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SEXUAL DIFFERENCES IN SIZE AND SHAPE OF THE MOSOR ROCK LIZARD [*DINAROLACERTA MOSORENSIS* (KOLOMBATOVIĆ, 1886)] (SQUAMATA: LACERTIDAE): A CASE STUDY OF THE LOVĆEN MOUNTAIN POPULATION (MONTENEGRO)

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Abstract — Sexual differences in size and shape of the Mosor rock lizard, *Dinarolacerta mosorensis* (Kolombatović, 1886), from Lovćen Mountain (Montenegro) were examined on the basis of the intersex variation pattern of nine morphometric, eight pholidotic, and four qualitative traits. Sexual dimorphism was apparent for all morphometric characters except snout-vent length, while scalation and dorsal pattern exhibited small differences between sexes. The value of the sexual size difference (SSD) index based on snout-vent length was 1.028. The sex-specific allometric slopes for head dimensions and interlimb distance significantly diverged. Head dimensions, especially head height, showed strong positive allometry in males, while interlimb distance was the only character which showed positive allometry in females. Generally, males had significantly greater body size than females. This was true of all body measurements except interlimb distance. The influence of sexual and natural selection on the examined traits is discussed.

Key words: *Dinarolacerta mosorensis,* morphological characteristics, sexual dimorphism, Mt. Lovćen, Montenegro

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INTRODUCTION

Sexual dimorphism in body size or other morphological characteristics has been reported in many lizard species (Braña, 1996; Olsson et al., 2002). It has been shown to be related to sexual selection, fecundity selection, and resource partitioning between the two sexes (Shine et al., 1998; Herell et al., 1999; Olsson et al., 2002; Kratochvil and Frynta, 2002). However, alternative models of the evolution of sexual dimorphism suggest that it can also arise as a consequence of non-adaptive processes (Karubian and Swaddle, 2000; Cox et al., 2003) such as differences in age distribution between the sexes or in body size within age classes (Stamps and Krishnan, 1997), as well as differences in strategies for allocation of energy during growth (Haenel and John-Alder, 2002).

Although males are generally the larger sex in lacertid lizards, some species (or populations) are monomorphic or show female-biased sexual dimorphism (Braña, 1996; Ji et al., 1998; Li et al., 2006). Nevertheless, many authors reported that males possess elongated tails and limbs and larger heads but shorter trunks compared with females of the same body size (Olsson et al., 2002; Bruner et al., 2005; Vogrin, 2005; Kaliontzopoulou et al., 2006). Head dimensions and trunk length have been shown to exhibit a positive allometric relationship with total size in males and females, respectively, offering indirect support of sex-specific selection for these traits (Braña, 1996; Olsson et al., 2002; Kratochvil et al., 2003): sexual selection for large male size, which represents an advantage in intrasexual mate competition, and natural selection for large female trunk size, which represents a fecundity advantage (Cox et al., 2003). The degree of sexual dimorphism has been documented to differ among populations of species due to geographical variations in selective pressures on male body size associated with the mating system (Pearson et al., 2002) and climate – related resources (Schauble, 2004). Alternatively, demographic differences between populations (e.g., relative survival rates of males and females) can contribute to the observed geographic variation in sexual size dimorphism (Howard, 1981).

