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Research article

IN SITU PROGRAMME FOR THE CONSERVATION OF THE AUTOCHTHONOUS LIPE TYPE OF ZACKEL SHEEP

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The aim of this study was to emphasize the importance of conservation of the Lipe sheep, as a local endangered type of Zackel breed, and to perform a comprehensive phenotypic characterization in order to ensure a better use and preservation of this genetic resource. In addition, we compared the results of a detailed morphometric characterization of the modern Lipe sheep carried out in the present study with the morphometric parameters of the native form of this breed described in 1935. The comparative analysis revealed the development dynamics of the local Lipe sheep in the traditional habitat, over a period of nearly one century. Throughout this period, different factors affecting Lipe sheep management, such as biogeografic, agro-economic, sociocultural and others, led to significant population erosion, and to the current status of the Lipe sheep as an endangered genetic resource. Although a slight increase has been registered in some body measurements, the major body indexes of the Lipe sheep, such as body format, body compactness, body massiveness, body proportion, pelvic, and head index, remained without significant fluctuations over the last century ($p>0.05$). Body length of the modern type still exceeds the height at withers, which was also recorded in the native Lipe sheep nearly 100 years ago. A prominent sexual dimorphism is still evident. Therefore, our comparative analysis showed no significant differences between the native and modern form of Lipe sheep in their body format and growth potential. The slight increases in absolute body measurements of the modern Lipe type we recorded could be linked to better housing conditions and improved quality of feed, without application of strategic selection measures over the last 100 years. The importance of conservation of this ovine resource is less economical, but mostly cultural, historical and heritage oriented, and still essential for the survival of the breed.

Key words: autochthonous genetic resource, conservation, phenotype characterization, Lipe type Zackel sheep

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INTRODUCTION

Lipe Zackel sheep belongs to the category of local type of breeds. It is also called Gara, Garulja by the local people, and represents a triple purpose, late maturing sheep raised under semi-intensive management conditions in the traditional habitat.

The first detailed research on sheep origins in Serbia indicates that sheep derived presumably from mouflons were reared in the Balkans since the Neolithic period [1]. The historical records indicate that all Celtic tribes reared sheep with long tails. A Celtic tribe that had been living for a long time on the territory of southern Serbia (Belgrade to Morava) reared a long tail sheep whose description resembles that of the modern type of the Lipe sheep. Namely, the major traits were a light black head, black legs, and a long tail. During the migration of Slovenian tribes to the Balkans, they brought along their sheep probably originating from the Asian mouflon. The archaeological and historical data indicate that the Lipe sheep descended from the Asian mouflon, as was confirmed by Sanson [2] who classified this Danube variety as "Ovis aries asiatica". The first detailed description of the Lipe sheep is found in the doctoral dissertation by Pavlović [3]. He described this type of local autochthonous Zackel sheep as a robust sheep with excellent milk properties for cheese production, adapted to wetlands, and conditions for extensive breeding system.

At the beginning of the twentieth century the Lipe sheep had been bred in the region located at the south of the Danube River, bordered by the cities of Grocka, Sopot, Arandjelovac, Rača, Svilajnac, and Petrovac on Mlava. The Lipe sheep type was named after the center of breeding allocated in the village of Lipe. It used to be a flood plain until the land drainage system in Morava valley had been implemented in the last thirty years of the 20th century. This intervention increased the arable land, and the opportunities for other forms of agricultural production. The change of habitat, therefore, led to a decreased interest in rearing autochthonous Zackel types, including the Lipe sheep. The development of intensive farming systems based on a limited number of selected exotic breeds led to a decrease in diversity within some autochthonous sheep breed populations. Loss of genetic biodiversity has already been noted in some Zackel types, as a result of lack of profitability, indiscriminate cross-breeding mainly with Wurttemberg and Ile de France [4,5]. According to the data of the Ministry of Agriculture of the Kingdom of Yugoslavia in 1932 the number of Lipe sheep on the territory of Pomoravlje was around 40.000. Nowadays, according to the breed classification system provided by the Food and Agriculture Organization of the United Nations (FAO) Domestic Animal Diversity Information Service (FAO DAD IS), the Lipe sheep is a local breed and an endangered population, registered at the Endangered - Maintained breed list [6].

