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Observations on arthropod predation of uropeltid snakes (Squamata: Uropeltidae) from the Western Ghats, India

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The family Uropeltidae constitute a group of 65 species of poorly-known, small-sized snakes (usually <60 cm in total length), mostly restricted to the wet forests of peninsular India and Sri Lanka (Pyron et al. 2016; Uetz et al. 2023). Currently, the family has seven genera, all of which occur in India (Cyriac and Kodandaramaiah 2017; Sampaio et al. 2023). All members of the family are fossorial and have small, highly ossified, generally pointed heads and elongated bodies that allow them to burrow into the soil (Cyriac and Kodandaramaiah 2021). Many species also have a highly modified tail that terminates in a bony structure covered by one or more highly keratinised scales (Huntley et al. 2021). Owing to their secretive habits, these snakes are rarely encountered and very little is known

about their ecology, behaviour, natural history and predator-prey interactions.

Although these snakes spend most of their time underground, they occasionally emerge to the surface and get predated upon by above-ground predators (Rajendran 1985; Cyriac and Kodandaramaiah 2019). Most observations of predation events on uropeltid snakes indicate that birds, such as jungle fowls, domestic chickens, peafowls, house crows, and thrushes are the main predators of these snakes (Rajendran 1985; Kumara and Chaitra 2001; Chandramouli and Ganesh 2010). Studies have suggested that the short, rounded, highly keratinized shielded tail in many uropeltid snakes mimic the snake's head (cephalic mimicry) and diverts the attacks of avian predators towards the highly protected tail (Gans 1986; Cyriac and Kodandaramaiah 2019). Experiments have also suggested that the conspicuous colourations in many uropeltid snakes function as warning signals advertising their long handling times associated with diverted attacks towards the tail, reducing avian predation rates (Cyriac and Kodandaramaiah 2019). However, little information is available on other non-avian predators of uropeltid snakes, and how these snakes respond to such predation events.

Apart from birds, mammals and snakes are reported to feed on uropeltid snakes. Rajendran (1985) reported that Wild Boars (*Sus cristatus*) and mongooses (*Urva* spp.) may feed on uropeltid snakes. Remains of a *Uropeltis* sp. was also recorded from the scat of an Asiatic Wild Dog (*Cuon alpinus*) (Krishnakumar et al. 2019). Uropeltids have also been found in the diet of a few snakes such as the Ceylon Krait, *Bungarus ceylonicus*, Spectacled Cobra, *Naja Naja*, Striped Coral Snake, *Calliophis nigrescens* and Vine snakes, *Ahaetulla* sp. (Slowinski 1994; Mukherjee and Bhupathy 2004; Lobo 2006; Datanwala and Durso 2020; Kalki and Weiss 2020). Apart from these records, there are no other observations on uropeltid predators. Here, we report multiple instances of predation by two species of ants and one observation of predation by centipede on three species of uropeltid snakes.

Ant predation on uropeltid snakes. On 11th September 2019, DK observed a swarm of Procession Ants (*Leptogenys* sp.) attacking a live

adult *Rhinophis* cf. *sanguineus* at ca.16:22 hrs on a paved porch of a house near Huttinagadde (13°20'02.7"N, 75°23'10.9"E), Basarikatte, Koppa, Chikkamagaluru district of Karnataka. The observation was made a day after it had rained heavily and the weather was cloudy. The snake was identified as a *Rhinophis* cf. *sanguineus* based on its pointed head with a long rostral scale dividing the nasal scales and by its distinctive dome-like tail shield (Pyron et al. 2016). The snake had no apparent external inju-

ries and was seen struggling to move away from the ants. It took about six hours for the ants to finish consuming most of the snake except for the posterior end of the snake. Upon checking the next day around 13:00 hrs, only a small part of the tail was left, leaving just the cranium and the vertebrae visible.

Two more instances of ants feeding on dead adult *Rhinophis* cf. *sanguineus* were observed on 19th October 2020 around 17:47 hrs close to the same location as the first observation. Both



