First records of melanism (including in tail bifurcation) of lacertid lizards (Reptilia: Lacertidae) in Bulgaria

Variations in skin coloration, including complete or partial melanism (a phenotype of increased black pigmentation) have been of interest for at least 130 years in lacertid lizards (Reptilia: Lacertidae) (Camerano 1886). Although widely documented for some lacertids in Europe (see Domeneghetti et al. 2016 and citations therein), until now, no published data exist for lizards with partial or complete melanism in Bulgaria.

Here we present five unpublished cases from Bulgaria of two widely-distributed lacertid species exhibiting melanism. In Bulgaria, the European Green Lizard *Lacerta viridis* (Laurenti, 1768) is found in diverse habitats generally up to 1,600 m a.s.l.; the Viviparous Lizard *Zootoca vivipara* (Lichtenstein, 1823) is a glacial relict at the southern edge of its range, inhabiting the mountains above 1,400 m a.s.l.

1.) On 16.6.2005, around 10:30h, near Kostilkovo village in the Eastern Rhodopes mountain (41.42441°N, 26.06738°E; 282 m a.s.l.), GP closely observed (without catching or photographing) a completely melanistic adult male *L. viridis* (likely *meridionalis*) in a sparse forest of Pubescent Oak *Quercus pubescens*.

2.) On 25.06.2015 NTz and YK were conducting a herpetofaunal survey in the Natura 2000 Site of Community Importance (SCI) "Emine - Irakli", at the central part of the Black Sea coast. At around 13:45h, in a bright deciduous forest dominated by *Q. pubescens* with sparse undergrowth, we observed a basking adult female *L. v. meridionalis* (42.74139°N, 27.88457°E; 83 m a.s.l.). What looked from a distance like damaged scales, upon capture of the individual and close inspection was identified as 10–15 irregularly-shaped spots with black coloration (Fig. 1). Since we could not discriminate any mechanical damage to the skin or the scales, the spots were at multiple locations, and some scales had both normal and black coloration, we presume this was caused by partial melanism. The coloration (besides the melanistic spots) was typical for the subspecies. Four other individuals of this taxon that were observed in the same survey had normal coloration.

3.) We note here a highly intriguing case of *L. v. viridis* with a bifurcated tail (Stojanov et al. 2011, Fig. 402). The authors only mention the bifurcation in the figure caption, but we include this observation here as the secondary tail also bears signs of melanism (Fig. 2). Typically, in lacertids, the re-growing tail after an autotomy differs from the original not only in a replacement of the bone with cartilage but in coloration – ranging from paler to darker than the original and usually with less patterning. We did not observe melanism on the additional tail upon inspection of published images and descriptions of lacertids with bifurcated tails: e.g. a case of a Bosk's Fringe-fingered Lizard *Acanthodactylus boskianus asper* without a seeming change in coloration (Tamar et al. 2013); a Sand Lizard *L. agilis* with no change in color, and a *Z. vivipara*, with a slight change (Dudek & Ekner-Grzyb 2014); and an Erhard's Wall Lizard *Podarcis erhardii* with a discolored tail lacking the black striped pattern (Brock et al. 2014). Thus, the cause for such extreme change in coloration we present here is still to be identified.

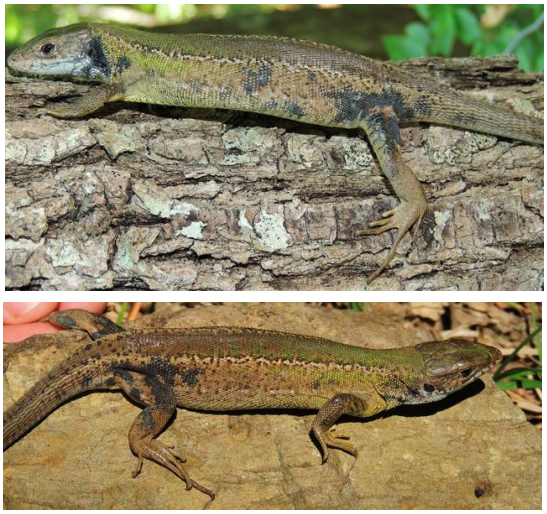


Figure 1. Partially melanistic female *Lacerta viridis meridionalis* (A. - left side; B. - right side).

Figure 2. Partially melanistic *Lacerta v. viridis* with a bifurcated tail, mentioned in Stojanov et al. (2011). Photographed by Georgi Popgeorgiev.

