Herpetology Notes, volume 14: 667-669 (2021) (published online on 18 April 2021)

Wandering spider (*Cupiennius* sp.) predation on the emerald glass frog (*Espadarana prosoblepon*) in a montane rainforest of southwestern Costa Rica

Darko D. Cotoras[1,*] and Johana Goyes Vallejos[2]

Documenting predation events across species' ranges is key for understanding the biogeography of species interactions. This is especially true for species with large distribution ranges as it cannot be assumed that species interact homogenously all across. Spider predation on frogs is still a poorly known interaction (Toledo, 2005). A recent global review reports only 374 known predatory records between 1883 and 2019, encompassing more than 200 frog species from 32 different families being predated by more than 200 spider species from 22 families (Nyffeler and Altig, 2020). However, given the total species diversity on both taxa, frog predation events by spiders remain rarely documented.

The region with the highest numbers of predation records is the Neotropics (Menin et al., 2005; Nyffeler and Altig, 2020). A publication focused exclusively on Costa Rica summarises 12 predation events, in which spiders of the genus *Cupiennius* Simon, 1891 (Family Trechaleidae, formerly Ctenidae) are one of the most common predators (Folt and Lapinski, 2017).

The genus *Cupiennius* has 11 species predominantly of tropical distribution from Mexico to northern South America, including the island of La Española in the Caribbean (World Spider Catalog, 2020). *Cuppiennius* are large-bodied spiders, with some species reaching cephalothorax size bigger than 9 mm (Lachmuch et al., 1984; Medina, 2006). Published records of four species of *Cupiennius* (*C. coccineus* F.O. Pickard-Cambridge, 1901; *C. getazi* Simon, 1891; *C. salei* (Keyserling, 1877); and *Cupiennius* sp.) describe spider predation on five frog species from three families (Centrolenidae, Craugastoridae, and Hylidae) (Folt and Lapinski, 2017; Nyffeler and Altig, 2020). Experimental feeding trials characterise *Cupiennius* as a generalist, with a diet based mostly on arthropods (Nentwig, 1986; Nentwig, 1990).

The family Centrolenidae, commonly known as "glass frogs", encompasses 12 genera, with *Espadarana* consisting of five species. *Espadarana prosoblepon* (Boettger, 1892) has the most extensive geographical range within the genus (Guayasamin et al., 2009; AmphibiaWeb, 2020), found from Honduras to Ecuador, at elevations up to 1900 m (Kubicki, 2007). Like most centrolenids, *E. prosoblepon* is strongly associated with vegetation along the banks of rivers and creeks in lowland and mountainous tropical and urban forests (Savage, 2002; Basto-Riascos et al., 2017a). Adults of the emerald glass frog *Espadarana prosoblepon* have been reported only one time as a prey item for the spider *Cupiennius* in Monteverde, Costa Rica (Hayes, 1983). Also, spiders from the family Anyphaenidae are known to predate on *E. prosoblepon* eggs (Basto-Riascos et al., 2017b).

On 23 June 2018, at 00:52 h, we observed an adult male *Cupiennius* sp. predating on an adult male of *E. prosoblepon* on the underside of a ginger leaf (Alpinieae, Zingiberaceae) on the trail between Culvert creek and the Researcher cabins (Colibrí) at the Estación Biológica Las Cruces (Organization for Tropical Studies) in San Vito de Coto Brus, Costa Rica (8.7833°N, 82.9500°W; 1200 m elevation) (Fig. 1A). The presence of the femoral spine allowed us to identify the frog as a male *E. prosoblepon*. The spider was holding the paralysed frog belly-up by one of its hind legs (Fig. 1B). We could not determine the spider's identity beyond genus, as it was not possible to inspect the pigmentation of the ventral femora or, more importantly, the genitalia. The individuals were not collected.

Our record expands biogeographically the area where

[1] Entomology Department, California Academy of Sciences, 55 Music Concourse Dr., Golden Gate Park, San Francisco, CA 94118, USA.

[2] Division of Biological Sciences, University of Missouri, 105 Tucker Hall, Columbia, MO 65201, USA.

