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New records of malformations of anuran limbs from Paraguay

Olivia Atlas Flores[1,2], Matthew Thomas Owen[1], Wendy Yael Kobrinsky[1], Melissa Morrisson[1,3], Paul Smith[1,4]

[1] Fundación Para La Tierra, Centro IDEAL, Pilar, Dpto. Ñeembucú, Paraguay.

[2] Oregon State University, Oregon, USA.

[3] Queen's University Belfast, Belfast, Northern Ireland.

[4] FAUNA Paraguay, Encarnación, Paraguay.

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ABSTRACT

Morphological abnormalities in anuran amphibians have been documented throughout South America. Here, we report on six individual anuran morphological abnormalities in five species (*Rhinella dorbignyi, Pseudis platensis, Chacophrys pierottii, Elachistocleis bicolor, and Physalaemus cuvieri*) from two Paraguayan departments (Ñeembucú and Boquerón). We briefly discuss potential implications of malformation of the limbs and associated causes, identifying avenues of future research on this topic in Paraguay.

Key Words: Amphibians; Abnormalities; South America.

Amphibians are widely recognized as ecological indicators due to their increased sensitivity to environmental stressors (Alford and Richards, 1999). Throughout their life cycle amphibians inhabit both aquatic and terrestrial habitats exposing their highly permeable skin to hazards in both environments (Blaustein and Johnson, 2003). Exposure to environmental hazards can leave anurans at a higher risk of developing morphological abnormalities which can be associated with impaired mobility, increased vulnerability and decreased overall fitness (Blaustein and Johnson, 2003). While the direct causes of morphological abnormalities differ by case, the four main theories suggest exposure to: increased UV-B radiation (Spolyarich *et al.*, 2010), chemical pollutants (Loeffler *et al.*, 2001; Gardiner *et al.*, 2003), parasitic infection (Johnson *et al.*, 1999), and predation (Ballengée and Sessions, 2009; Reeves *et al.*, 2010). It is important to note that the appearance of an abnormality does not identify its cause and that more complex studies are required to determine the root causes of high levels of abnormalities in any given population (Meteyer, 2000).

Reports of malformations exist in South America from Argentina (Attademo *et al.*, 2005; Peltzer *et al.*, 2011; Agostini *et al.*, 2013; Guerra and

Author for correspondence: livyatlas@gmail.com

Aráoz, 2016), Brazil (Pedroso-Santos *et al.*, 2017; Silva-Soares *et al.*, 2017; Ascoli-Morrete *et al.*, 2019; Jorgewich-Cohen *et al.*, 2019; Carmo *et al.*, 2021; Diaz-Ricaurte *et al.*, 2025), Colombia (Zuluaga-Isaza *et al.*, 2017, Molina-Betancourt *et al.*, 2022), Venezuela (Barrio-Amorós *et al.*, 2010), Ecuador (Ramírez-Jaramillo, 2019; Figueroa-Coronel *et al.*, 2025), Paraguay (Brouard and Smith, 2014; Pett *et al.*, 2019) and Uruguay (Gobel *et al.*, 2022). In Paraguay, the most common documented abnormalities are Ectrodactyly (33%), Ectromelia (25%), and Brachydactyly (21%), (Table 1).

In this study, we report morphological abnormalities of the limbs in five anuran species from Paraguay: *Rhinella dorbignyi* (Duméril and Bibron, 1841); *Pseudis platensis*, Gallardo, 1961; *Chacophrys pierottii* (Vellard, 1948); *Elachistocleis bicolor* (Guérin-Méneville, 1838); and *Physalaemus cuvieri* (Fitzinger, 1826). Individuals with limb abnormalities were collected from Ñeembucú department and observed in Boquerón department of Paraguay. Specimen examinations were based on external observation under an AmScope SZM stereo microscope. All collected individuals were euthanized according to Simmons (2002) and deposited in the Colección Zoológica de Para La Tierra (CZPLT) registered by the Ministerio del Ambiente y Desarrollo Sostenible (MADES). Our classification of abnormalities follows Meteyer (2000) and Henle *et al.*, (2017); (Table 1).

