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MORE THAN ONE PATH TO SUCESS: AN ALTERNATIVE STRATEGY FOR *PHYSALAEMUS ATLANTICUS* (AMPHIBIA; LEPTODACTYLIDAE) LARVAL DEVELOPMENT.

Rafael Mitsuo Tanaka, Mariana Pedrozo, Edelcio Muscat*

Projeto Dacnis, Estrada do Rio Escuro, 4754, Sertão das Cotias, 11680-000, Ubatuba, SP, Brazil.
Corresponding author: *edelciomuscat@terra.com.br*

The order Anura currently comprises 39 described reproductive modes, of which 27 are found in the Atlantic Forest (Haddad & Prado 2005). However, little is known about some basic aspects of reproductive biology (Hartmann *et al.* 2010). For instance, data about the duration of larval development and the influence of environmental parameters in this process remain scarce (Hartmann *et al.* 2010). Herein we describe our observations on larval development and a new reproductive mode for the Atlantic Forest endemic species *Physalaemus atlanticus* Haddad & Sazima, 2004.

Physalaemus atlanticus is a small frog whose type locality is Núcleo Picinguaba, municipality of Ubatuba, São Paulo state, Brazil (Haddad & Sazima, 2004). This species is part of the *P. signifier* species group (Haddad & Sazima, 2004) and is listed as vulnerable, according to IUCN Red list criteria (Cox and Stuart, 2004). The species can be distinguished from other *Physalaemus* species by its morphological features, such as a smooth to slightly rugose dorsal skin texture and orange belly in life, and also by its advertisement call, with a duration of 0.6–0.84 s and a frequency between 0.9–1.8 kHz. *Physalaemus atlanticus* lays its eggs on a foam nest either in leaf litter or in small temporary puddles (Hartmann *et al.* 2010), defined by Haddad & Prado (2005) as mode 28 and 11, respectively.

The study took place in the municipality of Ubatuba (-23.4620, -45.1453; WGS 84; 14m asl), São Paulo state, Brazil. The study area encompasses 161.3 ha and is a private reserve belonging to

Projeto Dacnis (PD), a non-profit organization. The mean annual precipitation varies from 2000mm to 2500mm. The hot and wet season runs from the end of November to March.

Physalaemus atlanticus is the only species of the genus that occurs in the PD reserve and uses a foam nest as reproductive strategy. We confirmed our identification based on the morphological characteristics of adults found in the spawning area (Fig. 1), by the advertisement call, and by the imagoes observed.

We monitored the area daily between October 2014 and January 2015, and recorded the stages in the development of the tadpoles. For the description of anuran embryos and larvae development stages, we followed Gosner (1960). We collected some environmental data, including water pH (using the Macherey-Nagel system) and water temperature (Thermofocus model 01500/A3).

Advertisement calls were recorded using a Zoom H2n Handy recorder. We deposited the recording at Fonoteca Neotropical Jacques Vielliard (FNJV), Museu de Zoologia "Prof. Adão José Cardoso", Universidade Estadual de Campinas (Unicamp), Campinas, Brazil (FNJV-45024).

On 3 November 2014, we found a *P. atlanticus* foam nest in a water-filled bract of the palm *Syagrus botryophora* on the forest floor (Fig. 2A and 2B). On 25 November 2014, we recorded 16 larvae between stages 36-39 (Fig. 2C). On 15 December 2014, we observed four imagoes between stages 42-43 (Figure 2D). On the following day we did not find any imagoes in the area. Forty-two days passed from the day we found the foam nest to the last day we observed the imagoes on the bract. The pH of the water in the bract remained constant at 7.0. The water temperature was 20°C in the morning and 23°C in the late afternoon, and the temperature amplitude remained constant throughout the study.

