



# Body-inversion in the Cuban Racer, *Cubophis cantherigerus cantherigerus* (Dipsadidae): Death-feigning or Warning Signal?

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Predation is among the main selective pressures that drive biological evolution (e.g., Futuyma 2013). Snakes are frequent prey of other vertebrates. To avoid predation, they have developed a wide variety of defensive behaviors (see Greene 1994 for a review). Anti-predation behaviors reported for West Indian colubroids include immobility, tail-waving, concealment, locomotor escape, anterior body-raising and dorsoventral cobra-like neck-flattening, gaping, strike-feigning, biting, balling, cloacal discharge, meal-disgorging, and rapid body rotation when captured (see Henderson and Powell 2009 for a review).

These anti-predation behaviors are relatively simple and generalized for most snakes (e.g., Mattison 1995), but a few species can display more complex patterns, including death-feigning. This is a state of external unresponsiveness to tactile stimulation, exhibited as a last-resort anti-predation tactic for an individual unable to evade capture by a predator (e.g., Greene 1994, Caro 2005, Gregory 2008). Death-feigning can include body-inversion, kinetic (or “erratic”) display, tonic immobility, limp-mouth gape, tongue-hanging, eye rotation, autohemorrhaging, cloacal discharge, and even bradycardia (e.g., *Heterodon platirhinos*; see Platt 1969, Gehlbach 1970, McDonald 1974). Body-inversion usually occurs in association with death-feigning (e.g., Platt 1969, Gehlbach 1970), but Greene (1994) considered them independent behaviors (although he emphasized that they frequently appear in combination). Consistent with the separation of both behaviors, a warning function has also been suggested for body-inversion, particularly for certain death-feigning colubroids with strikingly marked venters such as *Heterodon nasicus*, *Natrix natrix*, and *Diadophis punctatus* (Heusser and Schlumpf 1962).

Death-feigning has been widely documented in the families Colubridae, Dipsadidae, Natricidae, Elapidae, Leptotyphlopidae, and Tropidophiidae (for a review see Greene 1994). However, neither death-feigning *sensu lato* nor

body-inversion *sensu stricto* have ever been reported for any West Indian snakes. Herein we report body-inversion behavior in the Cuban Racer, *Cubophis cantherigerus cantherigerus* (Bibron 1840), from western Cuba, and discuss its possible relationship to death-feigning or warning signal.



**Fig. 1.** A Cuban Racer (*Cubophis c. cantherigerus*) from the Jardín Botánico Nacional de Cuba exhibiting a cobra-like defensive posture. Photograph by Nancy de la C. Llevat.





**Fig. 2.** The same Cuban Racer lowering its head in transition to an inverted posture. Photograph by Roberto Cruz.

On 6 January 2012, at 1500 h, we observed a Cuban Racer (ca. 120 cm total length) pursuing a Cuban Tree Frog (*Osteopilus septentrionalis*, Hylidae) in a bromeliad (*Tillandsia valenzuelana*) on a tree ca. 3.5 m above ground

level at the Jardín Botánico Nacional de Cuba (23°00'00"N, 82°20'50"W; Datum: NAD 27 for Cuba), Arroyo Naranjo, La Habana Province, Cuba. The frog jumped to the ground and the snake rapidly followed. Once on the ground, four photographers surrounded the snake. About two minutes after the photographers started their work, the snake adopted the cobra-like defensive posture typical of this species and other alsophiines (Fig. 1; see also Henderson and Powell 2009). Each time the snake attempted to escape it was intercepted by one of the photographers, but never touched. After eight minutes of continuous harassment the snake lowered its head (Fig. 2) and suddenly rolled on its back and adopted an inverted semicoiled posture, with the head bent slightly upward (Fig. 3). The snake remained inverted for less than one minute before reverting to the normal position and resuming the cobra-like defensive posture for about five more minutes, after which it was allowed to escape. The snake was not subjected to any additional disturbance during the time it remained inverted.

We consider this behavior as a particular case of death-feigning, less elaborate than the stereotyped behaviors observed in continental species of the genera *Heterodon*, *Masticophis*, *Diadophis*, and *Natrix* (e.g., Platt 1969, Gehlbach 1970,



**Fig. 3.** The same snake in an inverted position. Photograph by Raimundo López-Silvero.

Greene 1994). The individual described herein did not gape, extend its tongue, or discharge its scent glands, and it rapidly reverted to a normal posture. However, we cannot identify an apparent advantage other than those related to death-feigning. Removal of cues (e.g., movement) that elicit prey-killing behavior in a potential vertebrate predator seems reason enough to adopt death-feigning, since it might provide an animal with subsequent opportunities for escape (Alcock 1975, Gregory 2008). The anti-predation function of death-feigning may lie in direct interference with the predator's ability to consume the prey (Honma et al. 2006). However, it may also depend on the predator not immediately consuming immobile prey, thereby giving the potential prey a window of opportunity to escape if the predator is even momentarily inattentive or distracted (Gregory 2008).

An alternative explanation for this behavior is as a warning signal, but this individual lacked aposematic coloration on its ventral region (which is the rule for its conspecifics, but see below). An inverted position could be assumed by the Cuban Racer after prolonged harassment without direct aggression, and as a last-resort tactic after failure of other anti-predation mechanisms (e.g., locomotor escape or the cobra-like posture). Death-feigning in other species (e.g., *H. platirhinos* and *Naja haje*) also comes at the end of a repertoire of other defensive behaviors, including intimidation and odor production (Mattison 1995).

Despite the lack of aposematic coloration in the individual described above, Schwartz and Henderson (1991) mentioned one pattern of *C. cantherigerus* that includes posterior ventral scales "sometimes entirely red, usually dark with more or less bold, red or yellow blotching." The senior author has observed individuals of *C. c. cantherigerus* and *C. c. schwartzi* with posterior black and red ventral markings. Some individuals of *C. c. pepei* from eastern Cuba possess blue throats and bicolored bellies (Schwartz and Thomas 1960). Some specimens from the Península de Guanahacabibes have ventral scales with yellow ventral markings (J. Torres, pers. obs.).

Furthermore, *C. cantherigerus* is known to have Duvernoy's glands and a venomous bite (Neill 1954, Jaume and Garrido 1980), which support the idea that striking ven-

tral coloration and body-inversion could serve as a warning signal. However, additional observations are required to corroborate body-inversion in this species and to elucidate triggering factors and function.

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