The objective of the present study was to determine the value of Lipe sheep for the conservation process *in situ* through the analyses of the phenotype characteristics of the breed relating to its history and development.

MATERIAL AND METHODS

Study area

Firstly, the rearing area and the traditional habitat were identified and described. The Lipe sheep type was named after the center of breeding allocated in the village of Lipe. The current traditional natural habitat is very narrow, and the only center of pure breeding is located in the Lipe village (44°38'17"N; 20°59'35"E) and surrounding villages in the lower Morava valley.

Data collection

The present status of the Lipe Zackel sheep within its natural habitat, and the strategy for its future management were analyzed according to the FAO guidelines (FAO, 2015) and the National Plan for animal genetic resource conservation.

The study was conducted in the Lipe village and surrounding villages, over a six month period, from January, 2016 to June, 2016. In order to collect the phenotype related parameters, identify the existing production systems and population status data of the Lipe Zackel sheep, onsite visits were done. These included detailed measurements of phenotypic parameters, insight into the registry, and interviews with the local breeders.

All the animal handlings were done taking into account the actual animal welfare legislation and ethical standards. Qualitative and quantitative variable traits were estimated in accordance with the guidelines provided by FAO [6-8].

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The phenotypic characterization was carried out on 52 adult ewes and 8 adult rams. All included animals were older than three years. They originated from five different populations of pure-breed Lipe Zackel sheep, reared under a semi-intensive system in the traditional habitat in Lipe, Umčari and Smederevo. General exterior characteristics of the sheep were assessed using the observation method, regarding type of fleece and wool pigmentation of hair and hooves as well as presence, shape and pigmentation of horns. General milk production traits and reproductive parameters were also assessed. The results obtained for the modern Lipe type were compared with phenotypic description of the Lipe sheep done by Pavlović at the begining of the 20th century [3].

For the morphometric database the following most important body measurements were taken: height to withers, as the distance from the ground to the top of the withers (HWi); body length, as the distance between the cranial point of the shoulder to the caudal margin of the pin bone (BL); chest circumference, as the circular volume of the chest just behind the withers and shoulders (ChC); chest depth, as the distance between the ventral edge of the sternum and the top of the withers (CD); chest width, as the distance between the lateral edges of shoulder joints (CW); cannon circumference, as

the circumference of the left front cannon (CC); head length, as the distance from the tip of the nose to the top of the occipital crest (HdL); front length, as the distance from the top of the occipital crest to the medial eye corner connecting line (FrL); face length, as the distance from the tip of the nose to the medial eye corner connecting line (FcL); head width, as the distance between the zygomatic arches (HW); height of the ear base, as the distance between the incisura vassorum mandibule to the ventral base of the ear (HeB); ear length, as the distance from the base to the top of the ear on lateral aspect (EL); horn length, as the distance between the base and the tip of the horn on lateral aspect (HL); hip height, as the distance between the ground and the top of the hip (HH); top height, as the distance between the ground and the top line of the lumbal part (TH); rump length, as the distance between the cranial part of the hip and the most posterior part of the pin bone (RL); hip width, as the distance between the coxal tubercles (HpW); coxo-femoral diameter, as the distance between the coxo-femoral joints (CfD); rump width, as the distance between the two most posterior points of pin bones (RW); tail length, as the distance between the base of the tail to the end of the last tail vertebrae (TL); and body weight (BW). The linear parameters were measured using metric tape (zootechnical ribbon, 50 and 250 cm), and a measuring scale was used for measuring body weight. In order to get a better insight of the body proportions, body indexes were calculated as follows: index of body format (HWi / BL x 100), body compactness index (ChC / BL x 100), index of chest (CW / CD x 100), index of depth (CD / HWi x 100), index of massiveness (ChC/HWi x 100), index of body proportion (BW / HWi x 100), head index (HW / HdL x 100), pelvic index (HpW / RL x 100), and cannon circumference index (CC / HWi x 100).

