

Note

Silver-white Variants of the Eastern Red-backed Salamander, *Plethodon cinereus*, from Eastern Canada

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The Eastern Red-backed Salamander (*Plethodon cinereus*) is well known for its colour polymorphism, which includes 8 colour phenotypes: the red-backed (striped), lead-backed (unstriped), and erythristic morphs, as well as the iridistic, albino, leucistic, amelanistic, and melanistic anomalies. Among these, the prevalence and geographic distribution of rare morphs have received little attention. In this article, we report 2 occurrences of silver-white variants of the red-backed morph of *P. cinereus* from Québec, Canada. To our knowledge, these variations in stripe colour on the red-backed phenotype represent the first 2 documented mentions for eastern Canada.

Key Words: Coloration; colour morph; dorsal stripe; silver-white variant; red-backed morph; Eastern Red-backed Salamander; *Plethodon cinereus*; Québec; Canada

Introduction

The Eastern Red-backed Salamander, *Plethodon cinereus*, has a broad geographic distribution in northeastern North America (Petranka 1998; Moore and Ouellet 2015). Like other terrestrial plethodontid salamanders, it plays an important role in forest ecosystems (Hickerson *et al.* 2012; Walton 2013; Semlitsch *et al.* 2014). This salamander's striking colour polymorphism has long attracted the attention of herpetologists and naturalists. Eight colour phenotypes are known and have been recently reviewed (Moore *et al.* 2012; Moore and Ouellet 2014). The red-backed (striped) and lead-backed (unstriped) morphs occur in most populations of *P. cinereus*, but in very different proportions (Moore and Ouellet 2015). The erythristic morph is also sporadically observed, but the iridistic, albino, leucistic, amelanistic, and melanistic anomalies are much rarer (Moore and Ouellet 2014).

In the red-backed morph of *P. cinereus*, the mid-dorsal stripe is generally red-orange, with gray-black borders that become mottled with white along the lower half of the body sides. Mid-dorsal stripe colours other than red-orange, such as shades of brown, gray, pink, white, and yellow, have also been reported (Bishop 1941; Test and Bingham 1948; Schueler 1975; Moore and Ouellet 2014). Surprisingly, little photographic evidence of these colour variations exists in the published literature. The dorsal stripe usually extends from the head to the tail; some individuals also show variations, such as disconnected stripe sections along the body or tail.

Silver-white variants of the red-backed morph of *P. cinereus* have recently been observed in the states of Ohio (Figure 18-1-C in Anthony and Pflingsten 2013;

Figure 5 in Moore and Ouellet 2014), Pennsylvania (Figure 2 in Neff *et al.* 2015; C. D. Anthony, unpublished data), and Virginia (Project Noah, unpublished data; Virginia Herpetological Society, unpublished data). “White-striped morphs” of *P. cinereus* have also been reported in Massachusetts and New York (Schueler 1975; Haines-Eitzen 2015). Furthermore, one account of a “silver-backed phase” and another of a “ghost-backed phase” with a white dorsal stripe have been described for the closely related Southern Red-backed Salamander (*Plethodon serratus*) in Missouri (Drake and O'Donnell 2014). The dorsal stripes in these rare occurrences vary from gray to silver-white or white. In this article, we document 2 new occurrences of silver-white variants of the red-backed morph of *P. cinereus* in Québec, Canada.

Methods

The 2 observations presented here were made by the authors during their multiple herpetological surveys, some of which specifically targeted *P. cinereus* (Moore and Ouellet 2015). In these surveys, unusual colorations were documented using various means, including digital photography vouchers. We measured snout–vent length (snout to middle of vent on the first specimen, and snout to posterior margin of vent on the second specimen) and total length (snout to tip of the tail) in the field with electronic calipers. Both specimens were immediately released on-site following documentation.

Results

The first silver-white specimen of *P. cinereus* was a subadult observed in May 2014, under a rock in the re-

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gional county municipality of Lévis, Québec (46°44'N, 71°11'W; datum WGS84). This area is located on the south shore of the St. Lawrence River, across from Québec City. The habitat consisted of a deciduous forested outcrop at an elevation of 90 m. The salamander's mid-dorsal stripe was silver-white (Figure 1), without visible xanthophores (yellow and red pigment cells or erythrophores), but with somewhat iridescent golden flecks. Its dorsolateral body was gray-black, while its ventral body was coarsely mottled with black and white, resulting in the distinctive salt-and-pepper appearance of the species. The pigmentation of both its irises was also standard. The specimen's length was 30.7 mm

snout to vent and 54.7 mm in total. On this particular site, we encountered 49 other individuals of *P. cinereus*, all of the standard red-backed morph.

