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FIRST RECORD OF A DEFENSIVE BEHAVIOR IN *MICROCAECILIA NICEFORI* (GYMNOPHIONA: SIPHONOPIDAE) PROVOKED BY THE SNAKEBITE OF *MICRURUS DUMERILII* (SERPENTES: ELAPIDAE)

PRIMER REGISTRO DE UN COMPORTAMIENTO DEFENSIVO EN *MICROCAECILIA NICEFORI* (GYMNOPHIONA: SIPHONOPIDAE) PROVOCADO POR LA MORDEDURA DE *MICRURUS DUMERILII* (SERPENTES: ELAPIDAE)

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Resumen.— Reportamos por primera vez un evento dinámico de depredación y comportamiento defensivo de *Microcaecilia nicefori* provocado por *Micrurus dumerilii* en Armero, Tolima, Colombia y presentamos un compendio de todos los registros de cecilias depredadas por serpientes en el Neotrópico.

Palabras clave.— Cecilias, Colombia, comportamiento, serpientes de coral, defensa, dieta.

Abstract.— We here report the first dynamic event of predation and defensive behavior in *Microcaecilia nicefori* provoked by *Micrurus dumerilii* in Armero, Tolima, Colombia, and we also provide a compendium of all the available literature records of caecilians being preyed upon by snakes in the Neotropic.

Keywords.— Behavior, caecilians, Colombia, coral snakes, defense, diet.

Microcaecilia nicefori (Barbour, 1924) is a small, pink-headed, dark gray-bodied caecilian (Fig. 1D), with a maximum total length of 256 mm (Taylor, 1968). It is endemic to a portion of the Middle Magdalena Valley lowlands between 225-400 m.a.s.l. in Colombia (Lynch, 2000) (Fig. 2). This species is easily distinguished from all its sympatric congeners by having 145-157 primary grooves and 94-155 secondary grooves, and its length/width ratio, between 43-63 times (Lynch, 2000). *Micrurus dumerilii* (Jan, 1858) is a venomous snake with a maximum total length of 954 mm (Meneses-Pelayo & Caicedo-Portilla, 2015) distributed in northern South America; Panama lowlands, Andean slopes, Pacific and Caribbean continental coasts of Colombia, the Pacific region of Ecuador and northwestern Venezuela, between 0-1500 m.a.s.l. (Campell & Lamar, 1989; Roze, 1996; Campbell & Lamar, 2004).

This species is easily distinguished from all sympatric congeners by the presence of a tricolored monadal pattern composed of 10-27 single black rings (in monadal populations) or 14 false triads (in "triads" populations); 177-206 ventrals and 44-58 subcaudals in males, and 198-220, 31-42 in females, respectively; and the supracloacal keels that are well developed in males and in some females (Campell & Lamar, 1989; Roze, 1996; Campbell & Lamar, 2004).

Coral snakes have been long regarded as predators who have become specialized eaters of other vermiform vertebrates, particularly of caecilian Amphibians (Roze, 1996). Currently, several coral snake species i.e., *M. dumerilii, M. lemniscatus* (Linnaeus, 1758), and *M. mipartitus* (Duméril, Bibron & Duméril, 1854) (among others) are known predators of different species of caecilians i.e., *Caecilia thompsoni* Boulenger, 1902, *Oscaecilia bassleri* (Dunn, 1942), *O. polyzona* (Fischer, 1880), and *Rhinatrema bivittatum* (Guérin & Méneville, 1838) (among others) (See Table 1 for a compendium of literature records).

Most of these studies are based on the examination of stomach content obtained from dissected snakes in natural history museums (Greene, 1983; Roze, 1996; Martins & Oliveira, 1998; Maschio et al., 2010), but reports carried on in the field are rare. Some of these are the result of snake regurgitation (either induced or natural) (Villacampa & withworth, 2016; Gonzalez et

