

ENYALIUS PERDITUS (SQUAMATA: LEIOSAURIDAE): VOMITING AS A DEFENSIVE BEHAVIOR.

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Lizards have many predators, mostly snakes, other lizards, birds, mammals, and invertebrates (mainly arachnids) (Schalk & Cove, 2018). Numerous strategies have evolved to escape this diverse range of predators, including mimicry and camouflage, rapid escape, death feigning, caudal autotomy, tail display and vibration, mouth opening, and gular expansion (Arnold, 1984; Green, 1988; Martins, 1996; Vitt & Caldwell, 2014; Pough *et al.*, 2015). In addition to natural predation pressure, introduction of invasive species (Trompeter & Langkilde, 2011) can lead to a change in the effectiveness of a particular strategy, and changes in behavioral defensive responses.

Enyalius perditus Jackson, 1978 (Squamata, Leiosauridae) is a semi-arboreal lizard endemic to the Atlantic Forest in southeastern and southern Brazil (Jackson, 1978; Rocha *et al.*, 2000; Sturaro & Silva, 2010; Rodrigues *et al.*, 2014). It is a diurnal species found in forest leaf litter, exhibiting sexual dimorphism in color and size, and a diet based on invertebrates (Jackson, 1978; Sousa & Cruz, 2008; Sturaro & Silva, 2010; Barreto-Lima & Sousa, 2011; Barreto-Lima *et al.*, 2013).

During fieldwork conducted from January to December 2010 in Serra do Ouro Branco, municipality of Ouro Branco, Minas Gerais, Brazil (20°30'32.91" S 43°36'30.47" W; datum SAD 69), we captured 52 specimens of *Enyalius perditus* using active searches and

pitfall traps with drift fences (Cruz *et al.*, 2014), and documented an unusual and unrecorded defense behavior for *Enyalius*. We sexed young specimens by everting the hemipenis, and used a digital caliper to take snout-vent length to 0.01 mm resolution. All captured specimens were deposited in the herpetological collection of the Laboratório de Zoologia dos Vertebrados (LZV), Universidade Federal de Ouro Preto (UFOP), Minas Gerais. The lizards were collected under permits issued by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA-481/06-NUFAS-MG) and Instituto Chico Mendes de Conservação da Biodiversidade (ICMBIO-21543-1).

In January 2010, while attempting to photograph a male (LZV-940s) the lizard performed the defensive behavior of mouth opening, hissing and gular expansion before and during handling. Following this behavior, it regurgitated its stomach contents. The second and third vomiting records were made in September 2010, while removing two males (LZV-1038s and LZV-1040s) from a pitfall trap, both exhibited the same vomiting behavior. In October 2010, another male (LZV-1077s) vomited while being transported in a transparent plastic bag.

All regurgitations were preceded by similar defensive behavior (mouth opening, hissing and gular expansion). Analysis of the vomit revealed the pres-

ence of beetles (Coleoptera), crickets (Orthoptera) and spiders (Araneae) (Table 1), common prey of *E. perditus* (Sturaro & Silva, 2010; Sousa & Cruz, 2008; Barreto-Lima & Sousa, 2011).

Most sedentary lizards, including *Enyalius*, use camouflage, running, or jumping and running as primary defensive behavior (Rautenberg & Laps, 2010). Previous studies report a wide range of defensive strategies for *Enyalius* when individuals are cornered or handled, such as mouth opening, hissing, biting, tail whipping, death feigning, gular inflation, cloacal discharge, and even physiological color changes (males becoming darker) (Rautenberg & Laps, 2010; Gomides & Sousa, 2011; Silva *et al.*, 2018). During our fieldwork, all these behaviors were also displayed by specimens of *E. perditus* on at least one occasion, except for death feigning and tail whipping, which were not recorded.

Different individuals or populations of a species do not always exhibit the same defensive strategies (Trompeter & Langkild, 2011). Indeed, in a population of *E. perditus* from Juiz de Fora, Minas Gerais (approximately 140 km southeast of Ouro Branco), Gomides & Sousa (2011) reported death feigning in approximately 9% of individuals during handling. None of the 52 individuals handled in Serra do Ouro Branco feigned death, although four adults (8%) regurgitated. Although these records represent a small percentage of

examined specimens, they may suggest differences in defensive response between the two populations.