Rhinella dorbignyi (Bufonidae): CZPLT-H 2559 10th of July, 2024 Estancia Santa Ana, Ñeembucú department (26.85238, 58.04756). Ectromelia of the tibiae fibulare on the left hindlimb (Fig. 1A). CZPLT-H 2278 25th of August, 2021 Estancia Santa Ana, Ñeembucú department (-26.841990, -58.029140). Hemimelia with only the basal extension of the tibiofibula present on the left forelimb with ectrodactyly of 4 digits and brachydactyly of the one remaining digit (Fig. 1B).

Pseudis platensis (Hylidae): CZPLT-H 2175 4th of June, 2021 Yegros Paso, Ñeembucú department (-26.864994, -58.274092). Ectromelia of the tibiae and fibulare on the right hindlimb (Fig. 1C).

Chacophrys pierottii (Ceratophyridae): 23rd of November, 2023 Fortin Toledo, Bonquerón department (-22.3538092, -60.3405092). An individual photographed with ectromelia of the tibiae and fibulare on the left hindlimb (Fig. 1D).

Elachistocleis bicolor (Microhylidae): CZPLT-H 1591 22nd of September, 2023 off Ruta IV near Pilar, Ñeembucú department (26.84991, 58.22940). The individual pictured has tarsal antroversion as well as Ectrodactyly of 2 missing digits and brachydactyly on its remaining 3 shortened digits (Fig. 1E).

Physalaemus cuvieri (Leptodactylidae): CZPLT-H 2675 23rd of August, 2025 Yegros Paso, Ñeembucú department (-58.272785, -26.865158). Brachydactyly of the left hindlimb with 5 metatarsal bones present but shortened (Fig. 1F).

These are the first records of morphological abnormalities for *R. dorbignyi, P. platensis, P. cuvieri,* and *C. pierottii* and increase the number of cases documented within two Paraguayan departments (Fig. 2). The only previously published records within these departments were of *Rhinella dypticha* and *Leptodactylus latrans* from Ñeembucú department and *Elachistocleis haroi* from Boquerón department (Pett *et al.*, 2019). Previously published records of *E. bicolor* from Paraguay were from San Pedro department, where a low frequency of abnormalities within the area was noted (Brouard and Smith, 2014).

Increasing anthropogenic land use in Paraguay has disrupted ecosystem services (Pavetti and Saito, 2012), diminishing habitat quality and leaving amphibians more susceptible to environmental hazards. Assessing amphibian populations within the remaining disturbed and natural ecosystems can determine the impact on their developmental patterns. However, amphibian malformations are often observed long after the developmental disruption occurred (Meteyer, 2000), making it difficult to attribute them to a single cause. Although environmental hazards such as pesticide runoff and

Table 1. Classification and description of morphological abnormalities observed in this paper, adapted from Meteyer (2000) and Henle *et al.*, (2017).

Condition	Description
Brachydactyly	Abnormal shortness of one or more digits
Ectrodacyly	Complete absence of one or more digits
Ectromelia	Complete absence of one or more bones
Hemimelia	Shortness of the bone with the distal limb and foot present

Figure 1. Photographs of individual anurans with morphological abnormalities, A) *Rhinella dorbignyi* CZPLT-H 2278 (hemmimelia of the left forelimb) B) *Rhinella dorbignyi* CZPLT-H 2559 (ectromelia of the left hindlimb), C) *Pseudis platensis* CZPLT-H 2175 (ectromelia of the right hindlimb), D) *Chacophrys pierottii* (ectromelia of the left hindlimb), E) *Elachistocleis bicolor* CZPLT-H 1591 (tarsal antroversion, ectrodactyly and brachydactyly of the right hindlimb), F) *Physalaemus cuvieri* CZPLT-H 2675 (brachydactyly of the left hindlimb). Photographs taken by: A, B, C (Fundación Para La Tierra), D (Paul Smith), E, F (Matthew Owen)

shifts in land use practices (Alford and Richards, 1999) are frequently implicated, other issues including parasitic trematodes and ultraviolet radiation (Blaustein and Johnson, 2003) may also contribute to such abnormalities. A population is considered to be healthy when the occurrence of abnormalities is below 5% (Blaustein and Johnson, 2003). Although reports in Paraguay have not documented levels exceeding this threshold, there is room to evaluate the causation and relationship of these abnormalities with environmental stressors.

