Extension of occurrence and geographic distribution map of the toad *Rhinella dapsilis* (Myers & Carvalho, 1945) (Amphibia: Bufonidae) in the mid-north region of Brazil

Aryel Morais de Queiroz[1,2], Alice Tôrres[1,3], Maria Claudene Barros[1,2], Thaís B. Guedes[1,4]

1 Centro de Estudos Superiores de Caxias, Universidade Estadual do Maranhão, Praça Duque de Caxias s/n, Morro do Alecrim, 65604-380 Caxias, MA, Brazil.
2 Laboratório de Genética e Biologia Molecular, Universidade Estadual do Maranhão, Praça Duque de Caxias s/n, Morro do Alecrim, 65604-380 Caxias, MA, Brazil.
3 Laboratório de Estudos dos Invertebrados/ Coleção Zoológica do Maranhão, Universidade Estadual do Maranhão, Praça Duque de Caxias s/n, Morro do Alecrim, 65604-380, Caxias, MA, Brazil.
4 Gothenburg Global Biodiversity Center, Department of Biological and Environmental Sciences, University of Gothenburg, Box 461, SE-405 30 Göteborg, Sweden.

*Corresponding author. E-mail: *aryel.morais@hotmail.com*.

DOI: *10.5281/zenodo.5838927*

Toads of the genus *Rhinella* Fitzinger, 1826 currently comprise 89 species widely distributed from southern Texas, USA to southern Argentina (Frost 2021; Pereyra et al. 2021). The genus includes the *Rhinella margaritifera* (Laurenti, 1768) species complex that contains 19 species occurring in Central and South America (Frost 2021; IUCN 2021; Pereyra et al. 2021). Of these, *Rhinella castaneotica* (Caldwell, 1991), *R. dapsilis* (Myers & Carvalho, 1945), *R. ocellata* (Günther, 1858), and *R. margaritifera* are known to occur in forested areas in the mid-north region of Brazil, in the state of Maranhão (Matavelli et al. 2014; IUCN 2021).

Although all species of the *Rhinella margaritifera* complex share the internal morphological character of the posterior expansion of the pterygoid branch (Pramuk 2006), the identification at species level of the specimens of the *R. margaritifera* complex is difficult (Fouquet et al. 2007; Lavilla et al. 2013; Moravec et al. 2014; Pereyra et al.

2021). The lack of geographic distribution data for some species, along with taxonomic inconsistencies, result in some taxa of the complex being categorized as Data Deficient [e.g., *R. scitula* Caramaschi & Niemeyer, 2003 and *R. alata* (Thominot, 1884)] in their conservation status in the Red List of the International Union for Conservation of Nature (IUCN 2021).

Recently, due to the absence of apparent morphological and molecular differences, *Rhinella gildae* Vaz-Silva, Maciel, Bastos & Pombal, 2015 was synonymized with *R. dapsilis* (Pereyra et al. 2021). The phylogenetic analysis based on mitochondrial and nuclear genes recognized a poorly supported clade formed by *R. dapsilis*, *R.* cf. *dapsilis*, *R. gildae*, and several divergent lineages of *R. margaritifera sensu latu* (e.g., the lineages *Rhinella* sp. A and *Rhinella* sp. B from Fouquet et al., 2007) (Pereyra et al. 2021). However, based on known disparity between morphological and molecular data of Neotropical frogs, Ferrão et al. (2020) highlight that low genetic divergence should be used along with morphology and behavior (among other characters) to decide whether populations within the *R. margaritifera* complex are conspecific. Following the recent classification of Pereyra et al. (2021), *Rhinella dapsilis* exhibits fragmented distribution, occurring in isolated populations in Brazil, Ecuador, Peru, and French Guiana. In Brazil, *R. dapsilis* occurs in the Amazon Forest and Cerrado biomes, plus forested enclaves in the Caatinga domain in the states of Tocantins, eastern Pará, southern Maranhão, and highlands of Ceará (Vaz-Silva et al. 2015; Ávila et al. 2018; Silva et al. 2018; Pereyra et al. 2021). However, distribution and taxonomy of *R. dapsilis* are still poorly understood, and its conservation status in any national or regional red lists has never been assessed. Herein we report a new record extending the distribution of *Rhinella dapsilis* in northwestern Maranhão, and discuss the known distribution in Brazil.