Up until very recently, the Mosor rock lizard (*Dinarolacerta mosorensis* Kolombatović, 1886, previously *Lacerta mosorensis*; see Arnold et al., 2007) was one of the least studied representatives of the European herpetofauna, despite the fact that it represents both a relict and a stenoendemic species of the Balkan Peninsula occurring in the southwestern Dinaric mountain karsts of Croatia, Bosnia and Herzegovina and Montenegro (Džukić, 1989; Odierna 0 Arribas, 2005). However, recent studies revealed substantial morphological and genetic differences among populations of the Mosor rock lizard (Carranza et al., 2004; Ljubisavljević et al., 2007) and certain peculiarities in life-history traits (Ljubisavljević et al., in press). These geographic differences, among other things, point to the need for local studies on morphology of this species to test sexual variability. Complex investigations of lacertid lizards from the Lake Skadar region that were conducted during the last decades (Crnobrnja et al., 1991; Crnobrnja et al., 1993; Avramov et al., 1994; Bejaković et al., 1996) did not deal with *D. mosorensis* from Lovćen Mountain or from other mountains in lake surroundings. Considering these facts, we analyzed sexual dimorphism in the Lovćen population of the Mosor rock lizard. An appropriate sample of both sexes procured for this study could give reliable results and make possible relationships detectable. Furthermore, the study of sexual dimorphism in this distinctly flattened saxicolous small lacertid species is of special interest in connection with effects of body shape of different morphotypes on the level of intersexual differences (Verwaijen et al., 2002; Kaliontzopoulou et al., 2006).

The goals of this study were therefore to investigate the level of intersexual differences in a number of quantitative and qualitative characters in *D. mosorensis* from Lovćen Mountain and try to elucidate the approximate mechanisms responsible for these differences.

MATERIALS AND METHODS

Study population

The Lovćen population of the Mosor rock lizard lives on the southeastern boundary of its distribution range. Here its occupies altitudes from 1200 to 1350 m, inhabiting cliffs and blocks of rocks surrounded by a subalpine beech forest (plant community *Fagetum montenegrinum subalpinum*) with Bosnian pine (*Pinus heldreichii*) as the differential species (Tomić-Stanković, 1970; Ljubisavljević et al., in press). Analyses were carried out on specimens collected from two localities Ivanova Korita (42° 22' N, 18°50' E) and Međuvršje (42°24' N, 18°50' E), preserved in 70% ethanol and deposited in the herpetological collection of the Natural History Museum of Montenegro, Podgorica, and Dr. Georg Džukić's herpetological collection of the Institute for Biological Research, Belgrade. A total of 22 adult males, 23 females, two immature males, and five immature females were examined. Maturity of each specimen was determined on the basis of gonadal investigations.

Characters studied

Specimens were examined for the following nine morphometric characters: Lcor – snout-vent length, Lcap – head length, Ltcap - head width, Altcap - head height, Lfo – mouth length, Ltfo – mouth width, Lpa – fore limb length, Lpp – hind limb length, and Pap – distance. Eight meristic characters included the number of: GUL - gular scales along the throat midline, COL – large collar scales, VENT – inner ventral scales counted longitudinally, DOR – dorsal scales around midbody, PAN – praeanal scales anteriorly surrounding the anal plate, FPO – femoral pores, FEM – femural scales, and SDG - lamellar scales under the fourth toe.

Qualitative characters were: (I) type of dorsal pattern: a—diffuse, scattered spots, b—diffuse, interconnected spots in a more or less reticulate pattern, c—banded pattern, spots arranged in a single vertebral and/or two narrow juxtaposed paravertebral bands, d—banded pattern, broad vertebral band consisting of scattered spots, e—absent. (II) spots of the dorsal pattern: a—large, b—medium, c—small, d—absent. (III) areas of background color free of dark pattern: a—broad, b—narrow, c—absent. (IV) lateral bands: a—distinct, b—indistinct. The names of dorsal pattern bands were according to Arnold and Burton (1978).

Symmetrical characters were taken from both sides of the body. For data processing, we took the mean of right and left values for quantitative traits, while for qualitative traits a combination of both sides was used.

Body and head dimensions were taken with digital calipers to the nearest 0.01 mm. Scale counts were taken under a stereoscopic microscope. For morphometric and qualitative characters, statistical analyses included only mature individuals, while for analysis of the scalation, adults and immature individuals were pooled.

