Some amphibian species when handled in the wild present defense mechanisms, such as the behavior of shrinking themselves and lying motionless, pretending to be dead and presenting full tonic immobility, or thanatosis (Duellman and Trueb, 1994; Toledo et al., 2011). These mechanisms, which evolved through increased survival rate, may be displayed together with other related antipredation strategies, such as cryptic coloration when torpid or possessing aposematic coloration in the hidden part of the members associated with skin toxicity (Prates and Bloch Jr., 2000; Bernarde and Santos, 2009). Such mechanisms may also be morphological, behavioral or biochemical, and are divided into primary, which act independently of the presence of a predator (poison, aposematic coloration and camouflage), or secondary, which are mechanisms used by the animal in the presence of predators (e.g. escaping, biting, contracting behavior, thanatosis) (Stebbins and Cohen, 1995; Hödl and Amezquita, 2001; Borteiro et al., 2014). Both mechanisms, primary and secondary, can be used simultaneously in the defense processes (Guerrero et al., 2010).

The behavior known as thanatosis has arisen in parallel in several invertebrate (Barreto and Anjos, 2002) and vertebrate taxa, including marsupials (Franq, 1969), lizards (Machado et al., 2007) and especially in anuran amphibians (Toledo and Haddad, 2009; Toledo et al., 2011). Probably this behavior has evolved as a result of their slow manner of moving, which is apparently not very effective to evade predators; however, there is still not enough data to confirm this (Sazima, 1974; Duellman and Trueb, 1994).

The deimatic behavior observed in amphibians consists of a secondary defense mechanism related to reduced risk of predation. It may involve an apparent increase in size, display of aposematic coloration or the illusion of similarity to another animal, as strategies to confuse a possible predator (Robinson, 1969; Toledo and Haddad, 2009).

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reaches a larger size than *O. carvalhoi*, occurring in the states of Goiás and Minas Gerais to Rio Grande do Sul, as well as Paraguay and Argentina, generally occurring in areas of leaf-litter in the countryside and in forest borders with different levels of conservation, associated with streams or lentic water bodies (Frost, 2015).

During a NUROF-UFC (Núcleo Regional de Ofiologia da Universidade Federal do Ceará) research project, in which the goals included monitoring the population of the threatened anuran *Adelophryne baturitensis* in Baturitê (4°05’-4°40’S, and 38°30’-39°10’W), monthly field trips to the regions of Baturitê, Guaramiranga and Pacoti (Ceará) were carried out and pitfall traps were deployed. Fieldwork was conducted from August 2004 to January 2006.

Another study was performed as part of the environmental licensing of a hydroelectric Queimado’s Power Plant (16°12’S, and 47°19’W), located at Preto River, São Francisco River Basin, covering the municipalities of Unai and Cabceira Grande (Minas Gerais), Cristalina and Formosa (Goiás), and the Paranoá Administrative Area (Federal District). The activities were related to animal rescue programs during the filling-up of the plant reservoir, during the period of June 2003 to March 2004, and subsequently in the monitoring phase in the post-filling of the lake, occurred between October 2006 and March 2007.

In both field surveys, the individuals were analyzed and then euthanized and fixed following appropriate procedures, identified and deposited respectively in the Coleção de Herpetologia da Universidade Federal do Ceará (CHUFC A3738, SVL = 570 mm; CHUFC A3739, SVL = 530 mm) (Figure 1) and in the Museu de Ciências Naturais da PUC Minas (MCNAM 8923) (Figure 2). Taxonomic assignments were performed by Dr. Ulisses Caramaschi (MNRJ) and Dr. Luciana Barreto Nascimento (PUC Minas).

Two *O. carvalhoi* captured on 4 and 5 March 2005 in pitfall traps applied in the Sítio Guaramiranga (Municipality Guaramiranga) (04°16’02,6” S, and 38°55’59,4” W, Height = ± 930 m) displayed death feigning. The specimens, when removed from the traps and transported in plastic bags, inflated the body as defensive behavior. Similar behavior was observed by Bezerra et al. (2010) in specimens of this population. However, later in the lab, these two specimens, while handled for photographic records, showed the following defensive behaviors: again they inflated the body, rose up on all four limbs, and then flipped belly-up, with the limbs contracted remaining in thanatosis for about 20 seconds (Figure 1). Soon after, the specimens returned to activity, turning themselves into the normal position.

