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► **To cite this version:**

Starace Fausto, Ferrieux T., Ivan Ineich. Second case of ophiophagy by a crotaline snake, *Bothrops atrox* (Squamata: Viperidae), on an aniliid, *Anilius scytale* (Squamata: Aniliidae), in French Guiana. *Herpetology Notes*, 2021, 14, pp.1367-1370. mnhn-03963767

HAL Id: mnhn-03963767

<https://mnhn.hal.science/mnhn-03963767>

Submitted on 30 Jan 2023

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Second case of ophiophagy by a crotaline snake, *Bothrops atrox* (Squamata: Viperidae), on an aniliid, *Anilius scytale* (Squamata: Aniliidae), in French Guiana

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Bothrops atrox (Linnaeus, 1758) is a predominantly nocturnal species, yet shows marked plasticity when it comes to its activity times, the prey it hunts, and the great diversity of the environments it frequents. In French Guiana, it is sometimes active in the morning, as evidenced by a case of predation reported (Ineich and Starace, 2015), but also active in the late afternoon, especially during the rainy season. During this period, the diurnal observations of activity are more frequent until 16:30 h, when the luminosity weakens (F.S., pers. obs.). Cunha and Nascimento (1978) and Martins and Oliveira (1998) also mention occasional diurnal activity.

A stomach contents study of 109 *Bothrops atrox* from the Brazilian Amazon identified prey in the gastrointestinal tracts 35% of the dissected snakes (Bisneto and Kaefer, 2019). Among these, 73% ingested exclusively an ectothermic prey item (centipede, anuran amphibian, lizard or snake), 24% exclusively an endothermic prey item (mammal) and a single individual (3%) presented both types of prey. At least two types of prey were represented in 30% of the dissected snakes (Bisneto and Kaefer, 2019). The snakes that ingested endothermic prey were significantly larger in size and an ontogenic deviation of the diet was clearly demonstrated in that study. Most likely, due to their morphology, larger individuals can prey on larger, and therefore, more nutritious prey. The frequencies of

each of the most abundant prey types are distributed as follows in decreasing order: anurans (38%), lizards (19.5%), mammals (19.5%), centipedes (15.2%), and snakes (4.3%). Insect fragments have been observed in some digestive tracts but they were considered secondarily ingested prey items (i.e., remnants of prey consumed by another, true prey item; Bisneto and Kaefer, 2019). A similar, older study, also carried out in Brazil on 107 preserved individuals, showed that 7% of *B. atrox* prey items were snakes (Martins and Gordo, 1993). The diet of this crotaline snake is clearly generalised and also includes cannibalism (Cunha and Nascimento, 1993; Rodrigues et al., 2016). All these results were corroborated by a recent analysis carried out by Monteiro et al. (2020), which showed the diet of newborn *B. atrox* mainly included arthropods (45.5%), anurans (27.3%), and snakes (9%), with a notable absence of mammalian prey. While juveniles showed the presence of many more lizards (44%), mammals (20%), amphibians (10.7%), and arthropods (16%), more rarely birds (2.7%) and snakes (6.6%). Finally, in adults, the diet consisted largely of mammals (56.3%) and lizards (28.1%), supplemented by amphibians (9.4%) and arthropods (6.2%), but lacking birds and snakes.

Ophiophagy is known in several species of the genus *Bothrops* Wagler, 1824 (see Campbell and Lamar, 1989, 2004; Mendoza and Lucero, 2011; García et al., 2018; Gabrysova et al., 2020; Oliveira-Jr et al., 2020). However, snake predation is unusual and shows a clear ontogenic association—as mentioned above. The snakes ingested by *Bothrops atrox* belong to at least five families: Aniliidae Stejneger, 1907; Colubridae Oppel, 1811; Dipsadidae Bonaparte, 1838; Elapidae Boie, 1827; and Leptotyphlopidae Oppel, 1811. The snake species that have been identified as prey for this pitviper are listed below (Table 1) in alphabetical order of families and genera in each family, combined with each prey specifying the country concerned and the source of the observation.

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Table 1. Snake species reported as prey of *Bothrops atrox*. We indicate family, prey identification, geographic location, number of occurrences and bibliographic reference(s) for each prey species.

