Predation by arachnids (Araneae, Scorpiones) on reptiles and amphibians (Anura, Squamata) in Costa Rica and Mexico

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Abstract: Three predation events are described from Costa Rica and Mexico: *Centruroides gracilis* (Latreille, 1804) on *Anolis sagrei* (Dumeril & Bibron, 1837), *Cupiennius coccineus* FO Pickard-Cambridge, 1901 on *Dendropsophus microcephalus* (Cope, 1886), and *Kiekie curvipes* (Keyserling, 1881) on *Anolis osa* Köhler, Dehling & Köhler, 2010. These events constitute the first official records.
Key words: Arachnidae, Buthidae, Ctenidae, Dactyloidae, Trechaleidae, Hylidae, predation, Costa Rica, Mexico.

Depredación por arácnidos (Araneae, Scorpiones) sobre reptiles y anfibios (Anura, Squamata) en Costa Rica y México
Resumen: Se describen de Costa Rica y México tres eventos de depredación que corresponden a *Centruroides gracilis* (Latreille, 1804) sobre *Anolis sagrei* (Dumeril & Bibron, 1837), A *Cupiennius coccineus* FO Pickard-Cambridge, 1901 sobre *Dendropsophus microcephalus* (Cope, 1886) , y A *Kiekie curvipes* (Keyserling, 1881) sobre *Anolis osa* Köhler, Dehling & Köhler, 2010. Estos eventos constituyen los primeros registros oficiales.
Palabras clave: Arachnidae, Buthidae, Ctenidae, Dactyloidae, Trechaleidae, Hylidae, depredación, Costa Rica, México.

There have been multiple reports of cases of predation by different arthropods (Valdez, 2020), among which myriapods, some insects and arachnids stand out (Reyes-Olivares *et al*., 2020; Valdez, 2020). Within the arachnids, the most diverse group is the order Araneae, which is made up of 50, 336 species (World Spider Catalog, 2022). Currently the family Ctenidae Keyserling, 1877, is among the most common to present predation interactions on amphibians and reptiles, with approximately 90 events (Menin *et al*., 2005; Folt & Lapinski, 2017; Babangenge *et al*., 2019; von May *et al*., 2019; Nyffler & Altig, 2020). The most representative genera in which amphibian and reptile predation has been documented are *Ctenus* Walckenaer, 1805, *Phoneutria,* Perty , 1833, *Ancylometes* Bertkau 1880 and *Kiekie* Polotow & Brescovit 2018, which have been found preying mainly on anurans of the families Bufonidae Gray, 1825, Craugastoridae, Duellman & Heinicke, 2008, Hylidae Rafinesque, 1815, Leptodactylidae Werner, 1896 and others (Menin *et al.,* 2005; Amaral *et al.,* 2015; Jablonski , 2015; Folly *et al.,* 2017; Folt & Lapinski, 2017; Bueno-Villafañe *et al.,* 2018; von May *et al.,* 2019; Dos Santos Jr. *et al.,* 2020; Figueiredo *et al.,* 2020; Negreiros *et al.,* 2020; Moura- Filho et al. 2021; Nyffler & Altig, 2020), and lizards of the families Dactyloidae Fitzinger, 1843, Gekkonidae Oppel, 1811, Gymnophthalmidae Merrem, 1820, Leiosauridae Frost, Etheridge, Janies & Titus, 2001, Sphaerodactylidae Underwood, 1954 (Martins *et al.,* 2021; Cavalcant *et al.,* 2020; Gómez-Martínez *et al.,* 2020; Reyes- Olviares *et al.,* 2020; Valenzuela-Rojas *et al*., 2020; von May *et al.,* 2019; de Oliveira *et al.,* 2017; Folt & Lapinski, 2017; Guyer, 1988; Plecker 2020; Massary & Ineich, 1997).

