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SHORT COMMUNICATION

Vertebrate-eating jumping spiders (Araneae: Salticidae) revisited: consumption of geckos and bird hatchlings

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Abstract. In this paper, vertebrate predation by jumping spiders (Salticidae) was revisited, taking into account incidents of this kind recently published in the scientific literature or on the internet. Our study revealed that vertebrate predation by salticids is more widespread than previously thought, geographically and taxonomically. Roughly ninety percent of all reported cases refer to predation on anurans (Hylidae and Ranixalidae) and lizards (Dactyloidae and Gekkonidae) by salticids from the subfamily Salticinae (*Hyllus* spp., *Phidippus* spp., and an unidentified species presumably related to *Hasarius* Simon, 1871). In the remaining cases, salticids from the subfamily Salticinae (*Paraphidippus* cf. *aurantius* (Lucas, 1833) and *Phidippus audax* (Hentz, 1845)) were observed attacking bird hatchlings (families Paridae and Trochilidae), weighing ≈4–6 times more than the spiders. In two instances, the spiders were observed biting the hatchlings, but only in one single case, a salticid was seen feeding on a hatchling.

Keywords: Large salticids, predation, Dactyloidae, Gekkonidae, Hylidae, Ranixalidae, bird hatchlings

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Recently, Nyffeler et al. (2017) reported that *Phidippus regius* C. L. Koch, 1846 occasionally captured small hylid frogs and anole lizards in suburban and natural habitats in various parts of Florida, USA. Using the same search method as Nyffeler et al. (2017), new evidence of jumping spider predation on small vertebrates surfaced over the past three years, which we present here.

This includes, among others, four previously unknown accounts of predation on tree frogs (Hylidae) by *Phidippus regius* in Florida (Table 1). Furthermore, an unidentified salticid spider (apparently related to the genus *Hasarius* Simon, 1871) was seen capturing and devouring a frog tadpole on the wet surface of a cliff near Satara, Western Ghats, India (Fig. 1A; Ahmed et al. 2017). The tadpole (an unspecified species in the genus *Indirana*; family Ranixalidae) was about the size of the spider if the tadpole's snout-vent length is compared with the spider's body length and about 4.5 times larger if the spider's body length is compared with the tadpole's total length (Fig. 1A).

Furthermore, evidence of lizard predation by salticids from geographic areas outside the USA is reported here, this time referring to large spiders of the genus *Hyllus* C. L. Koch, 1846. A first incident of this kind was witnessed and photographed in a wildlife conservancy area in Hluhluwe, KwaZulu-Natal, South Africa (Anton Roberts, pers. comm.). In this particular case, a female *Hyllus treleaveni* Peckham & Peckham, 1902, positioned on the ducts of an aquaponics system, fed on a Cape Dwarf Gecko *Lygodactylus capensis* (Fig. 1B). A second incident of gecko predation by a *Hyllus* jumping spider was recorded in the Sungei Buloh Wetland Reserve, Singapore (Nikita Hengbok, pers. comm.). There, a female Heavy Jumping Spider, *Hyllus diardi* (Walckenaer, 1837), was observed feeding on a gecko of the genus *Hemidactylus* (most likely the Common House Gecko *Hemidactylus frenatus*) (Fig. 1C). These large *Hyllus* spp. have a body length of 14–17 mm (Dippenaar-Schoeman 2014; Basumatary et al. 2018). Based on the photos, we estimated that the gecko victims were 1.3–1.8 times larger than their salticid predators if the geckos' snout-vent length is compared with spider body length, and 2.7–4 times larger if the geckos' total length is compared with spider body length. Furthermore, another incident of lizard predation by *Phidippus regius* was photographed at Archbold Biological Station near Lake Placid, Florida (Table 1). Using the process of elimination, William Lamar (pers. comm.) and some other herpetologists assumed the lizard in question may have been a neonate Florida Scrub Lizard (*Sceloporus woodi*; Phrynosomatidae), a species common at Archbold Biological Station; but other herpetologists felt that the ID of this lizard would remain uncertain because of the photo's low resolution.

While monitoring a nest of the Violet-crowned Hummingbird (*Amazilia violiceps*) in a greenhouse in San Juan del Rio, Mexico, from August to October 2010, an incident of jumping spider predation on one of the hatchlings was recorded (Fig. 1D; Domínguez-Laso & Rosas-Espinoza 2017). A jumping spider (*Paraphidippus* cf. *aurantius* (Lucas, 1833)) was found on top of the hatchling biting it several times in the throat area and subsequently biting it in some other body parts. A few minutes later the bird ceased moving. The spider fed on the bird for at least 40 minutes, after which time the observations were discontinued. The spider in question had a body length of approximately 10 mm, while the bird measured ≈40 mm from the tip of the beak to the tip of the tail. Jumping spiders of that size reach a body weight of ≈0.09 g (Carrel 1987), whereas neonate hummingbirds weigh about 5–6 times as much (≈0.5 g; Rahn 1982). When the human observers returned to the scene four hours later, the spider had disappeared leaving behind the hatchling carcass.