Wool samples were taken during shearing. Fiber diameter was determined by the optical fiber diameter fineness analyzer (OFDA-GSG, Australia Ltd.), as described by Baxter *et al.* [9].

The results obtained are presented using descriptive statistical parameters. Data were expressed as means ± standard deviation, interval of variation and coefficient of variation. Body indexes were calculated as percentage values. The significance of the differences between morphometric parameters of the native and the modern Lipe sheep was analyzed using the T-test and chi-squared test. The data analysis was performed with the statistical software Prism Pad 6.0 (GraphPad Software, Inc., San Diego, CA, USA). Differences with $p<0.005$, $p<0.001$, and $p<0.0001$ were considered as significant, highly significant, and extremely significant, respectively.

RESULTS

Breed description

Lipe sheep is a rare, local type of Zackel breed. In the heterogenous group of triple-purpose Zackel breed, the Lipe type has a medium to large body size. Coat color is mainly white, with black head and dark legs (Fig. 1A, 1B). There are also sheep with

yellowish to brownish colored wool on the neck, and sometimes on the chest, back or abdomen. Also, a dark coloration of the whole coat has been observed. Hooves are dark and firm. Horns in rams are yellowish to dark, large, triangularly shaped, and spirally twisted (Fig. 1C), while ewes are usually polled. The profile line is slightly convex (Fig. 1B). Eyes are prominent with expressed arcades. Ears are short and semi erected, horizontally oriented (Fig. 1C). The tail is long, almost reaching the ground (Fig.1B). Fleece is open with long whippy locks and rough fibers over 20 cm long (Fig. 1A, 1B). The average weight of adult ewes is 54.42±4.90 kg, and they are 70.53±3.12 cm high at the withers, while rams weigh 74.88±6.55 kg, and are 76.25±4.22 cm high at withers. The age of sexual maturity is around 18 months. General milk production of the Lipe sheep is estimated at 141±9.30 kg per 120 days. Lambing rate is 120-130%, starts in late December and lasts till the end of May. The average weight of the newborn lambs is 3.75±0.5 kg.

Figure 1. 1A. White coat colour with open fleece and long whippy locks, black head and dark legs – ewe of Lipe sheep; **1B**. Slightly convex profile line, semi erected, horizontally oriented short ears, long tail – ram of Lipe sheep; **1C**. Triangularly shaped and spirally twisted horns – ram of Lipe sheep; **1D**. White coat colour with black areas – lambs of Lipe sheep.

Population status

Breeding of the Lipe type in the region of Morava valley represents a historically important activity of the local people throughout centuries. At the beginning of the

20th century, the Lipe sheep enjoyed a popular status with over 40.000 sheep. In the subsequent era of intensive livestock breeding, primarily focused on highly productive breeds, its popularity decreased, and led almost to extinction. According to the FAO database, the type had a risk status in the period between 2003 and 2004, with only 80 breeding animals recorded. At the time, an *in situ* conservation programme has been initiated, and the status of the breed gradually stabilized. A slight and constant increase in the population size has been noted over the last decade. Currently, the active population status of the Lipe sheep comprises 500 animals and is considered stable, although it is still classified as an endangered-mantained autochtonous animal genetic resource. The ongoing national programme of *in situ* conservation of the Lipe type is of high importance, and there is a need for further characterization of the breed. The breeding programme is based on a natural mating system without the implementation of artificial insemination.

Adaptation to the habitat and production system

Lipe sheep is a local breed, reared mainly under semi-intensive production conditions. The current natural habitat is at Lipe village and surrounding villages at the lower Morava valley. In general, the region has a temperate continental climate, with temperatures varying from -5 ºC to +10 ºC in winter, and from +23 ºC to +35 ºC in the summer. The region is well known for a cold and dry wind, so called Košava, which periodically occurs.

The adaptive traits of the Lipe sheep should be specially reviewed in the context of adaptation to wet pedologycal conditions where the breed was traditionally reared and developed.

