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SHORT COMMUNICATION

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Dorsal stripe polymorphism of *Vipera berus* in south-east England

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The northern viper or adder (*Vipera berus*) is sexually dimorphic and well known for variations in both colour and dorsal markings. Typical markings are a dorsal stripe composed of mirror waves and zigzags (for convenience referred to as a 'zigzag' stripe) either side of which is a dorso-lateral row of spots/bars that oppose the indentations of the zigzag (Benson, 1999; Steward, 1971). Smith (1951) suggests that variations in dorsal patterning are restricted to about 2 % of individuals and mentions records of specimens from England (Lake District and Yorkshire) and South Wales where the zigzag is instead a smooth stripe and the dorsolateral spots/bars are lacking. Benson (1999) who studied *V. berus* in Yorkshire indicates that the stripe may be solid or have a lighter middle band. According to the Kent County recorder for reptiles and amphibians, there are no previous records of smooth striped northern vipers from Kent (Brady, L. pers. comm.). However, between 2005 and 2020 we recorded several cases in Kent where the dorsal stripe was not the classic 'zigzag'.

Here we report records of nine individuals with varying degrees of divergence from the classic zigzag from four sites in south-east of England, three in the county of Kent and one in the adjacent county of East Sussex (Table 1). In Kent, the first specimen recorded was an adult female (confirmed via cloacal probing) with a partial smooth stripe (Fig. 1A) and vestiges of the dorso-lateral spots/bars. This bears a close resemblance to the individual pictured by Smith (1951), where the zigzag is retained posteriorly. From the second Kent site, four further specimens were observed but with variants of the partial smooth stripe. This stripe had short lateral projections, making it in effect a rough stripe, no sign of the lateral bars/spots, and in all specimens the zigzag pattern was retained posteriorly (Fig. 1B). At the third Kent site, an adult male (Fig. 1C), an adult female (Fig 1D), and a sub-adult male (Fig. 1E) were observed with complete smooth stripes (no zigzag even posteriorly) and with lateral spots/bars completely absent. The adult female was unusual in being only very weakly patterned and with only with a hint of the stripe (Fig. 1D). The sub-adult male (Fig. 1E) had the classic brown colouration of a female *V. berus* but was identified as male based on hemipenal swelling, tail-length and rostral markings (Burghardt, 2005). Most other records of vipers from the third site were of normally patterned *V. berus* but our small sampling effort prevents us from making any justifiable estimate of the proportion of smooth striped individuals present on the third site but potentially this was greater than the 2 % quoted by Smith (1951). In addition to the Kent records, a smooth striped male was observed in April 2020 in East Sussex (Webster, pers. com.).

Table 1. Observations of *V. berus* in south-east England with variations on the classic zigzag dorsal stripe

Site and habitat	Date	Vipers observed	Marking
Kent, Lyminge and Denge Forests, 165 ha of mixed broad-leaf and coniferous woodland plantations and chalk grassland	June 2005	1 adult female	Partial smooth stripe (Fig. 1A)
Kent, Folkestone, 2.5 ha of open chalk grassland and mixed scrub habitat	June - August 2016	2 juvenile females	Partial rough stripe
		1 adult female	Partial rough stripe (Fig. 1B)
		1 adult male	Partial rough stripe
Kent, Ashford, 134 ha of chalk grassland, woodland and mixed scrub and grassland	April 2019	1 adult male	Complete smooth stripe, lateral spots / bars absent (Fig. 1C)
	June 2019	1 adult female (?)	Very weakly marked with faint hint of a complete smooth stripe, lateral spots / bars absent (Fig. 1D)
	March 2020	1 sub-adult male	Completely smooth stripe, lateral spots / bars absent (Fig. 1E)
East Sussex, 15 ha of chalk grassland	April 2020	1 adult male	Complete smooth stripe, presence of lateral spots/bars unknown

The 'striped' morph of *V. berus* is described as being extremely geographically confined, occurring alongside vipers with the zigzag stripe but not melanistic individuals (Wolf & Werner, 1994). This is consistent with the third site in Kent where no melanistic individuals have yet been recorded, which can be compared to another viper population, about 9.5 km away from the third site, where melanistic individuals occur but to date only the zigzag morph has been observed

Figure 1. Northern vipers with unusual dorsal stripes - **A.** Adult female with a partial smooth stripe that becomes a typical zigzag posteriorly, **B.** Adult females with a partial rough edged stripe that becomes a typical zigzag posteriorly, **C.** Adult male with a complete smooth stripe, i.e. extending the whole length of the body, **D.** Adult female (?) with only very faint body markings including a complete smooth stripe, and **E.** Sub-adult male with a complete smooth stripe (despite showing classic female brown colouration this specimen was confirmed as a male)

(Griffiths, pers. comm.). No evidence either way can be offered from the other sites.

We observed that the snakes with variants of the zigzag stripe often lacked lateral spots/bars. This may offer some clues as to how the marking pattern is formed during embryological development with perhaps the spots/bars cleaving from a stripe to create the zigzag. The zigzag stripe is common to eight of the European viper species (Speybroeck et al., 2016) and much research has focussed on identifying its role in behavioural ecology. It is suggested that it is cryptic (camouflage), and/or aposematic (a warning that the vipers are venomous), and particularly in the case of the males may facilitate 'flicker fusion' to disorientate predators (Santos et al., 2014; Valkonen et al., 2011; Lindell & Forsman, 1996). Such benefits may be lost by other phenotypes. For example, it has been demonstrated that there are differences in reproductive success and predation between zigzag and melanistic phenotypes, where the latter had a higher risk of predation but greater reproductive success than the former (Andren & Nilson, 1981).

Declines in northern viper populations have been a matter of conservation concern for some years. One possible factor in these declines emerged in Sweden where an isolated population of northern viper was found to suffer from inbreeding that resulted in still born or deformed young (Madsen et al., 1996); the problem was resolved by a conservation translocation of adult males into the inbred population. The genetic health of northern viper populations is therefore a matter of concern but it would appear that presence of a range of phenotypes within a single population may be an indicator that the population is genetically robust (Madsen, pers. comm.). The occurrence of variously striped individuals in our populations may therefore be considered a positive feature in that regard. Furthermore, although genetic sampling in southern England has found striking levels of relatedness amongst northern viper populations, it is more likely that demographic factors rather than genetic ones are the cause of declines in small British populations (Ball et al., 2020; Gardner et al., 2019). The advisability of conservation translocations of adders for genetic or demographic enhancements still requires detailed consideration while habitat management and public engagement are more firmly established conservation options (Julian & Hodges, 2019).

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