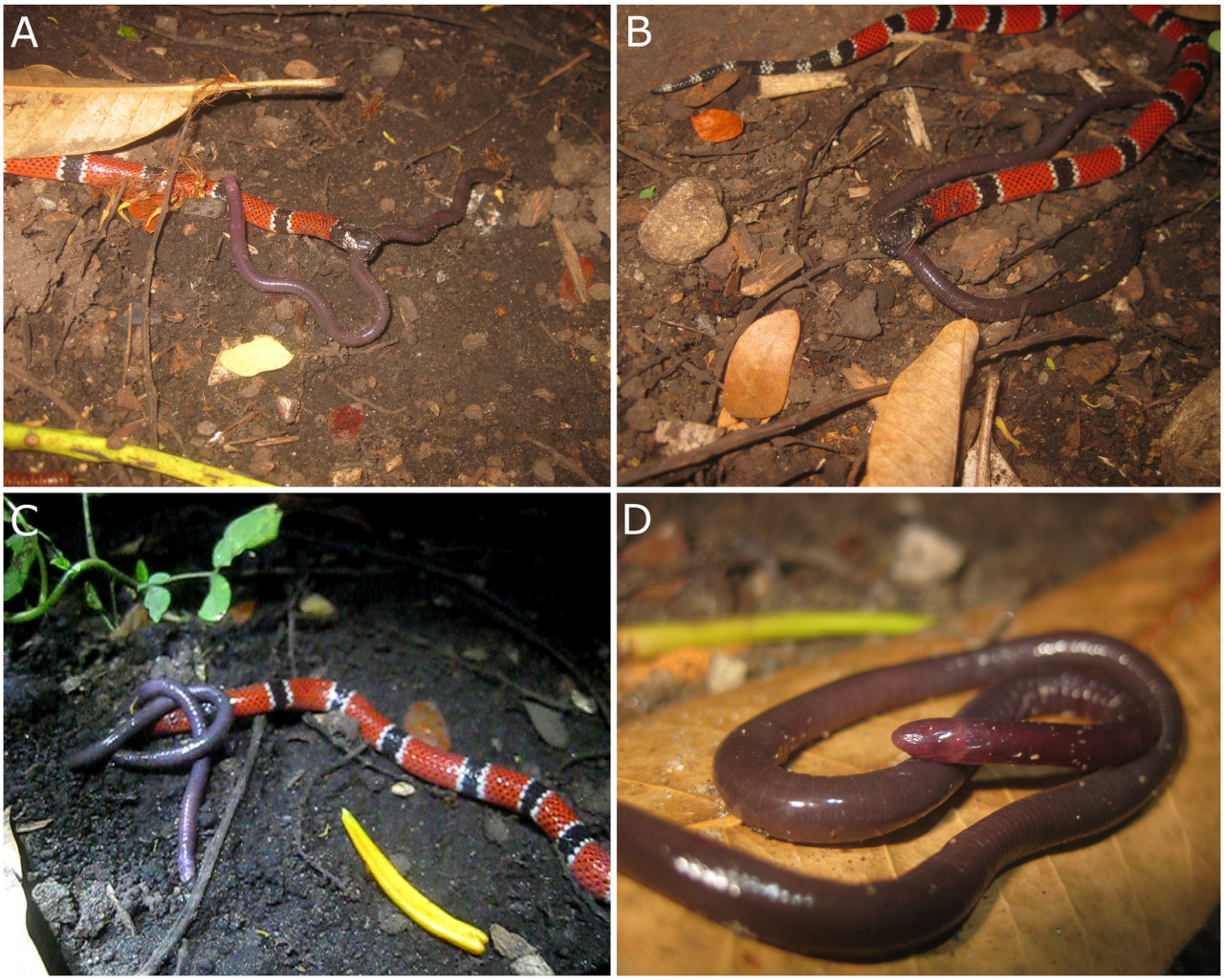

Figura 1. *M. dumerilii* depredando a *M. nicefori*. A-B) los primeros momentos del ataque, cuando la serpiente sacó a la cecilia del suelo; C) *M. nicefori* haciendo un nudo alrededor de la cabeza de la serpiente; D) vista general de *M. nicefori* tras haber sido envenenada.

Figure 1. *M. dumerilii* preying upon *M. nicefori*. A-B) the first moments of the attack, when the snake pulled the caecilian out of the ground; C) *M. nicefori* knotting itself around the head of the snake; D) overview of *M. nicefori* after envenoming.

al., 2018), and few cases have occurred in situ (Viana & Mello-Mendes, 2015; Ramos, 2017; Fernández-Roldán et al., 2021; this study).

The event that will be here discussed (Fig. 1) took place on April 24 2015 at 23:58h, in the Tolima University Farm (5.0032778, -74.9076666, 286 m.a.s.l.; Fig. 2). The exact locality is a nursery garden placed among several farming installations near a secondary forest used for wood supply in Guayabal, Armero, in the north zone of upper Magdalena Valley, Tolima department, Colombia. Initially, a *M. dumerilii* (snout-vent length 465 mm) was pulling out a *M. nicefori* (total body length 200 mm) from the ground. The caecilian had been bitten and strongly grabbed at mid-body by the coral snake (Figs. 1 A-B). Additionally, the snake's head was completely covered by a mucus substance (a glandular secretion by the caecilian). Subsequently, *M. nicefori* curled up and around itself forming a knot, and tried to move it towards the snake's head several times in an attempt to escape without success (Fig. 1C). *M. dumerilii* responded by spinning its body on its own axis repeatedly and did not release the caecilian. This event occurred for approximately two minutes before both animals were interrupted and separated by the researchers and brought to the field station. The caecilian died almost an hour later at 1:07h on April 25 of 2015 in the field station (Fig. 1D), afterwards the snake was euthanized and both animals were preserved. Lastly, the specimens were deposited at the Museum