An adult *Rhinella dapsilis* (Fig. 1; approximate snout-vent length 69 mm) was found by AT on November 1st 2019 in the private Sete Irmãos Farm, municipality of Cândido Mendes, state of Maranhão, Brazil (1.868333°S, 45.766583°W; 55 m elevation) (Fig. 2A-B). It was found at 11:53 h motionless in the forest leaf litter (Fig. 1). The specimen was not handled or disturbed. Several photographs were taken from approximately 30 cm and approximate measurements were taken from these photos. The locality is a well-preserved remnant of the Amazon Forest, characterized by dense forest, but surrounded by pasture (Fig. 2C). Although the specimen was not collected, the high-quality photos, the external morphology and pattern of coloration, and

geographic location support the identification of the specimen as *Rhinella dapsilis*. The images were examined by Wilian Vaz-Silva (Pontifícia Universidade Católica de Goiás, PUC-GO) who confirmed the identification. The information provided in this study is based on the approximate measurements and pictures taken from the toad *Rhinella dapsilis* in nature. We did not collect or euthanize the specimen reported here.

Brazilian specimens of *Rhinella dapsilis* exhibit cephalic crests poorly developed, parotoid glands without lateral line of tubercles, supratympanic crests not extending beyond the angle of the jaws in dorsal view, middorsal stripe present, SVL 69.6–76.4 mm in males (Vaz-Silva et al. 2015) and 67.3–68 mm in females (Ávila et al. 2018). It differs from *R. margaritifera*, a sympatric species in Maranhão, by its cephalic crests poorly developed (hypertrophied cephalic crests in *R. margaritifera*), absence of apophyses (presence of very small apophyses), bony protrusion at the angle of the jaws (slightly evident), and larger sizes of males (46.91–52.77 mm in males and 59.42–69.53 in females) (Fouquet et al. 2007; Lavilla et al. 2013). It differs from *R. castaneotica* by larger sizes of males (30.9–36.8 mm in *R. castaneotica*), tympanum evident (not evident), and dorsal skin finely granulose (smooth) (Caldwell 1991; Vaz-Silva et al. 2015). *Rhinella dapsilis* differs from *R. ocellata* by its smooth dorsum (warty), mid-dorsal stripe white (yellow) and dorsal skin with a small concentration of granules (dorsum granular with 4-5 pairs of black spots with yellow edges) (Hoogmoed 1985).

The new record extends the geographic distribution of *Rhinella dapsilis* 230 km north from Reserva Biológica (REBIO) do Gurupí and 183 km northwest from the municipality of Alcantara, the nearest previous known records in the state of Maranhão (Fig. 2B, Tab. 1). The new record comprises the ninth record for the species in the state of Maranhão, and is also in Amazon Forest habitat in the eastern part of the state (Fig. 2C, Vaz-Silva et al. 2015; Pereyra et al. 2021). It is the northernmost Brazilian record for the species.

Recently, the morphological variation, advertisement call, and phylogenetic relationships of Brazilian *Rhinella dapsilis* have been described (Ávila et al. 2018). Additional occurrence data for the species were obtained, notably the first in Ceará state (municipality of Guaramiranga; Ávila et al., 2018). For the state of Maranhão, Ávila et al. (2018) reported two new occurrences in the municipalities of Estreito (CFBH 15633, GenBank sequence number KU495519) and Alcantara (CFBH 19160, KU495520) identified as *R. margaritifera* by Lyra et al. (2017). Neither record was considered in a recent broad review of the genus

Rhinella (Pereyra et al. 2021), emphasizing the importance to continue further investigation of the distribution of *Rhinella dapsilis* in the mid-north region of Brazil.

The state of Maranhão is known for its rich biodiversity, but it harbors extensive sampling gaps, especially related to its herpetofauna (Barreto et al. 2011; Martins & Oliveira 2011; Freitas et al. 2017). Knowing the biodiversity of the region, by accessing all available genetic, morphological, behavioral, acoustic, and distribution data, is key to fill Linnean and Wallacean shortfalls (Hortal et al. 2015) and properly assess the biodiversity metrics in the state. It is also crucial to better plan conservation strategies to safeguard biodiversity in national and state levels.

ACKNOWLEDGMENTS

The authors thank to F.L. de Oliveira for have arranged the fieldwork to the area where the specimen was photographed (through the following approved projects: National Council for Scientific and Technological Development #457440/2012-0 and #406394/2013-0; Fundação de Amparo à Pesquisa e ao Desenvolvimento Científico e Tecnológico do Maranhão #00498/12, #00856/15, #0300112/12 and #03988/15) and to the Pontarollo family, for allowing collections on their farm. Wilian Vaz-Silva for helping with the specimen identification; Ricardo Marques and Fabricius Domingos for valuable comments in the first version of the manuscript. AMQ thanks Fundação de Amparo à Pesquisa e ao Desenvolvimento Científico e Tecnológico do Maranhão (FAPEMA) for the master's degree scholarship. TBG thanks to Universidade Estadual do Maranhão for the senior researcher fellowship.

