Clutch size in two Central Balkan populations of European common lizard *Lacerta vivipara*

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Abstract

Variation in a few reproductive traits (i.e. clutch size, female body mass after capture and after parturition and hatchling body mass and lenght) *of Lacerta vivipara* has been studied in two populations from Serbia (Stara Mountain - Southeastern Serbia and Šara Mountain - Southernmost Serbia). Mean clutch size was reported as 6.9 and 5.9 for samples from Stara Mt. and Šara Mt., respectively. Absence of difference in mothers' SVL among samples indicates similar age structure, as SVL is strongly correlated with age. Mean hatchling body mass per female varied significantly within populations. Significant between-sample differences were detected for mean effective relative clutch masses. Absence of a trade-off between clutch size and the average mass of offspring in analyzed populations from Serbia could mean that there is a strategy of producing a clutch size characterized by good body condition, but this strategy can be varied in order to be able to subsequently reduce the size of the brood in poor years.

Key words: *Lacerta vivipara,* Central Balkans, clutch size

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INTRODUCTION

Clutch size is an important determinant of fitness (Godfray, Partridge & Harvey 1991). The degree of intraspecific variation in clutch size on a large scale (across species) may express potential for evolutionary change in reproductive strategy determined by change in environmental conditions. Evaluation of a species' potential to respond to environmental changes is necessary for making management scenarios both on global and local levels (Stockwell, Hendry & Kinnison 2003).

Lacerta vivipara is one of the most widely distributed reptile species in Europe (Böhme 1997). It is predominantly adapted to humid habitats (from sea level to more than 2000 m altitude) and it exhibits great variability in life-history traits (Lorenzon, Clobert & Massot 2001). Because of scarcity of appropriate habitats (meadows within boreal forests and mountain pastures with appropriate vegetation and soil), it has a discontinuous distribution in the central part of the Balkan Peninsula (Radovanović 1951). The presence of *L. vivipara* in Serbia has been reported for several mountains: Tara (Dzukić 1974), Kopaonik (Radovanovic 1951), Stara (Radovanović 1951), Šara (Radovanović 1951) and Suva (Radovanović 1951). The occurrence of European Common Lizard in Montenegro has been observed in the Prokletije mountain belt (Radovanović 1951) and recently in Komovi (Cirović & Adziablahović 1993).

STUDY AREA AND METHODS

The reproductive biology of L. *vivipara* has not been studied in the Central Balkans and our aim was to contribute to the database with preliminary information about variation in a few reproductive traits (i.e. clutch size, female body mass after capture and after parturition and hatchling body mass and length) in two populations.

Pregnant females were collected at the end of July 1994 and 1995 from the southern slopes of Stara Mountain (43°22′ North, 22°45′ East) - Southeastern Serbia and the southwestern slopes of Šara Mountain (41°50′ North, 20°40′ East) - Southern most Serbia. They were collected within an area of high mountain pastures and within an altitude range of 1770 - 1990 and 2100 - 2300 m above sea level for Stara Mountain and Sara Mountain, respectively. The biotopes belong to the different provinces of the Middle European mountainous subregion (Stevanović 1995), the Balkan province (Stara Mountain) and Scardo-Pindus province (Šara Mountain).

Of the 13 pregnant females measured and photographed in the field in the sample from Stara Mountain, nine were transported into the laboratory prior to parturition. For the remaining four females, clutch size was estimated indirectly by counting the number of egg bulges on the sides of the body, while data about hatchlings' body mass and mother body mass after parturition were not taken. The validity of this indirect method was previously checked on females giving birth in the laboratory, by comparing the number of newborns per female with her clutch size estimation obtained by the palpation method. The sample from Šara mountain consisted of 11 pregnant females who were all brought into the laboratory before parturition occurred.

All females were placed individually into plastic cages and fed ad libitum with mealworms. Snout-vent length (SVL) of the mothers was measured to the nearest 0.1 millimeter with a dial caliper. Mothers were weighed both immediately after capture (Bm_{AC}) and post-partum (Bm_{AP}) with a Pessola balance to the nearest 0.1 g. Newborns were weighed to the nearest 0.001 g with an electronic balance. The females from Stara Mt. were returned into their native habitat, whereas females from Šara were deposited in the herpetological collection of the Institute for biological research, Belgrade. Statistical analyses were performed using Statistica 5.0 software and SAS Statistical Package (SAS Institute 1989).