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References

- Arnold E.N. 1984. Evolutionary aspects of tail shedding in lizards and their relatives. *Journal of Natural History* 18:127–169.
- Barreto-Lima A.F., Sousa B.M. 2011. Feeding ecology and sexual dimorphism of *Enyalius perditus* in an Atlantic forest, Brazil. *Herpetological Bulletin* 118:1–9.
- Barreto-Lima A.F., Pires E. O., Sousa B.M. 2013. Activity, foraging mode and micro-habitat use of *Enyalius perditus* (Squamata) in a disturbed Atlantic rainforest in southeastern Brazil. *Salamandra* 49:177–185.
- Cruz A.J.R., Drummond L. O., Lucena V.D., Magalhães A.P., Braga C.A.C., Rolim J.M., Pires M.R.S.. 2014. Lizard fauna (Squamata, Sauria) from Serra do Ouro Branco, southern Espinhaço Range, Minas Gerais, Brazil. *Check List* 10:1290–1299.
- Gomides S.C., Sousa B.M. 2011. *Enyalius perditus*: death-feigning. *Herpetological Review* 42:602.
- Greene, H.W. 1988. Antipredator mechanisms in Reptiles. Pp. 1–152, in: Gans C., Huey R.B. (Eds.), *Biology of the Reptilia*, Vol 16. Ecology, defense and life history. Allan R. Liss, New York.
- Jackson J.F. 1978. Differentiation in the genera *Enyalius* and *Strobilurus* (Iguanidae): implications for Pleistocene climatic changes in eastern Brazil. *Arquivos de Zoologia* 30:1–79.
- Martins M. 1996. Defensive tactics in lizards and snakes: the potential contribution of the Neotropical fauna. *Anais de Etologia* 14:185–199.
- Rautenberg R., Laps R.R. 2010. Natural history of the lizard *Enyalius iheringii* (Squamata, Leiosauridae) in southern Brazilian Atlantic forest. *Iheringia* 100:287–290.
- Pough F.H., Andrews R.M., Crump M.L., Savitzky A.H., Wells K.D., Brandley M.C. 2015. *Herpetology*. Sinauer Associates, Sunderland.
- Rautenberg R., Laps R.R. 2001. Natural history of the lizard *Enyalius iheringii*

(Squamata, Leiosauridae) in southern Brazilian Atlantic Forest. *Iheringia* 100:287–290.

Rocha C.F.D., Van-Sluys M., Puerto G., Fernandes R., Barros-Filho J.D., Silva R.R.E., Neo F.A., Melgarejo A. 2000. Répteis. Pp. 79–87, in: Bergallo H.G., Rocha C.F.D., Alves M.A.S., Van-Sluys M. (Eds.), A Fauna Ameaçada de Extinção do Estado do Rio de Janeiro. Editora UERJ, Rio de Janeiro.

Rodrigues M.T., Bertolotto C.E.V., Amaro R.C., Yonenaga-Yassuda Y., Freire E.M.X., Pellegrino K.C.M. 2014. Molecular phylogeny, species limits, and biogeography of the Brazilian endemic lizard genus *Enyalius* (Squamata: Leiosauridae): An example of the historical relationship between Atlantic Forests and Amazonia. *Molecular Phylogenetics and Evolution*, 81:137–146.

Schalk C.M., Cove. M.V. 2018. Squamates as prey: Predator diversity patterns and predator-prey size relationships. *Food Webs* 16:1–4.

Silva M.A., Hudson A.A., Souza B.M. 2018. *Enyalius bilineatus* (Two-lined fat-headed Anole). Defensive behavior. *Herpetological Review* 49:742.

Sousa B.M., Cruz C.A.G. 2008. Hábitos alimentares em *Enyalius perditus* (Squamata, Leiosauridae) no Parque Estadual do Ibitipoca, Minas Gerais. *Iheringia* 98:260–265.

Sturaro M.J., Silva V.X. 2010. Natural history of the lizard *Enyalius perditus* (Squamata: Leiosauridae) from an Atlantic forest remnant in southeastern Brazil. *Journal of Natural History* 44:1225–1238.

Trompeter W.P., Langkilde T. 2011. Invader danger: Lizards faced with novel predators exhibit an altered behavioral response to stress. *Hormones and Behavior* 60:152–158.

Vitt L.J., Caldwell J.P. 2014. Defense and Escape. Pp. 319–351, in: Vitt L.J., Caldwell J.P. (Eds.), *Herpetology: An Introductory Biology of Amphibians and Reptiles*. Academic Press, London/Waltham/San Diego.

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Table 1. Individuals of *Enyalius perditus* that regurgitated while/after handling in Serra do Ouro Branco, Minas Gerais, Brazil.

SVL = snout-vent length; M = male; F = female.

Collection number	SVL (mm)	Sex	Regurgitated content	Local coordinates
LZV- 940s	75.95	M	Aranae; Orthoptera	20°29'35.13"S, 43°36'24.17" W
LZV- 1038s	64.89	M	Aranae; Coleoptera	20°29'45.00"S, 43°35'48.53" W
LZV- 1040s	75.97	M	Aranae	20°29'37.08"S, 43°36'25.55" W
LZV- 1077s	78.98	F	Coleoptera	20°29'37.08"S, 43°36'25.55" W