On the other hand, within the family Trechaleidae Simon, 1890, has also evidenced amphibian and reptile predation with a total of 33 reported events (Menin *et al.,* 2005; Folt & Lapinski, 2017; Nyffler & Altig, 2020). Predation on Anurans particularly in the families Centrolenidae, Hylidae and Craugastoridae has been documented primarily in the spider genus *Cupiennius* (Menin *et al.,* 2005; Hernández & Rodríguez-Cabrera, 2014; Folt & Lapinski, 2017; Cotoras & Vallejos, 2021; Premel & Torres, 2021; Cambronero *et al.,* 2022)

Lastly, another of the known orders within the arachnids are the scorpions, including species considered of toxicological-medical importance (Borges *et al.,* 2012, Miranda *et al.,* 2015). Various observations have confirmed that in addition to feeding on arthropods they are capable of preying on amphibians, mammals, and small reptiles (Miranda *et al.*, 2015; Auguste *et al.*, 2019; Espinal *et al.*, 2020). The scorpion family Buthidae CL Koch, 1837 is one of the most representative regarding amphibian and lizard predation (Villanueva-Rivera *et al.,* 1999; Joglar 2005; Teruel, 2005; Teruel & Armas, 2012; Teruel *et al*., 2020; Rodríguez-Cabrera *et al.,* 2020; 2021).

The purpose of this work is to contribute to the natural history of *Kiekie curvipes* (Ctenidae), *Cupiennius coccineus* (Trechaleidae) and *Centruroids gracilis* (Buthidae), reporting three observations of predation on lizards and amphibians.

Material and method

The observations were made in Drake Bay, city of Pérez Zeledón in the province of San José, Costa Rica, and in Pomuch, Campeche, Mexico during the months of June, August, and September 2022, during night tours in search of fauna.

In addition, Facebook groups were consulted for the collection of records of arachnids preying on vertebrates, two of these events are published in the Facebook group Arachnids of Central America.

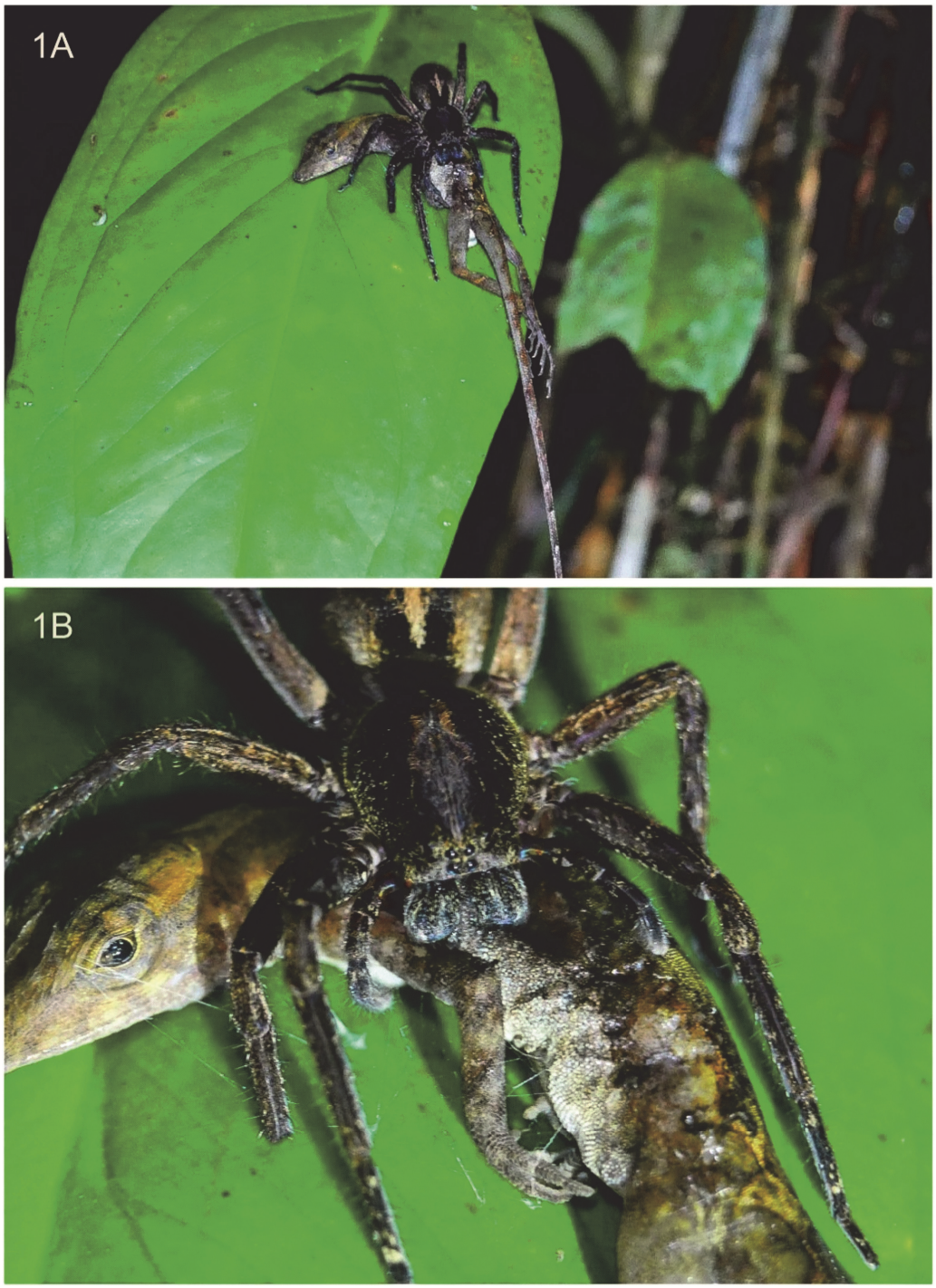
Based on specialized literature, it was confirmed that these records of interactions had not been documented before, so the people responsible for the observation were contacted to gather more information. The specimens were identified through photographs. Photographic records were made with the help of Canon and Nikon cameras equipped with a 100mm macro lens.

