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COOPERATIVES
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MORPHOMETRIC CHARACTERIZATION AND BODY DEVELOPMENT INDICES OF KRIVOVIR PRAMENKA

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Abstract: The Krivovir pramenka was created by crossing silk-fleece rams from Asia with local sheep. During World War II, it was crossed with Merino rams used for meat production, while pure breed breeding for the purpose of preservation of this indigenous population, started at the end of the 20th century. It is reared in eastern Serbia, more precisely in the area of the Crna Reka basin, which is bordered by the mountains Rtanj, Čestobrodica and Kučaj. The effective size of this population today is 315 heads, which makes it a potentially endangered population. The first step in the preservation of this breed is determining the morphometric characteristics of the animals.

The objective of the present study is to determine the phenotypic parameters of the Krivovir pramenka as well as their indices, which would ultimately contribute to its preservation, sustainable use, and improvement through selection work methods.

Morphometric tests were performed on 30 sheep, aged 3 years, reared in the area of Stara planina in semi-extensive conditions. The diet was traditional, pasture and hay with the addition of corn in the winter period. The variability of the morphometric parameters was determined using Lidtin stick and ribbon. The following exterior body measurements were determined: height to withers, body length, chest width, chest depth, tail length, chest circumference, pelvis width, shin circumference, head length, head width, earslength, neck girth, height of the back and height of the pelvis. Indices of body development are calculated values, expressed in percentages, and represent the ratio of the absolute values of the measurement in relation to another body measurement.

The descriptive statistical procedure was performed using the statistical package STATISTICA (version 8). The average height to withers of the sheep was 62.35 cm, body length 70.14 cm, chest width 16.60 cm, chest depth 26.57 cm, chest circumference 92.82 cm and shin circumference 7.94 cm. Krivovir Pramenka had a higher index of format, body compactness, massiveness and leg length, compared to sheep of Pirot and Travnik Pramenka breed and Vitorog Žuja breed sheep.

By comparing the results of this study with the results of earlier research conducted on this sheep strain, the conclusion is that the Krivovir sheep today is slightly larger, longer, with a stronger skeleton, which may be a consequence of changed management.

Key words: *Krivovir Pramenka, morphometric characterization, indices*

INTRODUCTION

According to FAO data, the number of registered sheep breeds in Europe is 771, and they make up 48% of the total number of sheep breeds registered globally, which certainly makes Europe one of the World's centers of sheep diversity. Given that a large number of breeds and local populations of sheep are present on the Balkan Peninsula (Ciani *et al.* 2020),

this region represents an extremely important area from the aspect of further improvement of sheep production both in Serbia and in Europe and the World.

Due to its geographical position, climatic conditions, zones and orobiomes, Serbia is an important center of biological diversity, at the national, European and global level (it is one of the 153 centers of world biodiversity as well as one of the 6 centers of European diversity, Biological Diversity Strategy of the Republic of Serbia 2011 - 2018).

Agrobiodiversity is an important segment of the total biological diversity, which is of great agro-ecological and economic importance, but not yet sufficiently recognized and affirmed. An important component of agrobiodiversity is the autochthonous breed of sheep, known as Pramenka.

The name Pramenka is a term for a sheep that was born in certain biological areas, in poor and bad rearing conditions, and is characterized by great resistance. It has more modest production performances, which cannot meet the expectations of intensive production, but have comparative advantages in traditional agriculture, giving the consumer a specific product. It got its name from the spiky appearance of the fleece strands with very or moderately coarse fibers. Other names for Pramenka are: Zackel, Tzurcana and Valachian.

However, the industrialization of agricultural production, new technologies, as well as market operations, favoured the spread of highly productive breeds, to the detriment of numerous autochthonous breeds. More precisely, breeders' preference for highly profitable breeds of sheep affected their biological survival, which is endangered, whereby certain strains are considered "endangered" populations (*Ružić-Muslić et al., 2015*), which imposes the imperative of their preservation for several reasons.

