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BODY-BENDING BEHAVIOUR IN SNAKES: NEW RECORDS OF A POORLY DOCUMENTED DEFENSIVE BEHAVIOUR

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Snakes exhibit a broad array of defensive tactics to avoid predators, and detection avoidance is an important component of many of them (Martins, 1996). To avoid detection, snakes may use morphology, such as cryptic coloration; defensive behaviour, such as immobility, or a combination of both strategies (Greene, 1988; Martins, 1994). Body-bending, which acts to break up the body silhouette, is one of the more rarely-reported and poorly understood defensive behaviours. Body-bending behaviour is a defensive strategy in which the snake contorts the body into a zigzag, "horizontal ladder" position, resembling the shape of certain fallen vine stems (Marques et al., 2006; Duarte, 2012). This behaviour has been previously reported in a few Neotropical snake species: *Coniophanes fissidens*, *Philodryas viridissima*, *Chironius fuscus*, *C. monticola*, *Pantherophis obsoleta*, *Phrynonax polylepis*, *Psomophis joberti*, *Spilotes pullatus*, and *S. sulphureus* (Bee-

be, 1946; Abuys, 1986; Marques, et al., 2006; Doherty-Bone, 2009; Maddock et al., 2009; Duarte, 2012; Martins et al., 2012). Here, we report records of this behaviour for five additional species of Neotropical Colubridae and Dipsadidae (*Chironius exoletus*, *Erythrolamprus sagittifer*, *Philodryas baroni*, *P. chamissonis*, *P. psammophidea*, *P. trilineata*), as well as additional reports for *Chironius fuscus* and *Spilotes sulphureus*.

In November 2002, a pregnant female of *Philodryas baroni* was captured near the city of Tucumán, Tucuman Province, Argentina (26°49'58.80"S, 65°12'57.60"O) and sent to the Fundación Miguel Lillo laboratory (FML), where oviposition occurred overnight 14 to 15 December 2002. At the time specimens were collected there were no regulations concerning collection of snakes in Argentina, so no permits were issued. The eggs hatched on 28 February 2003 and photos of the juveniles were taken on 4 April 2003. While being photographed, one individual (FML 13710; snout-vent length 377 mm, tail length 116 mm) attempted to escape several times, requiring frequent handling (Figure 1A). Following handling, it adopted a body-bending posture, raising its head and the anterior third of the body off the ground to an angle of approximately 45°. The individual retained this position for three or four minutes before attempting to escape again.

A specimen of Philodryas trilineata (adult female, total length 1550 mm) collected 10 km south of the city of Andalgalá (27°34'19.20"S, 66°18'14.40"W), Catamarca Province, Argentina, has been kept in captivity at FML since 21 October 2007. This individual sometimes exhibited body-bending behaviour during the cleaning of its terrarium (GS pers. obs.).

In October 2007 in an area of Chaco woodland, close to the headquarters of Parque Nacional Teniente Enciso (21°04'48.00"S, 61°36'54.00"W), Boquerón Department, Paraguay, a presumed juvenile of *Philodryas psammophidea* (Figure 1B) (approximately 35 cm total length), was encountered on an exposed path approximately 2.5 m wide through open-undergrowth woodland. As the observer approached, the snake assumed a body-bending posture, and as the observer moved closer to take photographs the individual became aggressive, striking at the lens of the camera from a distance of approximately 30 cm. Following the aggressive reaction of the snake, the observer withdrew and the snake moved rapidly into cover.

At 11:30 a.m. on 2 November 2007, in an area of the Distrito Chaqueño Occidental (Semi-arid or Dry Chaco), approximately 1km from Rivadavia municipality (24°10'30.00"S, 62°52'33.60"W), Salta Province, Argentina, an adult individual of *Erythrolamprus sagit-*

tifer modestus (Figure 1C) was observed motionless on the ground in the body-bending posture. The individual had recently emerged from a nearby water body and was on the dry shore. The snake remained motionless during the observations, despite the close proximity of the observer. On 13 July 2008, another adult individual of this species (Figure 1D) was also observed body-bending in the same general area, among fallen branches on the ground.