Results

We report three new predation events showing spiders and scorpions feeding on amphibians and reptiles. Two of these events correspond to spiders of the Ctenidae and Trechaleidae families preying on anurans and lizards, and the third corresponds to a scorpion of the Buthidae family preying on a lizard. In the field and through photographs we were able to identify three species of arachnids with the help of visible and distinctive characters.

Predation events

The first event took place on August 21, 2022, in Drake Bay, 1.6 km from the coast, Osa Peninsula, Costa Rica (8.675401°N, 83.665174°W). At 22:30 h, during a night walk on a little-used trail in the primary forest near Finca Río Agujitas, the wandering spider *Kiekie curvipes* was observed on a leaf (Araceae) approximately half a meter high, feeding on *Anolis osa* (Fig. 1A). At the moment of



Figs. 1. A. *Kiekie Curvipes* in Bahía Drake, Península de Osa, Costa Rica, while feeding on *Anolis osa*. **B**. Post inmobilization prey wrapping by Kiekie cuervipes on *Anolis osa*.

approaching, we appreciated the size of the lizard, which was larger than that of the spider. We were also able to observe the prey attached to the leaf by silk threads (Fig. 1B), a behavior known as post-immobilization. prey wrapping, something characteristic among the Lycosideos (Rovner & Knost 1974; Hazzi, 2014).

The second event took place on September 8, 2022, near the Tombs of Barú, Pérez Zeledón, province of San José Costa Rica (9.271357°N, 83.781621°W). At 18:50 h, while on a walk, in search of amphibians after a rainy afternoon in a site with dense vegetation at ground level, near the pseudostem of a banana (Musaceae) plant, a *Cupiennius coccineus* was feeding on *Dendropsophus microcephalus* (Fig. 2). The spider was almost twice the size of the frog, which was found immobile and covered by a thin layer of silk threads, which is known as post immobilization. prey wrapping, something very characteristic in Lycosideos (Rovner & Knost 1974; Hazzi, 2014), while attached to the strong chelicerae of the *Cupiennius*.

Finally, the third event took place on June 20, 2022, in Pomuch, Campeche, Mexico (20.136637°N, 90.173935°W). At 22:00 h, after a nocturnal walk, in search of fauna, a *Centruroides gracilis* was found ingesting an *Anolis sagrei.* about the same total length of the arachnid. The scorpion was found motionless on a wooden board in a downward position, firmly holding the lizard with the help of the pedipalps of the anterior region of the body (Fig. 3). Both the posture of the scorpion and the area where the scorpion began to ingest its prey are characteristic details of butids, especially those that belong to the wandering ecomorphotype (Miranda *et al.,* 2015; Teruel, 2020)

Figs.2. *Cupiennius coccineus* feeding on *Dendropsophus microcephalus*, in the Tumbas of Barú, Pérez Zeledón, San José, Costa Rica.