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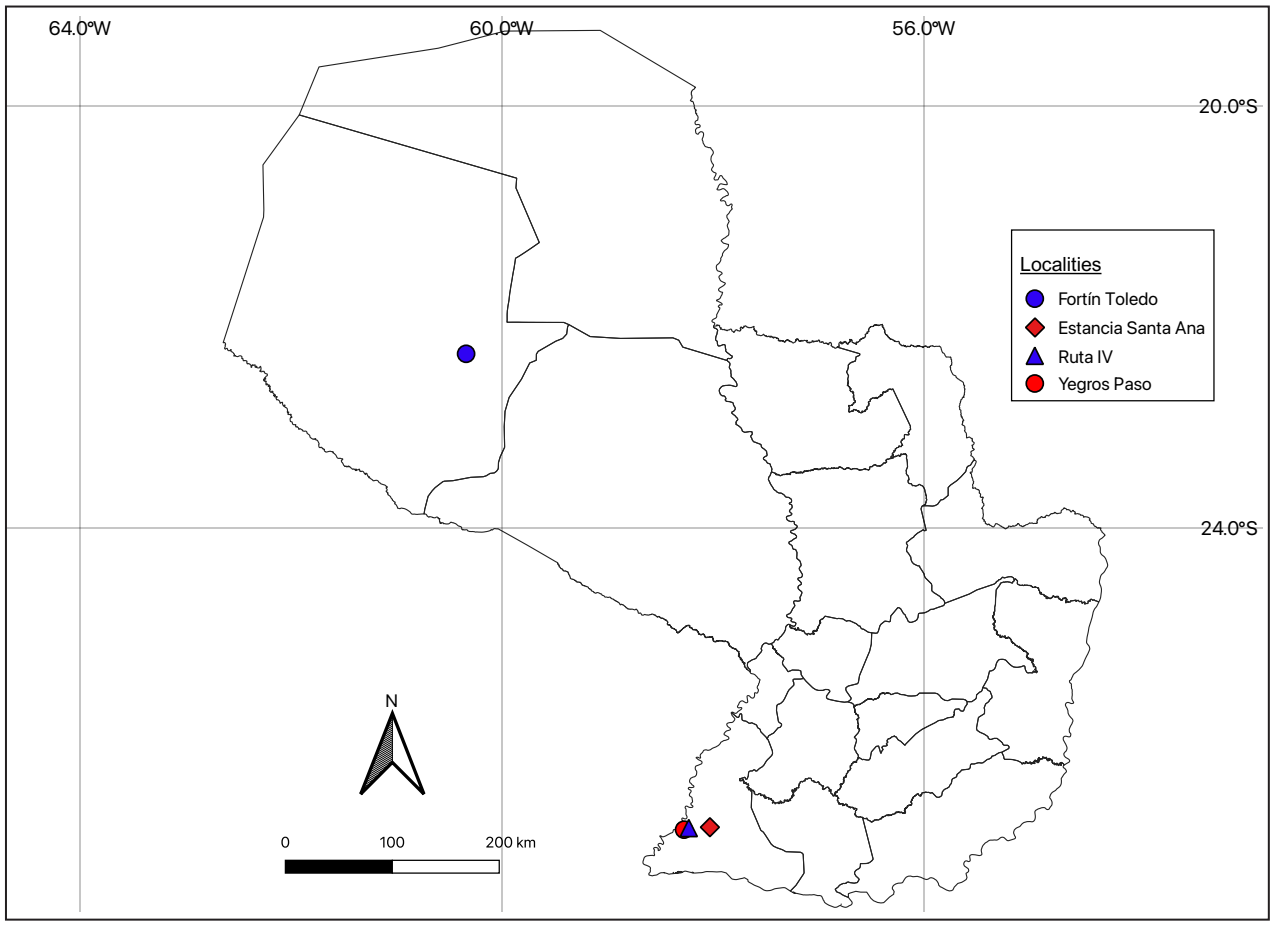

Figure 2. Geographical localities of morphological abnormalities recorded in this paper. Blue circle: Fortín Toledo (*C. pierottii*), Red Circle: Yegros Paso (*P. platensis*, *P. cuvieri*), Blue Triangle: Ruta IV (*E. bicolor*), Red Square: Estancia Santa Ana (*R. dorbignyi*).

