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Melanism in *Natrix tessellata* (Serpentes: Colubridae) from Slovakia

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The species of the genus *Natrix* Laurenti, 1768 exhibit a high color and pattern variability. In the past, this variability has been the reason of many taxonomical changes (e.g. *Natrix cetti* Gené, 1838, *N. megalocephala* Orlov and Tuniyev, 1986) that were later proved to be mostly incorrect without the use of molecular approaches (see Kindler et al., 2013). On the other hand, in some cases the variability may correspond with evolutionary events and coloration or morphological differences suggest complex phylogenetic relationships among populations. A good example is the species complex of dice snakes, *Natrix tessellata* (Laurenti, 1768), the group with high phenotype and genotype variability (Guicking et al., 2009). Based on mitochondrial cytochrome *b* sequences, nine clades associated with populations from Iran, southern Greece, Jordan/Egypt, Turkey, Caucasus, Kazakhstan, Uzbekistan, Crete and rest of Europe were identified. In most of the cases the clades are highly diverged from each other and some of them may represent cryptic taxa (Guicking et al., 2009; Kyriazi et al., 2013). Despite missing exact comparison, it seems that in all these lineages the melanistic individuals or populations are present and this phenomenon is increasing southward and eastward from Central Europe (for details see articles in Mebert, 2011 and references therein). Central Europe is the northern range border of the species and the records of melanistic individuals of *N. tessellata* are very rare there. Several cases of melanism were described and briefly documented from Slovakia (Geisenheyner, 1888; Laňka, 1978; Rehák, 1992). In the Czech Republic, there has been no melanistic individual recorded (Moravec, 2015).

During the fieldwork conducted on 11 April, 2015 the second author of the paper observed approximately 40 individuals of *N. tessellata* in the cottage settlement of Radvaň nad Dunajom village (47.749°N 18.379°E, 111 m a. s. l.), a few meters from the Danube River bank. This place is known as a hibernating site with dense population of the dice snakes. Observed snakes have basked on small trees or shrubs and on the roofs of local cottages. One observed individual was distinctive with the black coloration of the body. Therefore it was caught and examined. Basic morphometric data and photos of the individual were taken (Fig. 1). The specimen was a male with length of 700 mm. Overall coloration of the body was black without any pattern. However, there were also white places at the ventral part of the body, especially near the head (lower lips) and lower neck parts and scarcely spread white spots over the rest of the body (Fig. 1A).

The dice snake is very variable species as to its color pattern especially in southern populations, probably because of different evolutionary history (see Guicking et al, 2009; Kyriazi et al., 2013). Central European populations are formed by one evolutionary lineage and their typical coloration may differ between gray, olive and brown. These colors are not homogenous but alternate between lighter and darker shades. A dark, alternating row of markings, incomplete bands or longitudinal rows of spots are located on the back. Specimens with uniform ground color were also described. The ventral part of the body is whitish, yellowish, reddish-gray or blackish with more or less visible spot pattern (Gruschwitz et al., 1999). In European populations several color aberrations were described: *Tropidonotus tessellatus* var. *concolor* Jan, 1864 and *Natrix tessellata* var. *flavescens* Massolongo, 1853. While the first mentioned aberration is found also in Central Europe,

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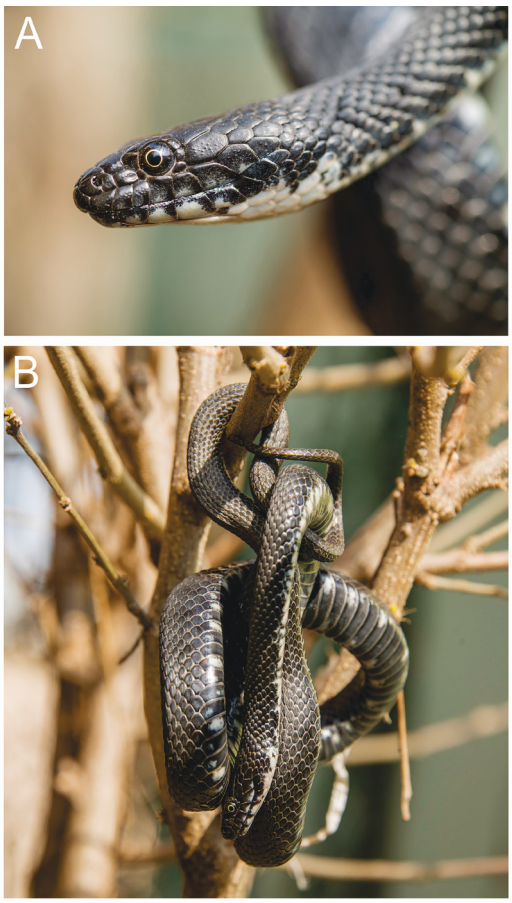