On 2 March 2012, on Isla Negra (33°26'16.80"S, 71°39'43.20"W), Region V, Chile, an adult *Philodryas chamissonis* (Figure 1E) was observed in a restinga area on a moist rocky depression, with no vegetation cover, approximately 30m from the edge of the water. The individual retained a body-bending posture for more than eight minutes, even when approached closely by the observer.

On 15 December 2013 at 2:48 p.m., approximately 50 km south of the municipality of Parecis (12°15'14.40"S, 61°12'07.20"W), Rondônia state, Brazil, an adult Chironius exoletus (approximately 2 m total length) was observed in an Amazonian seasonal semi-deciduous forest (Figure 1F). It lay motionless in leaf litter on the forest floor in the body-bending posture. At the approach of the observer, the individual moved its head slightly, but made no other significant movements. On a closer second approach the specimen fled, climbing a bush and remaining approximately 30cm above the ground. The observation lasted a total of four minutes.

At 12:30 p.m. on 21 December 2013, about 80 km west from the municipality of Comodoro (13°42'07.20"S, 60°26'09.60"W), Mato Grosso state, Brazil, an individual of *Spilotes sulphureus* was observed in body-bending posture on a dirt road in a seasonal semi-deciduous forest. Initially it was mistaken for a liana stem (Figure 1G). The individual was removed from the road after five minutes of observation in the body-bending posture.

At 15:38 p.m. on 14 May 2017 in the neighbourhood of Guapiruvu (24°18'57.60"S, 48°07'26.40"W), municipality of Eldorado, southern São Paulo state, Brazil, an adult *Chironius fuscus* (approximately 1.5 m total length) was observed crossing a trail in secondary Atlantic Forest (Figure 1H). The snake stopped when the observer approached, assuming the body-bending posture and retaining it for five minutes. When the observer attempted to catch the snake, it fled rapidly towards the forest.

Liana vines occur in most of all sites in which these observations were made and often litter the floor, offering a potential defensive camouflage opportunity for species that exhibit body--bending behaviour (Edmunds, 1974; Marques et al., 2006). The abrupt transition from a stretched to a body-ben-

ding posture could confuse a potential predator with a search image for animals with an elongated body shape.

Body-bending behaviour has to date been documented in two Neotropical families: Colubridae (genera *Chironius*, *Spilotes*, *Pantherophis*, and *Phrynonax*) and Dipsadidae (genera *Coniophanes*, *Erythrolamprus*, *Philodryas* and *Psomophis*) (Zaher *et al.*, 2019). Data is insufficient to confidently declare this behaviour as plesiomorphic in these groups, but our observations corroborate previous suggestions that body-bending behaviour is an adaptive behaviour found in arboreal and terrestrial snakes (Marques *et al.*, 2006; Doherty-Bone, 2009; Martins et al., 2012). *Chironius exoletus* and *Philodryas baroni* present tendencies towards arboreality; *Philodryas chamissonis* and *P. trilineata* are semi-arboreal; and *Chironius fuscus*, *Erythrolamprus sagittifer modestus* and *Philodryas psammophidea* are terrestrial species (Cei, 1993; Giraudo & Scrocchi, 2002; Machado-Filho & Marques, 2020).

For several of the cases here it was not possible to record the length of time that the individuals had been in body-bending posture prior to their detection However, the captive juveniles of *Philodryas baroni* and *P. trilineata* both exhibited this behaviour immediately following disturbance, as did the free-living individual of *Chironius fuscus* which assumed the posture on approach of the observer. On the other hand, the individuals of *Spilotes sulphureus* had already adopted body-bending posture before they were detected by the observer, who initially mistook the snake for a fallen branch and correctly identified it only at a close distance. The second individual of *Erythrolamprus sagittifer modestus* was also observed body-bending at a distance among fallen branches. It seems likely that individuals displayed the body-bending behaviour in response to the presence of the observer/predator, and maintained that posture until they were detected and the threat level increased. The data presented here is not consistent with the hypothesis that body-bending is a physiological response by snakes at non-optimal body temperature (Marques et al., 2006), as some individuals either attacked or escaped rapidly, with no obvious limitations to their mobility.

