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SHORT COMMUNICATION

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A potential mimic of the venomous dipsadid snake *Philodryas olfersii*

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Mimicry is a defensive strategy that usually involves a harmless species (mimic) that emits the signals of a dangerous species (model) and thus deceives potential predators (Bates, 1862). This strategy is widespread across the animal kingdom, being common among snakes (Greene & McDiarmid, 2005). Some non-venomous snakes mimic venomous species because many predators actively avoid venom-injecting snakes (Pfennig et al., 2001). The best known case of mimicry in reptiles is that of the aposematic coral snakes in which the highly venomous brightly colored elapids (*Micrurus* spp.) act as mimetic models for other harmless snakes (Greene, 1981; Greene & McDiarmid, 2005). However, even cryptically coloured venomous vipers have been recognised as models for harmless species (Gans, 1961; Sazima, 1992; Wüster et al., 2004; Mebert, 2020). Viperid and elapid snakes have grooved or tubular fangs positioned anteriorly in the upper jaws that facilitate delivery of potent venoms during a bite, making them good candidates for mimetic models (Brodie & Brodie, 2004).

Here we suggest that an apparently cryptically coloured, rear-fanged dipsadid snake *Philodryas ofersii* is a mimetic model for a harmless snake. This is supported by the similarity of their dorsal colour pattern and geographic distribution. We observed and took photos of live specimens of *P. ofersii* and other sympatric green snakes. We also examined preserved snakes from the herpetological collections of the Instituto Butantan and the Universidade Federal do Rio Grande do Sul and noted their geographical origins. Additionally, we searched Google Images to determine whether or not the details of the colour pattern used here to support the mimicry hypothesis are also found in other green snakes elsewhere in the world.

Philodryas olfersii inhabits open and forested areas, occurring widely in South America from Colombia, French Guiana and Venezuela to Argentina and Uruguay (Nogueira et al., 2019). It is a slender, green and semi-arboreal snake, foraging both in vegetation and on the ground. This snake feeds on a variety of prey types, including birds (Hartmann & Marques, 2005; Sazima & Marques, 2007). Analysis of the gland secretion of *P. olfersii* has revealed the presence of the main toxin classes found in highly venomous viperids (Ching et al., 2006). The high toxicity of *P. olfersii* venom likely favours capture of birds, an important item of its diet (Sazima & Marques, 2007). This snake can easily bite humans resulting in severe pain and extensive oedema (Castro et al., 2021) and rarely even death (Salomão & Di-Bernardo, 1995). Thus, *P. olfersii* can inject its toxins into predators, making it a potentially dangerous species to prey upon.

Figure 1. Specimens of *Philodryas olfersii* (**A.** & **C.**) and *Erythrolamprus jaegeri* (**B.** & **D.**) – Northern forms (**A.** & **B.**) lack a vertebral stripe while the widely sympatric (see Fig. 2) southern forms (**C.** & **D.**) both have a brown vertebral stripe

Two distinct patterns of colouration can be readily recognized in *P. olfersii*. The first pattern has a dorsum that is completely green whereas the second pattern is also green but possesses a brown vertebral stripe (Arredondo, 2011; Marques et al., 2015; 2019) (Fig. 1). Individuals with brown stripes are distributed mainly south of 15° S while the uniformly green specimens occur mainly north of this latitude (Arredondo, 2011; pers. obs.) (Fig. 2).

Some South American green snakes such as *Erythrolamprus jaegeri*, *E. typhlus* and *E. viridis* (Dipsadidae) occur in sympatry with *P. olfersii* (Marques et al., 2015; 2017; 2019; Nogueira et al., 2019). These terrestrial or semi-aquatic snakes are frog-eaters and do not have grooved teeth (Marques et al., 2015; 2017; 2019; Correa et al., 2016). Moreover, they are docile and do not bite when handled by humans (Borges-Martins et al., 2018; pers. obs.). Thus, these green snakes appear to be harmless to most potential predators. *Erythrolamprus typhlus*, *E. viridis* and the northern populations of *E. jaegeri* are uniformly or predominantly green (a few scales eventually have other distinct colours) (Souto, 2016; Nogueira et al., 2019). However, individuals in the southern populations of *E. jaegeri*