Figs. 3. *Centruroides gracilis* feeding on *Anolis sagrei* in Pomuch, Campeche, México.



Discussion

In Costa Rica there are three records to date of predation by *Kiekie curvipies* to lizards: *Loxopholis southi* (Ruthven & Gaige, 1924) in San José (Plecker, 2020), *Anolis humilis* Peters, 1863, the author only mentions Costa Rica (Reyes-Olivares *et al*., 2020) and *Craugastor stejnegerianus* (Cope, 1893) in Puntarenas (Ervin *et al*., 2007). In this paper we report for the first time *Kiekie curvipes* preying on *Anolis osa,* becoming the fourth known event for Costa Rica. Comparing our results with those reported by other authors, we can mention that until now in Costa Rica, incidents of predation by spiders of the genus *Kiekie* on lizards occur in the families Craugastoridae, Dactyloidae and Gymnophthalmidae.

Regarding the genus *Cupiennius* in Costa Rica, there are approximately seven published events of anuran predation (Folt & Lapinski, 2017; Cotoras & Vallejos 2021; Reyes-Olivares *et al.*, 2020; Vega *et al.*, 2022): *Cupiennius coccineus* preying on *Craugastor* sp (Szelistowski, 1985). *Cupiennius coccineus* preying on *Craugastor bransfordii* Cope, 1886 (Murray *et al.*, 2016). *Cupiennius* sp preying on *Pristimantis ridens* (Cope, 1866) (Jablonski, 2015). *Cupiennius coccineus* preying on *Agalychnis callidryas* (Cope, 1862) (Stynoski *et al.*, 2014). *Cupiennius coccineus* preying on *Duellmanohyla rufioculis* (Taylor, 1952) (Folt & Lapinski, 2017). *Cupiennius* sp preying on *Espadarana prosoblepon* (Boettger, 1892) (Cotoras & Vallejo, 2021). and *Cupiennius coccineus* preying on *Smilisca sordida* Peters, 1863, (Vega *et al.*, 2022). The case that we present here constitutes the first observation of *Cupiennius coccineus* preying on *Dendropsophus microcephalus*, bringing the number of reported events to eight for Costa Rica. Comparing our results with those provided by other authors, we can mention that the main families affected by these spiders in Costa Rica are Craugastoridae and Hylidae (Folt & Lapinski 2017; Cotoras & Vallejos, 2021; Reyes-Olivares *et al*., 2020; Vega *et al*., 2022).

Over the years, most interactions documented between *Centruroides gracilis* and vertebrates have been having the scorpion as prey by other organisms (Teruel, 1997; Armas 2014; Rodríguez-Cabrera *et al.*, 2021), but it has also been documented as a predator of *Anolis porcatus*, (personal observation of Morales see in Armas, 2001; Teruel *et al*., 2020; Rodríguez-Cabrera *et al*., 2021). Therefore, although there are records where other scorpions are found preying on lizards (Armas & Abud, 1992; Armas, 2001; Teruel, 2005; Teruel & Armas, 2012; Teruel *et al.*, 2020), the event we present is the first documented record of predation of *Anolis sagrei* by *Centruroides gracilis* in Mexico and the second documented for a scorpion, since *Anolis sagrei* was previously reported as prey of *Heteroctenus junceus* in Cuba (Teruel *et al.*, 2020; Rodríguez-Cabrera *et al.*, 2021).

These findings of interactions between arachnids, amphibians and lizards usually occur mainly in the Neotropical region. The predation events presented in this work suggest that under certain circumstances arachnids compete intensely with other predators for access to the same resources, where the dominant predator kills and devours the rival, an interaction known as intra-guild predation (Oliveira & Pereira, 2014; Reyes-Olivares *et al.*, 2020; Taucare-Ríos & Luri, 2021).

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