Few reports of body-bending in wild individuals exist, and we encourage the publication of future observations to construct a more complete knowledge of the causal factors of behaviours. A lack of reports of this behaviour in the wild may be due to under-reporting or because few taxa employ the defence. It could also be indicative of the efficiency of this defensive technique against visually-oriented predators.

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References

Abuys, A. 1986. The snakes of Surinam, part XIII: Subfamily Xenodontinae (genera *Pseudoeryx*, *Pseustes* and *Rhadinaea*). Litteratura Serpentium, 6:19-30.

Beebe, W. 1946. Field notes on the snakes of Kartabo, British Guiana and Caripito, Venezuela. Zoologica, 31:11-52.

Cei, J. M. 1993. Reptiles del noroeste, nordeste y este de la Argentina: Herpetofauna de las selvas subtropicales. Puna y Pampas. Monografia Museo Regionale di Scienze Naturali Torino, 16:1-949.

Doherty-Bone, T. M. 2009. Elaphe *obsoleta spilodes* (Grey Rat Snake): body-bending behaviour. Herpetological Bulletin, 109:38-39.

Duarte, M. R. 2012. The intriguing "Liana-mimicry" or "body bending" behaviour in snakes: cryptic or signaling behaviour. Herpetology Notes, 5:303-304.

Edmunds, M. 1974. Defense in animals: a survey of anti-predator defences. Longman Group, Ltd., Essex. 357p.

Giraudo, A. R. & G. J. Scrocchi. 2002. Argentinian snakes. An annotated checklist. Smithsonian Herpetological Information Service, 132:1-53.

Greene, H. W. 1988. Antipredator mechanisms in reptiles; pp. 1-152. In: C. Gans, & R. B. Huey (eds.), Biology of the Reptilia. Vol. 16, Ecology B, Defense and Life History. Alan R. Liss, New York.

Machado-Filho, P. R. & O. A. V. Marques. 2020. Feeding habits and diet of the snake genus *Philodryas* (Serpentes, Dipsadidae, Xenodontinae). Papéis Avulsos de Zoologia (in press).

Maddock, S., B. Tolhurst, M. Brown, M. Peck, E. V. Pérez & J. N. Morales. 2011. Body bending behaviour: more widespread than previously thought? New reports from two snake species of Northwest Ecuador. Herpetology Notes, 4:79-81.

Marques, O. A. V., M. G. Rodrigues & I. Sazima. 2006. Body bending: a cryptic defensive behaviour in arboreal snakes. Herpetological Bulletin, 97:2-4.

Martins, M. 1996. Defensive tactics in lizards and snakes: the potential contribution of Neotropical fauna; pp. 185-

199. *In*: K. Del Claro (ed.), Anais do XIV Encontro Anual de Etologia. Sociedade Brasileira de Etologia, Universidade Federal de Uberlândia, Brasil.

Miranda, J.P., J. C. Lopes Costa & C. F. D. Rocha, 2012. Body-bending behaviour: a new instance in a terrestrial snake from Brazil. Herpetological Bulletin, 122: 35-37.

Zaher, H., R. W. Murphy, J. C. Arredondo, R. Graboski, P. R. Machado-Filho, K. Mahlow, G. C. Montingelli, A. B. Quadros, N. L. Orlov, M. Wilkinson, Y. P. Zhang & F. G. Grazziotin. 2019. Large-scale molecular phylogeny, morphology, divergence-time estimation, and the fossil record of advanced caenophidian snakes (Squamata: Serpentes). PloS one, 14:e0216148.