REFERENCES

Ávila R.W., Pansonato A., Perez R., Carvalho V.T., Roberto I.J., Morais D.H., ... Farias I.P. 2018. On *Rhinella gildae* Vaz-Silva, Maviel, Bastos & Pombal, 2015 (Anura: Bufonidae): Phylogenetic relationship, morphological variation, advertisement and release calls and geographic distribution. *Zootaxa* 4462:274–290.

Caldwell J. P. 1991. A new species of toad in the genus *Bufo* from Pará, Brazil, with an unusual breeding site. *Papéis Avulsos de Zoologia* 37:389–400.

Barreto L., Ribeiro L.E.S., Nascimento M.C., Martins M.B., Oliveira T.G. 2011. Caracterização da herpetofauna em áreas da Amazônia do Maranhão. Pp. 204–217 in Martins M.B., Oliveira, T.G. (Eds.). Amazônia maranhense: diversidade e conservação. Museu Paraense Emílio Goeldi. Belém.

Duellman, W. E., Schulte R. 1992. Description of a new species of *Bufo* from northern Peru with comments on phenetic groups of South American toads (Anura: Bufonidae). *Copeia* 1992:162–172.

Ferrão M., Lima A.P., Ron S., Santos S.P., Hanken J. 2020. New species of Leaf-litter Toad of the *Rhinella margaritifera* species group (Anura: Bufonidae) from Amazonia. *Copeia* 2020: 967–986.

Freitas M.A., Vieira R.S., Entiauspe-Neto O.M., Sousa S.O., Farias T., Sousa A.G., Moura G.J.B. 2017. Herpetofauna of the northwest Amazon forest in the state of Maranhão, Brazil, with remarks on the Gurupi Biological Reserve. *ZooKeys* 643:141–155.

Fouquet A., Gaucher P., Blanc M., Vélez–Rodriguez C.M. 2007. Description of two new species of *Rhinella* (Anura: Bufonidae) from the lowlands of the Guiana Shield. *Zootaxa* 1663: 17–32.

Frost D. R. 2021. Amphibian species of the world: an online reference, version 6.1. Accessed 29 July 2021. Available at *https://amphibiansoftheworld.amnh.org/index.php*. American Museum of Natural History, New York, USA.

IBGE. 2019. Biomas Brasileiros. Available at *https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/25798-ibge-lanca-mapa-inedito-de-biomas-e-sistema-costeiro-marinho*

IUCN 2021. The IUCN red list of Threatened species. 29 July 2020. Available at *https://www.iucnredlist.org*.

Lavilla E.O., Caramaschi U., Langone J.A., Pombal Jr J.P., de Sá, R.O. 2013. The identity of *Rana margaritifera* Laurenti, 1768 (Anura, Bufonidae). *Zootaxa* 3646:251–264.

Lyra M.L., Haddad C.F.B., Azeredo-Espin A.M.L. 2017. Meeting the challenge of DNA barcoding Neotropical amphibians: polymerase chain reaction optimization and new COI primers. *Molecular Ecology Resources* 17:966–980.

Martins M.B., Oliveira T.G. 2011. Amazônia maranhense: diversidade e conservação. Museu Paraense Emílio Goeldi. Belém.

Matavelli R., Campos A.M., da Silva G.R., Andrade G.V. 2014. First record of *Rhinella ocellata* (Günther, 1858) (Bufonidae) for the state of Maranhão, northeastern Brazil. *Check List* 10:432–433.

Moravec J., Lehr E., Cusi J.C., Córdova J.H., Gvoždík V. 2014. A new species of the *Rhinella margaritifera* species

group (Anura, bufonidae) from the Montane forest of the selva central, Peru. *ZooKeys* 371:35–56.

Pramuk J.B. 2006. Phylogeny of South American *Bufo*. *Zoological Journal of the Linnean* Society 146:407–452.

Pereyra M.O., Blotto B.L., Baldo D., Chaparro J.C., Ron S.R., Elias-Costa A.J., ... Faivovich, J.. 2021. Evolution in the Genus *Rhinella*: A Total Evidence Phylogenetic Analysis of Neotropical True Toads (Anura: Bufonidae). *Bulletin of the American Museum of Natural History* 447:1–156.