Morphometric characterisation of the Lipe sheep

Main morphometric characteristics of the Lipe sheep

The detailed morphometric data of the main body measurements of the Lipe sheep type of both sexes are summarized in Table 1.

Table 1. Main body measurements of the Lipe sheep

Variable	Sex F (n=52) M (n=8)	$\bar{X} \pm SD$ (cm)	VI	CV (%)	p
Height at withers	F	70.50±2.06	68.00-74.50	2.92	0.0018**
	M	76.25±2.44	72.00-80.00	3.20	
Body length	F	78.00±3.13	72.50-84.00	4.02	0.0445*
	M	93.50±3.73	87.00-100.00	3.99	
Chest circumference	F	91.25±2.32	88.00-89.00	2.54	0.0003***
	M	97.87±4.55	89.00/103.50	4.65	
Cannon circumference	F	7.56±0.75	6.50-8.50	9.94	0.0030**
	M	9.32±0.66	8.50-10.50	7.07	
Chest depth	F	38.37±1.40	35.00-40.00	3.66	0.0001***
	M	43.25±2.05	40.00-46.00	4.73	
Chest width	F	22.31±1.49	19.00-24.00	6.67	0.0120*
	M	25.63±2.42	21.00-29.00	9.45	
Chest length	F	41.33±3.78	37.00-48.50	9.15	0.1649ns
	M	44.13±2.88	40.00-50.00	6.53	
Hip height	F	70.06±1.99	67.00-74.50	2.84	0.0017**
	M	74.81±1.77	72.00-77.00	2.36	
Top height	F	69.13±2.32	65.00-72.50	3.35	0.0128*
	M	73.19±2.25	70.00-77.00	3.07	
Carpal height	F	21.31±1.65	19.00-24.00	7.76	0.0219*
	M	24.13±2.12	20.00-26.50	8.78	
Tarsal height	F	25.19±2.11	21.50-28.50	8.37	0.0016**
	M	27.50±1.69	24.00-30.00	6.16	
Tail length	F	49.75±2.30	46.50-53.00	4.63	0.0001***
	M	56.63±3.24	51.00-61.00	5.72	
Body weigth	F	54.42±4.90+	43.00-62.50	9.00	0.0001***
	M	74.88±6.55+	62.50-84.00	8.74	
Testicle circumference	M	30.00±3.08	29.50-34.50	5.43	

$^{+}$– kg; *– $p<0.05$, significant; **– $p<0.01$, very significant; ***– $p<0.001$, extremely significant;
^{ns}– $p>0.05$ not significant

Morphometric analysis of main body measurements of the modern type Lipe sheep indicates the existence of prominent sexual dimorphism. Results of statistical analysis showed significant differences in thorax development, body weight and tail length among rams and sheep in the examined population.

Craniometric data of the breed

For the purpose of better phenotypic characterization and understanding of the development of the modern type of Lipe sheep, the craniometric data are evaluated in Table 2.

Table 2. Craniometric morphometry of the Lipe sheep

Variable	Sex F (n=52) M (n=8)	$\bar{X}$±SD (cm)	VI	CV (%)	p
Head length	F	24.62±1.34	22.00-26.50	5.44	0.0001***
	M	28.25±3.02	26.50-30.00	4.07	
Front length	F	9.11±0.87	8.00-10.50	9.55	0.0237*
	M	10.06±0.98	8.50-11.50	9.76	
Face length	F	15.54±1.06	13.00-17.00	6.82	0.0018**
	M	18.50±1.07	16.50-20.00	5.73	
Head width	F	12.38±1.17	10.00-14.00	9.42	0.0085**
	M	14.75±1.23	12.00-16.00	8.30	
Height of the ear base	F	10.13±1.18	8.50-12.00	11.65	0.0041**
	M	12.13±1.05	10.50-14.00	8.69	
Ear length	F	12.63±0.94	11.00-15.00	7.47	0.0037**
	M	14.13±1.05	12.00-15.50	7.46	
Horn length	F	–			
	M	62.31±4.58	55.00-70.00	7.34	

*– p<0.05, significant; **– p<0.01, very significant; ***– p<0.001, extremely significant

Craniometric data confirmed prominent sexual dimorphism present in Lipe sheep. Robust horns in rams and polled ewes present the most prominent evidence of the sexual dimorphism. The results also showed that the head length and the head width are significantly more developed in rams than in ewes.