Figure 1. Individual of *Natrix tessellata* from Radvaň nad Dunajom, Slovakia. (A) Detail view on the head; (B) overall view. Photo by Jan Kautman.

so-called aberration *flavescens* occurs most often in Central coastal Croatia (Jelić and Lelo, 2011). Another non-European form of *N. tessellata*, (formerly called as *Tropidonotus tessellatus* var. *nigerrima* Werner, 1897), links to the high incidence of melanism in Transcaspian populations of dice snakes.

When looking at some published records of melanism in *N. tessellata*, one fact can be noticed – higher presence of records southward and southeastward from Central Europe and their absence there (see Mebert, 2011). In general, melanism in *N. tessellata* is known from southern Switzerland to China but without geographical pattern (Mebert, 1993; Gruschwitz et al., 1999). For example, Tuniyev et al. (2011) presented that number of melanistic individuals in Sea of Azov is approximately 10% of population, in Lenkoran lowland at the Caspian Sea coast approximately 15% and in higher elevation of Armenia (Lake Sevan) it is about 50% of the population. Some of populations were formed even only by melanistic specimens (Kotenko et al., 2011; Litvinov et al., 2011). A significant proportion of melanism in geographically/spatially separated populations is also noticeable; 10-17% in Lake Lugano, Switzerland (Mebert, 2011), 13% in Golem Grad Island, Macedonia (Ajtić et al., 2013) or 20% on the Mediterranean island Korfu (Wütschert, 1984). On the other hand, melanism occurs less frequently in some northern areas, where only a single melanistic specimen has been observed occasionally (e.g. in Slovenia, Slovakia; Geisenheyner, 1888; Laňka, 1978; Rehák, 1992; Cafuta, 2011). Increasing number of melanism cases in southern/eastern populations has been observed in other snake species such as *N. natrix* (only two known cases from the Czech Republic and Slovakia; Jandzik, 2004; Berec et al., 2015) or *Zamenis longissimus* (see *Coluber longissimus* var. *subgrisea* Werner, 1897; Schreiber, 1912; Ščerbak and Scerban, 1980). Also almost completely melanistic species such as *Hierophis carbonarius*, *Dolichophis jugularis* or *Zamenis persicus* are known from southern regions. On the other hand, in viviparous species like *Vipera berus* (Linnaeus, 1758) melanistic specimens are found in higher densities up in the North and in higher elevations (Andrén and Nilson, 1981).

Without any experimental test or comprehensive research we can only speculate what is behind this color difference which occurs in the southern (climatically warmer) regions. It can be linked with high genetic diversity of populations in southern areas. As it is well known, the populations occurring nowadays in the north show primarily lower rate of genetic diversity due to founder effect of sources populations. Andrén and Nilson (1981) and Luiselli (1992, 1995) suggested that melanistic individuals are favored in climatically colder environment due to their faster accumulation of the heat from the sun and they basked more efficiently at lower temperatures than non-melanistic snakes. When concerning also semiaquatic life-history of *N. tessellata,* this could have certain logic. Because of this, snakes can be active for longer time, they can obtain more food, grow up to bigger size and they can have more offspring. In denser southern populations where the competition is higher, bigger body size can increase the mating success of males (Luiselli, 1995) and the coloration is thus under positive selection. One of the discussed adaptive hypotheses for melanism in snakes is also protection against sun damages (for details see

Lorioux et al., 2008), what could also potentially explain melanism cases in southern populations. However, these authors did not find any relationship in their observed melanism cases and they suggest that the phenomenon is non-adaptive (Lorioux et al., 2008). In any case, inter-population and intersex studies of vertical/horizontal distribution of melanism in the complex of *N. tessellata* is needed.

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