SHORT NOTES:

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MORPHOLOGICAL VARIATION IN RUSSELL'S VIPER IN BURMA AND THAILAND

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Russell's viper (*Vipera russelli*) is one of the most widespread venomous snakes in southern Asia. It is an important cause of snakebite mortality and morbidity in many areas, including Thailand and especially Burma (Looareesuwan, Viravan & Warrell, 1988; Warrell, 1989). The symptoms of Burmese and Thai Russell's viper bite differ considerably: bites in Burma result, among other symptoms, in pituitary infarction, generalized capillary permeability and primary shock (Myint-Lwin *et al.* 1985), whereas bites in Thailand result in intra- vascular haemolysis (Warrell, 1986, 1989).

In some venomous snake species complexes, venom differences have been found to be related to taxonomic differentiation of the populations concerned; in these cases, venom differences were accompanied by morphological differences, for instance in *Echis* (Warrell & Arnett, 1976) and in the Asiatic cobra complex (Wüster 1990; Wüster & Thorpe, 1989, 1991). However, in the case of Russell's viper, previous workers have found relatively little morphological differentiation between Burmese and Thai Russell's vipers (Anon. 1987; Warrell, 1989), and both populations are generally included in the subspecies *V. r. siamensis* Smith, 1917 (e.g. Harding & Welch, 1980; Warrell, 1989).

The aim of this paper is to investigate the pattern of geographic variation in Russell's viper in Burma and Thailand, and to show that advanced taxonomic techniques can lead to a clearer assessment of the pattern of morphological variation than univariate statistics.

Preserved *V. russelli* specimens were borrowed from a number of museums in Europe and the United States. Twenty-three scalation and colour pattern characters were recorded from all specimens. In order to record the position of characters along the body of the snakes, the ventral scales were numbered from the head to the vent. The position or length of a character along the body is recorded as the ventral scale at the level of which it is situated. This is then converted to %ventral scale (%VS) position in order to compensate for variation in the number of ventral scales. The width or height of colour pattern characters on the dorsum of the specimens, is recorded as the number of dorsal scale rows on which they encroach. This is then expressed as a percentage of the number of dorsal scale rows at the level of the character (%DS width).

Principal components analyses (PCAs) were run separately for each sex, using all specimens with good locality records, and 21 characters showing geographic variation across the entire *V. russelli* complex (Table 1). In addition, a two-way analysis of variance (ANOVA) was run on the specimens of both sexes and populations, in order to determine which characters show statistically significant differences between the two populations.

The ordination of the individual specimens along the first two principal components is shown in Fig. 1. In both sexes, the Burmese and Thai specimens are clearly separate, to the extent that there is no overlap between the males, and very little between the females of the two populations.

The results of the two-way ANOVA are shown in Table 2. Out of 21 characteristics investigated, 12 show significant differences between the Thai and Burmese populations.