Pelvimetric data of the breed

The results of morphometric characterization of the pelvis of Lipe sheep are presented in Table 3.

Table 3. Pelvimetric morphometry of the Lipe sheep

Variable	Sex F (n=52) M (n=8)	$\bar{X}$ ± SD (cm)	VI	CV (%)	p
Rump length	F	24.46±1.56	22.00-27.00	6.39	0.2176^{ns}
	M	25.56±1.04	24.00-27.00	4.08	
Hip width	F	22.23±2.30	19.00-26.00	10.35	0.9550^{ns}
	M	22.69±1.35	20.00-24.50	5.93	
Coxo-femoral diameter	F	24.13±2.13	20.00-28.00	8.84	0.5681^{ns}
	M	24.88±1.76	22.50-27.50	7.09	
Rump width	F	13.42±1.59	10.50-16.50	11.86	0.3264^{ns}
	M	14.44±1.24	12.50-16.00	8.56	

^{ns}– p>0.05, not significant

The results of statistical analysis of pelvimetric morphometry data revealed no significant differences between the sexes of the Lipe sheep.

Body indexes

In order to better understanding of the relations between some of the morphometric data and to underline the body proportions, body indexes were calculated (Table 4).

Table 4. Body indexes of the Lipe sheep

Variable	Index value (%)		p
Index of body format	F	90.38	0.50091^{ns}
	M	81.55	
Body compactness index	F	116.99	0.40752^{ns}
	M	104.66	
Index of chest	F	58.13	0.91647^{ns}
	M	59.26	
Index of depth	F	54.41	0.82658^{ns}
	M	56.72	
Index of massiveness	F	129.43	0.94362^{ns}
	M	128.34	
Index of body proportion	F	77.19	0.11262^{ns}
	M	98.20	
Cannon circumference index	F	10.72	0.75545^{ns}
	M	12.21	
Head index	F	50.28	0.87436^{ns}
	M	51.88	
Pelvic index	F	90.88	0.83453^{ns}
	M	88.73	

^{ns}– $p>0.05$, not significant

According to the results of body index analysis the Lipe type is regarded as medium to large sized sheep with body format index characteristic for the Zackel sheep.

Taking into consideration that Lipe sheep is a local breed, reared in its traditional habitat for a long period, and, accordingly, developed in accordance with the changing ecosystem, we comparatively reviewed the main morphometric traits of the native and modern type Lipe sheep (Table 5).

Table 5. Comparative review of the main morphometric traits of the native and modern Lipe type sheep

Variable (cm)	Lipe sheep Pavlović (1935)	Lipe sheep 2016	p
Height at withers	67.00	73.38	0.59022^{ns}
Body length	81.23	85.75	0.72687^{ns}
Chest circumference	90.00	94.55	0.73788^{ns}
Chest width	21.47	23.96	0.71229^{ns}
Chest depth	33.23	40.80	0.37898^{ns}
Head length	24.25	26.52	0.75063^{ns}
Head width	12.36	13.56	0.81293^{ns}
Ear length	12.39	13.39	0.84344^{ns}
Tail length	43.00	53.19	0.29892^{ns}
Hip height	69.92	72.43	0.83385^{ns}
Rump length	23.94	25.01	0.87945^{ns}
Hip width	20.82	22.45	0.80492^{ns}
Body weight^{+}	60.00	64.65	0.67745^{ns}
Index of body format^{++}	82.48	85.57	0.81130^{ns}
Index of body compactness^{++}	110.79	110.26	0.97477^{ns}
Index of body massiveness^{++}	134.33	128.85	0.73563^{ns}
Index of body proportion^{++}	89.55	88.10	0.91277^{ns}
Pelvic index^{++}	86.97	89.76	0.83385^{ns}
Head index^{++}	50.96	51.13	1.00017^{ns}

$^{+}$– kg; $^{++}$– %; ^{ns}– p>0.05, not significant

Comparison review of the main morphometric data of the Lipe type measured in 1935 and in 2016 revealed no significant differences between values (p>0.05).