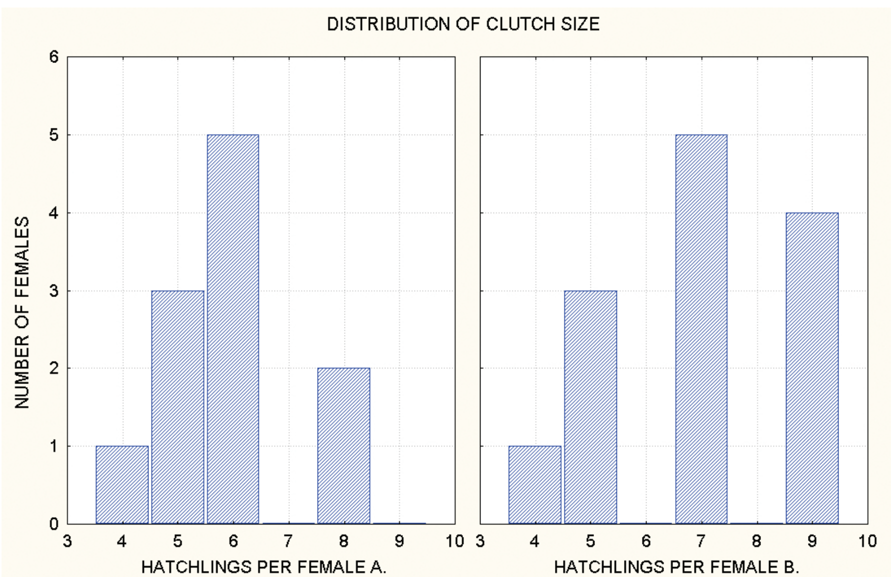
RESULTS AND DISCUSSION

Mean values of the analyzed reproductive traits in the two populations are presented in Table 1. No differences were found between clutch sizes of the two populations (Student t test, t = -1.73, df = 18, P > 0.1; Man Whitney U test, Z = -1.80, P > 0.05; see also Figure 1). Mean clutch size in two studied samples was 6.9 and 5.9 for Stara Mt. and Šara Mt, respectively. This is within the range of values reported for Holland (4 to 6.50, Strijbosh & Creemers 1988) and France (6.90 to 7.60, Pilorge 1985; 4.33

Table 1. Mean value ± standard deviations of reproductive characteristics in two populations of *Lacerta vivipara* from Serbia. Range is given in parentheses.
N = sample size; B_{m1}= mean body mass after capture; B_{m2}= mean body mass after parturition; SVL_m = mean snout-vent length; CS_m = mean clutch size/female. B_{m1} in newborns represents mean newborn mass per mother. SVL_m in newborns represents mean newborn SVL per sample.

Locality	N	B_{m1}	N	B_{m2}	N	SVL_m	N	CS_m
Females								
Stara Mt.	13	5.6±1.5	9	2.9±0.6	13	60.6±3.9	13	6.9±1.8
		(3.0 – 8.0)		(2.1–4.1)		(53.0-66.0)		(4 - 9)
Sara Mt.	11	5.5±1.3	11	3.5±0.5	11	59.2±2.5	11	5.9±1.2
		(3.0 – 8.1)		(2.9–4.6)		(54.9-61.5)		(4 - 8)
Newborns								
Stara Mt.	9	0.18±0.01			23	19.8±0.8		
		(0.17–0.20)				(18.5-21.0)		
Sara Mt.	11	0.19±0.02			58	20.2±0.9		
		(0.16-0.22)				(18.0-22.0)		

Figure 1. Frequency of clutch size in two populations of *L. vivipara* from the Central Balkans. A - Šara Mountain; B - Stara Mountain.



to 6.60, Pilorge, 1987), while Bauwens & Verheyen (1987) estimated mean clutch size from 3.9 to 4.8 for populations from Belgium. A significant correlation between clutch size and female SVL was found in two Central Balkan samples (Spearman R = 0.76, P < 0.05 and R = 0.72, P < 0.05 for samples from Šara and Stara mountains, respectively); this was in accordance with observations reviewed in Bauwens (1999). A student t - test revealed a significant difference between populations in mother Bm_{AP} (t = 2.58, df = 18, P < 0.05). No differences were detected in mother B_{AC} (t = -0.56, df =18, P > 0.5), nor in mother SVL (t = -1.16, df = 18, P > 0.05) between two samples. Results of ANCOVA analysis with mother Bm_{AP} as dependent variable, mother SVL as covariate and locality as a factor pointed to a strong effect of locality (F = 23.763, df = 1, P < 0.001) in covariation of Bm_{AP} and mother SVL (F = 21.709, P < 0.001 for covariation between two variables). There was no significant difference between populations on mean hatchling body mass per female (F = 1.10, df = 1, P > 0.05), but this variable varied significantly within populations (F = 2.51, df = 19, P < 0.05), as was also reported in Bauwens & Verheyen (1987) and, more generally, in King (2000). There was no significant correlation between mother SVL and mean hatchling mass, nor between number of hatchlings per clutch and their average mass, in both samples.