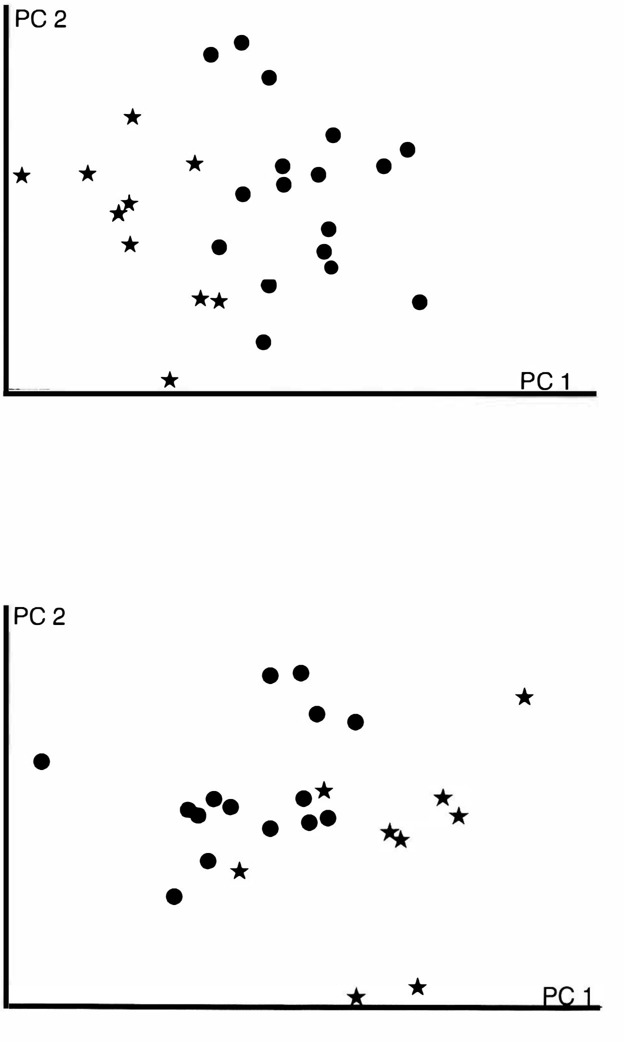

Fig. 1. PCA results: ordination of the Burmese (circles) and Thai (stars) Russell's viper males (top) and females (bottom) along the first two principal components.

This study shows that the Thai and Burmese populations of *V. russelli* differ considerably in their morphology. Although no single character can discriminate with absolute certainty between the two populations, there are significant differences in more than half the characters examined, including "standard" taxonomic characters such as the number of subcaudals. The differentiation in the overall phenotype is such that the PCAs reveal no overlap between male specimens, and very little between the female specimens of the two populations. The use of multivariate techniques allows a better assessment of the degree of morphological differentiation between populations than do univariate methods, as it analyses the pattern of variation in all characters used simultaneously (see Thorpe, 1987, for a review).

The reports suggesting only minor morphological differences between Thai and Burmese Russell's vipers have been held up in some cases as an example of extreme venom differentiation unaccompanied by morphological differentiation. We have shown here that the morphological differences are more important than was hitherto realised, although they are much more subtle than the very startling differences in venom effects. Nevertheless, it is important to emphasise the fact that there are significant differences, since it shows that detailed studies of the population systematics of venomous snakes can be used as a predictor of venom variation.

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1.	Number of ventral scales.
2.	Number of subcaudal scales.
3.	Number of dorsal scale rows at 25% VS length.
4.	Number of dorsal scale rows at 50% VS length.
5.	Number of dorsal scale rows at 75% VS length.
6.	Number of dorsal scale rows at 100% VS length.
7.	Number of supralabials.
8.	Number of infralabials.
9.	Number of scales contacting eye.
10.	Number of scales between supraoculars.
11.	Number of scales between chin shields and first ventral scale.
12.	Number of scales contacting rostral.
13.	Number of lateral spots between head and vent.
14.	Number of dark spots on the five ventrals situated at 50% VS length.
15.	% Infralabials with dark spot.
16.	%DS width of mid-dorsal spot row at 50% VS length.
17.	%DS width of lateral spot row at 50% VS length.
18.	%VS length of lateral spot at 50% VS length.
19.	%DS height of upper edge of lateral spot row at 50% VS length.
20.	Width of dorsolateral head spot (in scales).
21.	Number of scales between dorso-lateral head spots.

TABLE 1. List of *Vipera russelli* characters used in principal components analysis.

