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SHORT COMMUNICATION

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Will climate change affect the proportion of melanistic northern vipers *Vipera berus* in a western European population with an exceptionally high rate of melanism?

GRÉGORY DESO

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The northern viper *Vipera berus berus* has populations scattered across western Europe that include a proportion of melanistic individuals (Thiesmeier & Voelkl, 2002). The occurrence of melanism is particularly prevalent in the colder parts of its range, melanism being considered an advantage for thermoregulation (Luiselli et al., 1994; Monney, 1996; Broennimann et al., 2014) as well as for physical and reproductive performance (Clusella-Trullas et al., 2007). Populations of melanistic reptiles can also be found in good proportions in warmer regions of the globe (Ineich et al., 2009) and according to Lorioux et al. (2008), the phenomenon of melanism could also be non-adaptive while providing protection against sun damage. In France, there are almost no *V. berus* populations with a high rate of melanism (Guiller et al., 2019; Graitson et al., 2023), but there is one in the east of the country in the Jura region, along the Drugeon river (Guyétant et al., 1980). In a study 24 years ago, a remarkable melanism rate of 53% was found in a sample of 62 individuals (Pinston et al., 2000). This high rate of melanism is probably due to the humid, cold and forested nature of the study area. Melanism in vipers of the Jura region occurs mainly in humid forest environments (Monney, 1996). The high proportion of melanistic individuals is maintained by frequency-dependent negative natural selection in males and females (Madsen et al., 2022).

The study site along the Drugeon river covers the whole of the ENS (Espace Naturel Sensible) of the Etang de Bouverans and the Varot marshes, as well as the sites of the RNR (Réserve Naturelle Régionale des Tourbières de Frasne), which extend over three communes: Bouverans, Bonnevaux and Frasne (46° 49’46’’ N, 6° 12’16’’ E). Our study site is located at altitude (between 800 and 900 metres), which is also one of the conditions for the presence of a high rate of melanism in this viper (Andren & Nilson, 1981). These sites cover around 500 hectares of highly diverse wild habitats, including lakes, marshes, wet meadows, active peat bogs, beech-fir forests, mountain meadows and dry grasslands (Fig. 1). Due to climate change, the average global temperatures have already risen by 1.1 °C between the years 1850 and 2020 (IPCC, 2023) and it has been suggested that melanism trends in snakes can change depending on climatic conditions (Bury et al., 2022). The

Figure 1. Location of the study area in the Jura region of eastern France

climate projections to 2050 for our study area, made by the DRIAS platform (https://www.drias-climat.fr/decouverte), include three scenarios (RCP2.6/ RCP4.5/ RCP8.5) which all predict a greater rise in temperatures, with an increase of 1.56 °C (RCP 2.6), 1.82 °C (RCP 4.5) and a potentially extreme rise of up to 2.14 °C (RCP 8.5). Surprisingly, our study area, where temperatures are forecast to rise sharply, is today one of the coldest areas in France and western Europe. The accumulation of droughts and heatwaves is expected to result in geographical variations in morphology and hydro-regulation strategies (Chabaud et al., 2022). The lack of water for female European viper species is a constraint that has a strong impact on their physical condition, particularly when they are gravid (Le Galliard et al., 2021). Besides global warming, genetic isolation of population, due to their confinement within natural barriers, is also a threat to the Drugeon and Monts D’Or viper populations (Ursenbascher et al., 2009). The loss of genetic diversity has an impact on the functioning of populations, as it leads to lower ecological resilience (adaptability to disturbance) and a reduction in reproductive success.

We undertook field surveys to provide an updated estimation of the proportion of melanistic individuals at the study sites. To do this we photo-identified the head scale

Figure 2. Reproduction between the melanistic and typical zigzag phenotypes of *Vipera berus* in the Jura region of eastern France

patterns of the vipers to enable individual recognition, a technique commonly used for this species as it is considered very reliable (Bauwens et al., 2018), and supports capture-mark-recapture population estimates. The population census was undertaken from 2020 to 2023, although survey effort was not equal between the sites, with five days per year on the ENS site (i.e. a total of 15 days over three years) compared with eight days in a single year on the RNR site. We identified 76 vipers by photo-recognition and made 19 isolated viper records without recognition, i.e. a total of 95 viper contacts over four years, with a recapture rate of 25%. Of these vipers 56.84% were melanistic (Fig. 2) and 43.16% had the normal zigzag pattern. From this, we have concluded that there has been little or no change in the rate of melanism since the year 2000. Although melanistic individuals were more numerous, a very balanced sex ratio (52.3% female and 47.7% male) was noted among both melanistic individuals (with a slight tendency in favour of melanistic females 52.83%) and individuals with a zigzag pattern (also with a slight trend in favour of females at 51.43%). The fact that our population here has more melanistic females than in the zigzag pattern is positive because, according to Forsmann (1995), melanistic females have an advantage when it comes to breeding, whereas males, because of their ecology, are more likely to be predated (Andren & Nilson, 1981). During the sampling period, only two young individuals were found in the study area, one of which had a zigzag pattern and one of which was already fully melanistic, suggesting that individuals may be born already melanistic.

The large numbers of melanistic vipers we observed were most often found not far from water (70%) and in dense, cool forest areas (30%). According to Yenmis et al. (2022), melanistic populations of *Natrix natrix* in Anatolia were living three times closer to water than those with typical colouration and they frequently used areas with numerous insulating rock shelters at the water's edge, which allowed them to cool down more quickly during the hottest periods of the year. The hypothesis that melanistic reptile populations need moister conditions apparently also applies to those living in the tropics (Ineich et al., 2009). In order to combat the effects of rising temperatures and low rainfall, it seems important for reptile populations to have wet shelters and good access to water (Sears et al., 2016; Rozen-Rechels et al., 2020; Chabaud et al., 2022). The high melanism rate reported in our study site (56.84%) has apparently been constant since 2000 but given the expectation of rising temperatures due to climate change, the sites offer a good opportunity to study the effects of climate change on the proportion of melanistic vipers within the population. The capture-mark-recapture monitoring protocol we have established will be replicated over time and will enable us to monitor any future changes in the proportion of melanistic individuals.

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