In addition to being valuable genetic material, autochthonous breeds of sheep are an important stimulus for the revival of rural areas, especially mountainous and currently neglected regions, ensuring additional income. By preserving, cultivating and using them, we maintain and protect biodiversity and prevent biotope devastation. They are suitable for inclusion in ecological production programs, developing recognizable traditional brands and above all, they are part of our historical, national and cultural identity.

One of the eco-types of Pramenka is Krivovir Pramenka, reared in Eastern Serbia, more precisely in the area of the Crna Reka basin, which is bordered by the mountains Rtanj, Čestobrodica and Kučaj, which extends in the form of a vast plateau from the northeast to the southwest, at an altitude of up to 1170 m. The average annual precipitation is about 674 mm. The climate is continental, with hot and dry summers, while the winters are cold with long lasting periods of frost. The average annual temperature is 12.1⁰C.

Krivovirska pramenka derives its origin from the South European mouflon, that is, from the Balkan peat sheep, which has been reared in Serbia since the Neolithic era. At the end of the 18th and the beginning of the 19th century, it was crossed with silk-fleeced sheep from Asia. In the period from 1885-1890, the Krivovir sheep was crossed with Merino type sheep - Electoral and Rambouillet sheep. During World War II, it was crossed with Merino rams, and in 1950, it was crossed with domestic Merino rams. At the end of the 20th century, rearing in the pure breed started for the purpose of preservation of this locally adapted breed.

In terms of zoological classification, it belongs to short-tailed sheep. It is late-growing and belongs to the group of sheep with triple production performance (meat, milk, wool). It is covered with white wool all over its body, except for the face and the lower parts of the legs. The body is medium developed with insufficiently expressed widths and depths. The head and legs are covered with hair, which is solid yellow or splashed yellow in colour. On the forehead and on the top of the head there are long strands of wool that form the mane. Sheep are hornless and rams have spiral horns. The legs are of medium height and firm. Milk

yield is on average about 30-70 kg, in a lactation of 180 days. Fertility is on average about 110%.

The fleece is open, composed of spiky strands, and the tortuosity is weakly expressed. The wool yield of sheep is 0.6 - 1.5 kg, and rams 1.4 - 2.0 kg. The length of the strand is about 13 cm, and the length of the fiber is 13.83 cm. The diameter is about 40 microns.

According to the data of **the Domestic Animal Diversity Information System (DAD-IS)**, for the year 2022, 2,058 female and 82 male heads are reared in Serbia. The effective size of the population is 315 heads, which makes it potentially endangered. The basic prerequisite for conservation is the inventory and morphometric characterization of Pramenka sheep, which was the research subject of numerous authors.

The morphometric characterization of sheep is extremely important, because it represents the characteristic of the breed standard (*Verma et al., 2016*), it provides us with valuable information about the morphological structure and the ability of the animal to develop, it is an indicator of the growth of the animal during its life (*Attah et al., 2004*) and is helpful in the prediction of body weight and carcass properties (*Thiruvankadan, 2005*), as well as in the implementation of breeding and selection work

The aim of this paper is to present the results of the measurement of the exterior and indices of body development of the Krivovir Pramenka, which can be used as a basis for morphometric characterization and be the first step towards the preservation of this potentially endangered sheep.

MATERIAL AND METHOD

Morphometric measurements were performed on 30 sheep, aged about 3 years, reared in the area of Stara Planina mountain. The measurement was performed by one person, with the help of an assistant. The influence of the evaluator was excluded in this study. Each sheep was measured on a flat surface, on the left side of the animal, using a Lidtin stick and a measuring ribbon. The following body measurements were determined: height to withers, body length, chest width, chest depth, tail length, chest circumference, pelvis width, shin circumference, head length, head width, earlength, neck girth, height of the back and height of the pelvis, according to the methodology in the previous research (*Ružić-Muslić et al., 2021*).

Based on the established values, indices were calculated that represent the absolute values of the measurement in relation to some other body measurement, expressed as a percentage. They serve to determine the proportions of the animal's body as well as for a more precise comparison of the development of individual animals (*Činkulov et al., 2003*). Descriptive statistical data processing for the population of Krivovir Pramenka was performed using the statistical package STATISTICA (version 8).

