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DIET AND FEEDING BEHAVIOR OF THE MUSSURANA (*CLELIA CLELIA*, SERPENTES: DIPSADIDAE) IN COSTA RICA: REPORT OF FIVE CASES

DIETA Y COMPORTAMIENTO ALIMENTARIO DE LA ZOPILOTA (*CLELIA CLELIA*, SERPENTES: DIPSADIDAE) EN COSTA RICA: INFORME DE CINCO CASOS

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Resumen.– Presentamos una serie de eventos de depredación de la serpiente ofiófaga *Clelia clelia* (Serpentes: Dipsadidae) en diferentes regiones de Costa Rica y comentamos sobre la estrategia utilizada para cazar e inmovilizar las presas.

Palabras claves.– Reptilia, Serpentes, *Clelia clelia*, hábitos alimenticios, estrategias de forrajeo, Costa Rica.

Abstract.– We present a series of predation events by the ophiophagous snake *Clelia clelia* (Serpentes: Dipsadidae) from different regions of Costa Rica and comment on the strategy used to hunt and subdue the prey.

Key words.– Reptilia, Serpentes, *Clelia clelia*, food habits, foraging strategy, Costa Rica.

The Mussurana or locally called ¨Zopilota¨ (*Clelia clelia*), is a large snake species (2.5-3 m) that ranges widely in low elevation rainforests from Guatemala and Belize to northern Argentina (Wallach et al., 2014; Boundy, 2020). In Costa Rica, it is distributed in the Northern Region and the Caribbean slope, and the Central and Southern Pacific (Solórzano, 2004; Sasa et al., 2010). It is well known for its predominantly ophiophagous habits (including various venomous species of the Viperidae family). However, it also includes small mammals, lizards and birds in its diet (Savage, 2002; Solórzano, 2004). *Clelia clelia* actively searches for its prey at night and during the day, usually on the ground and sometimes on low-lying vegetation (Chavarría & Barrio-Amoró, 2014; Timofeevski et al., 2017) and around water sources such as streams and ponds. Its predation strategy uses its great muscular force or constriction to immobilize and suffocate the prey. Simultaneously, it bites and inoculates its venom with the posterior fangs (Solórzano, 2004) and then swallows the prey, starting by the head. During this event, the venomous species captured generally inflict numerous defensive bites that, other than a slight momentary inflammation, do not cause any significant effect due to its natural immunity to viper venoms (Cerdas & Lomonte, 1982; Lomonte et al., 1989). Despite its wide distribution and habits, the specific literature on eating behavior is surprisingly scarce (Vaughan & Ruiz-Gutierrez, 2006; Delia, 2009; Chavarría & Barrio-Amorós, 2014; McCranie, 2016; Barrio-Amorós & ter Harmsel, 2017; Timofeevski et al., 2017).

Documenting the species that constitute the diet of *C. clelia*, as well as the behaviors followed to subjugate and ingest them, is important as such observations provide information for more elaborated and complete reviews on the habits of this species and of snakes in general. In recent years, a series of *C. clelia* predatory events have been photographically recorded in Costa Rica, wich we present below.

On September 29, 2014, another *Clelia clelia* ca 1.50 m was observed subjecting by constriction a *Bothrops asper* ca 1.10 m, in La Gamba Biological Station, within the Esquinas Rainforest Lodge Reserve, Puntarenas province in southern Pacific (Fig. 1A).

On October 6, 2014 at 12:10 pm, an adult of *Clelia clelia* was photographed eating an adult female (probably gravid) of

Figura 1. Eventos de depredación por parte de *Clelia clelia* en Costa Rica. A) La Gamba, Golfito, Puntarenas. B) Rincón de la Vieja, Liberia, Guanacaste. C) Bahía Drake, Osa, Puntarenas. D) Nicuesa Rainforest Lodge, Golfito, Puntarenas. E) Cajón de Boruca, Buenos Aires, Puntarenas.

Figure 1. *Clelia clelia* predatory events in Costa Rica. A) La Gamba, Golfito, Puntarenas. B) Rincón de la Vieja, Liberia, Guanacaste. C) Drake Bay, Osa, Puntarenas. D) Nicuesa Rainforest Lodge, Golfito, Puntarenas. E) Cajón de Boruca, Buenos Aires, Puntarenas.

Bothrops asper of ca 1.80 m in Rincón de la Vieja, in Buena Vista Lodge, Guanacaste province (Fig. 1B). This site is located at ca 700 m in elevation in tropical premontane wet forest (Bolaños et al., 2005).

On March 21, 2015, an adult specimen of *Clelia clelia* ca 1.80 m was recorded in Drake Bay, in the Osa Peninsula, Puntarenas province in southern Pacific, while swallowing a subadult of Neotropical Bird Snake (*Phrynonax poecilonotus*, Colubridae) of ca 1.0 m (Fig. 1C). This encounter was observed in an area covered by early stages of succession interspersed with patches of secondary growth of tropical rainforest.

On the morning of June 27, 2016, an adult of *Clelia clelia* of ca. 2.10 m was found eating a *Bothrops asper* (locally called "Terciopelo") of ca. 1.70 m in the Nicuesa beach sector within the Golfo Dulce, Puntarenas province, in southern Pacific (Fig. 1D). Nicuesa is covered by secondary growth tropical rainforest (Bolaños et al., 2005). At the time of the encounter, the Mussarana had already swallowed a little more than a half of the Fer de Lance (Fig. 1D).

On June 11, 2018, in Cajón de Boruca in Buenos Aires of Puntarenas province, a specimen of *Clelia clelia* ca 1.75 m while using constriction to immobilize and kill a subadult of *Iguana rhinolopha* (Green Iguana) (Fig. 1E). The region where the encounter ocurred corresponds to tropical wet forest transition to dry, with high rainfall seasonality and highly degraded coverage of reduced fragments of secondary growths. This case shows that *C. clelia* is capable of subjugating and manipulating relatively bulkier prey than snakes.

In all cases, the prey was swallowed head-first. These events clearly suggest that *Bothrops asper* is a frequent and important food resource for this species, at least in Costa Rica, which is congruent with the abundance reported for *B. asper* in this country (Solórzano & Cerdas, 1989; Solórzano, 2004).

As in the other species of its genus, *C. clelia* presents ontogenic dichromatism: the young are born with a uniform red dorsal pattern except for the black nuchal ring. The dorsal red color is maintained during the juvenil period, darkening at it grows and is replaced by the dark blue or dark grey pattern characteristic of subadults and adults. The red color pattern causes the juveniles to be considered a different species, popularly called "blood viper" (víbora de sangre; Solórzano, 2003), mistakenly assumed to be a hazardous, highly venomous species that should be eliminated at sight. Ironically, the adults of this species are often recognized and protected by farmers who consider them allies in control of venomous snakes.

As large apex predators in tropical forests food webs, *Clelia clelia* is not a particularly abundant species, although it used to be observed with some frequency throughout its range in the Caribbean and Pacific lowlands of Costa Rica. Currently in the Osa Peninsula it is observed with the same frequency as in the past. However, in recent decades, encounters with this impressive snakes have decreased significantly across the country. The causes of this population decrease are unknown, although they are probably related to changes in prey abundances in their environments.

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