Statistical analyses

Morphometric data were logarithmically transformed to meet the assumptions of normality and homogeneity of variances. The existence of significant differences between the sexes was tested by one-way analysis of variance (ANOVA). To express the magnitude of sexual size differences (SSD), the standard index (Lcor males/Lcor females) was calculated (Lovich and Gibbons, 1992). Scaling relationships of morphometric measurements were determined by regressing these variables against SVL using reduced major-axis linear (RMA) regression (Sokal and Rohlf, 1981). A principal component analysis (PCA) on correlation matrix was performed to investigate the general patterns of sexual size and shape variation. Meristic and qualitative characters were examined for differences between sexes using the nonparametric Mann-Whitney U test and Williams' corrected G test, respectively. Statistical analyses were done using SAS (SAS, 1996) and STATISTICA (StatSoft Inc., 1997) softwares. RMA was performed using the SMATR program, ver. 2.0 (http://www.bio.mq.edu.au/ecology/SMATR/).

RESULTS

Morphometric characters

With respect to body measurements, the results of ANOVA showed significant differences in eight morphometric characters (Table 1). Females and males did not significantly differ with respect to snout-vent length (Lcor). For all other morphometric traits except interlimb distance (Pap), males were significantly larger than females. The SSD index calculated using Lcor as the measure of size was I = 1.028. To investigate the allometric pattern between sexes, the relations between body measures and body size were investigated. RMA analysis showed that males and females shared common allometric slopes for head length (Lcap), mouth length (Lfo), and limb length (Lpa, Lpp) (Table 1). For all these traits, a significant shift in elevation of sex-specific allometric slopes was found ($F = 27.6 - 64.3$, $P<0.0001$ in all comparisons), indicating that males have significantly greater body size. However, the sex-specific allometric slopes for head width (Ltcap), head height (Altcap), mouth width (Ltfo), and interlimb distance (Pap) significantly diverge. These traits showed statistically significant positive allometry in males, while in females Pap was the only character which showed positive allometry (Table 2).

The PCA performed on morphometric variables yielded two significant axes (eigenvalue greater than 1), together explaining 91% of total variation in the analyzed sample (Fig. 1, Table 3). The first axis was a clear indicator of overall size and had similar positive loadings for all analyzed characters except Pap. The second axis represented shape and correlated strongly with two variables - Pap and Lcor. Analysis of individual score loadings on the first two PC axes (ANOVA, sex as factor) corresponded to results obtained for individual traits. A significant difference between sexes was found for both size (PC1 scores, $MS=214.56$, $F=115.42$, $P<0.0001$) and shape (PC2 scores, $MS=13.49$, $F=11.02$, $P<0.0018$). Also, a significant relationship between size (PC1) and shape (PC2) was found within each sex ($P<0.001$). To examine the pattern of size-dependent shape changes between sexes, the heterogeneity of slopes

Table 1. Descriptive statistics of nine morphometric characters, the results of ANOVA and RMA regressions for *Dinarolacerta mosorensis* from the Lovćen population. Sample size (N), mean value (in mm) ±SE, range, F-value, and statistical significance of differences between sexes (P) tested by ANOVA and RMA, df1,2 = 1,43. Abbreviations of characters are given in "Materials and Methods".

	Males (N = 22)			Females (N = 23)			ANOVA		RMA Common slope test	
Character	Mean		SE	Mean		SE	F	P	F	P
Lcor	65.53	±	0.67	63.76	±	0.74	3.14	0.08	-	-
	59.53	-	71.08	56.34	-	70.72				
Lcap	16.85	±	0.14	14.41	±	0.12	184.63	<0.0001	0.70	0.40
	15.67		17.62	13.46	-	15.71				
Ltcap	10.37	±	0.15	8.79	±	0.10	80.28	<0.0001	4.36	0.04
	9.03		11.68	7.80	-	9.74				
Altcap	6.75	±	0.16	5.49	±	0.07	58.35	<0.0001	11.85	0.001
	5.54		8.33	5.02	-	6.06				
Lfo	12.77	±	0.12	11.07	±	0.10	116.36	<0.0001	1.18	0.26
	11.62		13.59	10.35	-	12.05				
Ltfo	9.82	±	0.15	8.30	±	0.09	78.34	<0.0001	7.42	0.01
	8.67		10.90	7.30	-	9.33				
Lpa	22.79	±	0.19	20.23	±	0.18	95.39	<0.0001	0.05	0.83
	20.94		24.58	18.72	-	22.10				
Lpp	36.06	±	0.39	31.39	±	0.25	109.92	<0.0001	3.99	0.05
	32.70		40.57	29.73	-	34.37				
Pap	29.01	±	0.36	32.16	±	0.63	18.00	=0.0001	5.30	0.03
	25.85		31.96	25.82	-	38.24				

