the frog from its site of collection; on release, the frog the frog jumped down 135 cm from the leaf to the soil substrate alongside the creek. The *A. bogotensis* was perched amidst the leaf litter adjacent to the stream; the spider quickly seized the frog in its chelicerae and retreated up a nearby stick. After watching the spider for about 2 min, one of us (BF) collected both the spider and the frog for closer examination. The frog had been bitten in the head/left shoulder region, and quickly developed a darkened, hemorrhage-like discoloration (similar to that observed by Hayes 1983). It was dead and seemed to have died relatively quickly after being bitten. Both the spider and frog were preserved and deposited in the Auburn University Museum of Natural History (respectively: AUMS 21170; AUM 43011).

These spiders are the first known predators of *Teratohyla spinosa*. *Ancylometes bogotensis* is semi-aquatic and inhabits riparian zones alongside creeks in forested habitats (Lapinski and Tschapka 2013). The spider may be a frequent predator of *T. spinosa* in small-stream habitats where *T. spinosa* can be a dominant anuran (N. Rivera and B. Folt, in prep.). *Ancylometes bogotensis* has been reported to prey on a number of riparian anurans throughout

the spider's range in Central America and northern South America (e.g., Dehling 2007, Zumbado-Ulate *et al.* 2009), and it probably is a generalist predator that consumes anurans opportunistically.

Anura: Craugastoridae.—On 23 June 2011 at about 2000 hr, W. Lapinski observed an adult female *Cupiennius coccineus* F. O. P.-Cambridge, 1901 (Ctenidae; 1.64 g) with a *Pristimantis ridens* (Cope, 1866) (Rio San Juan Robber Frog; SVL = 23 mm) that it had recently captured at TBR (Figure 2A). The animals were discovered 15.8 m above the ground during an arboreal survey for spiders. When first reported, Lapinski and Tschapka (2013) identified the frog to order; here we verify the frog's specific identity as *P. ridens*. Additionally, on 28 June 2011 at 2316 hr., W. Lapinski found a small *Cupiennius* sp. (13 mm body length) consuming a dead *P. ridens* (Figure 2B) near a small forest creek at TBR. The spider was found perched with its prey in a bush about 1.7 m above the ground. The spider was actively consuming the arms and legs of the frog.

A recent report described predation of *Pristimantis ridens* by a ctenid spider (*Cupiennius* sp.; Ctenidae) in Monteverde, Costa Rica (Jablonski 2015). We add two more observations of predation of *P. ridens* by *Cupiennius* spiders, and verify one of these individuals as *Cupiennius coccineus*. *Pristimantis ridens* is a common terrestrial frog usually found in the leaf litter (Ryan *et al.* 2015), but our observation of an individual in the mid-story/under-canopy at TBR suggests that the frog may also occur in arboreal habitats more than has been previously appreciated.

Anura: Hylidae.—On 17 September 2010, a subadult male *Cupiennius coccineus* was observed with a recently captured adult *Duellmanohyla rufiocularis* (Taylor, 1952) (Rufous-eyed Stream Frog) by W. Lapinski at Rara Avis. The spider and the frog were about 1.2 m above the ground on the trunk of an understory palm, near a small forest creek that flows through the reserve's management facility.



Figure 1. Predation on *Teratohyla spinosa* (A) by *Eriophora* sp. at Tirimbina Biological Reserve and (B) *Ancylometes bogotensis* at La Selva Biological Station, both in Costa Rica.

The animals were first observed at about 1830 hr (Figure 3); when we returned to the location 4.5 hr later, more than one third of the frog had been consumed by the spider. To our knowledge this is the first published observation of predation on *Duellmanohyla rufioculis*.

Anura: Ranidae.—We observed two instances of predation on *Lithobates warszewitschii* (Schmidt, 1857) (Brilliant Forest Frog) by ctenid spiders. The first was 01 July 2008 at 340 hr, when a juvenile *L. warszewitschii* (SVL = 26 mm, 1.19 g) was found dead in the grasp of an adult female *Ctenus curvipes* (Keyserling, 1881) (0.94 g; Figure 4A) along a forest trail at TBR. Initially Lapinski and Tschapka (2013) identified the frog to order; here, we verify the frog to be

L. warszewitschii. The second observation was a juvenile *L. warszewitschii* that had been recently killed by an adult female *Ctenus sinuatipes* F. O. P.-Cambridge, 1897 on 15 July 2011 at 2140 hr (Figure 4B). The animals were found on a forest-edge trail at the CRARC. These are the first reports of the *C. curvipes* and *C. sinuatipes* as predators on *L. warszewitschii*.