[*] Corresponding author. E-mail: darkocotoras@gmail.com

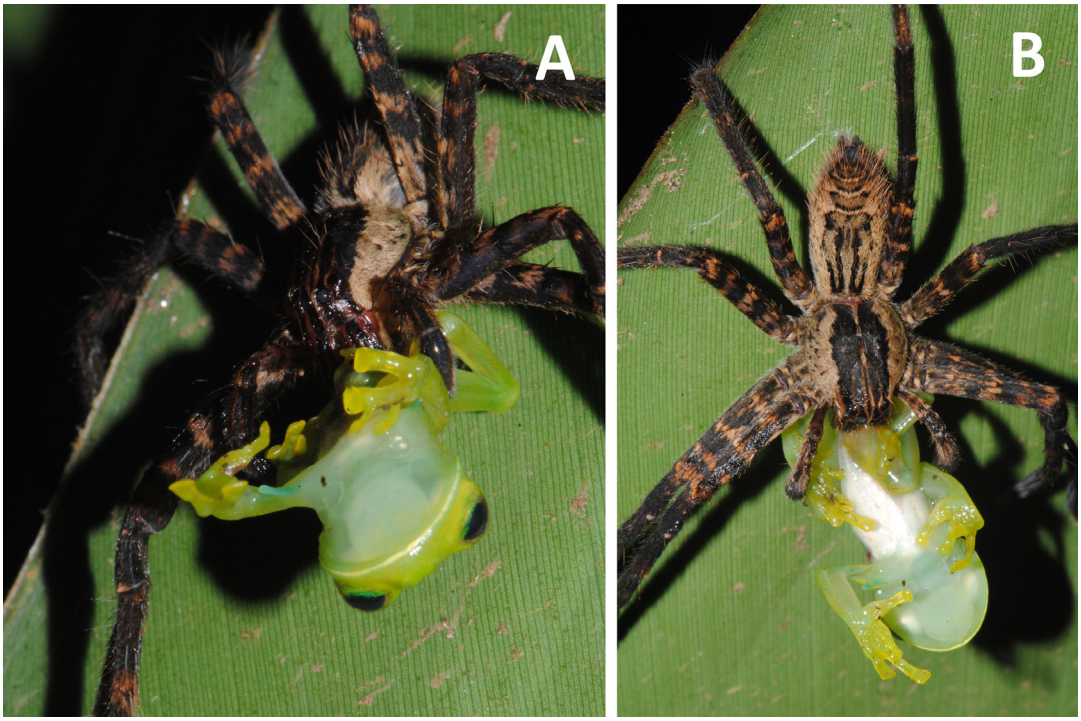

Figure 1. An adult male *Cupiennius* sp. (Trechaleidae) predating on an adult male of *Espadarana prosoblepon* (Centrolenidae): **A.** Frontal view; **B.** Dorsal view. Photographed with a Nikon DSLR D3000 and 85 mm macro lens.

the spider *Cupiennius* sp. predates on *E. prosoblepon*. This observation is congruent with the Monteverde record in terms of the time of the year (end of June), time of observation (mid-night), elevation (1200–1400 m), micro-habitat (near water), prey position (belly-up), and sex of the prey (male) (Hayes, 1983). Hayes (1983) also describes a second potential predation event where a *Cupiennius* spider was found sitting over a partially eaten body of a different species of glass frog (*Hyalinobatrachium fleischmanni* (Boettge 1893), Centrolenidae; sex undetermined) on the upper face of a *Heliconia* L. (Zingiberaceae).

This predatory interaction is also expected to occur at lower elevations because there is documentation of *Cupiennius* species predating on other frogs at sea level (Folt and Lapinski, 2017), and *E. prosoblepon* is present at that elevation.

The recent review on spider-frog predation shows a direct correlation between predator and prey body size (r = 0.729) (Nyffeler and Altig, 2020), a trend previously reported for spiders and frogs from the Neotropics (r = 0.892) (Menin et al., 2005). The average body size of predated frogs was 2.76 cm ± 0.13 cm (Nyffeler and Altig, 2020), which is very close to the measured size of the adult population of *E. prosoblepon* on the study site (2.33 cm ± 1.1 cm, range: 2.12–2.50 cm; Goyes Vallejos, unpublished data).

Male frogs are predated 4.3 times more than females based on global records (Nyffeler and Altig, 2020). Congruently, males are significantly more abundant (10:1, based on 815 sampled individuals) than females in this population (Goyes Vallejos, unpublished data), and therefore, more likely to be predated.

Due to semi-systematic multi-year monitoring of the study site, we argue that the presented interaction is rare. Both authors have worked at Las Cruces Biological Station several times and only observed this one event. In particular, DDC visited the station a total of six times: in November 2014 (10 days), January 2017 (9 days), January 2018 (5 days), June-July 2018 (10 weeks), June-July 2019 (8 weeks), and January 2020 (7 days). During the first visit, he did arachnid surveys every night between 19:00 – 22:00 h, while on the other visits, he surveyed approximately on a third of the days at the site. JGV visited the station three times between 2017–2019. During 2018 and 2019, at the onset of the

breeding season of *E. prosoblepon*, she surveyed the area with two students starting at 18:00 h (5 person-hour/day for ca. 30 days).

In summary, our observation expands the area where the spider *Cupiennius* sp. predates on the emerald glass frog *E. prosoblepon*, from Monteverde (northwestern Costa Rica) down to the mountains in the southwest of the country.

Acknowledgement. We are grateful to Nicolás Hazzi for his confirmation of the spider identification; Rodolfo Quirós Flores and Christine Joelle Pardo for their help on plant identification; Stephanie Clements for her pre-peer review evaluation and anonymous reviewers for constructive comments. The Organization for Tropical Studies provided opportunities for the authors to teach and conduct research at Las Cruces Biological Station. At the time of the observation, DDC was the co-coordinator and JGV was a mentor for the NSF funded Research Experience for Undergraduate students (REU) program for Underrepresented Minorities 2018. DDC supported part of his work with personal funds.

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Accepted by Gonçalo Rosa