Death simulation behavior of the lizard *Lygodactylus klugei* of the Gekkonidae (Reptilia: Squamata) family in northeastern Brazil

Comportamento de simulação de morte no lagarto *Lygodactylus klugei*, da família Gekkonidae (Reptilia: Squamata), no Nordeste do Brasil

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Abstract: Natural selection favors primary defense strategies that reduce the chance of prey being spotted and discovered by a potential predator, such as camouflage, aposematism, and secondary defense strategies that include tail loss and escape, immobility, and thanatosis. The behavior of thanatosis (playing dead) or tonic immobility (body paralysis) is a strategy adopted by the prey, in which the animal simulates immobility to avoid being ingested. This simulation is effective against visually oriented predators or predators that do not feed on dead prey. Belonging to a complex of cryptic species, *Lygodactylus klugei* is a gecko that has a wide distribution in Northeast Brazil, occupying areas of the Caatinga and Cerrado, and that has a diurnal habit. On August 25th and September 2nd, 2021, three individuals of *L. klugei* were observed exhibiting thanatosis behavior during plant suppression work in the Curaçá municipality, Bahia state, Brazil. This behavior is reported for the first time for *L. klugei*, and the species may use it if it is unable to escape from visually oriented predators. However, we suggest that future observations may generate new hypotheses about the benefits of this behavior in the species. Our observation adds important data to the behavioral repertoire of lizards from the Gekkonidae family, providing important natural history data to try to understand the defense mechanisms adopted by lizards in general.

Keywords: Defense strategies. Natural selection. Predation. Reptiles. Thanatosis.

Resumo: A seleção natural favorece estratégias primárias de defesa que diminuem a chance de a presa ser avistada e descoberta por um potencial predador, tais como camuflagem, aposematismo e estratégias de defesa secundárias, que incluem perda da cauda, fuga, imobilidade e tanatose. O comportamento de tanatose (fingir-se de morto) ou imobilidade tônica (paralisação corporal) é uma estratégia adotada pela presa na qual o animal simula imobilidade para evitar ser ingerido. Esta simulação é eficaz contra predadores visualmente orientados ou que não se alimentam de presas mortas. *Lygodactylus klugei* possui ampla distribuição no Nordeste do Brasil, ocupando áreas de Caatinga e Cerrado, tendo hábito diurno. Em 25 de agosto e 02 de setembro de 2021, três indivíduos de *L. klugei* foram observados em comportamento de tanatose, no município de Curaçá, Bahia, Brasil. Tal comportamento é relatado pela primeira vez para a espécie, sugerindo que pode ser utilizado em caso de impossibilidade de fuga frente a predadores visualmente orientados. Entretanto, sugerimos que observações futuras possam gerar novas hipóteses acerca dos benefícios deste comportamento na espécie. Nossa observação acrescenta dados importantes ao repertório comportamental de lagartos da família Gekkonidae, fornecendo informações sobre a história natural para tentar entender os mecanismos de defesa adotados pelos lagartos em geral.

Palavras-chave: Estratégias de defesa. Seleção natural. Predação. Répteis. Tanatose.

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Lizards are part of the diet of several animal groups (Rocha, 1994), such as spiders, snakes, birds and mammals (*e.g.* Shine, 1991; Poulin et al., 2001; Gurgel & Quintas-Filho, 2014; Oliveira et al., 2017; Webster et al., 2018).

Generally, when they are at high risk, prey shapes the use of their microhabitats, reducing predation rates. These inductions caused by predators can result in reduced growth and fecundity rates, since, when they detect the potential danger, heliothermic the lizards often pause foraging or warming up and seek out environments that offer more protection (Rocha, 1994; Downes, 2001). Natural selection can also favor primary defense strategies that decrease the chance of prey being spotted and discovered, such as camouflage (Rautenberg & Laps, 2010; Souza et al., 2020), aposematism (Tseng et al., 2014; Lee et al., 2018), and secondary strategies that can reduce the chances of these animals being predated, such as escape and tail loss, immobility, and thanatosis (Greene, 1988; Autumn & Han, 1989; Downes, 2001).

Thanatosis behavior (playing dead) or tonic immobility (body paralysis) is a strategy adopted by prey, in which the animal simulates immobility to avoid being ingested (Michelan et al., 2006; Santos et al., 2010). This simulation is effective against predators that do not feed on dead prey or need to visualize movements to find the food (Toledo et al., 2011). In response to external stimuli, thanatosis is described for several families of lizards, such as Dibamidae (Torres-Cervantes et al., 2004), Gekkonidae (Anaissi et al., 2020), Gymnophthalmidae (Muscat et al., 2016; Machado-Filho et al., 2018), Liolaemidae (Rocha, 1993; Santos et al., 2010), Mabuyidae (Anaissi et al., 2020), Scincidae (Langkilde et al., 2003; Patel et al., 2016), Sphaerodactylidae (Anaissi et al., 2020), and Tropiduridae (Galdino & Pereira, 2002; Gomes et al., 2004; Kosldorf et al., 2004; Bertoluci et al., 2006).

Gekkonidae is a family composed by small lizards, that have adhesive lamellae on their fingerips, which aid in displacement, and are inhabitants of trunks, trees and bromeliads, and have oviparous reproduction (Rocha, 1994). According to Lanna et al. (2020), *Lygodactylus klugei* (Smith, Martin & Swain, 1977) comprises a complex of cryptic species with a diurnal habit and wide distribution in the Caatinga and Cerrado biomes in northeastern Brazil (Teixeira et al., 2013; Mesquita et al., 2017; Lanna et al., 2020).

