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Larval masquerade: a new species of paedomorphic salamander (Caudata: Plethodontidae: *Eurycea*) from the Ouachita Mountains of North America

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Abstract

Species with truncated developmental patterns may go undetected if they resemble the juveniles of their close relatives. Herein we present an example of this phenomenon with the description of a highly divergent, relict species of stream-dwelling plethodontid salamander from the Ouachita Mountains of North America. Both mitochondrial and nuclear sequence data show that this new species is most closely related to its syntopic relative, *Eurycea multiplicata*. Interestingly, *E. multiplicata* exhibits the ancestral biphasic (metamorphic) life cycle, whereas the new species maintains an aquatic larval form throughout life (paedomorphic) and superficially resembles larval *E. multiplicata*. The new species is the first known paedomorphic plethodontid from the Ouachita Mountains, and the most divergent paedomorphic salamander discovered in over seventy years. This species represents an independent instance of the evolution of paedomorphosis associated with a porous streambed, which may facilitate vertical seasonal movements. This new species currently has an extremely limited known distribution and is of immediate conservation concern.

Key words: endemic species, *Eurycea*, life history

Introduction

Developmental truncations can produce species that resemble the larvae or juveniles of close relatives (e.g. Camp *et al.* 2002). However, some ontogenetic stages, such as larval forms, can be difficult to identify morphologically and are often understudied (Thomas *et al.* 2005; Vences *et al.* 2005; Barber & Boyce 2006; Hubert *et al.* 2010; Ko *et al.* 2013). Therefore, without close examination of specific life history stages, species that arise from developmental truncations can go undetected, resulting in an underestimation of biodiversity.

The lungless salamanders, Family Plethodontidae, have diversified extensively since the Late Cretaceous (Vieites *et al.* 2007), and are the most species rich clade of caudates (currently 440 recognized species; AmphibiaWeb 2014). More than 80% of recognized plethodontids have been described since Dunn's (1926) seminal work on the family. This is in part due to increased survey efforts, but also due to the application of molecular techniques, which have revealed many cryptic species in morphologically conserved groups (e.g. Highton 1989; Chippindale *et al.* 2000; Garcia-Paris *et al.* 2000; Jockusch *et al.* 2002). Plethodontids are known to exhibit a wide diversity of life histories and developmental modes (Wake 1966; Chippindale *et al.* 2004; Mueller *et al.* 2004; Bonett *et al.* 2014), but ecologically and developmentally distinct new species are extremely rare, especially within North America, which has been extensively surveyed (Dunn 1926; Highton 1989; Camp *et al.* 2009).

The plethodontid tribe Spelerpini includes five genera (*Eurycea*, *Gyrinophilus*, *Pseudotriton*, *Stereochilus*, and *Urspelperpes*) and thirty-five recognized species. These primarily stream-dwelling salamanders display multiple areas of endemism in the southern Appalachian Mountains, Edwards Plateau, and Interior Highlands (Ouachita Mountains and Ozark Plateau; Fig. 1). While most spelerpines have a biphasic (metamorphic) life history, typical of amphibians, several members of this clade display paedomorphosis (Wake 1966; Ryan & Bruce 2000; Bonett *et*

the western Ozark Plateau (Bonett & Chippindale 2006). Like *E. tynerensis*, *E. subfluvicola* appear to undergo seasonal movements into the streambed when the surface streams recede. Paedomorphosis in *E. subfluvicola* seems to have enabled access to an otherwise unexploited subterranean niche, and may be important in maintaining reproductive isolation with syntopic *E. multiplicata*.

Over the last decade we sampled *E. multiplicata* from over 100 locations throughout the Ouachita Mountains, but often only metamorphic adults were collected and sequenced. Our fortuitous discovery of a highly divergent larval form in 2011 prompted intensive examination and sequencing of both larvae and adults in and around Lake Catherine State Park, which allowed us to delineate the new species. *Eurycea subfluvicola* represents an example of how species that primarily differ by an ontogenetic shifts can mask species diversity. This phenomenon may be more likely in organisms which display complex life histories, where deviant adult forms can masquerade as different developmental stages of related species. This discovery highlights how much biodiversity may still remain hidden, even in well studied areas.

Eurycea subfluvicola currently has one of the smallest, if not the smallest, known distribution of any North American salamander (AmphibiaWeb 2014). Surveys up and downstream of these sites, and several nearby streams, have yet to produce additional specimens, despite the presence of adult and larval *E. multiplicata*. It is possible that previously sampled *E. multiplicata* localities across the Ouachita Mountains also contain *E. subfluvicola*, since collection of larval forms was not emphasized. Regardless, *E. subfluvicola* is of immediate conservation concern, given this species' current known distribution. Fortunately, the known distribution of *E. subfluvicola* is within a protected site (Lake Catherine State Park). To ensure the long-term conservation of this unique species we recommend the following actions: 1) conduct additional surveys to further delineate the distribution; 2) establish conservation measures (as applicable) to preserve known sites; and 3) captive propagation efforts to ensure reserve stock in case of wild population extirpation.

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