



First Record of Thanatosis in a Baja California Coachwhip, *Masticophis fuliginosus* (Cope 1895) (Squamata: Colubridae)

Leonardo Ponce-Rosales^{1,3}, Gabriel Suárez-Varón^{1,2,3}, Justin L. Rheubert⁴, and Oswaldo Hernández-Gallegos¹

¹Laboratorio de Herpetología, Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario #100 Centro, 5000 Toluca, Estado de México, México (lponce.biocienciasb@gmail.com)

²Laboratorio de Morfofisiología de la Reproducción, Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario #100 Centro, 5000 Toluca, Estado de México, México

³Red de Investigación y Divulgación de Anfibios y Reptiles MX, Toluca de Lerdo, Estado de México, México

⁴Department of Biology, University of Findlay, 1000 N. Main St., Findlay, Ohio, 45840, USA

Thanatosis or death-feigning is an anti-predator behavior used by various prey species when threatened or in response to physical contact with a potential predator (Humphreys and Ruxton 2018). This behavior is generally used as a “last resort” (Fuentes et al. 2021) when other actions fail (Bauder et al. 2015). Snakes engaging in this behavior can assess their surroundings through chemical and visual cues, allowing them to evaluate escape opportunities (Durso and Mullin 2013; Zañartu and Urra 2020). Thanatosis has been documented across various ophidian taxa, including but not limited to *Rena dulcis* (Leptotyphlopidae) (Gehlbach 1970), *Drymobius margaritiferus* (Colubridae) (Farr and Lazcano 2011), *Conopsis vittatus* (Dipsadidae) (Ahumada-Carrillo

2013), *Micrurus tener* (Elapidae) (Pineda 2013), *Thamnophis elegans* (Natricidae) (Gregory and Gregory 2006), *Crotalus cerastes* (Viperidae) (Thomas et al. 2020), and others (see Table 3 in Fuentes et al. 2021). Detailed studies of thanatosis often have focused on snakes in the genera *Heterodon* (Durso and Mullin 2013) and *Natrix* (Gregory 2008; Golubovic et al. 2021), using large samples and a pre-planned experimental design to statistically test the factors that influence this behavior.

The Baja California Coachwhip (*Masticophis fuliginosus*) is a peninsular snake distributed from southern California, USA, to Los Cabos in Baja California Sur, Mexico, except for the region east of the San Pedro Mártir Mountains and



Figure 1. Thanatosis in an adult Baja California Coachwhip (*Masticophis fuliginosus*) from Tecate, Baja California, México. Photograph by Leonardo Daniel Ponce Rosales.

north of Bahía San Felipe. This semi-arboreal species has two-color morphs, one with a yellow or light gray dorsum with a zigzag pattern of black bands along the body and broader dark brown bands on the neck, and the other with a dark grayish-brown coloration with a lateral linear pattern of variable length and varying amounts of cream coloration on the ventral scales (Wilson 1970). The varied diet of this species comprises lizards, small snakes, birds, and small mammals (Grismer 2002).

During a hike at 1025 h (ambient temperature 17.2 °C) on 4 May 2024 near Tecate, Baja California, México (32.51816, -116.60083; elev. 632 m asl.), we witnessed thanatosis in an adult *M. fuliginosus* (SVL ~1,000 mm, TL 250 mm) of indeterminate sex (Fig. 1). We followed the snake, which was encountered initially while crossing a dirt road dominated by chaparral vegetation, and followed it for ~10 m until it was cornered under a tree (*Quercus* sp.). We captured the snake to count scales and confirm its identity. During handling, it initially attempted to escape, but when grasped behind the head, it quickly relaxed and hung from the collector's hand in a "flaccid" state. It was placed on the ground and, while otherwise remaining completely still, moved its jaws posteriorly, spreading the quadrate bones and widening the back of the head to give it a triangular shape. Subsequently, the snake began to salivate. When turned over, it remained immobile (tonic immobility) for ~20 min. However, after being placed in a tree, it became active again and began to move slowly upward until it disappeared into the branches.

These observations contrast with those reported in other snakes, which exhibit death-feigning behavior immediately like *Heterodon*, whereas others engage in that behavior after several seconds of handling (Golubovic et al. 2021). For instance, in Banded Grass Snakes (*Natrix helvetica*), this behavior is triggered by handling, especially when the snake is held by the head (Gregory 2008), whereas Western Terrestrial Garter snakes (*Thamnophis elegans*) become immobile only after handling, with handling time influencing whether the snake attempts to flee immediately or remains immobile for a longer period (Gregory and Gregory 2006). Extrinsic factors, such as temperature, in combination with intrinsic factors, including sex and size, appear to affect the initiation and duration of thanatosis (Durso and Mullin 2013). During and after handling, while immobile, many snakes appear to monitor their environment and adjust the duration of tonic immobility until they can safely escape (Durso and Mullin 2013).

Unlike thanatosis, the ability of some non-venomous snakes to flatten or triangulate their heads is considered an active defense, as it serves as a visual signal that might deter a predator (Tozetti et al. 2009), functioning as a signal for predators to avoid the encounter, which has been tested with artificial clay models (simulating passive defense) dur-

ing which snakes with triangular heads were less frequently attacked (Dell'Aglio et al. 2012). Combinations of head triangulation and thanatosis with other characteristics such as aposematic patterns (or those that mimic venomous snakes) and secretion of musk appear to be particularly advantageous against predators that endeavor to avoid venomous snakes (Valkonen et al. 2011).