The correlation between some of the selected morphometric parameters are summarized in Table 6.

Table 6. Pearson correlation between selected morphometric parameters of Lipe sheep

	BL	ChC	CW	CC	HdL	HW	E L	RL	HpW	TL
HWi	0.006	0.591**	0.207	-0.118	-0.209	0.030	-0.056	0.087	0.061	-0.247
BL		-0.184	0.363	0.172	-0.481*	-0.440*	-0.375	-0.135	0.012	-0.164
ChC			0.273	-0.727****	0.256	0.443*	0.482*	0.112	-0.249	-0.176
CW				-0.145	-0.012	0.061	0.039	-0.094	0.148	-0.236
CC					-0.372	-0.215	-0.217	0.059	0.254	0.025
HdL						0.676***	0.632***	-0.117	0.271	0.085
HW							0.866****	0.154	0.026	-0.057
E L								-0.002	-0.133	-0.029
RL									-0.179	-0.072
HpW										0.161

* – p <0.05, ** – p <0.01, *** – p <0.001, **** – p <0.0001

Wool production traits

The analysis of wool traits showed that Lipe sheep has coarse wool. Fleece is open with long whippy locks, composed of rough fibers whose length is 20.56 ±2.5 cm and 22.25±1.5 cm in ewes and rams, respectively. The average wool yield is 2.55±0.5 kg and 3.50±0.7 kg in ewes and rams, respectively. Fiber analysis showed that the fiber diameter varies between 39.2-45.3 μm, with the average fiber diameter of 42.2±3.2 μm, which corresponds to D sortiment. Although the wool of rams is slightly coarser than the wool of ewes, it also belongs to D sortiment.

SWOT analysis

The Streangth, Weakness, Opportunities and Threats (SWOT) analysis is widely used as a valuable decision making tool in planning the optimal programme for conservation of animal genetic resources in complex systems. We performed the SWOT analysis of the Lipe type Zackel sheep, and the results are summarized in Table 7.

Table 7. Streangth, Weakness, Opportunities and Threats analysis of the Lipe sheep characteristics identified for conservation strategy

Analysis phases	Breed characteristics
Strengths	The sheep have been recognized as a distinct sheep type in Serbia, since the 1888s. The unique robust constitution, excellent milk properties for cheese production, the adaptive characteristics and ability to cope well with wet terrain were emphasized in 1935. Nowadays, these characteristics make the Lipe sheep a significant animal resource adapted to the traditional environment, and other challenging aspects for the in situ conservation. The consumer's demand for local auththonous products, such as Lipe lamb meat with a unique flavor and Lipe cheese prepared in the traditional way, is increasing.
Weaknesses	Low production traits of the Lipe sheep. Increased use of exotic breeds. Loss of pasture production environment.
Opportunities	Low initial investment per animal compared with exotic breeds. Lipe sheep as a part of cultural heritage. Farmers are very interested in saving Lipe sheep as genetic resource. Traditional livestock festival from the past "Lipe shepherd days". Care for local Lipe sheep with application of modern knowledge required for conservation activities gives great chances for the in situ conservation of local Lipe sheep. Local Lipe type is supported by Republic measures.
Threats	Small population size. Low productivity. Low income. Cross breeding with exotic breed.

DISCUSSION

Although the size of the Lipe sheep population is small, consisting of 500 animals in total, this type of Zackel sheep represents an important genetic animal resource of Serbia. The significance of this type must be considered within the frame of the domestication process, and long tradition of animal breeding in the valleys of the Danube and Morava Rivers. There are several important Neolithic settlements belonging to the Vinča culture in this region. Paleozoological evidence suggests that *caprinae* subfamily was present at these Neolithic sites [10].

