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DYNAMICS OF THE EXTERIOR PARAMETERS OF THE BULGARIAN RHODOPE CATTLE BREED

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Abstract

The Bulgarian Rhodope Cattle is a specialized dairy breed Jersey type. The age and population dynamics of the exterior measurements and indexes of 168 representatives of the breed has been examined. The main exterior parameters - wither height, athwart body length, chest girth and cannon bone girth increase until the age of 4 years when they reach average values of respectively $121,7 \pm 0,40$ cm, $145,1 \pm 0,90$ cm, $173,3 \pm 0,74$ cm and $17,07 \pm 0,09$ cm. At 2 years old, the heifers are entirely developed reaching parameters of respectively 97,3%, 94,7%, 95,6% and 98,4% of those typical for the adult cows. The cows are slightly built with the specific proportions characteristic of the dairy cows. There is no enlargement trend, which is a characteristic of the dairy breeds, regarding the Bulgarian Rhodope Cattle and the main exterior parameters are close to those upon creation of the breed. In the last decade it has been observed that there has been a tendency for increase in the body heights, however, judging by the dynamics of the other main parameters - chest girth (-4,11cm), cannon bone girth (-0,05) and the athwart body length (-2,17) it cannot be stated that there has been an enlargement of the animals.

Keywords: Bulgarian Rhodope Cattle Breed, body indexes, exterior, age.

INTRODUCTION

The Bulgarian Rhodope Cattle Breed is a specialized dairy breed created by means of complex reproductive crossing of the Rhodope shorthorn cattle; the main improvement breed is the Danish Jersey (Nikolov, 2012). Thanks to that, the Bulgarian Rhodope Cattle has incorporated in itself a remarkable adaptability to the specific environmental and farming conditions of the Rhodopes and a high milk productivity. The breed is also valued due to its viability, fertility and continuous commercial

use. The focus is on the milk productivity which is relatively high when the rearing conditions are taken into account. The first-calving cows have milk yield per normal lactation of 2701 l with high content of fat - averagely 5,1% and protein - 3,71% (Gadzhev and Nikolov, 2008). The total quantity of dairy butter and milk protein (major selection criterion for the milk breeds worldwide) per lactation is $220,2 \pm 10,82$ kg, and when this is related to 100 kg live weight, it can be stated that the breed is comparable to the highly



productive European breeds (Nikolov, 2012). A shortcoming of the Bulgarian Rhodope cattle breed is the fact that it has a shortened lactation (Gadzhev, 2005; Gadzhev and Nikolov, 2008) of 240 days for over 23% of the animals, however, this is compensated by the continuous use and the high lifelong productivity.

The Bulgarian Rhodope Cattle is a representative of *Bos taurus brachyceros*. It is a small breed having the specific proportions of the dairy cattle. The animals have gentle, compact and strong construction, the head is light, the legs are strong and correctly positioned (Nikolov, 2012). Thanks to the well-developed bones, tendons and hoof horn, their resistance and adaptability to the mountainous regions of the Rhodopes have no analogue among the other dairy breeds in the country.

The latest world tendencies in the dairy cattle breeding indicate that the functional features, among which is the exterior, have higher relative share in the selection indexes (Abdelharith et al., 2017; Euro Genomics, 2020). The exterior is regarded as a source of information about the health condition, reproductive capacity, and the possibility of extending the length of use of the animals.

The aim of the present study is to lay the foundations of the design of a comprehensive system for evaluation of the functional traits of the Bulgarian Rhodope Cattle Breed and its subsequent inclusion in the breed's breeding programme.

MATERIALS AND METHODS

The study was carried out in 2020. The exterior measurements of 168 cows and heifers from the Bulgarian Rhodope Cattle Breed aged

between 2 and 7 years were taken. The animals were reared in two farms - 'Research Center for Animal Husbandry and Agriculture'-Smolyan, Smolyan province (n-81) and 'Varbitsa Milk' EOOD - Sokolino, Momchilgrad province (n-87). The farms are under the selection control of the Association of Breeding Bulgarian Rhodope Cattle and Jersey Cattle.