Table 2. The results of RMA regressions for growth patterns of *Dinarolacerta mosorensis* from the Lovćen population. Snout-vent length was the independent variable, while other characteristics were dependent variables. The null hypothesis of isometry was rejected if the confidence intervals did not encompass 1.0.

	Males (N = 22)					Females (N = 23)				
Character	slope	CI	F	P	Allometry	slope	CI	F	P	Allometry
Lcap	0.80	0.63-1.02	3.75	0.07	Isometric	0.69	0.52 -0.90	8.25	0.009	Negative
Ltcap	1.45	1.03-2.05	5.20	0.03	Positive	0.92	0.71-1.20	0.40	0.53	Isometric
Altcap	2.33	1.71-3.17	40.12	<0.0001	Positive	1.02	0.72-1.44	0.008	0.93	Isometric
Lfo	0.95	0.72-1.25	0.16	0.70	Isometric	0.77	0.58-1.01	3.89	0.06	Isometric
Ltfo	1.54	1.12-2.12	8.06	0.01	Positive	0.88	0.70-1.12	1.19	0.28	Isometric
Lpa	0.80	0.55-1.18	1.41	0.25	Isometric	0.76	0.57-1.02	3.73	0.07	Isometric
Lpp	1.05	0.80-1.37	0.11	0.74	Isometric	0.66	0.46-0.95	5.61	0.03	Negative
Pap	1.23	1.05-1.45	7.57	0.01	Positive	1.67	1.36-2.06	28.39	<0.0001	Positive

test was performed (ANCOVA, PC2 as dependent variable, PC1 as covariate, sex as a factor, PC1*sex interaction: F=6.31, P<0.0160). This result clearly showed that females and males of the Mosor rock lizard significantly diverged in the pattern of size-dependent shape changes.

Meristic and qualitative traits

Sexual dimorphism in meristic characters appeared to be low and was limited to two traits: number of ventral scales (VENT) and number of femoral pores (FPO) (see Table 4). Ventral scales showed a significantly higher mean number in females, whereas femoral pores were significantly more numerous in males. With respect to the dorsal pattern type, both sexes were characterized by predominance of the diffuse type consisting of large size spots coupled with indistinct lateral bands (Ia, b; IIa; IVb) and the absence of areas of background color free of any dark pattern (IIIc) (Table 5). The diffuse pattern with interconnected spots in a more or less reticulate pattern was predominant in males (Ib), while in females the reticulate pattern (Ib) and scattered spots (Ia) were present in the same percentage.

Table 3. Loadings from a principal component analysis of morphometric characters of male and female *Dinarolacerta mosorensis* from the Lovćen population. Abbreviations of characters are given in "Materials and Methods".