Figure 1. Ant predation on uropeltid snakes near Basarikatte, Koppa, Chikkamagaluru district of Karnataka. **A** – A swarm of Procession Ants attacking a live *Rhinophis* cf. *sanguineus*; **B** – Close up of the Procession Ants (*Leptogenys* sp.) attacking the snake; **C** – A swarm of Short-legged Hunchbacked Ants (*Myrmicaria brunnea*) consuming *Rhinophis* cf. *sanguineus*; **D** – Close up of Short-legged Hunchbacked Ants (*Myrmicaria brunnea*) feeding on the snake; **E** – Vertebrae of *Rhinophis* cf. *sanguineus* after completely consuming the snake; **F** – A swarm of Short-legged Hunchbacked Ants (*Myrmicaria brunnea*) consuming a *Uropeltis* sp. **G** – A swarm of Short-legged Hunchbacked Ants (*Myrmicaria brunnea*) consuming a *Rhinophis* cf. *sanguineus*. (Photographs by Deepika N. Karanth).

the snakes were dead and were seen about 20 m from each other and were being consumed by a swarm of Short-legged Hunchbacked Ants (*Myrmecaria brunnea*). Upon checking the next day around 09:00 hrs, the ants were feeding on

the tail of one of the shield tails and had some parts of the bones left behind.

A similar observation of Short-legged Hunchbacked Ants (*Myrmecaria brunnea*) feeding on a dead adult *Uropeltis* sp. was made on 4th July