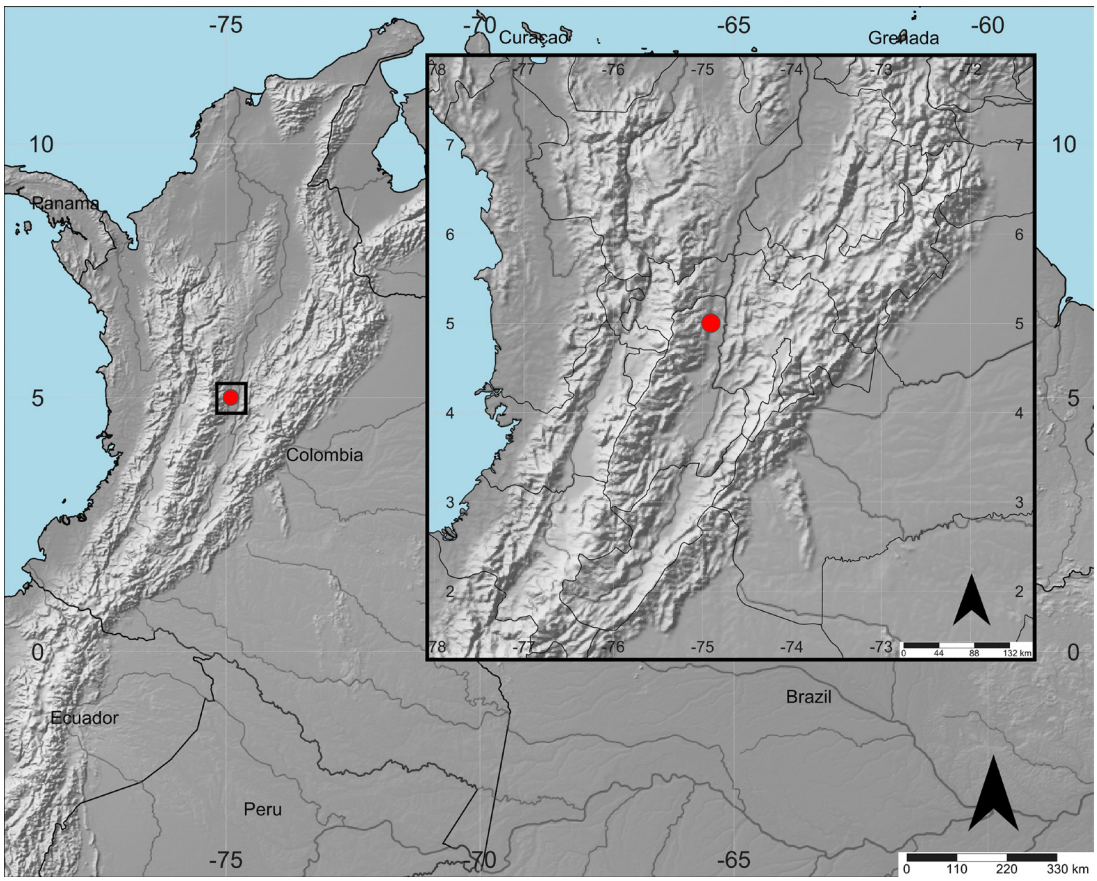

Figura 1. Mapa del noroccidente de Sur América mostrando el lugar donde ocurrió el evento de depredación (punto rojo); Guayabal, Armero, Tolima, Colombia.

Figure 1. Map of northwestern South America indicating the locality (red dot) where the event of predation took place; Guayabal, Armero, Tolima, Colombia.

of Natural History C.J. Marinkelle, Universidad de Los Andes, Bogotá, and cataloged as *M. nicefori* ANDES-A-3615 and *M. dumerilii* ANDES-R-959.

Usually, this kind of natural history observations focus on the behavior of the predator rather than on that of the prey (Ramos, 2017). However, a report by Viana & Mello-Mendes (2015) describes a predatory event of *M. lemniscatus* on *R. bivittatum*, which exhibited a defensive behavior similar to the one described here. In both cases the caecilians were bitten at mid-body by the coral snakes, and these responded to the attack by curling their bodies around that of their predators in an attempt to escape from their bite. It is important to highlight that 'caecilian body curling' has been reported to occur in two different ways: a spiral knot (i.e. *R. bivittatum*; Viana & Mello-Mendes, 2015), or a simple knot (i.e. *M. nicefori*) (Fig. 1C), similar to the defensive behavior reported in the snake *Trilepida jani* (Martins et al., 2018). We can confirm that the caecilian did not attempt to bite the coral snake, which could be an important defensive mechanism, given that caecilians have a powerful bite due to their well-developed dual jaw-closing mechanism and their many rows of long sharp teeth (Wake & Wurst, 1979; Greene, 1983; Nussbaum, 1983).

