

New records of malformations of anuran limbs from 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

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 (Ceratophryidae): 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
Ectrodactyly	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 (hemimelia 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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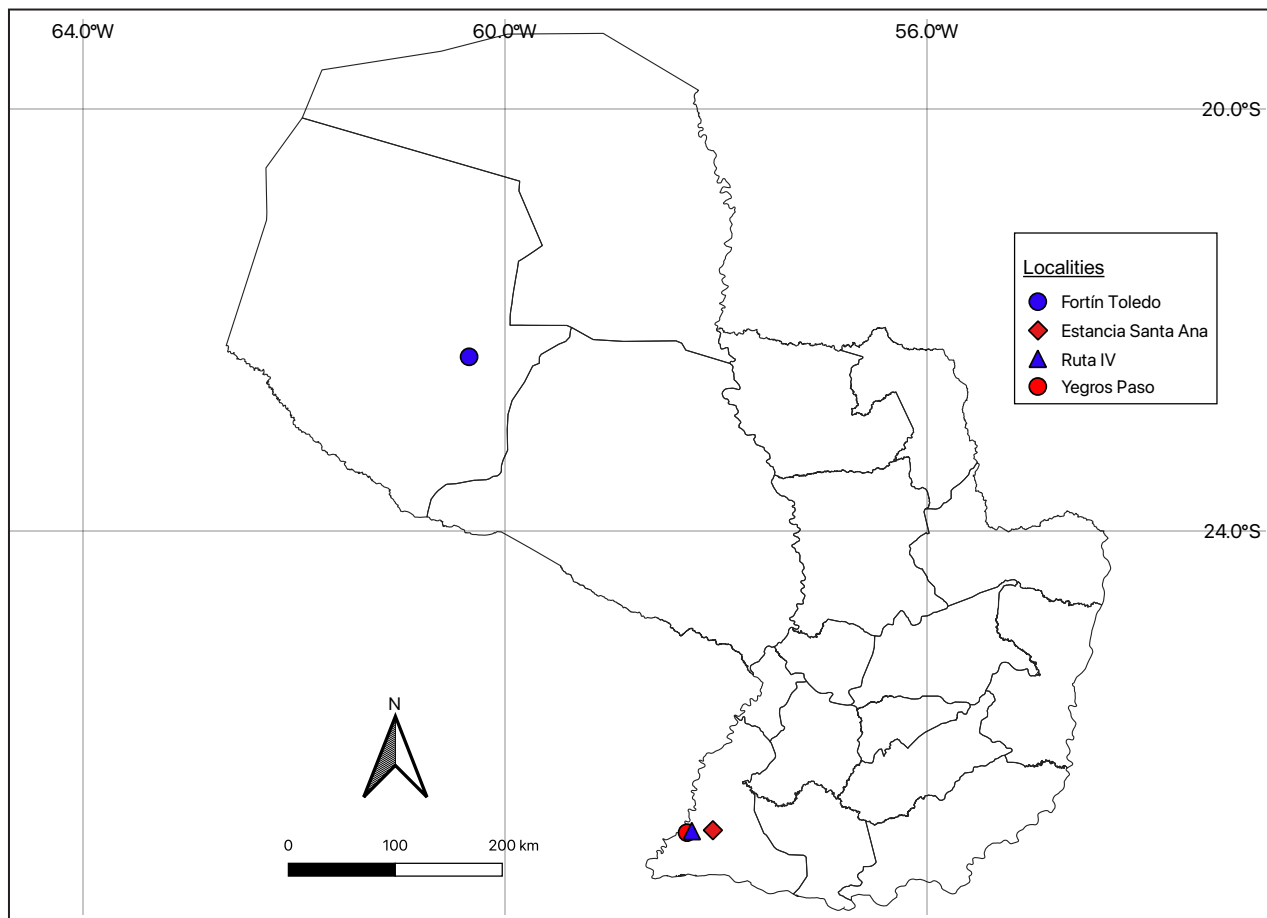


Figure 2. Geographical localities of morphological abnormalities recorded in this paper. Blue circle: Fortín Toledo (*C. pierottii*), Red Circle: Yegros Paso (*P. platensis*, *P. cuvieri*), Blue Triangle: Ruta IV (*E. bicolor*), Red Square: Estancia Santa Ana (*R. dorbignyi*).

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