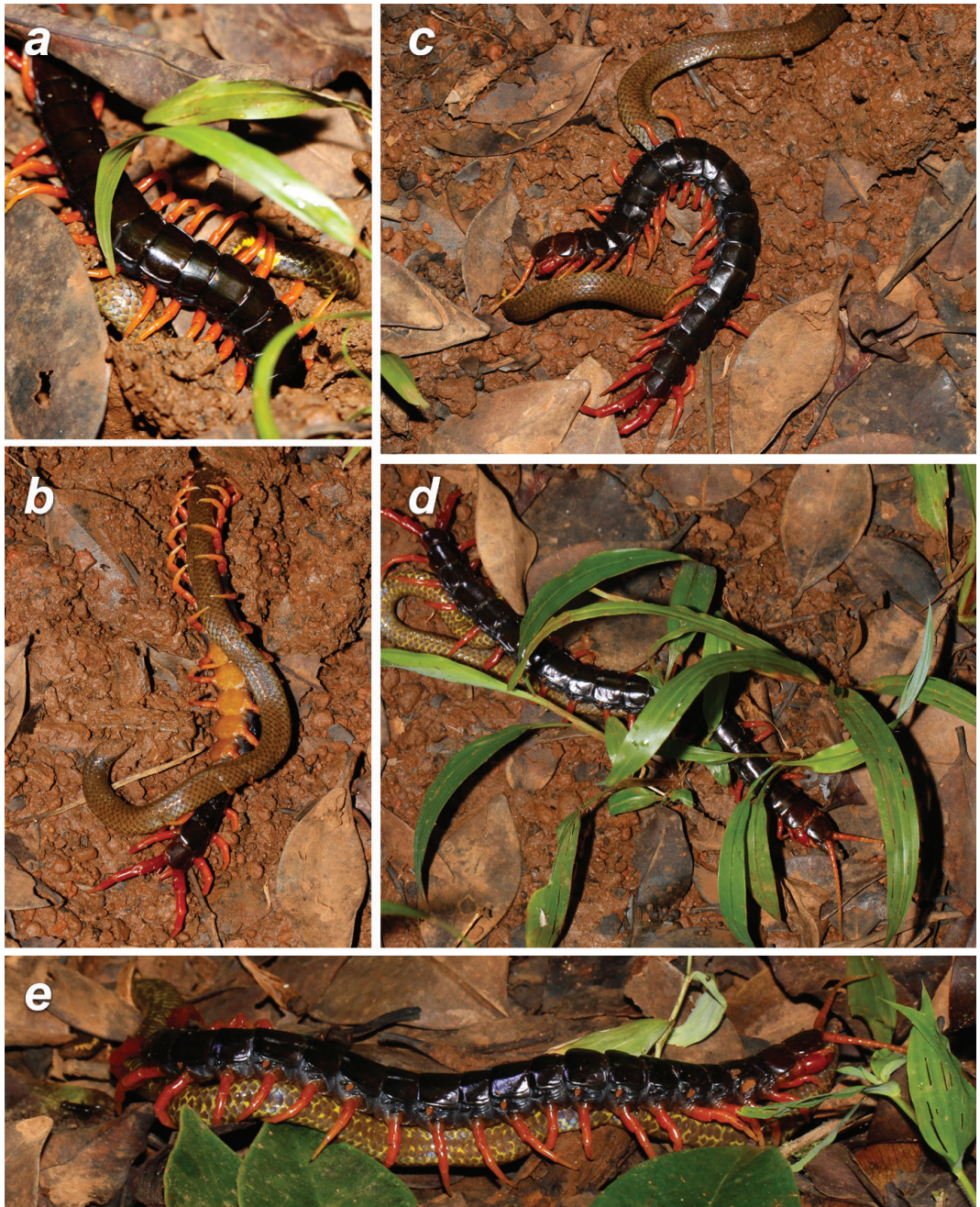


Figure 2. Centipede predation on *Uropeltis* cf. *phipsonii* from Amboli, Maharashtra. **A** – A centipede (*Rhysida* sp.) attacking a *Uropeltis* cf. *phipsonii* inside a burrow; **B** – The centipede clasp the anterior portion of the snake with its legs and pulling the snake out of its burrow; **C** – The centipede repositioning itself before pulling the snake out of the burrow; **D** – The centipede grabbing the snakes head by its forcipules; **E** – The centipede dragging the subdued snake away. (Photographs by Mahadev Suresh Bhise).

2021 around 14:58 hrs, a day after heavy rains near Huttinagadde (13°20'02.7" N, 75°23'10.9" E), Basarikatte, Koppa, Chikkamagaluru district of Karnataka. The snake was identified as *Uropeltis* sp. of the *ceylanica* group based on its size, robust body morphology, overall colouration (dorsally uniform brownish black with a blotched yellow pattern ventrally) and its distinctive, sharply truncated, flattened tail shield with rugose multicarinate scales (Pyron et al. 2016). The snake was found dead lying upside down near a small pond with portions of flesh eaten by the ants. There were no other visible injuries on the snake to the effect that the snake was killed by some other predator.

Two more instances of Short-legged Hunchbacked Ants (*Myrmecaria brunnea*) feeding on dead adult *Rhinophis* cf. *sanguineus* were documented on 18th October 2021 around 17:27 hrs close to the same location as all other observations. Both the individuals were found dead lying upside down in coils on the open ground ca. 5 m from each other. The first snake was already partially eaten with portions of the vertebrae visible on the anterior half of the snake. The second snake appeared to be freshly killed with only small portions of the flesh exposed by the ants.

Centipede predation on *Uropeltis* cf. *hipsonii*.

Another observation of active predation was observed on a live *Uropeltis* cf. *hipsonii* by a centipede (*Rhysida* sp.) on 8th September 2018 at around 20:35 hrs near Amboli Botanical Garden (15°57'34" N, 73°59'57" E), Maharashtra, India. About an hour and a half after heavy rains, MKB found a centipede with its anterior half of the body inside loose wet soil and small coils and the tail end of a snake visible above the ground. The snake was identified as *Uropeltis* cf. *hipsonii* based on its size, overall colourations (dorsally uniform brown with irregularly broken crossbands of yellow dots ventrally) and distinctive, dorsally truncated, flattened tail shield with rugose multicarinate scales (Pyron et al. 2016). As the centipede pushed further into the burrow, the snake could be seen wiggling backwards out of the burrow. After about 27 minutes, the centipede clasped the anterior portion of the snake with its legs and began pulling the snake out of its burrow. At about 21:06 hrs; when the snake was almost out with just the anterior-most

portion of the body in the burrow, the centipede let go of the snake, repositioned itself, and again crawled into the burrow and grabbed the snake by its forcipules and pulled the snake completely out of the burrow. The centipede was estimated to be about 100 mm long and was about 20 mm shorter than the snake. The snake was struggling initially but was eventually rendered motionless. After about five minutes, the centipede carried the snake away clasping it with its forcipules. The observation lasted about 36 minutes and the centipede disappeared into the undergrowth along with the snake.

Studies on prey-predator interactions in uropeltid snakes have considered birds as their primary predators (Gans 1986; Cyriac and Kodandaramaiah 2019). These studies suggest that the tail display (cephalic mimicry) and bright colourations in uropeltid snakes are part of an elaborate antipredatory strategy that reduce avian predation (Cyriac and Kodandaramaiah 2019). However, how these snakes respond to non-avian predators remain unknown, mostly because of the lack of information on other predators. Our note throws some light on the arthropod predators of these poorly-known fossorial snakes and also suggest that arthropods may be regularly preying on uropeltid snakes. Although five of our observations were on Short-legged Hunchbacked Ants (*Myrmecaria brunnea*) feeding on already dead uropeltid snakes, in at least two instances, the snake appeared to have been freshly killed with no obvious external injuries, suggesting that these observations were predation (rather than scavenging) events. Further, these ants have been classified as generalist omnivores (Baidya and Bagchi 2021), and have been observed actively feeding on live earthworms and other larger vertebrates (Pronoy Baidya pers. comm.).

