

An alarming case? Hindlimb malformation in the endemic Colombian glass frog, *Sachatamia punctulata* (Ruiz-Carranza and Lynch, 1995) (Anura, Centrolenidae)

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Amphibian malformations in Colombia have rarely reported in literature, despite consisting environmental change conditions indicator and results of natural mutations. The lack of corporal symmetry is correlated with a decline in amphibian populations (Meteyer, 2000; Lannoo, 2008; Whittaker et al., 2013) and an increasing frequency of these abnormalities may be a symptom of ecosystem health deterioration (Taylor et al., 2005; Rothschild et al., 2012; Bacon et al., 2013; Smith and Sutherland, 2014). Due to their physiological and ecological characteristics, amphibians are considered as good bio-indicators of environmental stress, especially those related to the toxic contamination that could possibly affect human health (Blaustein et al., 2003; Smith and Sutherland, 2014; Santori and McManus, 2014).

Different causes have been proposed to explain amphibian malformations: high UV-radiation exposure, chemical pollution by pesticides and other chemicals are amongst the main causes (Blaustein et al., 2003; Blaustein and Johnson 2003; Lannoo, 2008). Infection by helminthic parasites and injury caused by accidents or predators have also been identified as causes of these abnormalities (Alford and Richards, 1999; Daszak and Cunningham, 1999; Johnson et al., 1999, 2002; Blaustein et al., 2003; Lannoo, 2008), although a small proportion of malformation (typically under 5%) can be expected in any amphibian population (Blaustein and Johnson, 2003). In amphibians, morphological anomalies include

the partial or total loss of the limb, the emergence of an additional limb, the emergence or loss of the digits, and the alterations in bone shape and size (Meteyer, 2000; Lannoo, 2008).

During a nocturnal survey (18:41 h) on 21 October 2016, we found a juvenile *Sachatamia punctulata* (Ruiz-Carranza and Lynch 1995; snouth-vent length = 11.9 mm; Figure 1) at “Quebrada Soto 2”, Montebello village, municipality of Norcasia, department of Caldas, Colombia, (5.5754°N, -74.9406°W; WGS84; elevation 608 m a.s.l.) perched on a bush 0.56 m above the ground and 0.4 m from the stream. This individual presented a distinguishing hindlimb malformation, and a detailed examination of this limb revealed that the frog had a shortened right tibia-fibula (hemimelia *sensu* Meteyer, 2000) and a bony triangle right femur (taumelia *sensu* Lannoo, 2008). The animal was collected and deposited in the Colección Herpetológica Museo de Historia Natural de la Universidad de Caldas (MHN-UCa 0804).

Sachatamia punctulata is a nocturnal glass frog endemic to Colombia, distributed across humid and sub-Andean forests on the eastern flank of the Cordillera Central, between 360 – 1100 m a.s.l. (Rojas-Morales et al., 2014; Acosta-Galvis, 2017). The species has a restricted distribution, which is decreasing especially because of habitat fragmentation caused by the expansion of agricultural crops and contamination of water sources (Rojas-Morales et al., 2014; IUCN 2017).

Even though amphibian malformations have been reported worldwide (Schoff et al., 2003; Galán, 2011; Ferreira et al., 2014; Firoj-Jaman et al., 2017; Rebouças et al., 2019), in Colombia there are only a few records (see Rojas-Morales and Escobar-Lasso, 2013; Zuluaga-Isaza et al., 2017; Cruz-Esquivel et al., 2017). In addition, the possible causes of these deformities and the frequency in which these events occur within populations are difficult to infer. Taumelia is evident when the limb element fuses to form a solid triangle skeletal element (Gardiner and

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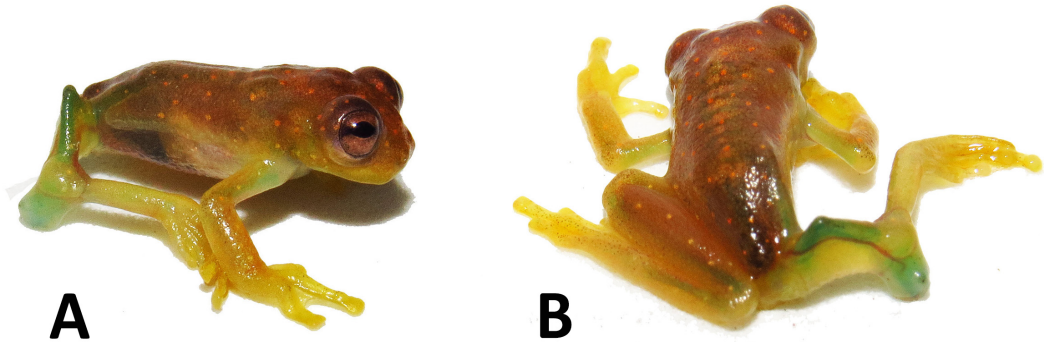


Figure 1. Individual of *Sachatamia punctulata* (MHN-UCa 0804; SVL = 11.9 mm) with a shortened right tibia-fibula (hemimelia) and a bony triangle right femur (taumelia). A) Lateral view; B) posterior view. Photographs by Mateo Marín-Martínez.

Hoppe, 1999; Lanno 2008), and hemimelia is defined as a short bone with distal limb and foot present (Meteyer, 2000). The specific mechanism whereby taumelia is induced remains unclear; however, some authors have pointed out that this malformation may be the result of the exposure to unusual levels of retinoids during the stages of limb development (Gardiner and Hoppe, 1999; Sessions et al., 1999; Degitz et al., 2000). These retinoids are signaling molecules, metabolic derivatives of vitamin A, that regulate many critical processes to early embryonic development, and authors such as Degitz et al. (2000) have associated their excess or deficit to deformations such as bone triangle in the limbs. Some chemicals present in pesticides and dermatological drugs that are spilled into the environment can act as retinoid mimics, antagonists, or inhibitors (Harmon et al., 1995). Also, in both hemimelia and taumelia, it has been demonstrated that the parasite *Ribeiroia ondatrae* metacercariae (Trematoda, Platyhelminthes) can cause this kind of malformations too (Johnson et al., 1999, 2002).

So far, the malformed individual represents two percent of the sampled population ($n = 50$; between October 2016 and November 2017), which is congruent with the natural frequency expected in a population (Lunde and Johnson, 2012). However, the studied area might be receiving agricultural residues coming from higher up in the mountain. Infection by the trematode *R. ondatrae*, which is distributed across North to South America (Wilson et al., 2005; Ballengée and Sessions 2009; Barroso et al., 2009; Lunde and Johnson, 2012), should not be discarded. Considering that malformations in amphibians in Colombia have rarely been recorded, we suggest that evaluating the physicochemical parameters

of the stream and the presence of the *R. ondatrae* in the area are crucial to understand whether this event represent a natural genetic mutation or a conservation concern.

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