The first descriptions of these sheep populations underlined the contrast of black colored head and legs and white wool as major phenotype characteristics [2]. The detailed description of the Lipe sheep phenotype was given at the beginning of the 20th century [3]. Pavlović in his PhD thesis gave the phenotypic characterization of the native form of Lipe sheep. The description emphasized that Lipe sheep had variable body weight (average 60 kg), and that body length was always greater than its height at the withers. The head profile line was described as straight or slightly convex. In rams the convex profile was a preferred quality as a sign of outstanding sexual dimorphism. Ewes were polled, and rams had massive horns spirally twisted, yellowish to brownish colored. On the forehead there was a taft of short wool. Head and legs were characteristically covered with black short hair. Wool was coarse and the fleece was open, mainly white colored. The contrast between black hair and white

wool made the Lipe sheep easily recognizable. Apart from typically white colored ones, there were sheep with yellowish, brownish and russet wool. Also, there were sheep of white color with colored spots of different size, variously distributed across the body. Depending upon color, distribution and size of spots, there were various local names for those variants of the sheep. It was also reported that some sheep had white nasal vault discoloration, which could had been a result of crossbreeding making them undesirable for breeding. In general, robustness, strong constitution, and good adaptation for rearing on wetlands made Lipe sheep specific and valuable. Despite the efforts to standardize the Lipe sheep, the native populations of the type were obviously phenotypically highly heterogenous. One century later, the Lipe sheep is still a point of interest as a genetic animal resource in Serbia. The extensive morphometric characterization performed in our study showed that body format of the Lipe sheep has not changed significantly over the last century. According to statistical analysis of the observed values of morphometric parameters, it can be concluded that the modern Lipe type is a rather homogenous population. The Lipe type remained a medium to large size Zackel sheep. Body length of the modern type still exceeds the height at the withers, which was also recorded in the native Lipe sheep nearly 100 years ago [3]. A prominent sexual dimorphism is still evident. A slight, but not significant increase in body mass has been observed. The major body indexes such as index of body format, body compactness, body massiveness, body proportion, pelvic and head index, also remained without significant alterations ($p>0.05$) over the last century, regardless of the slight increase in some body measurements we recorded. Therefore, our study clearly shows that there are no significant differences between the body format and growth potential of the native and modern type of Lipe sheep. The slight increase in absolute body measurements of the modern Lipe type could be linked to better housing conditions and improved quality of feed but without the implementation of planned selection measures over the last 100 years [11,12]. Comparing the phenotype characteristics with other Zackel sheep types, the Lipe sheep is a medium to large Zackel type [4,5,13-15].

A comparison of milk production results of the Lipe sheep (149.52±4.26kg), with other autochtonous breeds, such as the Tsigai (131.23±4.08kg) and the Pirot improved sheep (76.12±3.58 kg) has shown that the Lipe sheep has a significantly higher milk yield [14]. Our results of milk yield of the modern Lipe sheep confirm the results of Pavlović [3], who emphasized the strong potential of the native Lipe sheep for milk production. Nearly one century ago it was established that the chemical composition of milk produced by the Lipe sheep was favorable for making the specific Lipe cheese [3].

The results of this study, with comprehensive phenotype assessment, would provide a good basis for designing future conservation programs of the Lipe type, focusing on further development of the potential for milk production. Promotion of high quality milk could ensure the production of the traditional and well known Lipe cheese, and, thus, contribute to the added value of the breed. As the Lipe type is reared in the

traditional habitat with abundant pastures, the meat has also a unique sensory and chemical composition, which has been increasingly appreciated by the consumers [16]. The resilience of the Lipe type, and its successful adaptation to the traditional habitat [17], provide a good opportunity for rational utilization in the conservation process.

In recent history, many locally adapted breeds of different species were non-desirable in new intensive breeding programs in Europe. This trend inevitably led to a marked reduction in animal genetic resource biodiversity [4,15,16,18-22]. It is, therefore, clear that appropriate in situ conservation methods are urgently needed to prevent this tendency.

