

MORPHOMETRICAL CHARACTERISATION OF KARAKACHAN SHEEP FROM STARA PLANINA, SERBIA

M. STOJILJKOVIC^{1*}, O. STEVANOVIC², S. IVANOV³, D. DROBNJAK¹, M. UROSEVIC¹ and R. TRAILOVIC⁴

¹ Center for Preservation of Indigenous Breeds, 11186, Zemun, Belgrade, Serbia

² PI Veterinary Institute of Republic Srpska "Dr. Vaso Butozan", 78000 Banja Luka, Bosnia and Herzegovina

³ Stado Doo, 18320 Dimitrovgrad, Serbia

⁴ Faculty of Veterinary Medicine University of Belgrade, 11000 Belgrade, Serbia

Abstract

STOJILJKOVIC, M., O. STEVANOVIC, S. IVANOV, D. DROBNJAK, M. UROSEVIC and R. TRAILOVIC, 2015. Morphometrical characterisation of Karakachan sheep from Stara Planina, Serbia. *Bulg. J. Agric. Sci.*, 21: 1278–1284

Karakachan sheep is small autochthonous three-purpose Zackel with black fleece and modest requirements. Population status of the breed is critical. This sheep, rarely described in the literature, is important component of cultural and biological heritage. Historically bred by Karakachan nomads, flocks of these sheep migrated throughout mountains of Macedonia, Serbia and Bulgaria during the summer and in Vardar valley and further South to Thessaloniki during the winter. Morphometric analyses were performed in aim to provide the data necessary for morphological characterization, estimation of variability and assessment of conservation importance of Karakachan sheep. The morphological evaluation can also encourage process of breed preservation by providing the data necessary for estimation of regression of the breed. A total of 105 Karakachan sheep: 8 rams and 97 ewes, divided into two groups upon age, were included in the evaluation. Morphometric parameters were estimated by tape measuring (250 cm zoo-technical ribbon). The following body parameters: Height at Withers, Body Length, Thoracic Girth, Thoracic Depth, Chest Width, Cannon Circumference, Tail Length, and several head and pelvic variables were measured; body indexes calculated and the difference between sexes and age related differences were tested. The correlation between the parameters obtained was also established. The basic descriptive population data together with age related and the sex related morphometric differences were established in the investigated breed. The mild body frame enlargement was observed in comparison with the literature data. Morphological characteristics of the Karakachan sheep in Serbia are stable and homogenous. The sex related polarization of the parameters was established. The observed increase of body frame could reflect improved breeding conditions. The growth is harmonious and completes after the third year of life. The data obtained provide foundation for future research and selection of the breed.

Key words: Karakachan sheep, morphometric parameter, characterisation

List of abbreviations: HWi - Height at Withers; BL - Body Length; TGi - Thoracic Girth; TD - Thoracic Depth; CW - Chest Width; HdL - Head Length; FL - Front Length; HdW - Head Width; BEH - Base of the Ear Height; CC - Cannon Circumference; HLr - Horn Length; EL - Ear Length; HpW - Hip Width; CfD - Coxo-femoral Diameter; BiW - Bi/ischial Width; PL - Pelvic Length; TL - Tail Length; \bar{x} - Arithmetical Mean; SD - Standard Deviation; VI - Variation Interval; CV - Coefficient of Variation.

Introduction

Karakachan sheep (karakacanska pramenka, crna vlaska ovca) is an old indigenous sheep breed, which descended di-

rectly from European Mouflon - *Ovis musimon* (Balevska and Petrov, 1972; Dervisis et al., 2007). Karakachan people (*Sarakatsani*, Greek: Σαρακατσάνοι) were original breeders

of this sheep. They grazed their herds on the mountain pastures of Macedonia, southern Albania, South East Serbia and Bulgaria during the summer, and in the winter period they stayed in the Vardar basin region and reched Thessaloniki on the South. Karakachan sheep is among smaller Pramenka (Zackel) types with characteristic with black fleece (but individual with white wool exist, especially in the Bulgarian flocks), combined production, compact strong constitution, modest nutritional needs and exquisite resistance (Mitic, 1984). Nomadic sheep breeding directly influenced the breed development and traits such as disease resistance and ability to adapt to different climatic conditions.