In 2017, the nest activity of the Black Capped Chickadee (*Poecile atricapillus*) was monitored and recorded 24/7 during the May-August nesting season by means of "nest cam" video cameras placed inside and outside a nestbox attached to the outside of a residence in Eugene, Oregon (R. Arkin, pers. obs.). The nest contained seven eggs from which five healthy chicks hatched by mid-May. From then onwards, the chicks were fed by the mother bird. During this period, a peculiar incident occurred. In a video recording from 19 May, an adult female jumping spider *Phidippus audax* (Hentz, 1845) could be seen entering the nestbox. After briefly following an insect, the intruder noticed and approached the chicks and rapidly inflicted one

Table 1.—Eighteen incidents of vertebrate predation and one vertebrate predation attempt. P = Predation; A = Attempt (spider bit a hatchling bird; consumption prevented by intervention by the mother bird).

Spider species	Prey species	Prey family	Type of incident	Number of incidents	Geographic region	Source
Hyllus diardi	*Hemidactylus (frenatus ?)*	Gekkonidae	P	1	Singapore	Nikita Hengbok [A]
Hyllus treleaveni	*Lygodactylus capensis*	Gekkonidae	P	1	South Africa	Maritz & Maritz 2020
Paraphidippus cf. *aurantius*	*Amazilia violiceps*	Trochilidae	P	1	Mexico	Domínguez-Laso & Rosas-Espinoza 2017
Phidippus audax	*Poecile atricapillus*	Paridae	A	1	USA, Oregon	R. Arkin, pers. obs.
Phidippus bidentatus	*Anolis sp.*	Dactyloidae	P	1	Costa Rica	Nyffeler et al. 2017
Phidippus regius	*Dryophytes femoralis*	Hylidae	P	1	USA, Florida	Nyffeler et al. 2017
	Dryophytes squirellus	Hylidae	P	1+3	USA, Florida	Nyffeler et al. 2017; Internet sources [B,C,D]
	N/A	Hylidae	P	1+1	USA, Florida	Nyffeler et al. 2017; Internet source [E]
	Osteopilus septentrionalis	Hylidae	P	3	USA, Florida	Nyffeler et al. 2017
	Anolis carolinensis	Dactyloidae	P	1	USA, Florida	Nyffeler et al. 2017
	Anolis sagrei	Dactyloidae	P	1	USA, Florida	Nyffeler et al. 2017
	N/A *(Sceloporus woodi* ?)	N/A (Phrynosomatidae ?)	P	1	USA, Florida	Internet source [F]
Unknown salticid species (apparently related to *Hasarius* spp.)	*Indirana* sp. tadpole	Ranixalidae	P	1	India	Ahmed et al. 2017
Total	—	—	—	19	—	—

[A] Nikita Hengbok – *Hyllus diardi* preying on a *Hemidactylus* (*frenatus ?*) in Singapore - Online at: http://ihengbok.blogspot.com/2011/05/my-adventures-in-sungei-buloh-wetland.html Accessed 11 September 2020

[B] George Grall – Alamy images. A female regal jumping spider, *Phidippus regius*, preying on a squirrel tree frog, *Hyla squirrella*. - Image ID: JDMBE2 Online at: https://www.alamy.com/stock-photo-a-female-regal-jumping-spider-phiddipus-regius-preying-on-a-squirrel-146121530.html Accessed 11 September 2020 / No longer accessible on 7 January 2021

[C] Ellen Humble – Female *Phidippus regius* eating a frog (*Dryophytes squirellus*?) in Alachua County, Florida. Online at: https://www.youtube.com/watch?v=vIG-mdh8zP0 Accessed 11 September 2020

[D] Male *Phidippus regius* eating a frog (*Dryophytes squirellus*?) in a saw palmetto, Hillsborough River State Park, Florida. Online at: https://www.youtube.com/watch?v=Z63kBmDRTGk Accessed 11 September 2020

[E] *Phidippus regius* eating a hylid frog in Florida. Online at: http://snap361.net/ig-post/1875148836249088810_197468702 No longer accessible on 11 September 2020

[F] *Phidippus regius* eating a lizard http://snap361.com/ig-tag/archboldbiologicalstation/ No longer accessible on 23 October 2020

with a presumably venomous bite (Fig. 2; see video online at: https://doi.org/10.6084/m9.figshare.13585169). Only a short time later, the mother bird returned and removed the intruder from the nestbox (transporting it in its beak, as it seems without harming the spider). The following day, one of the chicks was found dead while the other four chicks were still alive. We assume that the chick died as a result of the presumably venomous bite inflicted by the spider. The spider in question had an estimated body length of ≈13.5 mm whereas the dead hatchling had a length of 34 mm (from head to bottom not including legs; R. Arkin, pers. obs.). Adult *P. audax* females reach a body weight of ≈0.15–0.34 g (Carrel 1987; Anderson 1996), and a neonate chickadee, on the other hand, may weight about 4 times as much (≈0.85 g; Wetherbee 1961). Although this incident does not qualify as actual predation event (because the spider was prevented from eating the chick), the spider attacking and biting a hatchling may be considered a possible predation attempt.