Recently, Jared et al. (2018a) and Mailho-Fontana et al., (2020) provided anatomical and chemical evidence that *Siphonops annulatus* (Mikan, 1822) - a member of the same family as *M. nicefori* (Siphonopidae) - has dental glands that secrete proteins associated with toxicity (Gelatinolyc, Caseinolyc, Fibrinogenolytic, Hyluronidase, Phospolipase A2). Additional poisonous glands have also been found on the terminus of *S. annulatus* by Jared et al. (2018b). Still, the presence of these glands in *M. nicefori* needs to be determined. Furthermore, the only other report of defensive behavior by a caecilian in the Neotropic (Viana & Mello-Mendes, 2015) did not show evidence of any defensive bite by the caecilian. We consider this strategy of secreting mucous substances as an anti-predatory behavior because these secretions were generated as a direct response to the bite of *M. dumerilii*; perhaps attempting to make itself slippery and escape from the grasp of its predator.

Tabla 1. Compendio de registros publicados de depredación de cecilias por serpientes en la región Neotropical.
Table 1. A compendium of published records of predation of caecilians by snakes in the Neotropic region.

Predator	Prey	Source
Anilius scytale	*Siphonops annulatus*	Greene, 1983
Anilius scytale	*Typhlonectes* sp.	Greene, 1983
Anilius scytale	*Caecilia gracilis*	Greene, 1983; Maschio et al., 2010
Anilius scytale	*Oscaecilia bassleri*	Villacampa & Witworth, 2016
Anilius scytale	*Microcaecilia unicolor*	Bittencourt-Silva & Wilkinson, 2018
Bothrops asper	*Dermophis parviceps*	Jones et al., 2014
Clelia clelia	*Siphonops* sp.	Jared et al., 2018b
Micrurus bocourti	*Unidentified caecilian*	Roze, 1996
Micrurus corallinus	*Chthonerpeton* aff. *braestrupi*	Gonzalez et al., 2018
Micrurus corallinus	*Siphonops* sp.	Marques & Sazima, 1997; Roze, 1996
Micrurus decoratus	*Siphonops* sp.	Marques, 2002
Micrurus diastema	*Gymnopis syntrema*	West et al., 2019
Micrurus dumerilii	*Caecilia thompsoni*	Herrera-Lopera et al., 2018
Micrurus dumerilii	*Microcaecilia nicefori*	This study
Micrurus ibiboboca	*Siphonops annulatus*	Roze, 1996
Micrurus latifasciatus	*Dermophis mexicanus*	Roze, 1996
Micrurus lemniscatus	*Rhinatrema bivittatum*	Viana & Mello-Mendes, 2015
Micrurus lemniscatus	*Microcaecilia* sp.	Martins & Oliveira, 1998
Micrurus lemniscatus	*Oscaecilia* sp.	Martins & Oliveira, 1998
Micrurus mipartitus	*Unidentified caecilian*	Roze, 1996
Micrurus mipartitus	*Caecilia occidentalis*	Vera-Pérez et al., 2019
Micrurus mipartitus	*Caecilia thompsoni*	Bernal & Palma, 2011
Micrurus mipartitus	*Oscaecilia polyzona*	Fernández-Roldán et al., 2021
Micrurus narduccii	*Oscaecilia* cf. *bassleri*	Ramos, 2017
Micrurus nigrocinctus	*Gymmopis multiplicata*	Campbell, 1998
Ninia sebae	Unidentified caecilian	Landy et al., 1966

Although *M. dumerilii* is a medically important species because of the compounds in its venom (Rey-Suárez et al., 2016), not much of its natural history is known aside from the fact that this species preys on caecilians (*C. thompsoni* and *M. nicefori*), fishes (*Synbranchus marmoratus* Bloch, 1795) and lizards (*Bachia* spp.) (Roze, 1996; Herrera-Lopera et al., 2018; this study). Our report provides a small contribution to the ecology and natural history of *M. dumerilii* by adding a new prey item to its diet, but perhaps even more importantly this record represents the first documented case of a defensive behavior ever made upon *M. nicefori*, given that no other natural history aspects or events had ever been documented for this endemic caecilian.

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