It was impossible to calculate clutch weight or the mean egg mass at parturition because data concerning female body mass immediately before parturition were incomplete (for procedure see: Bauwens & Verheyen 1987).

Data were available for overall offspring mass per mother where we didn't find between-sample differences (t = -1.14, df = 18, P > 0.05). Overall hatchling mass was positively correlated with both mother Bm_{AC} and Bm_{AP} (Spearman R = 0.98, P < 0.001 and R = 0.70, P < 0.05, respectively), as well as with its SVL (Spearman R = 0.69, P < 0.05) and clutch size (Spearman R = 0.92, P < 0.0001) in a sample from Šara Mt. In a sample from Stara Mt., overall hatchling mass per mother was correlated only with its clutch size (Spearman R = 0.96, P < 0.0001).

Finally, we compared effective relative clutch masses (EFCM = average newborn mass x litter size/female mass after parturition, see in Pilorge, 1987) between localities and found significant differences between mean values (Šara EFCM= 0.311 and Stara EFCM = 0.433; t = -4.15, df = 18, P < 0.005).

The observed between-sample difference in variation of female Bm_{AP}, which was not followed by difference in variation of overall offspring mass, can be explained by the existence of differences in clutch weight (difference between female weights just before and after parturition), e.g. by different reproductive investment. Differences in clutch weights, if overall hatchling masses are similar, may occur in the relative masses of membranes and extra-embryonic water (Bauwens & Verheyen 1987). Significant differences in mean EFCM between localities also could point to different female investment into offspring fr om an energetic point of view (Pilorge 1987).

Pilorge (1987) concluded that, in a favorable environment, L. vivipara females reach a larger SVL and produce many young per brood. High mean clutch size and high SVL values of females from Sara and Stara Mountains (for comparison see Pilorge 1987) point to optimal environmental conditions at these particular localities, and absence of difference in mothers' SVL among samples indicates similar age structure, as SVL is strongly correlated with age (Bauwens & Verheyen 1985). Lorenzon et al (2000) showed that certain life history traits (juvenile body length, body condition, growth rate and female reproductive traits) in this species are affected by habitat humidity, and they showed in their experiment that mean family hatchling body length decreased with the humidity of the maternal habitat. We had the opportunity to calculate mean hatchling SVL per locality (Table 1) only, not per family, because of insufficient data. The results of t-tests showed that hatchlings from Šara Mt. are slightly larger (t = 2.048, df = 79, P < 0.05). According to ANCOVA results, among localities differences between hatchling SVL are independent of differences in mother SVL (covariation of hatchling and mother SVL is non-significant: F = 0.655, P > 0.05) even if there is significant interaction of mother SVL as a covariate with the locality as a factor (F = 5.275, df = 1 P < 0.05). Thus, differences in reproductive investment between females from Šara and Stara Mountain, if there are any, could be the result of fine-grained differences in environmental conditions that vary from year to year.

There are certainly some inconsistencies and unknown facts about population dynamics and environmental conditions that prevent us from making any general conclusions about the reproductive potential of the populations under study when yearly variation of clutch size within the populations is unknown (see in Branch, 1989). Yearly variation in clutch size of *L. vivipara* was shown to represent a significant proportion of the total variation in its viviparous populations (Pilorge 1985, Bauwens, Heulin & Pilorge 1986). Also, as predicted by theory, there is an inverse relationship between clutch size and the average mass of offspring (Pilorge 1985), while we didn't find significant correlations in analyzed populations from Serbia. Absence of a trade-off between these two traits could mean that there is a strategy of producing a clutch size characterized always by the same body condition, but there may also be another strategy to be able to subsequently reduce the size of the brood in poor years (Godfray, Partridge & Harvey 1991).

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