BODY MEASURES IN ENDANGERED DOMESTIC BALKAN DONKEY BREED

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Abstract

Information regarding morphology of endangered autochthonous donkey breed in Serbia is insufficient. The aim of the study was to establish 18 morphometric values for the Balkan donkey breed and to explore possible age dependence of the parameters tested. In addition, inter-breed similarity of morphometric parameters was assessed by comparing the data obtained for the Balkan donkey with available morphometric measurements of several previously characterized donkey breeds. The study population included 74 donkeys, divided in two age groups (group A ≤ 3 years; group B > 3 years). Significant morphometric differences ($p < 0.05$) in body length, head length, chest circumference and body weight were found between two age groups. Significant differences in morphological parameters were revealed among the Balkan donkey and other donkey breeds (Catalonian, Croatian and Albanian). However, the smallest distance was between the Balkan donkey and Albanian donkeys as demonstrated by the results of cluster analysis. The results of morphometric analyses showed consistency of the obtained values within the breed, and diversity as compared to other donkey breeds, and, thus, could be taken as referent for the Domestic Balkan donkey. The information gained through this comprehensive morphometric characterization of the Balkan donkey breed provides a basis for conservation and development of the breed standard.

Key words: *breed characterization, Domestic Balkan donkey, morphological measures*

Introduction

Local donkey breeds are important genetic resources. However, many of them are at risk of extinction as a result of intensive agrarian production and the socio-economic changes in the rural areas. Protection of genetic resources is one of the crucial issues aimed at biodiversity conservation as autochthonous breeds are vanishing at disturbing rate (Allendorf and Luikart, 2007). Genetic or morphological data for the most of donkey breeds are lacking. Information regarding main morphological and genetic characteristics should be acquired in initial investigations in order to preserve breeds.

Domestic Balkan donkey (Balkan donkey) is an endangered autochthonous breed widespread across the Serbian territory (Official Gazette of RS, no. 38/10, Kugler et al., 2008). Over the last decades, the population of Balkan donkey has been constantly declining due to the loss of their economic importance. It is estimated that current number of sexually mature Balkan donkeys in Serbia is as low as 250-300 and they are under some form of surveillance and protection (Trailovic et al., 2011).

The initial research in the process of donkey breed preservation relies on the phenotype study including the geographical distribution and morphometric characterization, along with the age differences (Folch and Jordana, 1997; Ivankovic et al., 2000; Rischkowsky and Pilling, 2007; Papa and Kume, 2012). Scientifically based data on donkey population in Serbia are deficient. The only available data are basic body measures (Trailovic et al., 2011) and major hematological parameters (Vucicevic et al., 2011). Both these surveys, however, included small number of Balkan donkeys located in Stara Planina Mt. region. The aim of our study was to establish morphometric values for the endangered Balkan donkey breed by using representative sample acquired from two age categories. In order to assess inter-breed similarity within a context of morphometric parameters, the data obtained for the Balkan donkey were compared with morphometric parameters of several previously characterized domestic donkey breeds.

Material and Methods

The Balkan donkey population

The majority of donkey population in Serbia is situated in following locations: the Special Nature Reserve "Zasavica" (SNR "Zasavica", $44^0 57' 32,2''$ N $19^0 31' 32,7''$ E), the Stara Planina Mt. region ($43°06'37''$N $22°57'14''$E) and in Kovilj village ($45^0 25' 16,7''$ N $19^0 83' 69,4''$ E) near Novi Sad. Besides that, small number of adult donkeys and foals is distributed over the country in individual households. In total, 74 heads have been included in this survey: 39 donkeys from SNR "Zasavica", 16 donkeys from Stara Planina Mt. and 19 donkeys located in Kovilj village. The study population included 6 males and 68 females. In accordance with the previous investigations (Folch et al., 1997; Jordana et al., 1998), the study population consisted of two age groups. The group A included 22 young donkeys ($\leq$ 3 years of age) while group B included 52 adult donkeys older than 3 years. The oldest animals in group B were 10 years old.