The second specimen, an adult, was observed in July 2014 under woody debris in the metropolitan area of Québec City, Québec (46°45'N, 71°19'W; datum WGS84). This area is on the north shore of the St. Lawrence River, almost facing the first location (Lévis). The site was in a forested park, at an elevation of 80 m. The habitat consisted of mostly uneven-aged Sugar Maples (*Acer saccharum*). As on the first specimen, the mid-dorsal stripe was silver-white and the dorsolateral body was normally coloured (Figure 2). The col-



FIGURE 1. Silver-white variant of a red-backed morph of the Eastern Red-backed Salamander (*Plethodon cinereus*) from Québec, Canada. Natural light photo. Photo: M. Ouellet.



FIGURE 2. Dorsolateral view of a second silver-white variant of the Eastern Red-backed Salamander (*Plethodon cinereus*) from Québec. Artificial light photo. Photo: J.-D. Moore.

oration of the ventral body and irises was also typical of the red-backed morph. Snout to vent and total lengths were 37.8 mm and 73.5 mm, respectively. Autotomy caused tail loss just before photos were taken. A total of 24 other individuals of the red-backed morph of *P. cinereus* were also found in the site during the same survey.

Discussion

Silver-white variants of the red-backed morph of *P. cinereus* are documented here for the first time in eastern Canada. This phenotype appears to be rare, although it has already been encountered in the United States. In these occurrences, the dorsal stripes vary from gray to silver-white or white. Silver-white variants are thus characterized by the absence of visible xanthophores on the mid-dorsal stripe, compared with other variations of *P. cinereus*, which usually involve yellow and/or red pigment cells (Moore and Ouellet 2014). This phenotype of *P. cinereus* should be distinguished from the cream-backed variant (Figure 4 in Moore and Ouellet 2014) and similar colour combinations ("creamy-white stripe" in Reed 1955). Unlike the silver-white variant, xanthophores (yellow pigment cells in this case) are visible in the dorsal stripe of the cream-backed variant. Regarding terminology, the silver-white variants presented here are unrelated to the "axanthic" colour condition reported in certain amphibians, in which all the skin lacks visible xanthophores and iridophores (Lyerla and Dalton 1971; Frost *et al.* 1984; Jablonski *et al.* 2014).

Pigmentation plays significant ecological and evolutionary roles for some amphibians, and many amphibian species exhibit phenotypic variation in nature (Frost-Mason *et al.* 1994; Hoffman and Blouin 2000). Among salamanders, colour polymorphism is particularly common in *P. cinereus* throughout its range. For most of these, the environmental or genetic factors and the mechanisms involved are still unknown. Behavioural differences and the real significance of such coloration is also a matter of debate (Petranka 1998; Gibbs and Karraker 2006; Moore and Ouellet 2015). The role of the dorsal stripe itself in a rather fossorial species like *P. cinereus* is unclear. The red-backed morph may be less fossorial than the lead-backed morph, a hypothesis supported by the presence of fewer costal grooves (vertebrae) in some *P. cinereus* populations (Williams *et al.* 1968; Fisher-Reid and Wiens 2015). Given also that *P. cinereus* is mostly nocturnal (Piersol 1909; Petranka 1998), visual predation selection pressure at night is likely to be minimal. A wide variety of animals will prey on this salamander, including birds, small mammals, and snakes (Casper 2005; Anthony and Pflingsten 2013). Although colour discrimination by these predators could be limited at night, some studies have suggested that bird and snake predators can nevertheless differentiate coloration in *P. cinereus*, probably when foraging in the leaf litter during the day (Brodie

and Brodie 1980; Venesky and Anthony 2007). Both silver-white variants described here appeared in good physical condition among conspecifics of the red-backed morph.

New occurrences of rare or new colour variants in *P. cinereus* are still reported, even though this species has been studied extensively since the 1900s. We hope that this article will prompt documentation of these rare morphs to better assess their prevalence and distribution in North America.

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