The observation of oviposition in a leaf bract by *P. atlanticus* is the first record of this species using this mode. When the rain filled the bract with water, it provided an environment with the necessary conditions for the continuity of egg development in a place with potentially fewer predators and competitors. This reproduction strategy is classified as mode 14 by Haddad & Prado (2005), and is already known for other species of the genus *Physalaemus* (e.g. *P. caete* Pombal & Madureira, 1997; *P. erythros* Caramaschi, Feio & Guimarães, 2003; *P.crombiei* Heyer & Wolf, 1989).

On 6 October 2014 we found a *P. atlanticus* foam nest deposited on dry soil. After a few days of precipitation, temporary puddles formed, surround-

ing the foam with water. We observed dozens of tadpoles being released in the water and occupying the temporary puddle surrounding the nest. However, after a few days, the puddle began to dry out and many tadpoles were found dead.

Physalaemus atlanticus may deposit its foam nest on different substrates such as the water surface of rock crevices, anchored to plants or directly on leaf litter near ponds (Haddad & Sazima, 2004; Hartmann *et al*., 2010). This may show, to some extent, a plasticity in foam nest deposition site selection, or may simply be related to the availability of oviposition sites (Taylor, 1962; Schleich, 2002). The species shows a dependence on puddles, formed mainly by precipitation. They provide an ideal aquatic habitat for the larvae before the terrestrial phase begins (Wilbur & Collins, 1973), but they rely on rain to remain constantly full, which can expose the larvae to a high mortality risk or accelerate the metamorphosis process (Newman, 1992). In the case of the bract, the strategy was successful.

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References

Caramaschi U., Feio R.N., Guimarães-Neto A.S. 2003. A new, brightly colored species of *Physalaemus* (Anura: Leptodactylidae) from Minas Gerais, southeastern Brazil. *Herpetologica* 59:519–524.

Cox N., Stuart S. 2004. *Physalaemus atlanticus*. The IUCN Red List of Threatened Species 2004: e. T57240A11607388. https://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T57240A11607388.en. Downloaded on 05 June 2020.

Gosner K.L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* 16:183–190.

Haddad C.F.B., Prado C.P.A. 2005. Reproductive modes in frogs and their unexpected diversity in the Atlantic forest of Brazil. *BioScience* 55:207–217.

Haddad C.F.B., Sazima I. 2004. A new species of *Physalaemus* (Amphibia; Leptodactylidae) from the Atlantic forest in southeastern Brazil. *Zootaxa* 479:1–12.

Hartmann M.T., Hartmann P.A., Haddad C.F.B. 2010. Reproductive modes and fecundity of an assemblage of anuran amphibians in the Atlantic rainforest, Brazil. *Iheringia* 100:207–215.

Heyer W.R., Wolf A.J. 1989. *Physalaemus crombiei* (Amphibia: Leptodactylidae), a new frog species from Espírito Santo, Brazil, with comment on the P. signifer group. *Proceedings of the Biological Society of Washington* 102:500–506.

Newman R.A. 1992. Adaptive Plasticity in Amphibian Metamorphosis. *Bioscience* 42: 671–678.

Pombal Jr. J.P., Madureira C.A. 1997. A new species of *Physalaemus* (Anura, Leptodactylidae) from the Atlantic rain forest of northeastern Brazil. *Alytes* 15:105–112.

Schleich H.H. 2002. Amphibians and reptiles of Nepal: biology, systematics, field guide. A.R.G. Gantner Verlag, Ruggell.

Taylor E H. 1962. The amphibian fauna of Thailand. *University of Kansas Science Bulletin* 43:265–499

Wilbur H.M., Collins J.P. 1973. Ecological aspects of amphibian metamorphosis. *Science* 182:1305–1314.