	Eigenvectors	
	PC1	PC2
Lcor	0.263	0.574
Lcap	0.376	-0.096
Ltcap	0.363	-0.012
Altcap	0.349	-0.006
Lfo	0.368	-0.021
Ltfo	0.366	0.009
Lpa	0.358	-0.080
Lpp	0.368	-0.107
Pap	-0.046	0.801
eigenvalues	6.693	1.503
% of variance	74.37	91.06

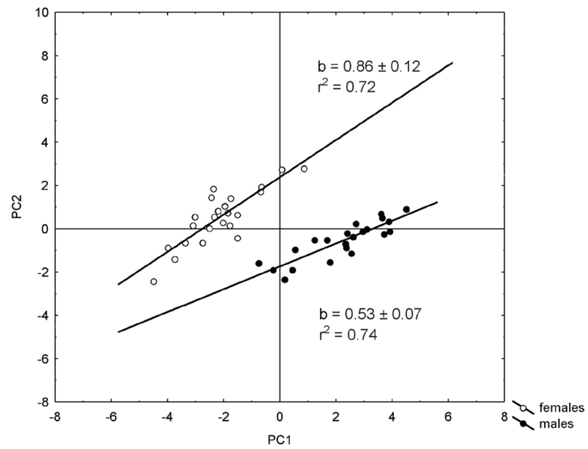

Fig. 1. Bivariate plot of PC1 and PC2 scores and regressions for the male and female *Dinarolacerta mosorensis* of the studied population. r^2 is the coefficient of correlation, b (±standard error) is the value of the coefficient of allometry (slope).

However, these differences were not great enough to be statistically significant. A certain percentage of males with complete absence of a dorsal pattern (Ie, IId) were also recorded from the Lovćen population. The only character that presented significant differences between the sexes was the clarity of lateral bands, a somewhat greater percent of distinct lateral bands being recorded in females (IVa).

DISCUSSION

Size and shape dimorphism

In regard to the Mosor rock lizard, it is generally recognized that males are more robust than females (Tomassini, 1889; Radovanović, 1951; Bischoff, 1984; Veith, 1991), although this difference is mainly reflected in greater total length of males (Bischoff, 1984). Our study showed that although no significant differences in standard measure of body size (snout-vent length) were found, males of *D. mosorensis* had larger head and limb dimensions than females. On the other hand, females had significantly larger trunk size, measured as interlimb distance. Sexual size dimorphism (SSD) is believed to evolve in lizards mainly owing to intersexual differences in reproductive success related to adult body size (Cooper and Vitt, 1989). Theoretically, two selective pressures - fecundity selection (favoring of large females) and sexual selection (favoring of large males via male competition) could cancel each other out and consequently result in a lack of SSD between males and females (Li et al., 2006). Non-significant differences in snout-vent length between the sexes were also reported for some other lacertid lizards (Braña, 1996; Ji et al., 1998; Li et al., 2006), mainly in those without male-male combat behavior. According to some authors (Bischof, 1984; Veith, 1991), the Mosor rock lizard is a relatively calm and unaggressive species. Although published data revealed male-male combats only in unsuitable conditions of captivity (Mauruschat et al., 1990), some field observations (Džukić, pers. comm.) indicate that territorial males vigorously bite intruding males. Clearly, more quantitative data are needed to evaluate male competitive behavior in this species. Since the larger females of *D. mosorensis* from the Lovćen population enhance their reproductive success through increase of snout-vent length (Ljubisavljević et al., in press), potential low selective pressure towards increased male size in this population could cause non-significant differences in size between the two genders. This has still to be investigated, since factors other than sexual selection may also influence body size (Ji et al., 1998).

In our study, males had absolutely (size) and relatively (shape) higher values than females, except for interlimb distance, which is in accordance with

Table 4. Descriptive statistics of eight meristic characters for male and female *Dinarolacerta mosorensis* of the studied population and results of Mann-Whitney U test. Sample size (N), mean value ± SE, range, Z-value, and statistical significance of differences between sexes (P). Abbreviations of characters are given in "Material and Methods".