Furthermore, since GP has observed and photographed as well the individual from Stojanov et al. (2011) alongside the authors, here we provide additional information. The subadult was observed on 2.05.2008, around 10:00h, near Zornitsa village, next to Studen Kladenets Reservoir (41.63081°N, 25.52371°E; 275 m a.s.l.), at the ecotone between a sparse forest (*Q. pubescens* and Jerusalem thorn *Paliurus spina-christi*) and an open grassland.

All observations of *L. viridis* were within the zone where both *L. v. viridis, L. v. meridionalis* and their hybrids are found (Stojanov et al. 2011; Fig. 403).

4., 5.) Additionally, we report two cases of complete melanism in Viviparous Lizards *Z. vivipara*, obtained during an ongoing mark-recapture study in Vitosha Mountain, western Bulgaria. EV captured an adult male on 27.06.2016 (42.59306°N, 23.28899°E; 1,828 m a.s.l.; body length: 48.5 mm; tail length: 88.5 mm; weight: 2.72 g; Fig. 3) and a juvenile on 29.09.2016 (42.60026°N, 23.28257°E; 1,821 m a.s.l.; body length: 30.0 mm; tail length: 43.5 mm; weight: 0.73 g; Fig. 4). Thus, we add additional data on the occurrence of melanism of *Z. vivipara* close to the southern extent of its distribution, in addition to a female reported from Montenegro (Iković et al. 2014).

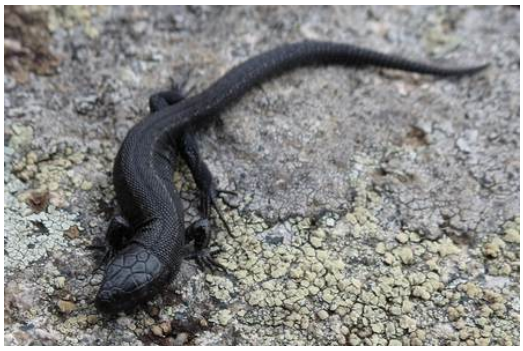
Except for the animal with the bifurcated tail, all other individuals had intact tails and seemed in good body condition, with no signs of trauma or injuries. All captured animals were released on site after pictures and measurements were taken.

A.

B.

Figure 3. Adult melanistic *Zootoca vivipara*. (A. – dorsal view; B. – ventral view).

A.



B.

Figure 4. Juvenile melanistic *Zootoca vivipara*. (A. – dorsal view; B. – ventral view).

The observations presented here are the only ones of complete or partial melanism of lacertids that we know of in Bulgaria. Based on our personal unpublished data, we presume that, in general, the frequencies of melanism in lacertid lizards in Bulgaria are very low (<0.01%): we have over 9,000 records of *L. viridis* from diverse locations, and 723 of *Z. vivipara* (including 329 from Vitosha).

The evolutionary significance of melanism in reptiles, and especially lacertids, still remains controversial and is subject to debate. Observations of melanistic *L. viridis* are few, mostly incidental and provide limited possibilities to discuss hypotheses (e.g. Camerano 1886, Werner 1897, Boulenger 1913, Arnold & Ovenden 2002, Korsós & Nagy 2006, Stošić 2014). On the other hand, for various populations of *Z. vivipara* in Europe, different frequencies of melanism have been reported. Frequencies seem higher in males and very low to missing in females, respectively: 0.05% in Pyrenees (San-Jose et al. 2008), 1.13% in the Swiss Alps (Cavin 1999), 2.5% in Slovakia (5.9% in males, 0% in females; Jambrich & Jandzik 2012), 8.3% in Czech Republik (15% of all males, but only 2% of females; Gvoždík 1999, but see Boulenger 1917). The hypothesis that melanistic specimens have a thermoregulatory advantage has not been confirmed for the Viviparous Lizard, and decreased crypsis likely is strongly disadvantageous for gravid, slower females (Gvoždík 1999). Thus, the difference of between-population melanism frequencies could be linked either to different levels of predation pressure or to habitat specifics (e.g. some microhabitats offer better opportunities for melanistic individuals to avoid visual predators). Jambrich & Jandzik (2012) also support the idea that the different frequency of melanism in *Z. vivipara* can be linked to habitat quality. However, San-Jose et al. (2008) did not find any evidence of decreased body condition resulting from higher conspicuousness. However, the causes might be more complicated as, in male *Z. vivipara*, melanin-based ventral colouration may signal an aspect of immune capacity to sexual rivals or potential partners (Vroonen et al. 2013).

Although we briefly review possible evolutionary drivers for melanism in lacertid lizards, due to the low sample size, the proximate causes in Bulgaria are yet to be determined. With the increase of the amount and geographic range of the field data being obtained in Bulgaria, we expect that future studies might identify existing populations with higher frequencies of melanism that could be suitable for testing further ecological and genetic question.

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