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A case of color aberration in a fire salamander (*Salamandra salamandra*) larva

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Abstract

Color aberrations in salamanders are caused by defective chromatophores or by disrupted synthesis of the pigments, and have been previously reported in Europe. In this paper we report the first case of leucism in a fire salamander larva from a cave-dwelling population in Romania. The leucistic larva was larger and heavier compared to the other larvae from the same breeding habitat.

Key Words

Amphibia, cave, leucism, Romania

The fire salamander *Salamandra salamandra* is present in most of continental Europe, except for the Baltic and Nordic countries (Steinfartz et al. 2000; Kuzmin et al. 2009). Adults inhabit mainly deciduous and mixed forests and can be easily recognized by their distinct color pattern – black background with yellow-orange large spots. However, it is a highly polymorphic species, and colorations that may appear as anomalies in one subspecies are common in some populations and part of the normal coloration in other subspecies (Seidel and Gerhardt 2016 in Henle et al. 2017).

Conditions such as albinism, when pigmentation is lacking completely, or leucism, when pigments are present in a lower amount than normal, are among the most common color aberrations in wild amphibian populations and are induced by defective chromatophores (McCardle 2012), or when the chromatophores are fully functional, by disrupted synthesis of the pigments (Frost-Mason et al. 1994). The first albino fire salamander was reported in the 17th century (Wurffbain 1683 in Henle et al. 2017), and ever since it was proved that the absence of pigmentation is not uncommon both in this species (e.g. Varga 2010; Moore and Ouellet 2014; Gergely 2016; Lunghi et al. 2017) and in other salamanders (e.g. McCardle 2012; Lunghi et al. 2017; Hartzell 2020). Nonetheless, the background rates of albinism in amphibians from presumably unaltered habitats are usually much lower than 1% (Henle et al. 2017), and sometimes larvae lacking pigmentation develop a yellow pattern after metamorphosis (Pastors and Greven 2016 in Henle et al. 2017). In this paper we report the first case of color aberration in the larval stage of a cave-dwelling population of *Salamandra salamandra* from Romania.

During a herpetological survey carried out in April 2017 in South-Western Romania, we checked a known breeding habitat of the fire salamander inside the cave Gaura cu Muscă (44.66472°N, 21.69916°E, 100 m elevation a.s.l.). The cave is located within a compact karstic area (Bădescu and Tîrlă 2020), very close to the Iron Gates Reservoir. Numerous larvae in different stages of