![Figure 1. *Odontophrynus carvalhoi* (CHUFC A 3739); thanatosis behavior. (Photographed by Diva M. Borges-Nojosa)](image)

![Figure 2. *Odontophrynus cultripes* (MCNAM 8923); thanatosis behavior. (Photographed by Ronald R. Carvalho Jr.)](image)
The same behavior was displayed about 3-4 times by each of the two individuals, when manipulated.

A similar behavior was observed in individuals of *O. cultripes* captured in Cabeceira Grande (Minas Gerais). In 2003, it was possible to document the thanatosis of an adult. When handled to take morphological measurements, the specimen inflated its body showing great dilation of its lateral portion, remaining motionless for a few seconds. When handling continued, the next response was to put itself belly-up, exposing the tainted aspect of the entire ventral region. Members remained contracted and kept in the thoracic anatomic position. After a few seconds, the animal turned and stood still for short a period.

This behavior was also observed in a similar way in another adult (MCNAM 8923; SVL = 59.20 mm) (Figure 2) from the same location, along with other specimens caught in pitfall traps from the hydroelectric Queimado ‘s Power Plant, in 2006. Some records were also observed during handling of the samples to take photographs. However, the specimen, when subjected to persistent disturbance, presented an accessory defense mechanism: its body was inflated with the animal in natural position, remaining static for a few seconds; later, a dorsolateral flattening while body inflation was maintained. Soon after this act, the specimen flipped itself, presenting the still inflated posterior region of the body, bent its head close to the ground and lifted the hind limbs, exposing the entire posterior face, and remained like this for a few seconds, characterizing deimatic behavior (Figure 3). This clearly displays two circular patches of highlighted dark brown in a differential tone when compared to the rest of the body surface, located laterally to the cloacal opening, as well as a clear disruptive line perpendicular to the base of the coccyx. The animal maintained this position for several minutes extending and contracting the hind limbs, until it reaches a limit when it tries to escape and to search for shelter. The perceived effect may be an attempt to confuse the predator by simulating the face of another larger animal, what may cause intimidation. There were no outstanding inguinal glands and no apparent formation of toxin accumulation in either analyzed samples.

The defense strategy known as thanatosis has been reported for several species of frogs from different families, such as Hylidae, including the species *Phyllomedusa burmeisteri* (Lutz and Lutz, 1939; Haddad and Sazima, 1992), *P. iheringii* (Langone et al., 1985), *P. nordestina* (Santos et al., 2003), *P. rohdei* (Sazima, 1974), *Phasmahyla guttata* (Lutz and Lutz, 1939) and *Aparasphenodon brunoi* (Teixeira et al., 2002); Bufonidae, such as *Melanophryniscus moreiraes* (Almeida-Santos et al., 2010), *Rhinella cf. crucifer* (Toledo, 2004) and *O. ocellata* (Kokubum, 2005); Microhyliidae, such as *Elachistocleis cf. ovalis* (Kokubum and Menin, 2002), *E. erythrogaster* (Kwet and Solé, 2002), *E. piauiensis* (Borges-Leite et al., 2012) and *Stereocyclops incrassatus* (Guerrero et al., 2010); Cyclorampphidae, such as *Zachaenus carvalhoi* (Moura et al., 2010); and Odontophrynidae with *Proceratophrys boiei* (Toledo and Zina, 2004). Together with Bezerra et al (2010) our records for *O. carvalhoi* and *O. cultripes* extend the occurrence of thanatosis behavior to the genus *Odontophrynus*.

Deimatic behavior, in which an individual seeks to intimidate or startle a predator through a series of actions and attitudes (Hödl and Amezquita, 2001), has been reported in the literature for Leptodactylidae, including the species *Physalaemus deimaticus*, and *P. nattereri* (Sazima and Caramaschi, 1986; Lenzi-Mattos et al, 2005), as well as *Leptodactylus labyrinthisus*, *L. pentadactylus*, *L. mystacinus* (Carvalho-Júnior, 2005; Lima et al., 2006; Toledo and Haddad, 2009), and *Pleurodema brachyops* (Martins, 1989), with some recent records for other families, such as the bufonid *Melanophryniscus cambaraensis* (Sebben, 2015) and the dendrobatid *Ameerega flavopicta* (Toledo et al., 2004). The report here extends the occurrence of deimatic behavior to Odontophrynidae and reaffirms the need for further investigations to obtain more precise information about the occurrence and evolution of this behavior among anurans.
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References


Defensive behaviors in two species of *Odontophrynus*


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