Studies have indicated that birds and squamates are the primary predators of herpetofauna (Jaksić et al. 1983; Schalk and Cove 2018; Valdez 2020). However, recent reviews have also started to recognise arthropods as important predators of amphibians and reptiles (Toledo 2005; Valdez 2020). Among arthropods, spiders, scorpions and beetles have been found to be the main predators of squamate reptiles (O'Shea and Kelly 2017; Valdez 2020), while comparatively fewer reports exist on other

groups of arthropods (von May et al. 2019; Valdez 2020). Ants being social hunters are known to attack larger prey, including snakes (Sazima 2015), and can have a significant impact on reptile populations. For instance, the presence of the red imported fire ants (*Solenopsis invicta*) has been associated with the decline in some ground-dwelling snake species (Tuberville et al. 2000). There are also several reports of centipedes preying on snakes (Arsovski et al. 2014; Chiacchio et al. 2017; von May et al. 2019; Vazifdar et al. 2021; Pwa et al. 2023), so much so that some centipede-eating snakes have specialised behaviours and skull morphologies that have evolved to protect them from retaliatory bites (Gripshover et al. 2023). Here, we add to these observations by reporting a total of seven observations of potential predation on fossorial uropeltid snakes by two species of ants and one species of centipede. However, further studies and experiments are required to understand the propensity of arthropod predation on uropeltid snakes and how these snakes respond to such predation attempts.

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**A regurgitation event in Indian Ratsnake
Ptyas mucosa (LINNAEUS, 1758)
provides insights into its diet**

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The prey-predator relationship is a key component that explains the trophic ecology of an environment (Dorresteijn et al. 2015). Functionally, the mechanised prey-predator dynamics conceptualise the trophic cascade, which determines changes in prey abundance and behaviour (Silliman and Angelini 2012). The predatory dichotomy that includes active and ambush predators differ in foraging mode, which intertwines with morphological and behavioural traits through the adaptive syndrome hypothesis (Eckhardt 1979; McLaughlin 1989). The adaptive syndrome can enhance behavioural syndrome, which explains how behaviour changes in different foraging scenarios (Sih et al. 2004). The community profile is the size profile of prey species, and the food profile is the ingested species from the community profile,

which is mediated through the prey-predatory dynamics (Griffiths 1975). The optimal foraging theory involves animals balancing energy expenditure with each predation event's success to avoid starvation. This relates to trade-offs in foraging ecology (Higginson and Ruxton 2015). The foraging pattern of predators can also switch depending on prey availability, abundance, and how widely the area is occupied by the prey species (Hirvonen 1999; Higginson and Ruxton 2015). Predators may choose their prey based on factors such as size and predation cost. Among active foragers, there is likely to be higher energy expenditure compared to ambush foragers (Downes 2002; Higginson and Ruxton 2015). This note reports an observation of the stomach contents in the active foraging Indian rat snake (*Ptyas mucosa*). The Indian rat snake is a common, widespread, non-venomous snake found across India in different habitats such as xeric regions, mesic habitats, coastal lines, open fields, deciduous forests, evergreen forests, scrub jungles, and agricultural lands (Whitaker and Captain 2004; Parmar and Tank 2019; Biodiversity portal 2023). The diet of *P. mucosa* varies with age and habitat. Juveniles primarily feed on insects, reptiles, and frogs but shift to consuming mammals, birds, fishes, amphibians, snakes, and other reptiles as they grow (Parmar and Patel 2022).

On 4th October 2018 at 17.00 h, we got a rescue call about a snake's presence inside a house near Thiyagarajar School of Management on Avaniyapuram road, Thirupparankundram, Madurai, Tamil Nadu (9.8796°N; 78.0863°E). We rushed to the spot and found an Indian Rat snake (*Ptyas mucosa*) approximately 7 feet in size hanging on the window. We gently rescued it from the house and brought it outside (Figure 1). Instantly, the snake started regurgitating a variety of prey items, including a marbled balloon frog (*Uperodon systoma*). This individual had an olive-yellowish dorsum with a marbled design and a smaller head with a blunt snout. We also spotted an unidentified rodent and a juvenile three-striped palm squirrel (*Funambulus palmarum*) with three stripes on its dorsum. Additionally, we found two bird eggs — one was broken with a partially grown juvenile bird inside. Later identification revealed that the eggs belonged to a white-breasted water hen (*Amau-*