How common are incidents of spider predation on bird hatchlings? In the past, multiple video recording studies on predation at nests of small passerine and other small birds were conducted over time periods of tens of thousands of hours with the purpose of identifying the predators of hatchlings, but in none of these other video recordings were attacks of jumping spiders or other spiders on bird hatchlings witnessed (e.g., Thompson & Burhans 2003; Stake et al. 2004; Benson & Cartier 2010). One major reason for the near-absence of spider attacks on hatchlings seems to be the fact that the nests usually are well protected by the parent birds. Nevertheless, there are a few anecdotal reports of predation on bird hatchlings by mygalomorph spiders (Pocock 1899; Gudger 1925; McKeown 1952; Wehtje 2007). In the vast majority of cases where bird predation by spiders was reported, this referred to situations in which volant birds got entangled in the large, strong orb-webs (≈0.5–1.5 m in diameter) of large araneid and nephilid orb-weaving spiders (Brooks 2012; Walther 2016; Smith et al. 2020).

Our study revealed that vertebrate predation by salticids is more widespread than previously thought, geographically and taxonomically. Nevertheless, two-thirds of all cases of vertebrate predation (or predation attempts) reported so far have been attributable to *Phidippus regius* in Florida, USA (Table 1). With a body length of ≤2.2 cm, this species is one of the world's largest salticids (weighing 0.5–1 g; Anderson 1996; Nyffeler et al. 2017), and among the >6,200 described salticid species, *P. regius* appears to be uniquely successful in supplementing its arthropod diet by occasionally capturing small anurans and lizards. The question arises whether large salticids have some unique venom properties that allow for these types of oversized prey to be taken, as is the case in the black widow spiders (*Latrodectus* spp., Theridiidae) equipped with a neurotoxin (α-latrotoxin) specifically targeting the vertebrate nervous system (see Escoubas et al. 2000). Unfortunately, salticid spider venoms are still largely unexplored (Jessica Garb, pers. comm.; Escoubas et al. 2000; Kuhn-Nentwig et al. 2011), so this question cannot be answered with certainty. Nevertheless, the fact that the majority of the paralytic activity observed/studied so far in spiders is due to the action of peptides makes it highly likely that this is true in salticids as well (Pierre Escoubas, pers. comm.). Furthermore, it is known that salticids have fast-acting venoms (Grothaus 1967; Domínguez-Laso & Rosas-Espinoza 2017). It can therefore be hypothesized that salticids

Figure 1.—A. Unidentified salticid spider (apparently related to the genus *Hasarius* Simon, 1871) was seen capturing and devouring a frog tadpole (*Indirana* sp., Ranixalidae) on the wet surface of a cliff near Satara, Western Ghats, India (photo by Sagar Satpute). B. Female *Hyllus treleaveni* feeding on a gecko (*Lygodactylus capensis*) in South Africa (photo by Anton Roberts). C. Female *Hyllus diardi* feeding on a gecko (*Hemidactylus (frenatus*?)) in Singapore (photo by Nikita Hengbok). D. Jumping spider (*Paraphidippus* cf. *aurantius*) is sucking out a Violet-crowned Hummingbird hatchling (*Amazilia violiceps*) in a greenhouse in San Juan del Rio, Mexico (Photo by Matias Dominguez-Laso).

may use fast-acting peptides targeting the prey's central and/or peripheral nervous system as one of the components of their prey capture strategy (Pierre Escoubas, pers. comm.). The amount of venom for prey capture (i.e., the amount per bite) is likely to be related to the size of the salticid predator, which might explain why only large salticids are effective in capturing vertebrate prey.

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Figure 2.—Adult female *Phidippus audax* jumping spider had entered a nestbox and was approaching a nest of *Poecile atricapillus* (Paridae) containing five hatchlings. After briefly following an insect, the intruder noticed and approached the chicks and rapidly inflicted one with a presumably venomous bite. A short time later, the mother bird returned and removed the spider from the nestbox. The following day, one of the chicks was found dead and we assume that the chick may have died as a result of the spider bite (Photo by Raymond Arkin).

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