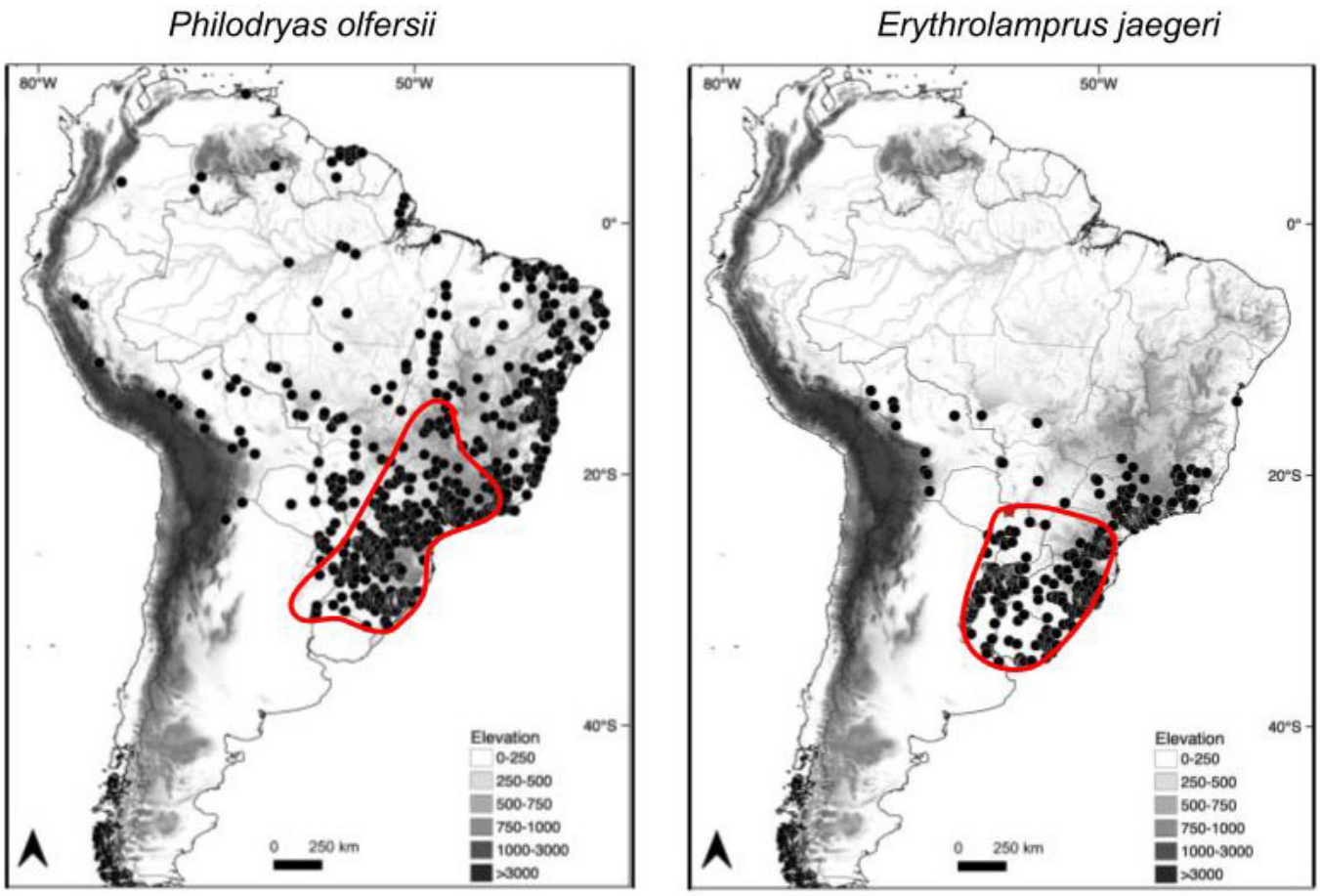

Figure 2. Distribution of *Philoryas olfersii* and *Erythrolamprus jaegeri*. The occurrence of specimens of both species with the brown vertebral stripe are delimited by the red line based on Arredondo (2012) and Souto (2016). Map adapted from Nogueira et al., 2019.

have a brown vertebral stripe similar to that of *P. olfersii* (Fig. 1) (Souto, 2016). Among specimens of *E. jaegeri* preserved in collections, part are almost uniform in colour with few dark-edged dorsal scales (in the northern range, < 25° S) while others have uniform colour with or without a brown vertebral stripe (in the southern range, > 25° S) (Fig. 2). This vertebral stripe was not detected in older preserved specimens. This may be due to the change in the colour of the snake in the preservative liquid, as the stripe was present in all specimens preserved in alcohol in the last three years as well as in all live specimens observed from the southern region. Souto (2016) suggests a taxonomic distinction between the southern and northern groups of *E. jaegeri*. Regardless of taxonomic problems, the wide area of sympatry of *P. olfersii* and southern populations of *E. jaegeri*, both uniformly green with a very similar brown vertebral stripe suggests the existence of a mimetic relationship between these two snakes. Although *P. olfersii* is a semi-arboreal species and *E. jaegeri* is semi-aquatic (Hartmann & Marques, 2005; Correa et al., 2016) potential predators of snakes roam these habitats and can be considered the selective agents where a mimicry complex can evolve. In this case, *P. olfersii* should be the mimetic model due to its potential to bite and inject its toxic venom into predators. Alternatively, a dark vertebral stripe may contribute to a countershading effect, which enhances camouflage by removing the cues associated with three-dimensional form (Donohue, 2020). If the brown vertebral stripe evolved to reduce the detectability by predators or prey, then the selective pressures may have operated independently in these two snakes, as a response to similar detectability processes. It is noteworthy, however, that our search revealed that a brown vertebral stripe is not a feature commonly seen in other green snakes, as in other species of *Philodryas* and *Erythrolamprus*, or in green species (which inhabit various habitats) in other genera, such as *Opheodrys*, *Oxybelis*, *Ahaetulla*, *Ptyas*, *Leptophis*, *Liochlorophis*, *Philothamnus*, *Dispholidus*, *Dendroaspis*, *Bothrops*, *Trimeresurus*, *Corallus* or *Morelia*. This rarity indicates that a brown vertebral stripe is not a common pattern in green snakes, which weakens the hypothesis of a disruptive/camouflage function. Conversely, the evolution of a similar and rare pattern in two different lineages of sympatric species – one of them with a highly toxic venom – seems to support the hypothesis of a mimetic complex.

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