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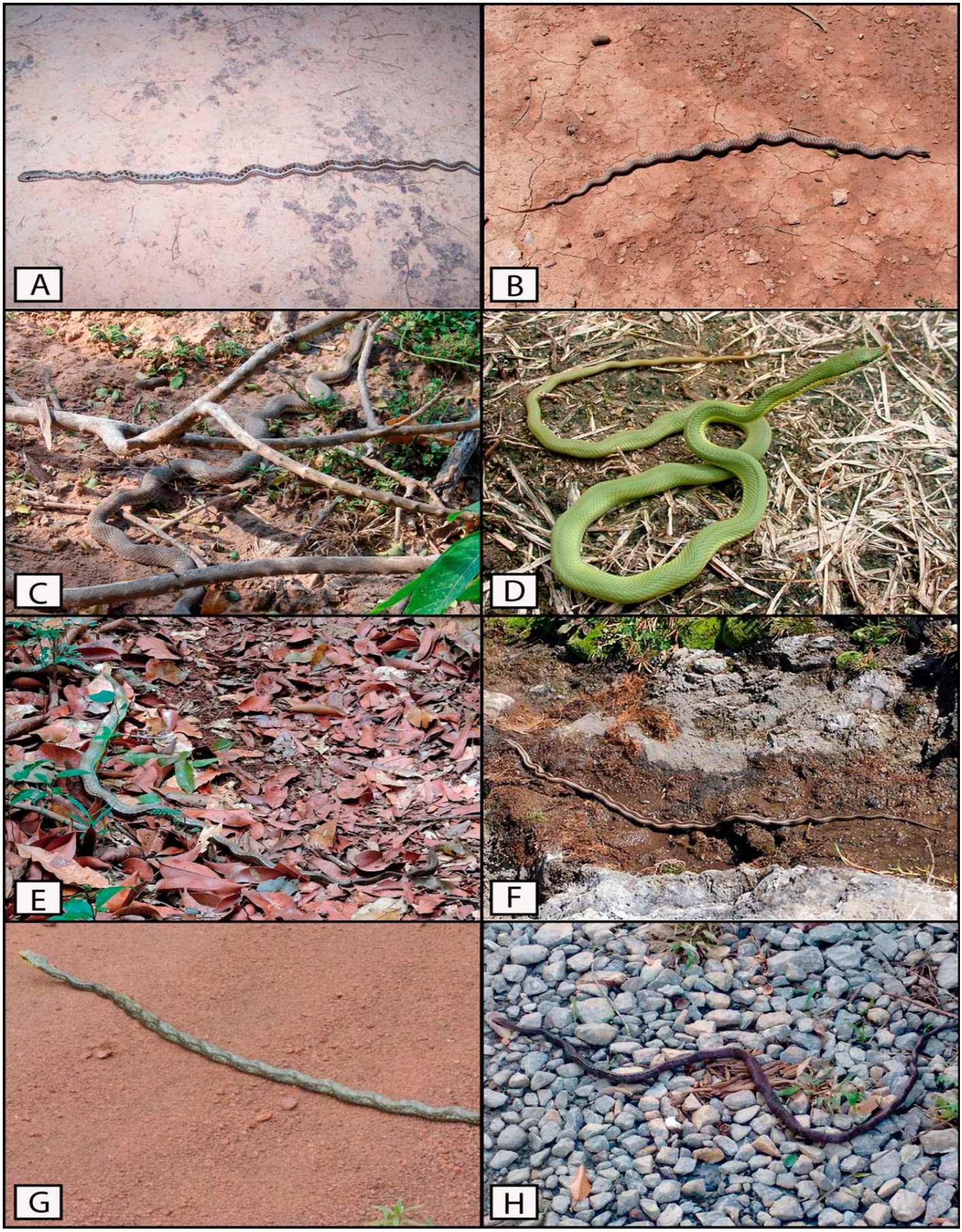

Figure 1. New reports of body-bending behaviour in Neotropical snakes: (A) *Philodryas baroni*, (B) *Philodryas psammophidea*, (C-D) *Erythrolamprus sagittifer modestus*, (E) *Philodryas chamissonis*, (F) *Chironius exoletus*, (G) *Spilotes sulphureus* and (H) *Chironius fuscus*.

Enyalius leechii Castelo dos Sonhos - PA @ Arthur Sena

