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## One or two species? On the case of *Hyperolius discodactylus* Ahl, 1931 and *H. alticola* Ahl, 1931 (Anura: Hyperoliidae)

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### Abstract

In 1931, Ernst Ahl described two species of reed frogs inhabiting montane forests of the Albertine Rift in East Africa, *Hyperolius alticola* and *H. discodactylus*, which were synonymized two decades later by Raymond Laurent. Since then, this revision has been questioned repeatedly, but taxonomists have been reluctant to make a conclusive decision on the matter, especially since the type material of *H. alticola* was reported as being lost. Here, we examine the rediscovered type material of *H. alticola* and reassess the validity of Laurent's synonymy using morphological data from historic and new collections including all available type material, call recordings and molecular data from animals collected on recent expeditions. We find evidence for a northern and southern genetic clade, a divide that is somewhat supported by diverging morphology as well. However, no distinction in advertisement calls could be recovered to support this split and both genetic and morphological differences between geographic units are marginal and not always congruent and thus more likely reflect population-level variation. We therefore conclude that *H. alticola* is not a valid taxon and should continue to be treated as a synonym of *H. discodactylus*. Finally, we also report on newly collected material from outside the species known range, with first records of this species from Burundi.

**Key words:** Albertine Rift, amphibian, morphology, phylogeny, 16S rRNA, reed frog, sexual dimorphism, advertisement call

### Introduction

The taxonomy of the African reed frog genus *Hyperolius* Rapp, 1842 (Anura: Hyperoliidae) has undergone multiple revisions in recent history (Drewes 1984; Richards & Moore 1996; Vences *et al.* 2003; Odierna *et al.* 2007). With 131 currently described species (Frost 2013), it is the most species-rich genus of African anurans, distributed across all of Sub-Saharan Africa. As their vernacular name suggests, these small to medium sized frogs (average snout-vent length of 20 to 35 mm; Channing & Howell 2006) inhabit the edges of permanent or temporary water bodies in forests, savanna and farm bush where males call from reeds protruding from the water's surface. Females fix clutches of eggs to submerged vegetation or leaves overhanging the water, and also to terrestrial vegetation presumably to evade aquatic larval predators (Vonesh 2005). Where known, males are often brightly coloured with species showing sexual dimorphism (Schjötz 1999) and dichromatism (Schjötz 1999; Veith *et al.* 2009; Bell & Zamudio 2012). Due to a combination of conserved interspecific morphology and extreme intraspecific variation in colouration (e.g. more than 40 different colour morphs are recognized for the *Hyperolius viridiflavus* complex; Channing & Howell 2006), species identification can be difficult. Furthermore, most pigmentation appears to be soluble in alcohol and thus is usually absent from museum specimens (Laurent 1950)

sexual dimorphism, which accounts for most of the variation. Furthermore, measurements were taken from material of vastly differing ages (collections from 1908 to 2013), which can also cause a range of error that hampers determining minimal morphological differences among populations. The paralectotype of *H. discodactylus* collected from west of Lake Edward (MCZ A-176634) presents a further discordance. In morphology, it best resembles the southern *H. cf. discodactylus* clade and Ahl was therefore correct in recognizing these similarities. However, geographically, it should be affiliated with the *H. cf. alticola* clade. The acoustic data is similar, with the greatest variances in advertisement calls being observed within the *H. cf. discodactylus* clade, not between *H. cf. discodactylus* and *H. cf. alticola*. The inconsistencies in genetics, morphology and acoustics in general, therefore point towards an incomplete separation of lineages, a pattern in favour of population-level variances. In this scenario, we have opted for taxonomic stability and therefore support Laurent's (1947) synonymy of *H. alticola* with *H. discodactylus*.

Further research on montane hyperoliids of the Albertine Rift is clearly necessary. In addition to understanding species diversity, the area is of high biological importance (Plumptre *et al.* 2007). Similar to patterns observed in other montane taxa (Tolley *et al.* 2010; Loader *et al.* 2013), areas of lowland are potential barriers to gene flow, with individuals of *H. discodactylus* from adjacent Nyungwe Forest NP and Kahuzi-Biega NP showing unexpectedly high levels of genetic divergence. Due to its fragmented range with a distribution across most of the Albertine Rift, this species would serve as an interesting model for testing biogeographic hypotheses of the evolutionary history of the fauna of the mountain chains.

## Conclusion

*Hyperolius* in general show strong sexual dimorphism, a characteristic also present in the studied species. *H. discodactylus* and *H. alticola* were most likely described based only on preserved males of the former and females of the latter. The diagnostic features provided by Ahl (1931a; 1931b) are attributable to sexual dimorphism, population variation and potentially preservation age of material. The biological relevance of the few morphometric, acoustic and molecular differences recovered in this study are not unequivocal and we therefore concur with previous authors (Laurent 1947; Schiøtz 1975), that there is little evidence to support the recognition of two separate species. Although Schiøtz (1975) argues that the description of *H. alticola* correspond better to what he understands to be the synonymised *H. discodactylus*, we do not find support for this claim and stand by the argument of page priority for *H. discodactylus* as proposed by Frost *et al.* (2006). We also extend the known range of this species considerably to the south, with new records from Bururi Forest Nature Reserve, Burundi.

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