	Burma		Thailand		Significance
	M (n = 17)	F (n = 15)	M (n = 10)	F (n = 9)	
1.	159.2 ± 3.33	160.7 ± 3.24	158.8 ± 4.71	161.4 ± 4.64	n/s
2.	46.9 ± 2.10	41.2 ± 2.86	51.7 ± 5.54	48.0 ± 3.89	P<0.0001
3.	26.6 ± 0.70	26.5 ± 0.83	28.0 ± 0.82	27.7 ± 1.00	P<0.0001
4.	28.9 ± 0.78	28.9 ± 0.52	30.3 ± 1.25	29.9 ± 0.81	P<0.0001
5.	22.9 ± 1.27	23.7 ± 1.18	24.1 ± 0.88	24.4 ± 1.01	P<0.005
6.	20.8 ± 0.66	21.1 ± 0.88	21.4 ± 0.70	21.6 ± 0.86	P<0.05
7.	10.4 ± 0.45	10.7 ± 0.42	10.4 ± 0.39	10.6 ± 0.55	n/s
8.	13.1 ± 0.51	13.5 ± 0.46	12.8 ± 0.48	13.3 ± 0.71	n/s
9.	12.8 ± 1.04	12.8 ± 0.65	13.4 ± 0.70	13.6 ± 0.74	P<0.01
10.	8.1 ± 1.11	8.8 ± 0.41	8.1 ± 0.74	8.6 ± 0.88	n/s
11.	6.3 ± 0.77	6.2 ± 0.86	5.4 ± 0.52	6.1 ± 0.60	P<0.05
12.	6.2 ± 0.44	6.5 ± 0.52	5.8 ± 0.42	6.2 ± 0.67	P<0.05
13.	26.3 ± 1.73	25.3 ± 2.80	23.2 ± 2.03	25.0 ± 1.48	P<0.01
14.	13.6 ± 3.28	12.2 ± 1.74	13.7 ± 1.77	12.4 ± 1.74	n/s
15.	96.4 ± 4.32	94.9 ± 5.85	95.7 ± 9.09	100.0 ± 0.00	n/s
16.	34.1 ± 4.95	36.4 ± 3.31	28.4 ± 2.31	30.3 ± 1.88	P<0.0001
17.	21.0 ± 2.90	22.1 ± 1.84	23.2 ± 2.80	21.9 ± 2.00	n/s
18.	2.5 ± 0.43	2.4 ± 0.47	2.5 ± 0.49	2.5 ± 0.34	n/s
19.	26.3 ± 2.04	26.9 ± 1.46	28.0 ± 1.38	27.2 ± 1.26	P<0.05
20.	7.0 ± 10.00	7.6 ± 0.62	6.8 ± 0.53	6.8 ± 0.79	P<0.05
21.	3.1 ± 0.49	3.1 ± 0.52	3.0 ± 0.67	2.6 ± 0.88	n/s

TABLE 2. Geographic differences in individual characters. Data are means ± SD, and significance of geographic differences of all characters. Numbers of characters as in Table 1. n/s, not significant (P>0.05).

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THE SAND LIZARD, *LACERTA AGILIS*, IN ITALY: PRELIMINARY DATA ON DISTRIBUTION AND HABITAT CHARACTERISTICS

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Lacerta agilis Linnaeus is a lacertid lizard whose wide range extends from NE Iberia and W France to central Asia through most of Europe. This species is rare or absent from the European regions characterized by a Mediterranean climate, such as most of the Iberian Peninsula, the Italian Peninsula and S Balkans (Arnold & Burton, 1978; Jablokov, Baranow & Rozanow, 1980; Bischoff, 1984, 1988). The occurrence of the sand lizard in northern Italy has never been reported in the existing distribution accounts on the species (Bischoff, 1984, 1988).

In this note preliminary data on the known distribution and habitat characteristics of the species in northern Italy are reported.

Distribution. Lacerta agilis has been observed and collected only in one locality of NW Italy (Piedmont) and in two localites of NE Italy (Friuli). Fig. 1 shows the approximate locations of the sites at which specimens of *L. agilis* were encountered (for conservation reasons the precise localities of the *L. agilis* populations are not reported). In the locality 1 (numbers refer to Fig. 1), which is sited 50 km NW of Cuneo (Cottian Alps, NW Italy), an adult male was collected; this specimen is now preserved in the Collection of the "Craveri" Natural History Museum of Bra (Cuneo, Piedmont) (Lapini, Morisi, Bagnoli & Luiselli, 1989). In the locality 2, which is sited 6 km east of Tarvisio (Carnic Alps, NE Italy) the species was first observed in July 1987 and then collected in August 1989. Two specimens (two adult females) from this locality are now preserved in the Collection of the Museo Friulano di Storia Naturale of Udine (Friuli). In the locality 3, which lies 14 km south of Tarvisio (Julian Alps, NE Italy), were observed two specimens (two females) during herpetological investigations carried out in the periods July 1987 and August 1989, but none of these specimens was collected and preserved, due to the apparent rarity of the species.

Both the specimens from NE Italy, and those from NW Italy can be probably ascribed to the nominal form, i.e. *Lacerta agilis agilis*. In fact, according to Bischoff (1988) and Rahmel (1988) the subspecific status of *Lacerta agilis argus* - which could occur at least in NE Italy (see Bischoff, 1984) - cannot be supported, since there are no definitive diagnostic characters (morphometric and/or meristic) between this subspecies and the nominal form.

Habitat characteristics. Locality 1 is a broad alpine valley; the grass vegetation of the pastures in which the specimen of *Lacerta agilis* was collected belongs to the *Nardetum strictae*