Morphometric measurements

In total, 18 body measures were selected for morphometric characterization of Balkan donkey. For six body variables (chest circumference, carpal circumference, tarsal circumference, tibia circumference, ear length and head length) a measuring tape was used. The additional 11 parameters (wither height, back height, hip height, chest depth, carpal height, tarsal height, body length, head width, chest width, croup length and croup width) were measured by the Lydtin stick. The body weight (BW) for each animal was calculated according to the formula:

BW (kg) = (CC^2 x BL) / 11877

where CC and BL represent chest circumference and body length, respectively (Pejić, 1996). Microchip number, followed by age, coat color, specific distinctive signs and possible external defects were recorded for each animal.

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The five body measures (wither height, chest depth, body length, chest width and chest circumference) were selected for inter-breed analysis among Balkan donkey and Catalonian donkey (Folch and Jordana, 1997), Croatian donkeys (Ivankovic et al., 2000) and Albanian donkeys (Papa and Kume, 2012).

Statistical analysis

The data recorded in this study were presented through mean, median, quartile range and coefficient of variation (CV). Shapiro-Wilk's W test was used in order to assess the normal distribution of the data followed by Levene's test for determination of the homogeneity of variances. Variables with normally distributed data and homogenous variances were compared between groups through the t-test, otherwise, the Mann-Whitney U-test was used. Similarity of Balkan donkey with other donkey breeds was examined through the cluster analysis, based on Euclidean distances and Ward's method of linkage. The statistical differences for the five selected morphological parameters among donkey breeds were determined by using t-test. Differences were considered as significant for p values <0.05. Statistical analysis of the results obtained in the experiment was carried out using software STATISTICA v. 6 (StatSoft, Inc., Tulsa, OK, USA).

Results

The values of body measures displayed homogeneity (CV<30%) in both age categories (Table 1). Most of the body measures for adult donkeys followed normal distribution, while majority of the variables for young donkeys indicated not-normal data distribution (Shapiro-Wilk's W test, $p<0.05$). Between groups A and B, there was a significant difference ($p<0.05$) in four out of eighteen parameters: body length, head length, chest circumference and body weight.
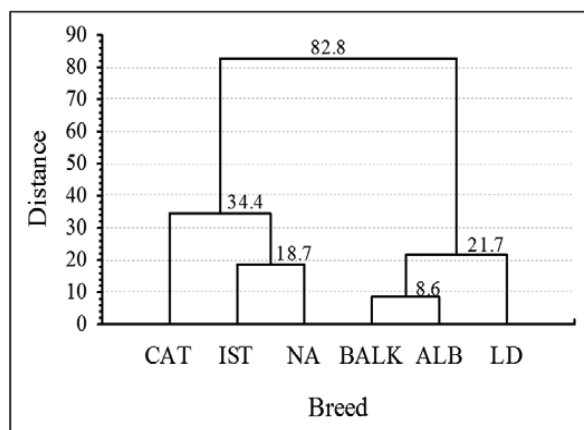

Figure 1. *Dendrogram of the cluster analysis showing relationships among the Domestic Balkan donkey and previously described European donkey breeds, based on the morphometric data.*

The results of t-test (Table 2) for five selected body measures showed the significant differences (p<0.01) when Balkan donkey (BALK) was compared to Catalonian donkey

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(CAT) and Croatian donkeys (LD - Littoral-Dinaric donkey; NA - North-Adriatic donkey; IST - Istrian donkey). Comparison of Balkan donkey with Albanian donkey population (ALB) revealed no significant differences in body length values (p>0.05); however, values of chest depth (p<0.05), wither height (p<0.01), chest width (p<0.01) and chest circumference (p<0.01) were significantly different (Table 2). Results of hierarchical clustering demonstrated the smallest distance between Balkan donkey and Albanian donkeys (Figure 1).