	Males (N = 24)			Females (N = 28)			Mann-Whitney Z	P
Character	Mean		SE	Mean		SE		
GUL	25.88	±	0.52	24.48	±	0.40	1.92	0.06
	20.00	-	32.00	19.00	-	28.00		
COL	8.83	±	0.21	8.67	±	0.22	0.79	0.43
	6.00	-	10.00	7.00	-	11.00		
VENT	25.25	±	0.23	26.72	±	0.21	-4.04	<0.001
	23.50	-	27.50	25.00	-	29.00		
DOR	39.06	±	0.66	38.46	±	0.59	0.53	0.59
	33.00	-	44.00	30.50	-	43.00		
PAN	7.71	±	0.13	7.30	±	0.18	1.78	0.08
	6.00	-	9.00	6.90	-	9.00		
FPO	18.35	±	0.23	17.19	±	0.32	2.46	0.01
	16.50	-	21.00	12.00	-	20.50		
FEM	4.00	±	0.11	3.67	±	0.10	1.99	0.05
	3.00	-	5.00	3.00	-	4.50		
SDG	22.29	±	0.24	21.96	±	0.26	0.97	0.33
	20.00	-	24.50	20.00	-	25.50		

Table 5. Percentages of states of qualitative traits (in %) in *Dinarolacerta mosorensis* of the Lovćen population and results of Williams' corrected G test. Sample size (N), G-value, degrees of freedom (df), and statistical significance of differences between sexes (P). Abbreviations of characters are given in "Material and Methods".

	Males (N = 22)	Females (N = 23)			
character	%	%	G	df	P
Ia	23	46			
Ib	64	46			
Ic	5	13	5.41	3	0.14
Id	0	0			
Ie	9	0			
IIa	73	83			
IIb	9	13	3.02	3	0.39
IIc	9	4			
IId	9	0			
IIIa	5	4	2.22	2	0.33
IIIb	0	9			
IIIc	95	87			
IVa	5	35	6.78	1	0.009
IVb	95	65			

sexual dimorphism patterns present in other lacertid lizards (Braña, 1996; Olsson et al., 2002). The observed growth patterns could indicate sexual selection for head dimensions in males, since sexually selected characters usually show positive allometry with body size in one of the two sexes (Green, 2000; Bonduriansky, 2007). Head height exhibited the most pronounced positive allometry in males. This trait could be related to the ability of males to immobilize females during copulation, since it has been shown to be directly related to volume and power of the jaw muscle and consequently bite force in lacertid lizards (Herrel et al., 1996, 1999; Verwaijen et al., 2002). It follows that large head size is probably important as an attribute enabling *D. mosorensis* males to increase their reproductive success by subjugating females and perhaps other males (see above!).

Having in mind habitat preferences of this saxicolous species and its generally flattened morphology, we expected certain constraints in growth patterns of vertical head dimensions. However, in this case sexual selection is obviously a stronger selective force acting on head dimensions. The low level of male-biased SSD recorded in *D. mosorensis* was also found in another Balkan endemic species with the same morphotype (*D. oxycephala* I = 1.041, Aleksić et al., unpublished), as well as in some other lacertid species with different morphotypes and preferred habitat-types [1.033 in *Podarcis hispanica* (Kaliontzopoulou et al., 2006; Braña 1996); 1.011 in *Takydromus septentrionalis* (Ji et al., 1998); 1.002 in *Calotes versicolor* (Ji et al., 2002); and 1.033 in *Podarcis bocageii*, 1.002 in *P. muralis*, 1.041 in *Lacerta lepida*, and 1.004 in *L. schreiberi* (Braña 1996)]. These results also indicate that the level of SSD is not affected by the body shape of different morphotypes.

On the other hand, head length showed significant negative allometry in females; in other words, the heads of females get proportionately shorter for their size as they grow, whereas other head dimensions increase at the same rate as overall body size. This could be a result of increasing sacrifice of head growth for rapid increase in snout-vent length (which naturally also includes length of the abdomen) in order to realize the greater reproductive output deriving from larger body size. One potential consequence of negative allometric head growth is a constraint on the ability to swallow larger prey because of the effect of gape width on prey selection (Vincent et al., 2004), which could further reflect natural selection leading to dietary partitioning between the sexes. However, it is sometimes difficult to elucidate whether intersexual differences developed from competitive interactions or whether niche segregation was a consequence of dimorphism promoted by sexual or fecundity selection (Braña, 1996).