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Literature cited

Agostini, M.G.; Kacoliris, F.; Demetrio, P.; Natale, G.S.; Bonetto, C. & Ronco, A.E. 2013. Abnormalities in amphibian populations inhabiting agroecosystems in northeastern Buenos Aires Province, Argentina. *Diseases of Aquatic Organisms.* 104: 163-171

Alford, R.A. & Richards, S.J. 1999. Global amphibian declines: a problem in applied ecology. *Annual Review of Ecology and Systematics.* 30: 133-165

Ascoli-Morrete, T.; Signor, E.; Santos-Pereira, M. & Zanella, N. 2019. Morphological abnormalities in anurans from southern Brazil. *Austral Ecology.* 44: 1025-1029

Attademo, A.M.; Peltzer, P.M. & Lajmanovich, R.C. 2005. Amphibians occurring in soybean and implications for biological control in Argentina. *Agriculture, Ecosystems and Environments.* 106: 389-394

Ballengée, B. & Sessions, S.K. 2009. Explanations for missing limbs in deformed amphibians. *Journal of Experimental Zoology (Mol. Dev. Evol.)* 312: 1-10

Barrio-Amorós, C.L.; Rivas, G.A.; Molina, C.; Santos, J.C.; Kaiser, H. 2010. Intraspecific variation in the endangered frog *Mannophryne riveroi* (Anura, Dendrobatidae, Aromobatinae), with comments on coloration and natural history. *Herpetological Notes* 3: 151-160.

Blaustein, A.R. & Johnson, P.T. 2003. The complexity of deformed amphibians. *Frontiers in Ecology and the Environment.* 1: 87-94

Brouard, JP. & Smith, P. 2014. *Elachistocleis bicolor* (Amphibia: Anura: Microhylidae) and *Eupemphix nattereri* (Amphibia: Anura: Leuiperidae): Morphological abnormalities from Reserva Natural Laguna Blanca, Paraguay. *Herpetología Brasileira.* 3: 85-87

Carmo, L.F.; Guimarães, S.O.; Miguel, I.R.; Pinna, P.H.; Fernandes, D.S. & Woitovicz-Cardoso, M. 2021. High prevalence of anomalies in *Nyctimantis brunoi* (Anura: Hylidae) from a restinga protected area in southeastern Brazil. *Phyllomedusa.* 20: 165-179

Diaz-Ricuarte, J.C.; Vieira-Alencar, J.P.S.; Golnich, M.P.; Navarro-Morales, A. & Martins, M. 2025. Frogs with faulty feet: hindlimb anomalies in the Lesser Escuerzo Toad, *Odontophrynus reigi* (Rosset *et al.* 2021), and the Muller's Termite Frog, *Dermatonotus muelleri* (Boettger, 1885), in the Brazilian Cerrado. *Herpetology Notes.* 18: 93-98

Figueroa-Coronel, E.; Tietge, M. & Peñaherrera-R, P. 2025.

First Report of Limb Abnormalities in the Mashpi Stream Frog, *Hyloscirtus mashpi* (Anura: Hylidae). *Reptiles and Amphibians.* 32: e23093.

Gardiner, D.; Ndayibagira, A.; Grün, F. & Blumberg, B. 2003. Deformed frogs and environmental retinoids. *Pure and Applied Chemistry.* 75: 2263-2273

Gobel, N.; Laufer, G.; Kacevas, N.; Carabio, M.; Merni, R.; Rosano, A.; Mendieta, F.; Pineda, G. & Bergós, F. 2022. Morphological abnormalities in amphibians in and adjacent to Esteros de Farrapos e Islas del Río Uruguay National Park, Uruguay. *Herpetological Conservation and Biology.* 17: 573-581

Guerra, C. & Aráoz, E. 2016. Amphibian malformations and body condition across an agricultural landscape of northwest Argentina. *Diseases of Aquatic Organisms.* 121: 105-116