Sheep breeding development in Serbia during the 20th century was based on introduction of highly selected breeds and production improvement by crossbreeding of local breeds. Locally adapted and traditionally raised sheep breeds in our country became economically unattractive, so the populations sharply decreased and original characteristics disappeared. Agricultural experts and decision makers in the period after the 2nd World War avoided pure breeding and selective improvement of the autochthonous breeds. Unfortunately, their decision was to import allochthonous sheep breeds and use them for systematic cross-breeding with local Serbia breeds. This trend also struck the Karakachan sheep, which is now endangered breed. According to DAD-IS (Domestic Animal Diversity Information System), active population of this breed in Serbia was estimated at 150-300 individuals in 2012. The whole Serbian population of Karakachan sheep is located in the "Stara Planina" Nature Park area, and one small group in the vicinity of Bosilegrad. The entire national flock originates from a several smaller flocks from the area of Crna Trava, Bosilegrad and Vranje, which were identified after the most homogeneous flock of Mitrovic family, was identified on Chemernik Mountain, in 2005. Until that moment, the Karakachan sheep was considered extinct in Serbia. In addition to the lack of planned selection, survival of this breed was influenced by social and demographic factors such as abandonment of nomadic animal husbandry. The remaining sheep were small and undergrown. Breeding of the remaining sheep was unfavoured due to low production, disappearance of nomadic habits; change of production practice, especially sheep milking and under pressure of exotic, highly productive breeds.

Literature data on morphometric characteristics of Karakachan sheep are rare and incomplete. According to Mitic (1984) Karakachan sheep is the smallest Serbian Zackel type, weighing 28-39 kg ewes and 36-50 kg rams, Height at Withers is 55.49 cm to 61.44 cm ewes and rams, with medium-developed chest and a spacious trunks. This short-tailed sheep has 12 caudal vertebrae (24.22 cm). Rams are horned with long spirally twisted horns, while in 7-10% of sheep small horns

can develop (Milic, 1953; Mitic, 1984; Porcu and Markovic, 2006).

There is a need for research on the variability of this breed in aim to describe the breed, determine the evolutionary position of the sheep, as well as to define the importance of the population in the conservation of biodiversity at national and global level and also to preserve traditional sheep products with specific geographical origin which are important cultural and traditional heritage of the Balkan people.

Morphometric studies have huge significance, they are necessary to start the process of selection and to define phenotypic characteristics of the breed or type. In intensive livestock production they can be used to indirectly determine body weight (Sowande and Sobol, 2008), morphological variability and welfare (Rogic et al., 2011). In addition, morphometry performed continuously for a long period may indicate structural characteristics of the population and trends throughout generations, and so define the direction of selective breeding (Milner et al., 1999). There are no specific data on body measures constitution, development and the weight of the present day population of Karakachan sheep. In recent literature, the information on some morphological parameters of the breed can be found (Dervisis et al., 2007; Sedefchev and Sedefchev, 2011).

Our research evaluated detailed morphometric measurements of body regions and calculation of body indices. The morphometric analysis was performed in aim to characterize Karakachan sheep as indigenous and endangered breed with socio-cultural and historical significance to several Balkan nations. Also, research is important for fullfilling the information on breed characteristics in order to establish the data necessary for preservation of the traits and prevention of the regression of the breed, thus providing the basics for biodiversity conservation.

Materials and Methods

Morphometric analyzes were performed on 105 Karakachan sheep (8 rams and 97 ewes). Measured animals were divided into two age categories, I (1-3 years old) and II (3-6 years old). Age was determined upon dentition (FAO, 2011). The measured animals originated from the farm in the village of Kamenica, Nature Park "Stara Planina", the municipality of Dimitrovgrad, Serbia. The flock was bred in semi-extensive husbandry practice. The diet was pasture based, except during the winter months, when the animals are confined and when rich meadow hay diet is enriched with cereals.