Family	Species	Location	Number of cases	References
Aniliidae	<i>Anilius scytale</i> (Linnaeus, 1758)	French Guiana	2	Ineich and Starace, 2015; this study
Colubridae	<i>Drymarchon corais</i> (Boie, 1827)	Brazil	1	Pelegriani et al., 2019
Colubridae	<i>Mastigodryas boddaerti</i> (Santzen, 1796)	Brazil	1	Da Frota, 2003
Colubridae	<i>Tantilla melanocephala</i> (Linnaeus, 1758)	Brazil	3	Martins and Gordo, 1993; Maschio et al., 2010; Bisneto and Kaefer, 2019
Dipsadidae	<i>Atractus torquatus</i> A.M.C. Duméril, Bibron & A.H.A. Duméril, 1854	Brazil	1	Egler et al., 1996; Oliveria and Martins, 1996; Campbell and Lamar, 2004
Dipsadidae	<i>Erythrolamprus typhlus</i> (Linnaeus, 1758) [as <i>Leimadophis typhlus</i> or <i>Liophis typhlus</i>]	Unknown	1	Credited to Greene (1997) in Da Frota (2003) but there is no such mention in Greene (1997) and the source for that report remains a mystery to us
Dipsadidae	<i>Imantodes cenchrina</i> (Linnaeus, 1758)	Brazil	1	Bisneto and Kaefer, 2019
Dipsadidae	<i>Leptodeira annulata</i> (Linnaeus, 1758)	Brazil	1	Puerto et al. in Martins and Gordo, 1993
Dipsadidae	<i>Ninia atrata</i> (Hallowell, 1845)	Trinidad	2	Rodriguez, 1976 cited in Boos, 2001; Murphy, 2007 (<i>B. cf. atrox</i>)
Dipsadidae	<i>Oxyrhopus melanogenys</i> (Tschudi, 1845)	Brazil	1	Gavira and Loebmann, 2011
Dipsadidae	<i>Siphlophis compressus</i> (Daudin, 1803)	French Guiana	1	Denis Faure, December 2016, pers. comm.
Elapidae	<i>Micrurus circinalis</i> (A.M.C. Duméril Bibron & A.H.A. Duméril, 1854)	Trinidad	1	Boos, 2001
Leptotyphlopidae	« <i>Epictia</i> sp. » or ? « <i>Epictia tenella</i> Klauber, 1939 »	Brazil	1 (male)	Bernarde and Abe, 2010; Batista et al., 2020; Monteiro et al., 2020
?	« small snakes »	Guyana and Venezuela	?	Beebe, 1946
?	Unidentified	Brazil	?	Martins and Gordo, 1993
?	« serpientes »	Venezuela	?	Natera-Mumaw et al., 2015



Figure 1. *Bothrops atrox* found dead on road on the Guyanese Space Center area road at the guard post in Karouabo, French Guiana. Photo by Thibaut Ferrieux.



Figure 2. Section of *Anilius scytale* emerging from the bowels of the crushed *B. atrox* in Figure 1 above. Photo by Thibaut Ferrieux.

Despite the wide distribution and relative abundance of *B. atrox*, observations of ophiophagy remain rare. Each case is therefore valuable and should be reported. Here, we report a second case of ingestion of a Neotropical pipe snake, *Anilius scytale* (Linnaeus, 1758), by *B. atrox*. The sighting of a dead on road (DOR) snake was made on 26 March 2021 around 13:30 h on the Guyanese Space Center area road at the Karouabo guard post (5.22745°N, -52.78619°W; WGS 84). The surrounding vegetation, composed of shrubby savannas, is crossed by the Karouabo stream. The animal was likely freshly killed because one of us (T.F.) had not observed the dead snake during a first pass on this same road earlier around 11:00 h. The snake was an adult *B. atrox* (total length = ca. 60 cm; midbody diameter = 4 cm; Fig. 1).

While moving the carcass off of the road, a section of another snake, *Anilius scytale*, measuring about 10 cm in length, came out of the viscera of the crotaline venter (Fig. 2). Although this segment was small and damaged, it is easily identifiable as *A. scytale*. This sighting occurred on a stretch of road where roadkill snakes are quite common. No specimens were preserved but photographic vouchers are provided herein (Figs. 1–2).

Anilius scytale is a fossorial snake with diminutive eyes that prefers lowland wetlands with the presence of watercourses (Cunha and Nascimento, 1978; Martins and Oliveira, 1998; F.S., pers. obs.). It is thought to be nocturnal and can be regularly seen active at night on the trails and main roads of French Guiana. Martins and Oliveira (1998) also mention that *A. scytale* is nocturnal, but can become diurnal under certain circumstances (e.g., flooding of underground galleries, search for food, etc.).

Indeed, another observation provides further evidence for diurnal behaviour in *A. scytale*. In French Guiana, 6 km east of Saint-Laurent-du Maroni in a primary forest called “Forêt des Malgaches”, on 29 December 2016 at 12:30 h, a surface-active, gravid female was observed moving on the forest floor in wet lowlands during sunny weather (Starace Emma, pers. com.).

The two observations of ophiophagy on *A. scytale* in French Guiana show that some purportedly nocturnal snakes may regularly display diurnal activity. The first case of ophiophagy mentioned shows that, like *B. atrox*, *A. scytale* is also sometimes active during the day (Ineich and Starace, 2015), and in the second case reported here, the *B. atrox* likely subjugated and ingested an *A. scytale* in the morning (dry, clear conditions), which further supports diurnal activity in these two snake species. Moreover, these two species–predator and

prey—which do not (*a priori*) share the same ecological niches (e.g., terrestrial vs. fossorial, respectively), may come into contact somewhat frequently. The additional case of ophiophagy by *B. atrox* on *A. scytale* suggests that these species likely interact somewhat regularly in French Guiana. Altogether, the observed surface-level movements of *A. scytale* as well as the generalist ecological requirements of *B. atrox* probably explain these two unexpected prey–predator observations reported for French Guiana.

Acknowledgements. We thank an anonymous reviewer for his constructive inputs during the development of this manuscript.

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