RESULTS AND DISCUSSION

Table 1 shows a descriptive statistical analysis of the morphological characteristics of the Krivovir Pramenka. The highest coefficient of variation (11.63%) was found for the chest width.

Table 1 Descriptive statistics parameters for the observed morphometric characteristics of Krivovir Pramenka

Parameter	Mean	SD	SEM	Min.	Max.	CV (%)
Head length	21.91	0.93	0.17	20.00	23.00	4.26
Head width	14.03	1.00	0.19	12.00	16.00	7.19
Ear length	13.37	1.16	0.22	11.00	16.00	8.73
Neck circumference	38.21	4.067	0.76	31.00	48.00	10.64
Withers height	62.35	3.25	0.61	55.00	69.00	5.22
Body length	70.14	2.46	0.46	66.00	75.00	3.51
Chest width	16.60	1.93	0.36	13.00	20.00	11.63
Chest depth	26.57	1.77	0.33	23.00	30.00	6.67
Chest circumference	92.82	5.77	1.09	84.00	105.00	6.22
Pelvic width	13.17	1.12	0.21	12.00	16.00	8.53
Shin circumference	7.94	0.56	0.10	7.00	9.00	7.13
Tail length	38.28	4.03	0.76	30.00	45.00	10.54
Back height	59.35	2.93	0.55	53.00	64.00	4.94
Pelvis height	61.71	3.52	0.66	54.00	68.00	5.71

Krivovir Pramenka belongs to the group of smaller sheep, with a smaller body format. In terms of height to withers, compared to other strains, such as Pirot Pramenka (*Ružić-Muslić et al., 2021*), Krk (Mioč et al., 2004;), Pag (Pavić et al., 2005), Dubrovnik (Mioč et al., 2003) and Lika Pramenka (Važić et al., 2017), it has a higher withers (62.35 cm), while in comparison with Dub, Privor and Kupres Pramenka (*Važić et al., 2017*), it is inferior. Body length is a trait that is very important in the phenotypic characterization and selection of future animals, for further reproduction, based on the phenotype (*Pihler et al., 2019*) and for the Krivovir sheep it is 70.14 cm. By comparing the results of the authors, who measured other strains of Pramenka sheep, it can be concluded that in terms of body length, the Krivovir sheep is similar to the Wallachian White-Horned sheep (69.56 cm) (*Pihler et al., 2019*). The Krivovir sheep is insufficiently developed in terms of their width, given that the chest width is 16.60 cm, which is identical to the chest width of the Rab sheep (16.60 cm) (*Mioč et al., 2006*), and smaller compared to the Pirot and Lipe Pramenka (*Ružić-Muslić et al., 2021, 2022*), Vitorog Žuja (*Pihler et al., 2019*), Privor, Dublje, Kupres Pramenka (*Važić et al., 2017*) as well as Travnik Pramenka (*Novoselec et al., 2020*). According to earlier research by Mitić (1987), the height of withers of the Krivovir Pramenka is 61.35 cm, and the length of the body 67.97 cm. By comparing the aforementioned data with the results obtained in this study, it can be concluded that the morphometric characteristics of this sheep have changed in a positive sense. Today, these sheep are slightly larger, longer, with a stronger skeleton. Therefore, the measured animals are not identical to the heads of the same population 50 or more years ago. The explanation lies in improved management: a smaller number of sheep are reared on large pastures, compared to the previous period. In addition, the nomadic way of keeping sheep is a long time gone, better, more modern facilities for sheep are being built, and nutrition in the winter period includes the use of corn in the diet.

