

SHORT COMMUNICATION

A failed predation attempt by *Chrysopelea paradisi* (Serpentes: Colubridae) on *Hemidactylus frenatus* (Squamata: Gekkonidae) in Borneo, Malaysia

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Predation is fundamental to the lives of animals because it influences key aspects of fitness such as feeding, breeding, and ultimately, mortality (Humphreys and Ruxton 2018). Animals that are preyed upon develop a broad range of defense strategies, one of which is tonic immobility exhibited late in the sequence of a predation event (Humphreys and Ruxton 2018). This strategy has been called thanatosis in the literature and is described as a behavior where the animal is observed feigning death. This behavior is present in several taxonomic groups, including reptiles (Honma *et al.* 2006, Caro 2014). Humphreys and Ruxton (2018) suggested that a better description of this behavior would be tonic immobility (TI), by not assuming a predatory response or underlying mechanisms

leading to a predatory response. We agree with the authors, and herein will refer to TI to describe our observations. This behavior is effective against predators that need movement as a cue for further handling of their prey (Toledo *et al.* 2011).

TI is a defensive mechanism considered the last option after the physical contact between the predator and its prey (Humphreys and Ruxton 2018). It has been described in a wide range of taxa, although often anecdotally (Humphreys and Ruxton 2018). It is widespread among vertebrates, observed in mammals, birds, reptiles, amphibians, and fish (Caro 2014, Humphreys and Ruxton 2018). Among lizards, TI has been described for Crotaphytidae (Gluesing 1983), Dibamidae (Torres-Cervantes *et al.* 2004), Gymnophthalmidae (Muscat *et al.* 2016, Machado-Filho *et al.* 2018), Liolaemidae (Rocha 1993, Santos *et al.* 2010), Scincidae (Langkilde *et al.* 2003, Patel *et al.* 2016), Tropicuridae (Galdino and Pereira 2002, Gomes *et al.* 2004,

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Kohlsdorf *et al.* 2004, Bertoluci *et al.* 2006) and Gekkonidae (Parmar 2020, Costa-Anaissi *et al.* 2020). The exhibition of TI, however, may vary among lizards, depending on age, sex, reproductive period, anatomical structures, and other features (Segovia *et al.* 2019).

Reptiles are highly diversified in Borneo, Malaysia, including several species that are widespread throughout southeastern Asia and others that are endemic (Das 2010). The Paradise Flying Snake (*Chrysopelea paradisi* Boie, 1827) and the Spiny-tailed House Gecko (*Hemidactylus frenatus* Duméril and Bibron, 1836) are examples of the first group. *Hemidactylus frenatus* occurs in southeastern Asia and has been introduced to several islands, as well as to Australia, America, and Africa (Das 2010). It is the planet's most widespread lizard, having been spread around the world following human activity (Cornelis *et al.* 2018). This small gecko measures about 67 mm SVL. It has a grayish-brown or dusky brown dorsum, sometimes with darker markings, and a uniformly cream or light beige venter (Das 2010). *Hemidactylus frenatus* is nocturnal (Daniel 2002, Parves and Alam 2015) or, at least, predominantly nocturnal (Neogi and Islam 2017). They generally hide during the day (Parmar and Tank 2019), but some diurnal activity has been observed, including basking and foraging (Nordberg 2019). This diurnal activity explains why *H. frenatus* is preyed upon by several diurnal species, including birds (e.g. Rojas-González and Wakida-Kusunoki 2012, Yannarella and Abarca 2017, Puri and Joshi 2021) and primates (e.g. Mata-Silva *et al.* 2013). *Hemidactylus frenatus* may occur naturally in forested areas, but it is usually associated with human habitations (Parmar and Tank 2019). It is often found inside buildings feeding on insects (Neogi and Islam 2017).

Chrysopelea paradisi is a slender, colorful arboreal colubrid snake, common from lowlands to 1500 m in elevation (Das 2010). The species occurs in Southeastern Asia, including Borneo (Das 2010). This diurnal snake is found in primary and secondary forests, tree-shaded

gardens, and old wooden houses (Mažát *et al.* 2016). One unique feature of *C. paradisi*, shared with other species in the genus, is that it is able to glide, moving up to 100 m through the air (Socha 2002, Das 2010, Holden *et al.* 2014).

The diet of this snake consists of lizards, amphibians, small birds, small bats, and small invertebrates (Malkmus *et al.* 2002, Baker and Lim 2012, Chan and D'Rozario 2013, Goh 2019, Maglangit *et al.* 2021), but mainly geckos (Das 2010), including *H. frenatus* (Morgany 2018, Tan and Chapman 2019). In this note, we report a failed predation event by an individual of *C. paradisi* on *H. frenatus* and give some possible explanations for the lizard's escape.

