



## Species diversity of *Hyalinobatrachium* glassfrogs (Amphibia: Centrolenidae) from the Guiana Shield, with the description of two new species

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### Abstract

Basic information about the taxonomy, biology and distribution of *Hyalinobatrachium* glassfrogs of the Guiana Shield (GS) is scarce, ambiguous, and in many cases even contradictory. In this review we aim to clarify the current taxonomic status of this group by means of phenotypic (morphology, morphometrics and bioacoustics) and molecular (mitochondrial DNA sequences) comparisons. Eight species have previously been recognized for the GS: *H. crurifasciatum*, *H. eccentricum*, *H. fleischmanni* (initially described as *Hylella cappellei* in the GS), *H. iaspidiense* (with the putative synonym *H. nouraguense*), *H. igniocus*, *H. mesai*, *H. mondolfii*, and *H. taylori*. Our data support the resurrection of *H. cappellei* from its synonymy with *H. fleischmanni*. *Hyalinobatrachium crurifasciatum*, *H. eccentricum*, and *H. igniocus* are proposed as junior synonyms of *H. cappellei*. We show that none of the four paratypes of *H. taylori* belong to this species and we assign two to *H. cappellei* and two to *H. mondolfii*. Additional specimens previously identified as *H. taylori* are reassigned to *H. cappellei*, and hence *H. taylori* is redefined. *Hyalinobatrachium nouraguense* is confirmed as a junior syn-

onym of *H. iaspidiense*. We also describe two new species of *Hyalinobatrachium* from French Guiana: *Hyalinobatrachium kawense* **sp. nov.** and *Hyalinobatrachium tricolor* **sp. nov.** In addition, and in concordance with the new taxonomic rearrangements, we provide diagnostic characters for all species, known distributions and main sources of references for their biology. We also report new distribution records for *H. iaspidiense* and *H. mondolfii*, and describe the formerly unknown tadpole of the later. Consequently, we recognize seven species of *Hyalinobatrachium* for the Guiana Shield: *H. cappellei*, *H. iaspidiense*, *H. kawense* **sp. nov.**, *H. mesai*, *H. mondolfii*, *H. taylori*, and *H. tricolor* **sp. nov.** We discuss the suitability of integrative taxonomy as an approach to identify taxonomic uncertainty and consider its significance for conservation purposes. We also address the implications of our results to understand phylogeographic patterns in this area.

**Key words:** Brazil, French Guiana, Guyana, *Hyalinobatrachium*, Integrative Taxonomy, Mitochondrial DNA, Phylogeography, Synonym, Suriname, Venezuela

## Introduction

Glassfrogs (family Centrolenidae) have long attracted the attention of biologists working in the Neotropics because of their morphological and ecological characteristics, as well as their phylogenetic and biogeographic complexity (Señaris & Ayarzagüena 2005; Castroviejo-Fisher *et al.* 2007; Guayasamin *et al.* 2008a). At present, the roughly 150 recognized species of glassfrogs are divided among 12 monophyletic genera (Guayasamin *et al.* 2009). Their main habitats are rainforests of Central America, Chocó, northern Andes, Guiana Shield, Amazonia, and southeastern Brazil.

The Guiana Shield (GS) or Guianan Region, *sensu* Gibbs and Barron (1993), with the biogeographic additions for amphibians of Señaris and MacCulloch (2005), is situated between the Amazon and Orinoco rivers (Fig. 1). It is an overlooked biodiversity hotspot and a priority area for conservation purposes (Rull 2005; Orme *et al.* 2005), encompassing the most intact (80–90%), least inhabited (0.6–0.8 people/km<sup>2</sup>) tropical rainforest region in the world (Huber & Foster 2003). Recent efforts aiming at the exploration of the amphibian biodiversity of the GS resulted in the description of various new species (e.g. MacCulloch & Lathrop 2002; Kok *et al.* 2006; Kok & Ernst 2007; Myers & Donnelly 2008), including members of the family Centrolenidae (e.g. Noonan & Bonett 2003; Barrio-Amorós & Brewer-Carías 2008).

Eight species of *Hyalinobatrachium* are currently recognized for the GS: *H. crurifasciatum* Myers & Donnelly, *H. eccentricum* Myers & Donnelly, *H. fleischmanni* (Boettger, initially described as *Hylella cappellei* van Lidth de Jeude in Guyana), *H. iaspidiense* (Ayarzagüena, including the recently proposed synonym *H. nouraguense* Lescure & Marty by Yáñez-Muñoz *et al.* 2009), *H. ignioculus* Noonan & Bonett, *H. mesai* Barrio-Amorós & Brewer-Carías, *H. mondolfii* Señaris & Ayarzagüena, and *H. taylori* (Goin). However, the taxonomic status of several of these species remains uncertain (Cisneros-Heredia & McDiarmid 2007; Kok & Castroviejo-Fisher 2008; Barrio-Amorós & Castroviejo-Fisher 2008), creating a confusing situation in terms of actual species richness and distribution that could potentially lead to misguided conservation strategies or erroneous biogeographic interpretations. In the following paragraphs we introduce the main problems concerning the taxonomy of *Hyalinobatrachium* species from the GS.

van Lidth de Jeude (1904) described *Hylella cappellei* from Suriname based on a single individual. However, the original description lacks essential details and is very rudimentary. Goin (1964) considered *Hylella cappellei* as a junior synonym of *Centrolenella fleischmanni*, now in the genus *Hyalinobatrachium* (Ruiz-Carranza & Lynch 1991). Several authors (Noonan & Harvey 2000; Cisneros-Heredia & McDiarmid 2007; Kok & Castroviejo-Fisher 2008) have questioned this taxonomic arrangement but no scientific publication has really addressed this taxonomic problem since Goin's seminal work. To the best of our knowledge, the holotype of *Hylella cappellei* constitutes the only current vouchered specimen assigned to *Hyalinobatrachium fleischmanni* from east of the Andes and by implication from the Guiana Shield.

The taxonomic history of *Hyalinobatrachium taylori* is complex and has created confusion among herpetologist working in the GS, to the point that at least two different species are referred to as *H. taylori* (Kok & Castroviejo-Fisher 2008). *Hyalinobatrachium taylori* was described by Goin (1968) from preserved material and on the basis of morphological characters. Despite including five specimens in the type series (four paratypes and the holotype), the author only provided a description of the holotype. Lescure (1975), Hoogmoed and Avila-Pires (1990), and Lescure and Marty (2000) assigned specimens from French Guiana and Suriname to *H. taylori*. Señaris