Table 2. Morphometric measurements of certain populations of Pramenka sheep

Population	Indicator, cm						Source
	WH	BL	CW	CD	CC	SC	
Krk sheep	54.96	61.78	16.26	28.29	77.18	6.99	Mioč et al., 2004
Pag sheep	56.14	64.27	17.11	28.98	83.26	7.04	Pavić et al., 2005
Dubrovnik sheep	60.12	65.05	19.81	30.32	86.45	7.54	Mioč et al., 2003
Lika Pramenka	60.75	67.35	16.64	29.28	83.83	7.48	Mioč et al., 1998
Dublje Pramenka	73.37	74.66	22.72	34.50	98.72	9.31	Važić et al., 2017
Privor Pramenka	70.28	73.04	20.83	32.49	88.89	8.45	Važić et al., 2017
Kupres Pramenka	69.71	72.84	21.12	31.98	90.75	7.91	Važić et al., 2017
Travnik Pramenka	69.63	74.78	20.15	31.40	93.61	7.31	Novoselec et al., 2020
Vitoroga žuja	64.31	69.56	18.89	37.97	85.25	7.99	Pihler et al., 2019
Rab sheep	56.83	64.60	16.60	28.29	82.28	7.51	Mioč et al., 2006
Pirot Pramenka	56.31	62.93	18.37	25.96	77.59	6.70	Ružić-Muslić et al., 2021
Lipe Pramenka	74.46	78.05	23.49	39.76	91.05	-	Ružić-Muslić et al., 2022

WH. = height to withers; BL = body length; CW = chest width; CD = chest depth; CC = chest circumference; S.C. = shin circumference

Indices of body development are important for a more precise comparison of individual animals. Table 3 shows the indices of body development of Krivovir Pramenka. The highest coefficient of variation (12.43%) was established for the pelvic-thoracic index, while the lowest (2.63) for the partition index.

Table 3. Indices of body development of Krivovir Pramenka

Indicator	Mean	SD	Min.	Max.	CV,%
Format index	112.96	5.21	101.4	125.0	4.61
Chest index	62.66	6.12	50.0	74.00	9.77
Compactness index	132.99	7.14	117.3	152.5	5.37
Massiveness index	150.16	9.56	133.3	172.4	6.36
Pelvic-thoracic index	126.59	15.74	92.80	150.0	12.43
Leg length index	57.16	2.52	51.60	60.90	4.41
Forehead width index	64.29	4.48	56.50	76.10	6.98
Partition index	98.83	2.59	95.16	108.19	2.63

Mean = arithmetic mean; SD = standard deviation;; CV = coefficient of variability

The format index is 112.96, which indicates an extremely compact form, while the body compactness index indicates a solid constitution of the Krivovir sheep.

By measuring the parameters of the development of the chest, it was determined that the thorax is relatively narrow and shallow. The chest index as a measure indicates the roundness and position of the ribs (table 3). Backward oblique ribs of small roundness in this sheep are a characteristic of low-selected natural populations.

Table 4. Indices of body development of individual Pramenka strains

Indicator	Vitoroga žuja (Pihler et al., 2019)	Travnik Pramenka (Novoselec et al., 2020)	Pirot Pramenka (Ružić-Muslić et al., 2021)
Format index	108.49	107.39	111.95
Chest index	62.75	64.12	70.87
Compactness index	112.67	125.25	123.51
Massiveness index	132.86	134.70	136.16
Leg length index	52.89	54.82	53.83

Comparing the indices of body development in the research with the results of the research on the Vitoroga žuja, Travnik and Pirot Pramenka, (table 4), it is evident that the Krivovir Pramenka has a higher index of format, compactness of the body, massiveness, leg length, in relation to the mentioned populations of Pramenka strains, which can be a consequence of differences in husbandry management, geographical area and climatic conditions.

The next step on the way to preserve the Krivovir Pramenka, as a potentially endangered population, is genetic characterization, which will be the subject of our future research.

Figure 1. Krivovir Pramenka



CONCLUSION

Krivovir pramenka belongs to the group of smaller sheep, with a smaller body format, which is reared in Eastern Serbia, in the area of the Black River basin. The effective size of the population is 315 heads and it is considered as the genetic resource (it has the status of a potentially endangered population). In order to protect biodiversity, its preservation is imperative. The first step on that path is the determination of morphometric parameters, which was the subject of this study. The determined phenotypic parameters show that the recently measured animals, compared to animals of the same population from 50 years ago, are somewhat larger, longer, with a stronger skeleton. Compared to some other populations of Pramenka sheep (Vitoroga žuja, Travnik, Pirot), Krivovir sheep has a higher index of format, body compactness, massiveness and leg length.

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