On 26 October 2011 at 14:35 h we observed a *Chrysopelea paradisi* that captured a *Hemidactylus frenatus* (Figure 1). The observation was made approximately 50 m from the headquarters area of Bako National Park in Sarawak, Borneo, Malaysia (01°42'56" N, 110°26'36" E, 11 m a.s.l.). The snake (about 60 cm long) bit the gecko and threw two coils of its body around the anterior torso of the lizard. The snake remained almost stationary, apparently constricting the gecko, for about 2–3 min. Movements of the gecko became erratic and less frequent until they ceased. The snake released the coils, changed position, and moved to the gecko's head to begin consuming it headfirst. At that time the gecko was not struggling and looked dead, but some seconds after the gecko was freed from the coils, it fled. After that, the snake climbed a nearby wooden pole and left (Figure 2A). The gecko ran to the grass and climbed onto a wooden structure where it perched for several minutes near a hole (Figure 2B). The snake did not follow it. We watched the gecko for more than 10 min until it moved higher up where we could no longer see it. Although this snake is believed to be mildly venomous (Tan *et al.* 2012), the lizard showed no evidence of envenomation.

Tail loss and escape are the most common defensive behaviors reported for lizards (Greene 1988, Autumn and Han 1989, Costa-Anaissi *et*

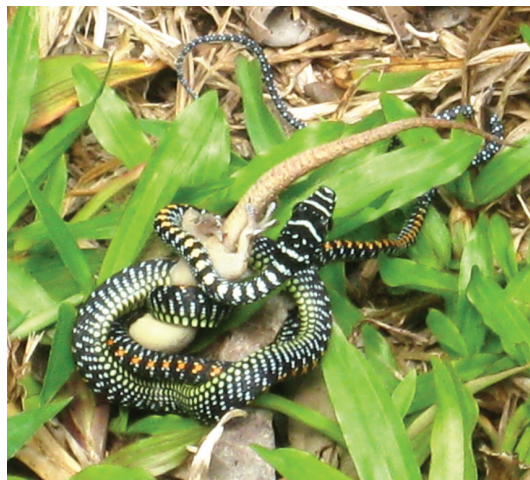


Figure 1. *Chrysopelea paradisi* “constricting” a *Hemidactylus frenatus* in Bako National Park, Borneo, Malaysia.

al. 2020), but the behavior we observed *H. frenatus* perform was tonic immobility. Other observations have been made on *C. paradisi* capturing lizards that defended themselves. A skink, *Lamprolepis smaragdina* (Lesson, 1829), was able to free itself several times, but was caught by the snake with a bite on its leg (Gaulke 1986). A gecko, *Gekko horsfieldii* (Gray, 1827),

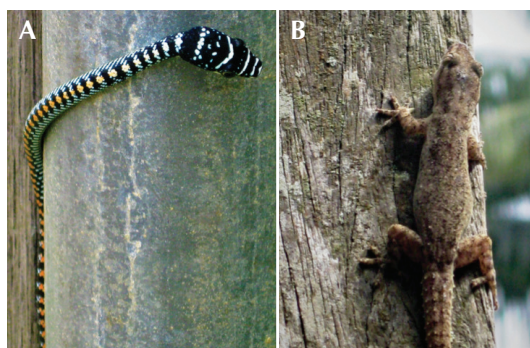


Figure 2. (A) *Chrysopelea paradisi* after it failed to predate a *Hemidactylus frenatus*. (B) The gecko escaped and went up a nearby wooden structure. Bako National Park, Borneo, Malaysia.

was bent into a horseshoe shape with its head and tail in the mouth of the snake, and after 5 min in this position, the snake opened its mouth and the gecko escaped (Mačát *et al.* 2016). Our observation is the first report of a lizard performing TI as an escape strategy to avoid predation by *C. paradisi*. The behavior seems common among lizards in the genus *Hemidactylus*, but it has only been reported while the lizard was being handled (Costa-Anaissi *et al.* 2020, Parmar 2020). Our report is the first to show *H. frenatus* performing TI in a predatory context.

Tonic immobility (TI) is normally triggered in situations where the prey perceives that death is a likely outcome. The behavior occurs during the final stages of predation and is elicited by a strong and sustained tactile stimuli consistent with having been caught by a predator (Rogers and Simpson 2014). Though widespread, few observations of TI in reptiles from southeastern Asia have been reported; for example, only seven observations have been reported in India (Patel *et al.* 2016). The occurrence of TI in reptiles in general is poorly documented. Additional studies of this behavior and its role in survival of the animal are needed (Patel *et al.* 2016, Costa-Anaissi *et al.* 2020). *Hemidactylus frenatus* is a common gecko in southern Asia, and although this is the first case of TI in a predatory context for this species, it would be a good subject to investigate this behavior at the population level.

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