Henle, K.; Dubois, A. & Vershinin, V. 2017. A review of anomalies in natural populations of amphibians and their potential causes. *Mertensiella.* 25: 57-164

Johnson, P.T.J.; Lunde, K.B.; Ritchie, E.G. & Launer, A.E. 1999. The effect of trematode infection on amphibian limb development and survivorship. *Science.* 284: 802-804

Jorgewich-Cohen, G.; Cavalcanti, I.R.S. & André, Kanasiro. 2019. Abnormalities in hylid frogs: a case study of schizodactyly in the striped snouted tree frog, *Scinax squalirostris* (Lutz, 1925) (Amphibia: Anura: Hylidae). *Herpetology Notes.* 12: 1015-1018

Loeffler, K.; Stocum, D.L.; Fallon, J.F. & Meteyer, C.U. 2001. Leaping lopsided: a review of the current hypotheses regarding etiologies of limb malformations in frogs. *The Anatomical Record.* 265: 228-245

Meteyer, C.U. 2000. Field guide to malformations of frogs and toads with radiographic interpretations. U.S. Geological Survey BSR 2000-0005, 20p, https://pubs.er.usgs.gov/publication/53882

Molina-Betancourt, K.J.; Serna-Botero, V. & Marín-Martínez, M. 2022. New records of limb malformations in the endemic Palm Rocket Frog, *Rheobates palmatus* (Anura: Aromobatidae), from Colombia. 2022. *Herpetology Notes.* 15: 229-232

Pavetti, A. & Saito, O. 2012. Changes in land use and ecosystem services in Paraguay. *Proceedings of Annual Meeting of Environmental Systems Research.* 40: 331-337

Pedroso-Santos, F.; Sanches, P.; de Sousa, J. & Costa-Campos, E. 2017. Morphological abnormality in *Leptodactylus podicipinus* (Cope, 1862) (Anura: Leptodactylidae) in an urban area of north Brazil, Eastern Amazon. *Boletín Asociación Herpetológica Española* 28: 70-72

Peltzer, P.; Lajmanovich, R.; Sanchez, L.; Attademo, A.; Junges, C.; Bionda, C.; Martino, A.L. & Basso, A. 2011. Morphological abnormalities in amphibian populations from the mid- eastern region of Argentina. *Herpetológica Conservation and Biology.* 6: 432-442

Pett, B.L.; Sarvary, J.; Davis, H-P.; Smith, P. & Atkinson, K. 2019. Records of morphological abnormalities of Anuran limbs from Paraguay. *Cuaderno de Herpetologia.* 33: 79-82

Ramírez-Jaramillo, S.M. 2019. First report on the presence of malformations in seven species of frogs (Amphibia, Anura) of tropical rainforest in Ecuador. *Latin American Journal of Herpetology* 2: 34-40

Reeves, M.K.; Jensen, P; Dolph, C.L.; Holyoak, M. & Trust, K.A. 2010. Multiple stressors and the cause of amphibian abnormalities. *Ecological Monographs.* 80: 423-440

Silva-Soares, T. & Mônico, A. 2017. Hind Limb malformation in the tree frog *Corythomantis greeningi* (Anura: Hylidae). *Phyllomedusa: Journal of Herpetology* 16: 117-120

Simmons, J.E. 2002. Herpetological collecting and collections management. Revised Edition. Herpetological Circulars. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah.

Spolyarich, N.; Hyne, R.V.; Wilson, S.P.; Palmer, C.G. & Byrne, M. 2011. Morphological abnormalities in frogs from a rice-growing region in NSW, Australia, with investigations into pesticide exposure. *Environmental Monitoring and Assessment.* 172: 397-407

Zuluaga-Isaza, J.C.; Marín-Martínez, M.; Díaz-Ayala, R.F.; Rojas-Morales, J.A. & Ramírez-Castaño, V.A. 2017. First records of limb malformations in a cane toad, *Rhinella marina* (Anura: Bufonidae), and a Palm Rocket Frog, *Rheobates palmatus* (Anura: Aromobatidae), from Colombia. *IRCF Reptiles & Amphibians.* 24: 132-134

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