Table 1. *Morphometric measurements for the Domestic Balkan donkey breed*

Parameters	Age group A				Age group B				p
Body variables (cm)	Mean	Median	Quartile range	CV (%)	Mean	Median	Quartile range	CV (%)	
Wither height	103.3	103.5	101.0-107.0	5.7	104.9	104.0	99.0-108.5	8.5	0.906
Back height	101.9	101.7	99.0-106.0	5.9	102.8	102.5	97.5-106.7	8.4	0.873
Chest depth	47.1	46.5	45.0-51.0	10.4	47.3	46.5	44.0-50.7	9.9	0.859
Hip height	106.8	107.0	105.0-111.0	5.0	107.2	106.7	102.0-112.0	7.9	0.731
Tarsal height	40.7	40.5	39.0-42.0	5.8	41.3	41.0	38.0-44.0	9.2	0.541
Carpal height	32.0	31.5	30.0-34.0	6.6	32.4	33.0	30.0-34.5	11.7	0.757
Body length	110.3	111.5	107.0-116.0	8.7	117.2	117.0	112.0-121.5	8.2	**0.002**
Head length (t)	47.6	48.0	45.0-51.0	7.7	49.6	49.7	47.0-52.0	7.3	**0.038**
Head width	21.0	21.0	20.0-22.0	6.8	22.1	21.7	20.7-23.0	12.4	0.145
Ear length (t)	26.1	26.0	25.0-27.0	8.2	25.6	25.0	24.0-27.0	8.4	0.318
Croup length	29.4	31.5	25.0-33.0	17.1	29.9	32.0	24.0-35.0	21.3	0.674
Croup width	33.7	34.0	33.0-36.0	12.3	35.0	36.0	32.5-38.0	12.5	0.198
Chest width	23.9	24.0	23.0-25.0	11.0	24.3	24.2	22.5-27.0	11.9	0.609
Chest circumference	114.2	114.7	112.5-118.0	8.0	119.6	118.5	114.5-124.5	8.8	**0.030**
Carpal circumference	21.0	21.0	20.5-22.0	6.8	21.4	21.0	19.7-22.5	11.5	0.896
Tarsal circumference	27.3	27.0	26.0-29.0	7.7	28.6	28.0	27.0-29.0	10.3	0.142
Tibia circumference	23.9	24.0	23.0-25.0	10.7	25.0	25.0	23.7-26.2	12.1	0.275
Body Weight (kg)	124.9	122.0	111.0-132.0	16.9	143.4	138.5	123.5-155.0	24.8	**0.005**

(t) – t-test; for the rest of the variables U test was used

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Body variables (cm)	Mean	Median	Quartile range	CV (%)	Mean	Median	Quartile range	CV (%)	
Wither height	103.3	103.5	101.0-107.0	5.7	104.9	104.0	99.0-108.5	8.5	0.906
Back height	101.9	101.7	99.0-106.0	5.9	102.8	102.5	97.5-106.7	8.4	0.873
Chest depth	47.1	46.5	45.0-51.0	10.4	47.3	46.5	44.0-50.7	9.9	0.859
Hip height	106.8	107.0	105.0-111.0	5.0	107.2	106.7	102.0-112.0	7.9	0.731
Tarsal height	40.7	40.5	39.0-42.0	5.8	41.3	41.0	38.0-44.0	9.2	0.541
Carpal height	32.0	31.5	30.0-34.0	6.6	32.4	33.0	30.0-34.5	11.7	0.757
Body length	110.3	111.5	107.0-116.0	8.7	117.2	117.0	112.0-121.5	8.2	**0.002**
Head length (t)	47.6	48.0	45.0-51.0	7.7	49.6	49.7	47.0-52.0	7.3	**0.038**
Head width	21.0	21.0	20.0-22.0	6.8	22.1	21.7	20.7-23.0	12.4	0.145
Ear length (t)	26.1	26.0	25.0-27.0	8.2	25.6	25.0	24.0-27.0	8.4	0.318
Croup length	29.4	31.5	25.0-33.0	17.1	29.9	32.0	24.0-35.0	21.3	0.674
Croup width	33.7	34.0	33.0-36.0	12.3	35.0	36.0	32.5-38.0	12.5	0.198
Chest width	23.9	24.0	23.0-25.0	11.0	24.3	24.2	22.5-27.0	11.9	0.609
Chest circumference	114.2	114.7	112.5-118.0	8.0	119.6	118.5	114.5-124.5	8.8	**0.030**
Carpal circumference	21.0	21.0	20.5-22.0	6.8	21.4	21.0	19.7-22.5	11.5	0.896
Tarsal circumference	27.3	27.0	26.0-29.0	7.7	28.6	28.0	27.0-29.0	10.3	0.142
Tibia circumference	23.9	24.0	23.0-25.0	10.7	25.0	25.0	23.7-26.2	12.1	0.275
Body Weight (kg)	124.9	122.0	111.0-132.0	16.9	143.4	138.5	123.5-155.0	24.8	**0.005**