To the best of our knowledge, head triangulation during thanatosis has not been described in other snakes, suggesting that this combination might warrant further observational and quantitative studies. Although thanatosis has been recorded in Eastern Coachwhips (*M. flagellum flagellum*) (Tucker 1989; Pflanz and Powell 1990) and Western Coachwhips (*M. flagellum testaceus*) (Gehlbach 1970; Smith 1975), our observation appears to be the first record for *M. fuliginosus*. Future experimental and observational studies could help determine the frequency and ecological factors involved in triggering these defensive behaviors in *M. fuliginosus* and other species of snakes.

Acknowledgements

We thank the Consejo Nacional de Humanidades, Ciencia y Tecnología (CONAHCYT), for the postdoctoral scholarship awarded to GS-V (CVU: 693584) and the Red de Investigación y Divulgación de Anfibios y Reptiles MX (RIDARMX) for support during this field trip.

Literature Cited

- Ahumada-Carrillo, I.T. 2013. *Conopsis vittatus* (Striped Road Guarder). Defensive behavior/death feigning. *Herpetological Review* 44: 152.
- Bauder, J.M., J.N. Macey, K.M. Stohlgen, A. Day, F. Snow, A. Safer, R. Redmond, J.M. Waters, M. Wallace, and D.J. Stevenson. 2015. Factors influencing the display of multiple defensive behaviors in eastern indigo snakes (*Drymarchon couperi*). *Herpetological Conservation and Biology* 10: 559–571.
- Dell'Aglio, D.D., T.S.P. Toma, A.E. Muelbert, A. Sacco, and A.M. Tozetti. 2012. Head triangulation as anti-predatory mechanism in snakes. *Biota Neotropica* 12: 315–318. <http://dx.doi.org/10.1590/S1676-06032012000300031>.
- Durso, A.M. and S. Mullin. 2013. Intrinsic and extrinsic factors influence expression of defensive behavior in Plains Hog-Nosed Snakes (*Heterodon nasicus*). *Ethology* 120: 140–148. <https://doi.org/10.1111/eth.12188>.
- Farr, W.L. and D. Lazcano. 2011. *Drymobius margartitiferus* (Speckled Racer). Defensive behavior: thanatosis. *Herpetological Review* 42: 613.
- Fuentes, R., M. Castillo, E. Belton, E. Zambrano, H. Quintero, and A. Batista. 2021. Dead Snake! A Strategy for survival: thanatosis in some Panamerican snakes with a review of death-feigning in American snakes. *Reptiles & Amphibians* 28: 389–396. <https://doi.org/10.17161/randa.v28i3.15753>.
- Gehlbach, F.R. 1970. Death-feigning and erratic behavior in leptotyphlopoid, colubrid and elapid snakes. *Herpetologica* 26: 24–34.
- Golubović, A., M. Anđelković, L. Tomović, D. Arsovski, S. Gvozdenović, G. Sukalo, R. Ajtić, and X. Bonnet. 2021. Death-feigning propensity varies within dice snake populations but not with sex or colour morph. *Journal of Zoology* 314: 203–210. <https://doi.org/10.1111/jzo.12882>.
- Gregory, P.T. 2008. Bluffing and waiting: Handling effects and post-release immobility in a death-feigning snake (*Natrix natrix*). *Ethology* 114: 768–774. <https://doi.org/10.1111/j.1439-0310.2008.01524.x>.
- Gregory, P.T. and L.A. Gregory. 2006. Immobility and supination in garter snakes (*Thamnophis elegans*) following handling by human predators. *Journal of Comparative Psychology* 120: 262–268. <https://doi.org/10.1037/0735-7036.120.3.262>.

- Grismer, L.L. 2002. *Amphibians and Reptiles of Baja California, Including Its Pacific Islands and the Islands in the Sea of Cortés*. University of California Press, Berkeley, California, USA.
- Humphreys, R.K. and G.D. Ruxton. 2018. A review of thanatosis (death feigning) as an anti-predator behaviour. *Behavioral Ecology and Sociobiology* 72: 22. <https://doi.org/10.1007/s00265-017-2436-8>.
- Pflanz, D.J. and R. Powell. 1990. Death feigning by a coachwhip from Missouri. *Missouri Herpetological Association* 3: 12.
- Pineda, D. 2013. *Reptiles Venenosos de América*. Bilineata Publishing, Bogotá, Colombia.
- Smith, D.D. 1975. Death feigning by the Western Coachwhip Snake. *Herpetological Review* 6: 126.
- Thomas, S., M.L. Paulley, and G.W. Schuett. 2020. *Crotalus cerastes* (Sidewinder). Possible death-feigning. *Herpetological Review* 51: 139.
- Tozetti, A.M., R. Baptista de Oliveira, and G.M.F. Pontes. 2009. Defensive repertoire of *Xenodon dorbignyi* (Serpentes, Dipsadidae). *Biota Neotropica* 9: 157–163. <https://doi.org/10.1590/S1676-06032009000300016>.
- Tucker, M. 1989. *Masticophis flagellum* (Coachwhip). *Behavior. Herpetological Review* 20: 72.
- Valkonen, J., O. Nokelainen, and J. Mappes. 2011. Antipredatory function of head shape for vipers and their mimics. *PLoS ONE* 6: e22272. <https://doi.org/10.1371/journal.pone.0022272>.
- Wilson, L.D. 1970. The Coachwhip Snake, *Masticophis flagellum* (Shaw): Taxonomy and distribution. *Tulane Studies in Zoology and Botany* 16: 31–99.
- Zañartu, N. and F.A. Urra. 2020. Death-feigning behaviour (thanatosis) in Chilean green racer, *Philodryas chamissonis* (Wiegmann, 1835) (Serpentes: Dipsadidae). *Herpetology Notes* 13: 731–732.