Body measurements were performed by use of the zoo-technic ribbon (250 cm). The following morphological parameters were measured: Height at Withers (HWi): the diameter from the ground to the top of the withers; Body Length

(BL): from the point of the shoulder joint to the caudal margin of the *pin bone*; Thoracic Girth (TG_i): the volume of the chest just behind the withers and shoulders; Thoracic Depth (TD): from the ventral edge of the *sternum* to the top of the withers; Chest Width (CW): the diameter between the lateral edges of the shoulder joints; Head Length (HdL) - from the tip of the nose to the top of the occipital crest; Front Length (FL): from the imaginary line which connects the medial eye corners to the top of the occipital crest; Head Width (HdW): the diameter between two zygomatic arches; Base of the Ear Height (BEH) - from *incisura vasorum* to the ventral ear base; Cannon Circumference (CC); Horn Length (HL_r) - from base to the tip of the horn on lateral aspect; Ear Length (EL): lateral aspect of the ear from base to the tip; Hip Width (HpW): the diameter between the coxal tubercles; Coxo-femoral Diameter (CfD): the diameter between the coxo-femoral joints; Bi-ischial Width (BiW) the diameter between the pin bones (*tuber ischii*); Pelvic Length (PL) - from the hip to the pin bone; Tail Length (TL): from the base to the tip of the tail. Based on

the measured parameters, following conformational indices were calculated: Body Frame Index - HW_i/BL * 100; Body Compactness Index - TG_i/BL * 100; Thoracic Wide Index - CW/TD * 100; Head Index - HdW/HdL * 100; Dactilo-Thoracic Index CC/TG_i * 100; Cannon Circumference Index - CC/HW_i * 100 and Pelvic Index - HpW/PL*100.

Statistical analysis of the parameters measured was performed by GraphPad Prism 5.0 program and the following descriptive data were calculated: Arithmetical Mean (\bar{x}), Standard Deviation (SD), Variation Interval (VI) and Coefficient of Variation (CV). To test the existence of statistically significant differences in relation to age and sex, t test was used. Parson's test was conducted to evaluate correlations between certain parameters in the population sample.

Results and Discussion

Results of measured morphometric body parameters of the Karakachan sheep by gender, and statistical comparison

Table 1
Variability and statistical comparison of morphometric body parameters in Karakachan ewes and rams

Variable	Sex	N	$\bar{x} \pm SD$	VI	CV (%)	t
Height at Withers	M	8	64.13±2.03	61.00 – 67.00	3.17	2.89**
	F	97	61.26±2.74	60.00 – 67.00	3.71	
Body Length	M	8	75.00±8.98	63.00 – 90.00	11.97	2.57*
	F	97	70.60±4.16	61.00 – 84.00	5.89	
Thorax Girth	M	8	80.25±7.44	69.00 – 90.00	9.27	0.68
	F	97	79.12±4.23	76.00 – 90.00	5.34	
Thorax Depth	M	8	33.63±1.41	31.00 – 36.00	4.19	4.32***
	F	97	30.40±2.07	29.00 – 36.00	6.79	
Chest Width	M	8	23.00±3.00	18.50 – 26.00	13.04	2.33*
	F	97	21.58±1.51	19.00 – 25.00	5.33	
Cannon Circumference	M	8	8.75±0.60	8.00 – 9.50	6.83	4.37***
	F	97	8.18±0.33	7.50 – 9.00	3.96	
Tail Length	M	8	29.44±1.74	27.00 – 32.50	5.91	0.32
	F	97	28.95±4.25	19.00 – 48.00	14.68	
Body Frame Index	M	8	86.37±8.61	74.44 – 100.00	9.97	0.33
	F	97	86.99±4.84	78.08 – 104.90	5.56	
Body Compactness Index	M	8	108.30±4.89	100.00 – 116.90	4.55	1.85
	F	97	112.30±5.95	98.81 – 130.40	5.30	
Dactyl-thoracic Index	M	8	10.97±1.07	9.88 – 13.01	9.79	2.76**
	F	97	10.36±0.55	9.09 – 11.49	5.33	
Thoracic wide Index	M	8	68.25±7.08	56.06 – 76.47	10.37	1.70
	F	97	71.17±4.44	61.76 – 84.62	6.24	
Cannon Circumference Index	M	8	13.66±1.04	12.50 – 15.57	7.62	1.33
	F	97	13.36±0.57	12.10 – 14.75	4.29	

