

Defensive behavior in *Leptodactylus vastus* A. LUTZ, 1930, in northeastern Brazil

The entire defensive repertoire of a species or a population typically evolves due to strong selective pressure exerted by their natural predators (GREENE 1997; VAMOSI 2005). The most common defensive strategies of mobile animals are either to remain motionless or to try to escape from potential predators. However, a variety of defensive strategies can be used depending on the risk posed by the predator (TOLEDO et al. 2011).

Anurans exhibit a variety of defensive behaviors (DODD 1976; WILLIAMS et al. 2000; TOLEDO et al. 2005, 2010, 2011), including combinations of ecological, morphological, physiological, or behavioral characteristics (DUELLMAN & TRUEB 1994; TOLEDO & JARED 1995), and this flexibility may improve their chances of survival (MARCHISIN & ANDERSON 1978).

The skin of amphibians plays an important role in defense against predators and microorganisms possessing dermal mucous and granular glands responsible for the secretion of mucus and toxins, respectively (STEBBINS & COHEN 1995; TOLEDO & JARED 1995; BARBOSA et al. 2015). A great variety of chemical compounds can be found in the secretion of granular glands. In many species these glands form aggregates, or macroglands (TOLEDO & JARED 1995), which are strategically placed on the body surface. In frogs of the family Leptodactylidae, macroglands are present on the skin of the dorsum (TOLEDO & JARED 1995) and usually exhibit bright colors that are exposed during deimatic behavior.

This is a report on three observations of defensive behaviour exhibited by *Leptodactylus vastus* A. LUTZ, 1930, recorded in an area of the type “Brejo de Altitude”, in northeastern Brazil.

Leptodactylus vastus is a leaf-litter frog of the *L. pentadactylus* group (LAURENTI, 1768), and like other members of this group it is large, reaching about 20 cm snout-vent length (SVL) (HEYER 2005; DE SÁ et al. 2014). This species is often found near water bodies in areas with typical Atlantic



Fig. 1: *Leptodactylus vastus* A. LUTZ, 1930, performing thanatosis. Photo by D. P. Castro.

Forest and Caatinga phytophysiognomies (FROST 2015). It is widely distributed in the Brazilian state of Ceará, occurring in areas of Caatinga (BORGES-NOJOSA et al. 2010; SANTANA et al. 2015), coastal regions (BORGES-LEITE et al. 2014) and “Brejos de Altitude” (BORGES-NOJOSA 2007; LOEBMANN & HADDAD 2010; RIBEIRO et al. 2012).

On April 14, 2015, working in a project on beta diversity of litter amphibians in Ubajara National Park (PARNA-Ubajara), Ceará (03°50'24.9" S / 040°54'41.6" W), the authors observed an individual of *L. vastus* performing three types of defensive behavior when it was manipulated for taking photographs and body measurements in the laboratory.

The first behavioral strategy was thanatosis (death feigning) by exposing its abdomen and retracting the front feet close to the body (Fig. 1). This behavior lasted

about seven minutes, after which the individual returned to a normal body position. After thanatosis, the specimen performed partial body-raising (TOLEDO et al. 2011), stretching its legs and lifting the body from the ground while keeping its snout in contact with the substrate. The individual remained motionless in this position for about five minutes, while the reddish color in its inguinal region was exposed (Figs. 2 and 3). Immediately after the specimen exhibited this posture, the manipulators began to feel their eyes and noses become irritated.

Thanatosis is often displayed by amphibians (GALLY et al. 2014), and has been reported for multiple families, including Bufonidae (ZAMPROGNO et al. 1998), Cycloramphidae (HARTMANN et al. 2003), Hylidae (AZEVEDO-RAMOS 1995), Microhylidae (BORGES-LEITE et al. 2012) and Odontophrynidae (BEZERRA et al. 2010; BORGES-NOJOSA et al. 2016). Remaining motionless can help avoid predators that are visually oriented or divert predator attention (MIYATAKE et al. 2009; TOLEDO et al. 2010). Records of thanatosis among leptodactylid frogs are common (TOLEDO et al. 2005) and have been recorded for *Leptodactylus chaquensis* CEI, 1950 (LOURENÇO-DE-MORAES et al. 2014), *Leptodactylus fuscus* (SCHNEIDER, 1799) (TOLEDO et al. 2010) and *Leptodactylus mystacinus* (BURMEISTER, 1861) (TOLEDO et al. 2010). Among the species of the *L. pentadactylus* group, only *L. labyrinthicus* (SPIX, 1824) has been reported to perform thanatosis (TOLEDO et al. 2005). However, to our knowledge, there are no previous reports of thanatosis behavior for *L. vastus* in the literature.

The behavior of body-raising is cited by TOLEDO et al. (2011), as one of 30 defensive behaviors performed by amphibians. This behavior is usually exhibited by toxic species, and can be displayed in two different modes: (1) partial, when the individual stretches the legs vertically and maintains the snout close to or touching the ground and (2) full, when the individual extends both anterior and posterior limbs and raises its belly and snout (TOLEDO et al. 2011).

This behavior is reported for the families Aromobatidae (TOLEDO et al. 2011) and Bufonidae (ESCOBAR-LASSO & GONZÁLEZ-



Fig. 2: *Leptodactylus vastus* A. LUTZ, 1930, performing partial "body-raising", keeping its snout touching the substrate while the hind legs remain extended. Photo by D. P. Castro.



Fig. 3: Behavior of "body-raising" in *Leptodactylus vastus* A. LUTZ, 1930, showing how the individual exposes the reddish regions of the inguinal region while releasing noxious substances that irritate the mucous membranes of potential predators. Photo by D. P. Castro.

DURAN 2012), and is probably used to make subjugation more difficult when the individual is captured (TOLEDO et al. 2011) and seems to be closely associated with the presence of noxious or odoriferous skin secretions (HÖDL & AMÉZQUITA 2001).

The production of secretions which is also considered a method of defense for amphibians (TOLEDO et al. 2011) is described in Leptodactylidae (HADDAD et al. 2013), such as the species group of *Leptodactylus latrans* (STEFFEN, 1815), the latter producing noxious secretions that leave the skin slippery (LOURENÇO-DE-MORAES et al. 2014). Members of the *L. pentadactylus* group, including *L. vastus*, also produce and secrete toxic substances from the skin (HADDAD et al. 2013). These substances can cause sensations of severe burning when in contact with the mouth, eyes or nostrils (TOLEDO et al. 2011; HADDAD et al. 2013), which is probably why frogs of this group are referred to as “pepper-frogs”.

Combining different defensive strategies can increase the chances of escape from a predators’ attack (TOLEDO et al. 2011). According to TOLEDO et al. (2005), species within a group of closely related amphibian species can exhibit similar defensive strategies, which is a result of phylogenetic relationships rather than ecological niches. However, lack of knowledge of anti-predator behavior in different families of amphibians limits meta-analyses regarding defensive strategies (LOURENÇO-DE-MORAES et al. 2014).

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Artikel/Article: [Defensive behavior in *Leptodactylus vastus* A. LUTZ, 1930, in northeastern Brazil 214-218](#)