Squamata: Dactyloidae.—Predation of anoles by ctenid spiders was observed twice at TBR. On 29 June 2010 at 2000 hr, W. Lapinski observed a hatchling *Norops humilis* Peters, 1863 (SVL = 16 mm, 0.12 g) jump into the leaf litter from a low understory plant; the anole was immediately attacked by a large juvenile female *Ctenus curvipes* (0.15 g). The spider grasped the

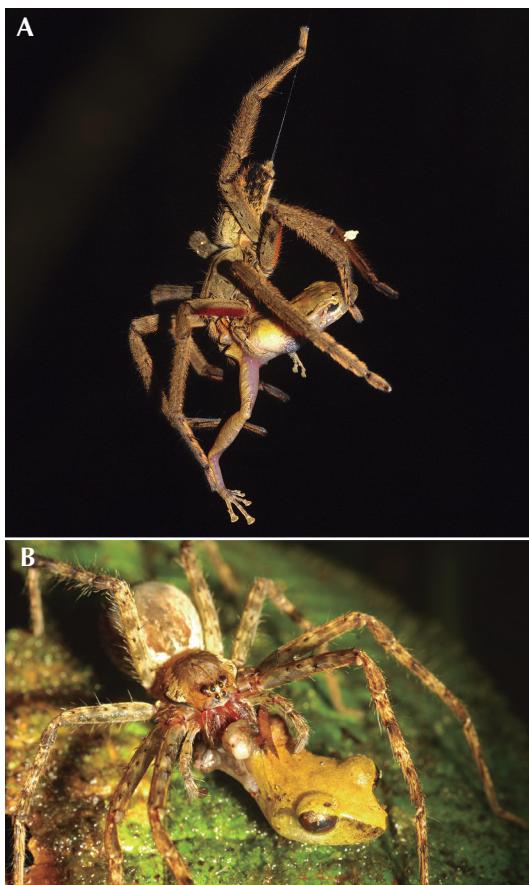


Figure 2. Predation on *Pristimantis ridens* by (A) an adult female *Cupiennius coccineus*, and (B) *Cupiennius* sp. at Tirimbina Biological Reserve, Costa Rica.

anol with its fangs (Figure 5A) and the anole died. Lapinski and Tschapka (2013) first identified the anole to order; here, but it is verified to be *N. humilis*. On 30 October 2011 at 1930 hr, an adult female of a small *Cupiennius* sp. (14 mm body length) was found with a recently captured young female *Norops humilis* (Figure 5B). The animals were perched on a large leaf about 1.5 m above the forest floor. Although predators of *N. humilis* and other anoles in Central America have been reported as



Figure 3. Predation on *Duellmanohyla rufioculis* by a subadult male *Cupiennius coccineus* at Rara Avis Rainforest Reserve, Costa Rica. After 4.5 hr, one third of the frog had been consumed.

ctenid spiders (Guyer 1988, Losos 2009), these are the first two documented records of predation on *N. humilis* by *C. curvipes* and an unidentified *Cupiennius* sp.

Discussion

Ctenid spiders seem to be indiscriminant generalist predators on anurans and lizards, but they have not been observed to consume poison frogs (Dendrobatidae). Nevertheless, we did observe an adult female *Ctenus sinuatipes* attempt to capture an adult *Oophaga pumilio* (Schmidt, 1857) (Strawberry Poison Frog) at TBR (W. L.). After the spider touched the frog



Figure 4. Predation on *Lithobates warszewitschii* by (A) an adult female *Ctenus curvipes* at Tirimbina Biological Reserve, and (B) an adult female *C. sinuatipes* at the Costa Rican Amphibian Research Center.

with its front legs, it immediately rejected the frog, which jumped away unharmed. This field observation is consistent with previous experiments in which *C. coccineus* attacked and then rejected *O. pumilio* (Szelistowski 1985, Stynoski *et al.* 2014, Murray *et al.* 2016). It is likely that the spiders evaluate dendrobatid chemical cues received during contact and deem them unpalatable (Murray *et al.* 2016; but see Summers 1999). Although the most frequent predators are wandering spiders of the family Ctenidae, an orb-weaver spider was observed consuming a frog caught in its web. These

observations suggest that neotropical anurans and lizards are prey to a diverse assemblage of predatory spiders that may have an impact on the population ecology of their prey (Hayes 1983, Guyer 1988)—a supposition that requires more detailed study.

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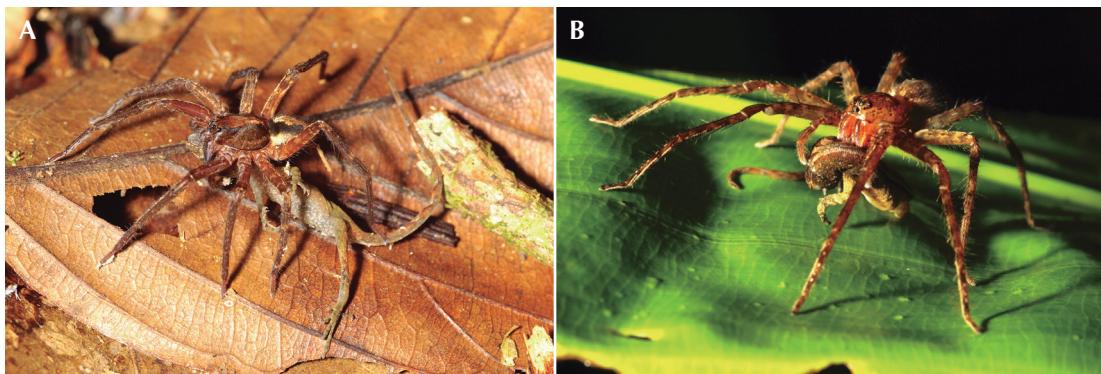


Figure 5. Predation on hatchling *Norops humilis* by (A) a *Ctenus curvipes* (female) and (B) a small *Cupiennius* sp. (female).

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