*p<0.05 - significant **p<0.01 - very significant ***p<0.001 - extremely significant

of their values in relation to sex are shown in Table 1. It can be observed that the values of the Standard Deviation, Variation Interval and Coefficient of Variation are relatively small in majority of the observed parameters, which indicates a very uniform population in terms of morphological variability. Furthermore, it can be noted that the values of a standard deviation in the rams are higher than in ewes, with the exception of the Tail Length, which is probably consequential to the small number of the rams measured. Based on the calculated body indices, it can be seen that the Karakachan sheep is breed of small size, narrow Thoracic, and light skeleton. The coefficients of variation of the calculated indices are also very small, which again reflects the high degree of morphological uniformity of the population. This may be a consequence of the paucity and subsequent growth of inbreeding in a small population.

The sex related morphological differences were established in Karakachan ewes and rams. Statistically significant differences between mean values were found in several parameters, as in the case of Dactyl-Thoracic Index. Statistically extremely significant differences ($p < 0.001$) were determined by examining the Thoracic Depth and Cannon Circumference. Very significant statistical differences ($p < 0.01$) were determined in Height at Withers and Dactyl-Thoracic Index. Significant differences ($p < 0.05$) were determined by comparing Body Length and Chest Width also. All of deter-

mined differences may be considered as normal and classified as sexual dimorphism.

Comparison of results obtained and the literature data of some of the morphometric parameters in Karakachan sheep was presented in Table 2. Upon the data presented, it is evident that the modern population of Karakachan sheep is slightly larger in relation to the data presented by Milic (1953) and the observed size increase is the most prominent alteration in Serbian population nowadays. It can be assumed that this size increase observed in Karakachan sheep is consequential to the improved breeding practice.

The statistical significance of the differences between different age groups in Karakachan sheep (Figures 1 and 2) was observed in the most of the examined parameters. Statistically significant differences between age groups - $p < 0.001$ were determined for the values of BL, HdL, HdW, PL, Body Frame Index and Dactyl-Thoracic Index; $p < 0.01$ - TG_i, TD, CfW and Pelvic Index; $p < 0.05$ - HW_i, CW and HpW. The values of all parameters were higher in the age group II, with the exception of Body Frame Index and Dactyl-Thoracic Index which were higher in age group I. Identified differences speak for late maturing of Karakachan sheep and long growth that ends after the third year of life.

Some craniometric parameters in Karakachan sheep and their comparison in relation to sex were presented in the Table 3. Upon the data obtained it can be observed that there are

Table 2
Comparison of literature data with results of our research

Variable	Sex	Our results (Serbia)	Milic, 1953 (Macedonia)	Dervivsis et al., 2009	Sedefchev and Sedefchev, 2011 (Bulgaria)
Height at Withers	M	64.13	61.44	63 - 68	-
	F	61.26	55.49	56 - 60	58.70
Body Length	M	75.00 (116.95%)	64.38 (104.80%)	-	-
	F	70.60 (115.25%)	59.25 (106.80%)	-	63.30
Chest Width	M	23.00 (35.86%)	20.01 (32.71%)	-	-
	F	21.58 (35.23%)	17.24 (37.01%)	-	-
Thorax Depth	M	33.63 (49.62%)	47.36%	-	-
	F	30.40 (52.44%)	48.39%	-	-
Hip Width	M	20.25 (31.58%)	16.32 (29.43%)	-	-
	F	20.76 (33.89%)	18.78 (30.56%)	-	-
Tail Length	M	29.44	24.22	25	-
	F	28.95	24.22	25	25.22
Cannon Circumference	F	8.18	7.63	-	7.20
Cannon Circumference Index	F	13.36	13.75	-	12.27