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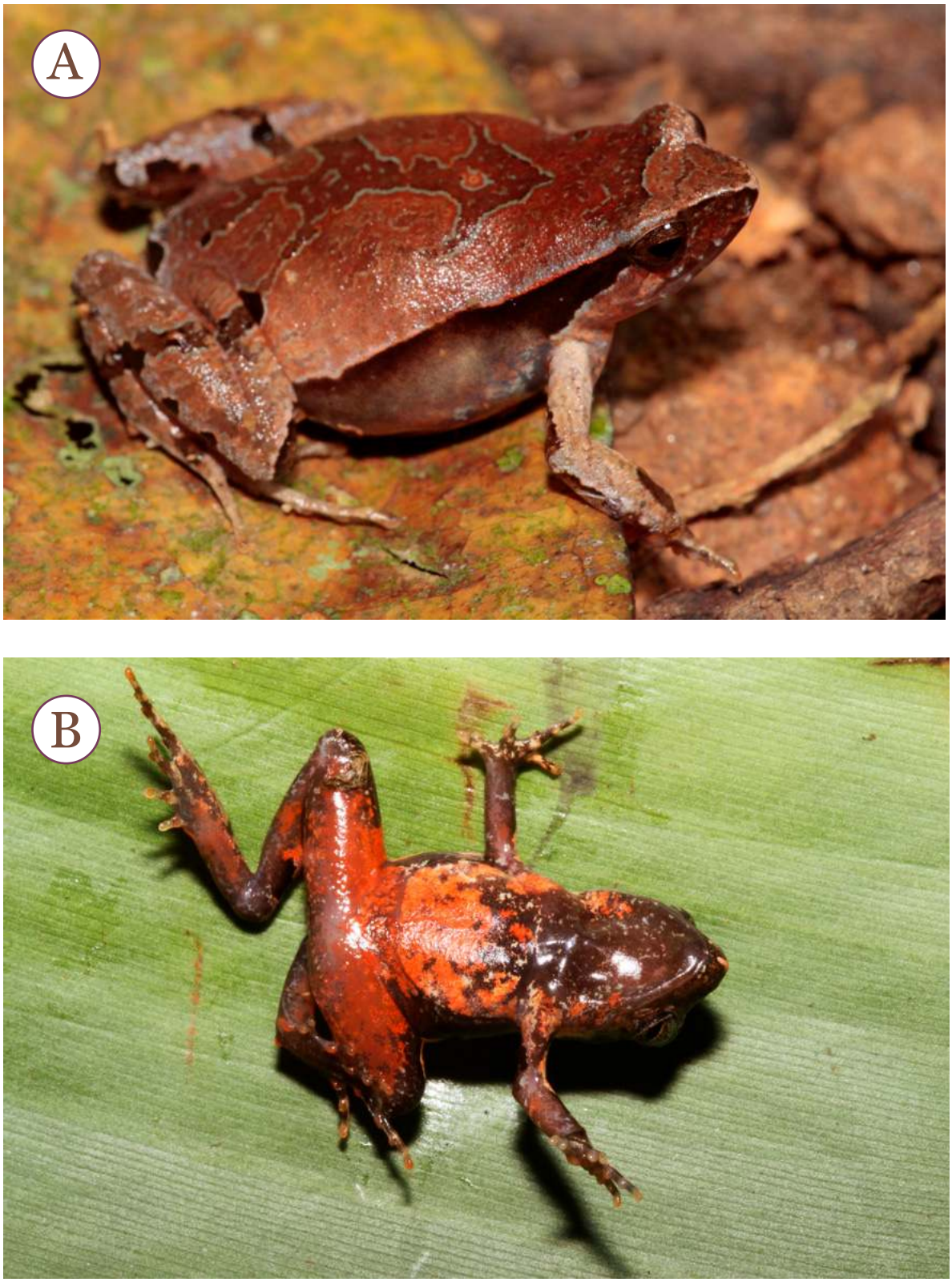

Figura 1. Physalaemus atlanticus individual found in the spawning area, municipality of Ubatuba, São Paulo state, Brazil, on 19 October 2014. A) Dorso-lateral view and B) ventral view. Photos by EM.









Figura 2. Physalaemus atlanticus development stages recorded in the municipality of Ubatuba, São Paulo state, Brazil. A) Foam nest; B) Spawn in a *Syagrus botryophora* bract; C) Tadpole between stages 36-39 and D) Imago recorded in the spawn area. Photos by EM.