QGIS Core Team. 2018. Quantum GIS Geographic INformation System, version 2.18.19. Available at http://osgeo.org/. Open Source Geospatial Foundation Project, USA.

Hoogmoed M.S. 1985. Bufonidae (Central and South America). Pp 25–77 in Frost D.R. (Ed.). Amphibian Species of the World: A Taxonomic and Geographical Reference. Association of Systematics Collections and Allen Press. Lawrence.

Hortal J., de Bello F., Diniz-Filho J.A.F., Lewinsohn T.M., Lobo J.M., Ladle R.J. 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. *Annual Review of Ecology, Evolution, and Systematics* 46:523–549.

Silva L.A., Dantas S.P., Santos D.L., Neto H.B., Santana D.J. 2018. Newly distribution of *Rhinella gildae* Vaz-Silva et al., 2015 (Anura, Bufonidae): a little known species of the *Rhinella margaritifera* species group. *Herpetology Notes* 11:121–125.

Vaz-Silva W., Maciel N.M., Bastos R.P., Pombal Jr. J.P. 2015. Revealing Two New Species of the *Rhinella margaritifera* Species Group (Anura, Bufonidae): An Enigmatic Taxonomic Group of Neotropical Toads. *Herpetologica* 71:212–222.

Editora: Sarah Mângia.



Figure 1. Individual of *Rhinella dapsilis* from Sete Irmãos Farm, municipality of Cândido Mendes, state of Maranhão, Brazil: (A) Lateral view, (B) Frontal view, and (C) Dorsal view. Photos by AT.