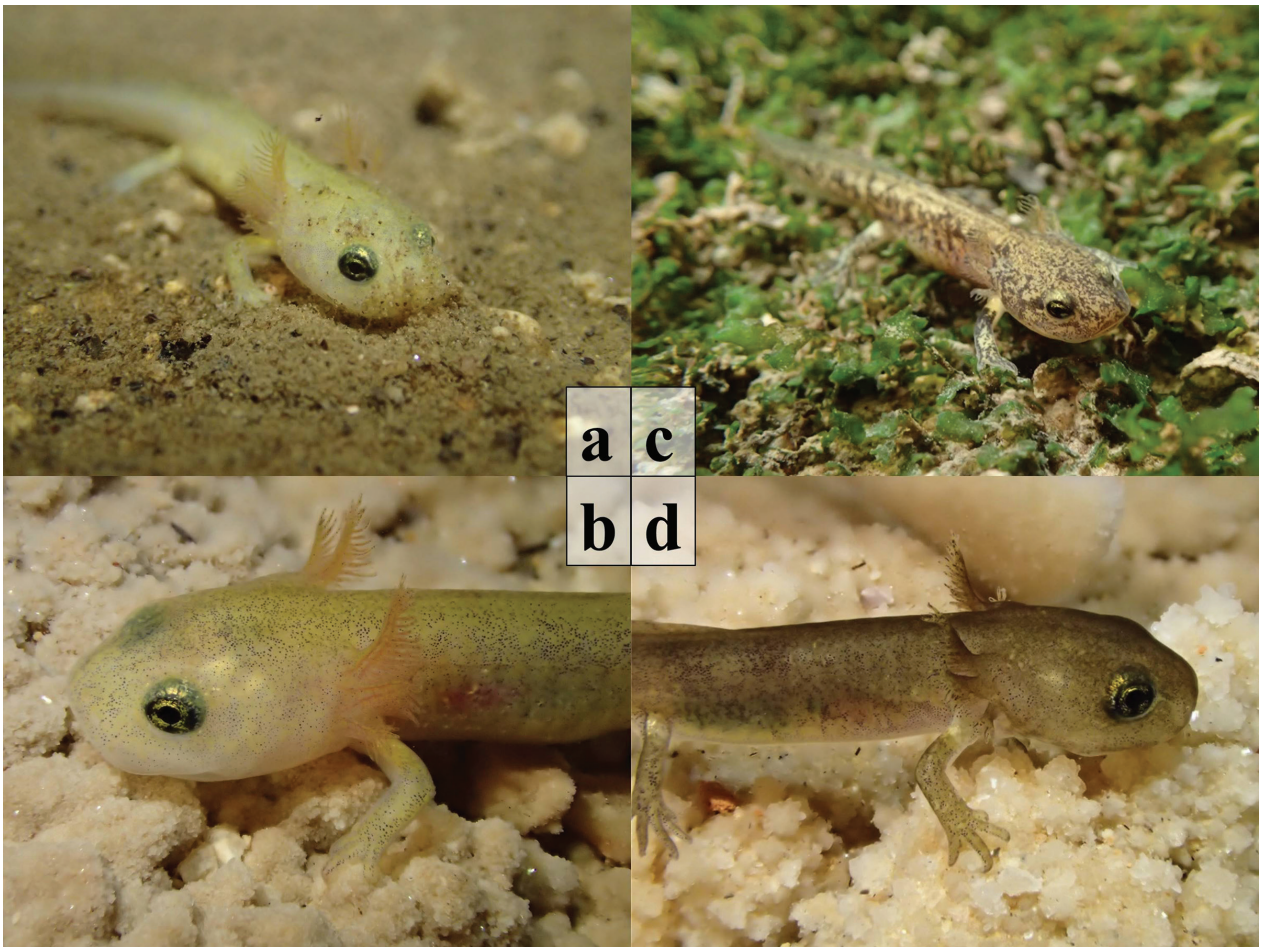

Figure 1. Leucistic larva of *S. salamandra* found in the cave Gaura cu Muscă, Romania (**a, b**); fire salamander larvae with normal coloration found in the same location (**c, d**). Photographs by F. Stănescu.

development occurred in the semi-permanent, shallow ponds formed at the entrance of the cave. Among them, one individual presented a much depigmented appearance. We used a small net to capture as many larvae as possible, and checked for the presence of other individuals with color aberrations. We measured the wet body mass on site by placing each larva in a plastic cup filled with water on an electronic pocket scale (Pesola, 0.01 g accuracy). We photographed each larva inside a plastic container, next to a piece of laminated millimeter paper, and used the photographs to measure the total body length with the software ImageJ v. 1.50i (Schindelin et al. 2012).

Only one in 44 larvae presented the abnormal coloration. Since melanophores and xanthophores were present in a very small amount and the eyes had a normal coloration (Fig. 1), we considered the observed aberrant coloration as leucism, following Henle et al. (2017). The rest of the larvae (n = 43) found within the same habitat presented the normal color phenotype, characteristic to the larval stage of the fire salamander. We calculated the upper and lower 95% confidence intervals for the total length (mean ± SD: 39.72 ± 5.71 mm) and body mass (mean ± SD: 0.34 ± 0.13g) of the normal colored larvae. Both measurements of the leucistic larva (46.06mm and 0.55g) are situated above the 95% CI [37.97, 41.48] for total length, and respectively 95% CI [0.30, 0.39] for body mass. This contrasts with the results of Varga (2010) who reported a leucistic *S. salamandra* larva smaller than the rest of larvae in the cohort, or Gergely (2016) who reported no difference in size between a leucistic larva of the same species and the rest of the cohort.

During the past ten years, only a handful of studies reported color aberrations in *S. salamandra*, from populations in Hungary (Börzsöny Mountains, partial albinism in one larva, Varga 2010; Gergely 2016) and Italy (Lombardy, partial albinism in four larvae, leucism in one adult; South Tyrol, leucism in one adult, Lunghi et al. 2017). Several older records of color aberrations are reported by Arribas and Rivera (1992), for populations of the fire salamander from Spain, and in the review studies by Seidel et al. (2012) and Henle et al. (2017), for populations from France and Germany. To the best of our knowledge, this is the first report of color aberration observed in larvae of the fire salamander from a cave habitat. In addition, previous studies regarding amphibians from Romania reported so far only one case of an albinistic frog, i.e., a specimen of *Pelophylax ridibundus* found in a mining habitat (Adlassnig et al. 2013), and morphological

anomalies such as malformations and polydactyly (e.g. Székely and Nemes 2003; Sas and Kovacs 2006).

In fire salamanders, the color pattern of both terrestrial and aquatic life-stages helps the animals to blend in with the natural environment, while also signaling the presence of toxic secretions to potential predators (i.e., aposematic coloration). Thus, the lack of pigmentation might lead to a shorter lifespan in nature due to increased conspicuousness to predators (Fertl and Rosel, 2009) or affect the thermoregulation due to the lack of the black pigment (Trullas et al. 2007); however, this will not affect cave-dwelling individuals.

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