Absolute values are presented in cm. relative measures (%) are presented in relation to HW_i



Fig. 1. Ewe (left) and ram (right) 1-3 years old (age group I)



Fig. 2. Ewe (left) and Ram (right) 3-6 years old (age group II)

significant differences between the values of FL, HdW, and Head Index, which additionally points to prominent sexual dimorphism in this sheep breed.

Results of pelvimetric variability analysed were presented in the Table 4. Significant difference in relation to gender was determined between mean values of Pelvic Index which reveals that the ratio of the HpW and PL is different in ewes and rams, showing that the females have a slightly wider and shorter pelvis than the males.

The results obtained by analyzing the correlations between some morphometric parameters evaluated in Karakachan sheep are shown in the Table 5. The existence of significant positive correlations was found between the large numbers of the studied parameters. The high correlation coefficients between selected parameters indicated that Karakachan sheep is very harmoniously conformed, reflecting balanced physical development, and also revealing that the breed has been adapted to the environmental conditions through the process of evolution.

Conclusions

- Morphological characteristics of the Karakachan sheep population in Serbia are stable and consolidated through population.
- Determined morphometric differences between the genders reflect very prominent sexual dimorphism.
- The comparison with morphometric characteristics described in the literature gave rise to the conclusion that modern population of Karakachan sheep in Serbia has slightly enlarged frame, probably due to the improved breeding conditions.
- Physical development in Karakachan sheep is slow, ends after the third year of life and the growth is very balanced.
- The data on morphometric parameters of Karakachan sheep obtained represent a contribution to the breed characteristics database, allows detailed morphological characterisation of the breed and designate the basis for further study of this, insufficiently described and endangered breed.

Table 3
Variability of craniometric parameters in Karakachan sheep

Variable	N	Sex	$\bar{x} \pm SD$	VI	CV	t
Head Length	8	M	27.00 ± 2.44	23.00 – 31.00	9.02	1.31
	97	F	27.64 ± 1.21	24.50 – 31.00	4.39	
Front Length	8	M	13.44 ± 1.35	12.00 – 16.00	10.03	6.01***
	97	F	15.69 ± 0.99	13.00 – 18.00	6.30	
Head Width	8	M	13.75 ± 1.20	12.00 – 15.50	8.69	2.69**
	97	F	13.03 ± 0.68	12.00 – 15.50	5.22	
Base of the Ear Height	8	M	10.19 ± 0.60	9.00 – 11.00	5.83	0.12
	97	F	10.16 ± 0.66	9.00 – 12.00	6.53	
Ear Length	8	M	10.07 ± 0.67	9.00 – 11.00	6.68	0.85
	97	F	10.49 ± 1.38	6.00 – 12.50	11.27	
Horn Length	8	M	49.88 ± 11.48	33.00 – 65.00	23.02	-
	97	F	-	-	-	
Head Index	8	M	51.06 ± 3.69	46.43 – 58.00	7.23	4.15***
	97	F	47.19 ± 2.43	41.38 – 54.90	5.15	

p<0.01 - very significant *p<0.001 - extremely significant

Table 4
Variability of pelvimetric parameters in Karakachan sheep

Variable	N	Sex	$\bar{x} \pm SD$	VI	CV	t
Hip Width	8	M	20.25±2.14	16.00 – 22.50	10.56	1.23
	97	F	20.76±1.02	17.50 – 22.50	4.90	
Coxo-femoral Width	8	M	23.38±2.86	18.00 – 28.00	12.25	0.99
	97	F	22.91±1.09	21.00 – 25.50	4.77	
Bi/ischiadic Width	8	M	10.63±2.20	7.50 – 13.50	20.70	0.31
	97	F	10.48±1.24	8.00 – 13.00	11.85	
Pelvic Length	8	M	23.94±1.50	22.00 – 25.50	6.26	0.91
	97	F	23.54±1.17	21.00 – 27.00	4.99	
Pelvic Index	8	M	84.58±7.32	72.73 – 95.45	8.65	2.32*
	97	F	88.29±4.04	72.92 – 100.00	4.58	