Our study showed that the sturdy phenotype of the Lipe sheep remained without significant changes over the period as long as nearly one century. This indicates an indisputably well adaptation of this local Zackel sheep type to the traditional environment. Therefore, the benefits of the in situ conservation of the currently endangered Lipe sheep type are clear. The importance of conservation of this animal resource is less economical, but mostly cultural, historical and heritage oriented. There is also an aesthetic argument that the Lipe sheep with its specific color, dark legs and head, long whippy fleece, long tail almost touching the ground, and massive spirally twisted horns in rams, presents a valuable element of nature and typical landscape of the region. Further analyses needed for detailed identification and characterization of the genetic variability of Lipe sheep, as recommended by FAO, are currently underway in our laboratory. Conserving the locally adapted breeds can promote the sustainable development, reduce production costs, enrich the sociocultural heritage of the nation, and prevent genetic pollution of a region's biodiversity. Previous investigations of the genetic term structure of other Zackel sheep types revealed the existence of high genetic variability and good adaptive ability of individuals to the often unfavorable growing conditions. The Lipe type of Zackel sheep is traditionally reared in the Lipe region and is evolutionarily adapted there. Over the last century its format and morphological parameters did not change significantly. The developmental dynamics with the very detailed morphometric data collected and compared to the parameters recorded over a century ago, could significantly contribute to the recent advanced characterization of the breed in the conservation process. It would also provide a good basis for designing breeding programs ensuring good health.

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Authors' contributions:

BZs, SM and DB collected the morphometrical data, milk and wool samples and other data regarding the phenotype characterisation. BZs, SM and DV have made substantial contributions to conception and design analysis and interpretation of data,

also performed the statistical analysis. BZs, SM, PB, TR and GA have been involved in drafting the manuscript and revising it critically for important intellectual content.

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PROGRAM *IN SITU* KONZERVACIJE AUTOHTONE LIPSKE PRAMENKE

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Glavni cilj ovog istraživanja bio je da se istakne značaj zaštite lokalnog lipskog soja pramenke, kao i da se izvrši detaljna fenotipska karakterizacija u cilju očuvanja ovog ugroženog genetičkog resursa. Takođe, izvršena je analiza morfometrijskih parametara savremenog, kao i izvornog soja lipske ovce, koji je detaljno opisan i čija je morfometrijska karakterizacija izvršena 1935. godine. Uporedna analiza ukazala je na dinamičan razvoj lokanog soja lipske ovce u tradicionalnom staništu tokom vremenskog perioda od skoro jednog veka. Tokom ovog perioda, različiti faktori uticali su na uzgoj ovaca, kao što su biogeografski, agroekonomski, sociokulturni i drugi. Ovi faktori uticali su u smislu značajnog smanjenja populacija i doveli lipski soj pramenke do statusa ugrožene rase. Iako uporedna analiza fenotipskih odlika savremenog i izvornog soja ukazuje na blago povećanje nekih od telesnih mera savremene lipske ovce,

pojedini indeksi telesnih mera, kao što su: indeks formata tela, indeks zbijenosti tela, indeks telesne mase, indeks širine čela i indeks karlice, ne pokazuju statistički značajnu promenu ($p>0.05$). Dužina tela savremenog tipa i dalje je veća od visine grebena, što je bila i izražena karakteristika izvornog oblika lipske ovce. Izraženi seksualni dimorfizam je i dalje karakteristična rasna odlika lipskog soja pramenke. Na osnovu rezultata komparativne analize fenotipskih karakteristika, može se zaključiti da nije došlo do značajnih promena morfometrijskih vrednosti i proizvodnog potencijala između izvornog i savremenog soja lipske ovce. Blago povećanje vrednosti apsolutnih telesnih mera savremenog lipskog soja može se objasniti boljim uslovima gajenja i ishrane, bez primene strateških mera selekcije tokom poslednjih 100 godina.