On August 25, 2021 and September 2, 2021, respectively two and one individuals of *L. klugei*, respectively, were observed during vegetation suppression work in the Curaçá municipality, Bahia state, Brazil (9° 02' 22.5" S, 39° 55' 00.7" W). When manipulated, the first and third individuals turned their belly up, putting themselves in a simulated death posture for about two minutes, keeping their eyes open, while the second specimen turned on its side and left its mouth open for approximately one minute (Figure 1).

The same behavior was observed twice more for each individual, for about a minute each time, which only returned to its normal position when placed on tree branches. The specimens were rescued from the vegetation suppression area and released in a legal reserve area with Caatinga physiognomy close to the environment in which they lived.

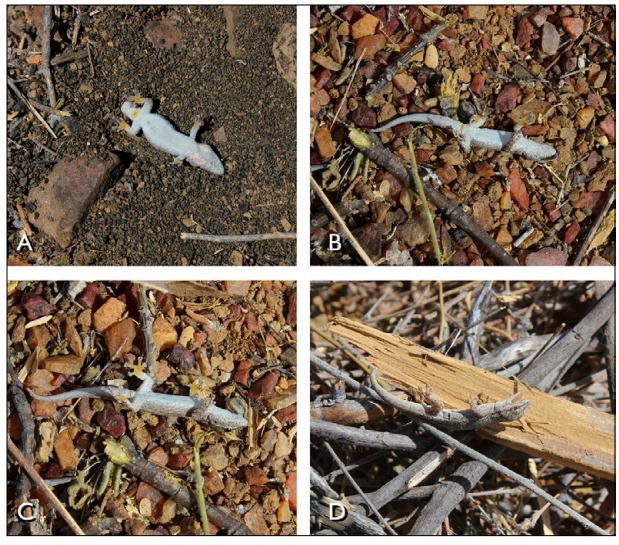

Figure 1. Thanatosis behavior in the lizard *Lygodactylus klugei*, during plant suppression work in the Curaçá municipality, Bahia state, Brazil. Legend: records of the 1st (A) and 2nd (B) specimens in ventral view; and of the 2nd (C) and 3rd (D) specimens in lateral view. Photos: Silvilene Matias (2021).

All the specimens were adults, but it was only possible to identify the sex of the first and third individuals, both females.

In Gekkonidae, the first record of thanatosis was recorded for *Hemidactylus mabouia* (Moreau De Jonnès, 1818) (Anaissi et al., 2020), this being the second observation for the family. This behavior is not primary defense, and occurs after individuals are stimulated or disturbed, as observed in our data collection and literature (Table 1). This practice of pretending dead in *L. klugei* is reported for the first time, and the species may use it when thying to escape from faults, which may confuse possible visually oriented predators. However, we suggest that additional observations of this behavior may generate new hypotheses that could explain and help understand the benefits of the thanatosis or tonic immobility.

Our observation adds important data to the behavioral repertoire of lizards in the Gekkonidae family and, in addition, provides natural history data that are important for trying to understand the defense mechanisms adopted by lizards in general.

Table 1. Thanatosis or tonic immobility behaviors with a brief description of the behavior in some families and species of lizards in the world.

Behavior	Brief description	Family (species)	References
Death feigning, autotomy	When handled, the lizard specie exhibited death simulation behavior and caudal autotomy.	Dibamidae: *Anelytropsis papillosus* (Cope, 1885)	Torres-Cervantes et al. (2004)
Death-feigning	All records of death-feigning behavior observed, occurred after the specimens had been stimulated.	Gymnophthalmidae: *Placosoma glabellum* (Peters, 1870); *Iphisa elegans* (Gray, 1851)	Muscat et al. (2016); Machado-Filho et al. (2018)
Death-feigning	All records of death-feigning behavior observed, occurred after the specimens had been stimulated.	Liolaemidae: *Liolaemus lutzae* (Mertens, 1938); *Liolaemus occipitalis* (Boulenger, 1885)	Rocha (1993); Santos et al. (2010)
Death-feigning	All records of death-feigning behavior observed, occurred after the specimens had been stimulated.	Scincidae: *Carlia jarnoldae* (Covacevich & Ingram, 1975); *Lygosoma guentheri* (Peters, 1879); *Lygosoma punctata* (Linnaeus, 1758); *Copeoglossum nigropunctatum* (Spix, 1825)	Langkilde et al. (2003); Patel et al. (2016); Anaissi et al. (2020)
Death-feigning	Upon capture, the lizards became immobile, remaining motionless during the handling interval (about 30 s). The death-feigning posture persisted even after the animals were gently placed upside down on the ground. Between 1-2 min, they recovered and fled rapidly.	Tropiduridae: *Tropidurus nanuzae* (Rodrigues, 1981); *Eurolophosaurus divaricatus* (Rodrigues, 1986) (two records); *Tropidurus torquatus* (Wied-Neuwied, 1820)	Galdino and Pereira (2002); Gomes et al. (2004); Kosldorf et al. (2004); Bertoluci et al. (2006)
Tail display, death-feigning	When handled, the lizard specie exhibited alternately tail display and death-feigning.	Gekkonidae: *Hemidactylus mabouia* (Moreau de Jonnès, 1818)	Anaissi et al. (2020)
Tail display, death-feigning	When handled, the lizard specie exhibited alternately tail display and death-feigning.	Sphaerodactylida: *Gonatodes humeralis* (Guichenot, 1855)	Anaissi et al. (2020)
Tail display	When handled, the lizard specie exhibited tail display.	Dactyloidae: *Norops ortonii* (Cope, 1868)	Anaissi et al. (2020)

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AUTHORS' CONTRIBUTION

C. S. L. Matias contributed to visualization, investigation, and writing (original draft, proofreading and editing); D. S. Araújo to formal analysis, methodology, and writing (proofreading and editing); and D. P. Castro to supervision, investigation, and writing (proofreading and editing).