*p<0.05 – significant

Table 5
Pearson correlation coefficients (r) between selected variable body parameters of Karakachan sheep

Variable	BL	HWi	TGi	TD	CW	HdL	CC	TL	HpW
HWi	0.480***								
TGi	0.627***	0.480***							
TD	0.445***	0.635***	0.552***						
CW	0.496***	0.505***	0.651***	0.530***					
HdL	0.505***	0.450***	0.578***	0.360***	0.410***				
CC	0.465***	0.419***	0.340***	0.431***	0.485***	0.291**			
TL	0.075	0.133	-0.049	-0.079	0.078	0.021	0.154		
HpW	0.381***	0.182	0.588***	0.266**	0.460***	0.409***	0.240*	0.118	
PL	0.737***	0.559***	0.742***	0.542***	0.629***	0.619***	0.483***	0.067	0.551***

*p<0.05 - significant, **p<0.01 - very significant, ***p<0.001 - extremely significant

Acknowledgements:

This paper has been supported by sheep breeders association „STADO“ and by Faculty of Veterinary Medicine, Belgrade.

References

- Balevska, R. and A. Petrov**, 1972. Das Zackelschaf in Bulgarien und Sudosteuroopa, Sofia, Bulgaria (Bg).
- Dervisis, D., S. Stojanovic, C. Ligda and A. Georgudis**, 2007. The Sarakatsaniko sheep breed in the South-Eastern Europe. *Contemporary Agruculture*, **56** (3-4): 18-23
- Domestic Animal Diversity Information System**, 2012. <http://dad.fao.org/>
- FAO**, 2012. Phenotypic Characterization of Animal Genetic Resources, Food and Agriculture Organization of United Nations (FAO), Rome 95-105, 132 pp.
- Milic, Lj.** 1953. Contribution to the characterization of the Black Vlachian (Karakachan) sheep and herding way with it. *Journal for Scientific Agricultural Research, Beograd*, **13-14** (Sr)
- Milner, J. M., S. D. Albon, A. W. Illius, J. M. Pemberton and T. H. Clutton**, 1999. Repeated selection of morphometric traits in the Soay sheep on St Kilda. *Journal of Animal Ecology*, **68**: 472-478.
- Mitic, N.**, 1984. Sheep Farming. *Institute for Textbooks and Teaching Aids*, Belgrade, pp. 144-146 (Sr).
- Porcu, K. and B. Markovic**, 2006. Catalogue of West Balkan Pramenka Sheep Breed Types. *Faculty of Agricultural Sciences and Food*, Skopje, Republic of Macedonia, pp. 56-57.
- Rogic, B., B. Vazic, S. Jovanovic, M. Stamenkovic-Radak, M. Savic and I. Ravic**, 2011. Investigations of variability of morphometric characteristics in Busa and Gatacko cattle in order to preserve autochthonous genome. *Vet. Glasnik*, **65** (1-2) 51-69.
- Sedefchev, S. and A. Sedefchev**, 2011. Comparison of exterior parameters of *in situ* conserved Karakachan sheep with the breed type from the first half of the twentieth century. *Agricultural sciences, Plovdiv*, **3** (6) 53-57.
- Sowande, O. S. and O. S. Sobola**, 2008. Body measurements of West African dwarf sheep as parameters for estimation of live weight. *Trop. Anim. Health Prod.*, **40**: 433-439.

Received June, 3, 2015; accepted for printing October, 5, 2015