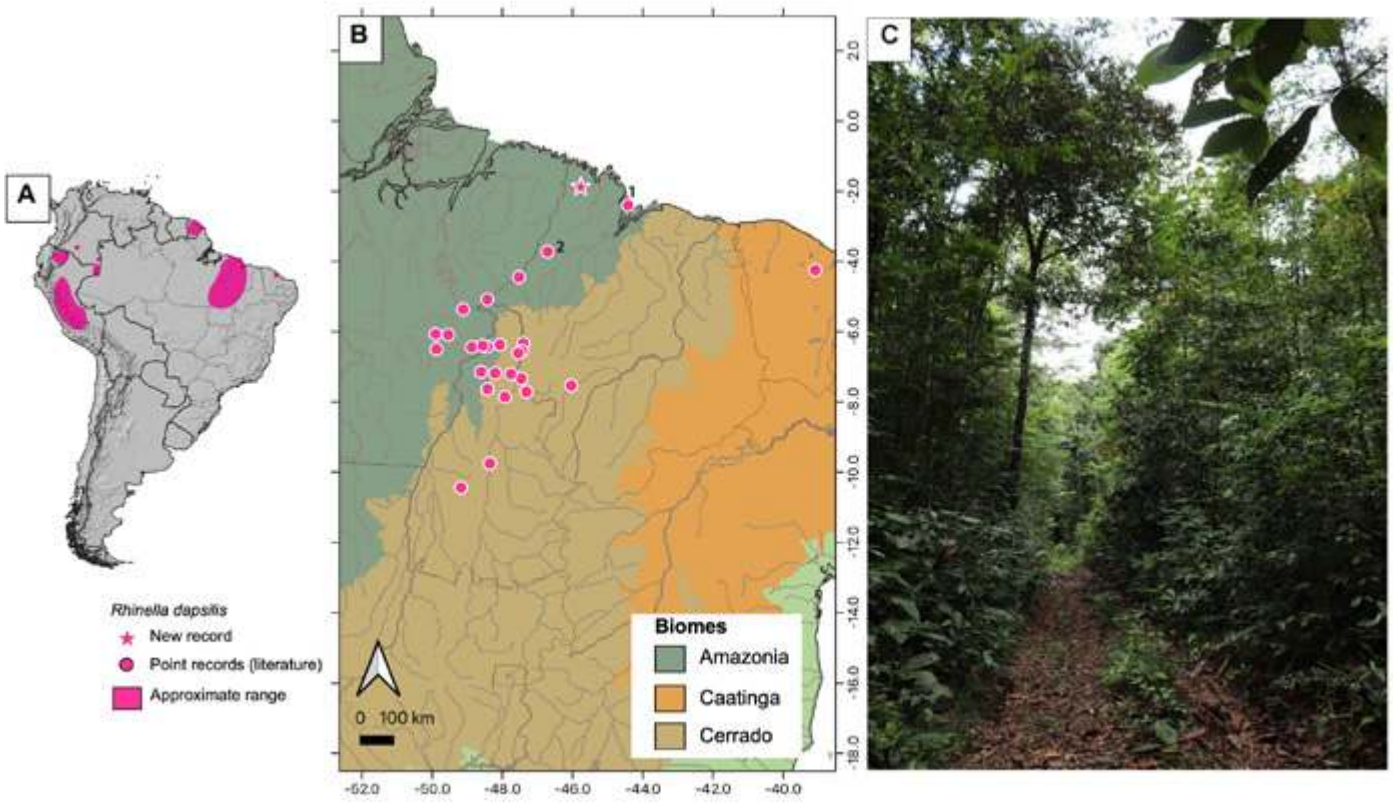


Figure 2. Geographic distribution and habitat of occurrence of *Rhinella dapsilis* in South America. (A). The approximate range of several populations of *R. dapsilis* in South America based on data provided by Ávila et al. (2018), IUCN (2021), and Pereyra et al. (2021). (B). The distribution based on point records (see Tab. 1) of the Brazilian population of *R. dapsilis*: 1. Municipality of Alcantara, Maranhão; 2. Reserva Biológica do Gurupi, Maranhão. Map was drawn using QGis v. 3.4 (QGIS Core Team, 2018) using the limits of the Brazilian biomes provided by IBGE (2019). (C). Habitat at the site of the new records in the Amazon Forest in eastern Maranhão. Photo by AT.

Table 1. Literature data of *Rhinella dapsilis* in Brazil. Localities are referred as municipality, state, country. *Ávila et al. (2018) referring to Lyra et al. (2017) may require further confirmation.

Locality	Latitude	Longitude	Reference
Cândido Mendes, Maranhão, Brazil	-45.7665	-1.8683	This study
São Pedro da Água Branca, Maranhão, Brazil (type locality)	-48.4290	-5.0850	Vaz-Silva et al., 2015
Carolina, Maranhão, Brazil	-47.4638	-7.3362	Fouquet et al., 2012
Reserva Biológica do Gurupi (REBIO), Maranhão, Brazil	-46.7064	-3.7223	Freitas et al., 2017
Balsas, Maranhão, Brazil	-46.0360	-7.5330	Ávila et al., 2018
Porto Franco, Maranhão, Brazil	-47.3990	-6.3380	Ávila et al., 2018
Alcantara, Maranhão, Brazil*	-44.4170	-2.3920	Ávila et al., 2018
Itinga do Maranhão, Maranhão, Brazil	-47.5260	-4.4500	Ávila et al., 2018
Estreito, Maranhão, Brazil*	-47.4450	-6.5480	Ávila et al., 2018
Araguaina, Tocantins, Brazil	-48.2058	-7.1818	Silva et al., 2018
Xambioa, Tocantins, Brazil	-48.4263	-6.4309	Silva et al., 2018
Ananas, Tocantins, Brazil	-48.0721	-6.3688	Silva et al., 2018
Muricilandia, Tocantins, Brazil	-48.6078	-7.1449	Silva et al., 2018
Goiantins, Tocantins, Brazil	-47.3141	-7.7126	Silva et al., 2018
Pium, Tocantins, Brazil	-49.1783	-10.4416	Silva et al., 2018

Babaçulandia, Tocantins, Brazil	-47.7570	-7.2050	Pereyra et al., 2021
Guaramiranga, Ceará, Brazil	-39.0833	-4.2500	Ávila et al., 2018
Marabá, Pará, Brazil	-49.1180	-5.3690	Ávila et al., 2018
Canaã dos Carajás, Pará, Brazil	-49.8780	-6.4970	Ávila et al., 2018
Curionópolis, Pará, Brazil	-49.5410	-6.0910	Ávila et al., 2018
Parauapebas, Pará, Brazil	-49.9020	-6.0680	Ávila et al., 2018
Piçarra, Pará, Brazil	-48.8720	-6.4380	Ávila et al., 2018
São Geraldo do Araguaia, Pará, Brazil	-48.5550	-6.4010	Ávila et al., 2018
Lajeado, Tocantins, Brazil	-48.3580	-9.7510	Ávila et al., 2018
Nova Olinda, Tocantins, Brazil	-48.4230	-7.6320	Ávila et al., 2018
Palmeirante, Tocantins, Brazil	-47.9260	-7.8600	Ávila et al., 2018
Palmeiras do Tocantins, Tocantins, Brazil	-47.5460	-6.6130	Ávila et al., 2018