(t) – t-test; for the rest of the variables U test was used

Table 2. *Comparison of morphological parameters of the Domestic Balkan donkeys and other donkey breeds and populations based on t-test*

Breed	Wither height			Chest depth			Body length			Chest width			Chest circumference		
	Mean	t	p	Mean	t	p	Mean	t	p	Mean	t	p	Mean	t	p
LD	96.9	7.9	<0.01	42.0	9.5	<0.01	102.6	10.6	<0.01	23.1	3.4	<0.01	112.7	4.3	<0.01
NA	115.2	-11.4	<0.01	50.9	-22.9	<0.01	121.1	-5.0	<0.01	27.3	-9.4	<0.01	131.8	-11.2	<0.01
IST	124.0	-20.7	<0.01	54.7	-13.6	<0.01	131.3	-13.6	<0.01	29.8	-17.1	<0.01	144.0	-21.3	<0.01
ALB	107.8	-3.5	<0.01	46.1	2.1	<0.05	113.4	1.5	**0.13**	26.7	-7.4	<0.01	125.2	-5.8	<0.01
CAT	136.2	-33.6	<0.01	59.3	-21.9	<0.01	143.8	-24.2	<0.01	32.4	-24.8	<0.01	154.7	-30.1	<0.01
BALK	104.5			47.3			117.9			24.3			114.9		

LD - Littoral-Dinaric donkey; NA - North-Adriatic donkey; IST - Istrian donkey (Ivankovic et al., 2000); ALB - Albanian donkey population (Papa and Kume, 2012); CAT - Catalonian donkey breed (Folch and Jordana, 1997); BALK - Domestic Balkan donkey.

Discussion

In this study the Balkan donkey breed was characterized through the morphometric investigation. The obtained values were compared between donkeys classified into group A (≤3 years of age) and group B (>3 years of age). Animals disclosed high homogeneity of body values (5.08% ≤ CV ≤ 24.8%) in both age groups although three different geographical populations of donkeys have been investigated. This high level of homogeneity points out to the uniformity of morphometric characteristics of the Balkan donkey breed. Significant morphometric differences in body length, head length, chest circumference and body weight were found between age groups. Since the body weight was calculated using body length and chest circumference, changes in these parameters obviously generated the change in weight. Variations in chest circumference and body length were expected due to the processes of growth and lipogenesis which follow increase in foals' weight and reproductive status of investigated animals. Comparison of the selected morphological parameters revealed significant differences among the Balkan donkey and other donkey breeds (Catalonian, Croatian and Albanian). Cluster analysis indicated morphological similarity between Balkan donkey and Albanian donkeys. This could be attributed to close geographic proximity and the overlap of their habitats. Additional molecular characterization of both breeds is needed to get insight in their molecular genetics diversity.

Conclusion

The results of morphometric characterization of the endangered Balkan donkey breed showed consistency of the obtained values within the breed and differences when compared to other previously described donkey breeds. According to the normal distribution of the body measures determined and significant morphological differences in wither height, chest depth, body length, chest width and chest circumference among the all above mentioned breeds, recorded values for Balkan donkey could be taken as referent. The information gained through the morphometric analysis provides a basis for development of the breed standard and an introduction for genetic research of donkey populations in Serbia, which is currently underway in our laboratory. The obtained results will provide useful information in order to preserve donkeys as animal genetic resource (FAO, 2011).

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