Finally, the relatively longer limbs in males and significant negative allometry of female hind limbs observed in the analyzed population could reflect mechanical restrictions imposed on female lizards by the presence of a longer interlimb distance and differences between the sexes in position of the center of gravity; they therefore may have evolved under conditions of selection for effective locomotion (Kratochvil et al., 2003; Kaliontzopoulou et al., 2006).

Pholidosis and dorsal pattern

In lacertid lizards, sexual dimorphism is often less expressed in pholidotic characters than in morphometric traits (De Luca, 1989; Ljubisavljević et al. 2005). A higher number of ventral scales and lower number of femoral pores in females have been frequently reported for lizards (De Luca, 1989; Ljubisavljević et al., 2005; Kaliontzopoulou et al., 2006). The greater number of ventral scales might be related to the presence of greater interlimb length in females, while possession of generally bigger femoral pores with higher secretory capacity by males is related to male sexual attractiveness, serving as the basis for adaptive choice of males by females in lizards (Martín and López, 2000).

The small intersexual differences of dorsal pattern in the Mosor rock lizard found in this study are in agreement with previous observations for this species (Tomassini, 1889; Bischoff, 1984) to the effect that dorsal color and pattern are mainly identical in both sexes or can be only slightly more intense in males. Some authors (Stuart-Fox and Ord, 2004) suggested that natural selection for crypsis may override or constrain sexual selection for conspicuous coloration in males, resulting in less pronounced sexual dichromatism in species occupying more open habitats (i.e., both sexes are cryptic). Although color of the specimens could not be analyzed, small intersexual differences of dorsal pattern (in the 'exposed' body region) could indicate that this may also act in the case of *D. mosorensis*, as a species of open rocky habitats.

Given all of the results presented in this paper, we can conclude that sexual dimorphism in the studied population of the Mosor rock lizard seems to be driven by sexual and natural selection for some traits. However, the allometric analysis suggested that sexual dimorphism in size and shape might also have developed as the result of a nonadaptive process, such as differential growth. Explanations for observed patterns of dimorphism in different morphological traits are not always apparent, as many other factors could also influence the degree of sexual dimorphism, such as differences in the behavior, demography, life-history, physiology, ecology and evolution of males and females within a population (Cox et al., 2003).

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СЕКСУАЛНИ ДИМОРФИЗАМ У ВЕЛИЧИНИ И ОБЛИКУ МОСОРСКОГ ГУШТЕРА [*DINAROLACERTA MOSORENSIS* (KOLOMBATOVIĆ, 1886)] (SQUAMATA: LACERTIDAE) НА ПРИМЕРУ ПОПУЛАЦИЈЕ СА ПЛАНИНЕ ЛОВЋЕН (ЦРНА ГОРА)

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У овом раду анализиран је сексуални диморфизам мосорског гуштера *Dinarolacerta mosorensis* (Kolombatović, 1886) са планине Ловћен. Ниво разлика између полова утврђен је на основу анализе варијабилности девет морфометријских, четири квалитативна и осам карактера фолидозе. У овој популацији утврђен је изражен сексуални диморфизам за већину анализираних морфометријских карактера, изузев за дужину трупа. Мужјаци и женке се мало разликују у погледу меристичких и квалитативних карактера. Индекс сексуалног диморфизма изражен преко дужине трупа износи 1,028. Анализа алометријских односа показала је да се мужјаци и женке значајно разликују у димензијама главе и дужини размака између екстремитета. Димензије главе, посебно висина главе, имају изражену позитивну алометрију код мужјака, док је код женки дужина размака између екстремитета особина са најизраженијом позитивном алометријом. У односу на величину тела, мужјаци се одликују значајно већим вредностима свих морфометријских карактера осим дужине размака између екстремитета који је значајно већи код женки. Разматрани су утицаји сексуалне и природне селекције на дате особине.