The measurements were taken with the following routine devices - Lydtin's rod, Wilkens' compass and a measuring tape upon observance of the requirements of the 'Instructions for performance of breeding activities upon preservation of aboriginal (autochthonous) breeds in Bulgaria' (2003).

The data were processed via Analysis of Variance and the model had the following general statistical expression: $Y_{ijk} = \mu + A_{Gi} + I_j + e_{ijk}$; where Y_{ijk} - observation vector; μ - total average constant; A_{Gi} is age and individual fixed effect, I_j - a random effect of the individual; e_{ijk} - residuals. The statistical processing was performed via SPSS version 20.

RESULTS AND DISCUSSION

In his report on the recognition of the breed from 1988, senior research fellow A. Vasilev describes the animals as small - with wither height of 115-125 cm, athwart body length - 145-165 cm, chest girth - 175-185 cm, cannon bone girth - 16-18 cm, live weight-360-420kg. The animals measured by us are entirely within the scope of the indicated values (table 1).

The Bulgarian Rhodope Cattle is a brachyceros craniological type with reference to which it is typical that the length of the forehead is approximately the same as the



widest part of the head. The lengths of forehead and the face are almost the same which makes the head look relatively short and wide (Nikolov, 2012). The animals measured by us displayed a relation between the face length and the largest width of 1,031/ 1. The face length is almost equal to the length of the forehead and the relation is 1,014/1.

When comparing the data from table 1 and the indicated by Vasilev (1988) it is noticeable that the main exterior parameters of

the Bulgarian Rhodope Cattle have been retained since the creation of the breed and the general worldwide dairy breeds enlargement tendency has been avoided. The latter is connected to the efforts made in the direction of increasing the milk yield. Thus following data of Abdallah and McDaniel (2000) the weight of the Holstein Cattle breed in North Caroline in the period 1950 - 1993 increased by 135,5 kg with the milk yield increasing with 1568 kg.

Table 1. Exterior measurements of cows from the Bulgarian Rhodope Cattle Breed, cm

Measurement	2020		RCAHA- Smolyan	
	X±Sx	SD	2009	2020
			X±Sx	X±Sx
Head Measurements				
Length	38,98±0,15	1,67	39,31±0,23	38,63±0,19
Largest width	19,03±0,11	1,26	18,71±0,17	18,78±0,15
Smallest width	10,83±0,08	0,94	13,91±0,15	10,77±0,10
Forehead length	9,35±0,11	1,14	20,54±0,22	19,44±0,14
Face length	19,62±0,13	1,41	18,77±0,23	19,20±0,14
Body Heights				
at the wither	121,7±0,40	4,47	120,20±0,39	121,41±0,35
at the back	120,8±0,48	5,33	119,46±0,46	119,68±0,45
at the lumbar	124,5±0,43	4,82	120,59±0,48	124,73±0,41
at the sacrum	126,9±0,45	5,09	125,37±0,43	127,64±0,47
at the tail base	126,0±0,43	4,91	124,73±0,48	126,58±0,52
at the rump	115,6±0,39	4,34	115,31±0,38	115,82±0,46
Chest Measurements				
Length	77,30±0,47	5,27	77,89±0,73	76,58±0,49
Width	40,29±0,31	3,41	37,28±0,50	40,18±0,40
Depth	69,02±0,36	4,00	66,49±0,34	68,46±0,22
Girth	173,3±0,74	8,35	176,17±1,04	174,72±0,64
Croup Measurements				
Length	45,89±0,26	2,96	48,10±0,48	46,39±0,30
Width behind hips	46,76±0,29	3,30	46,47±0,26	46,80±0,34
Width at hip joints	40,38±0,39	4,27	40,64±0,30	41,64±0,31
Width at rump	12,38±0,16	1,77	16,62±0,35	11,13±0,11
Other Measurements				



Athwart body length	145,1±0,90	10,30	145,56±0,82	143,39±0,68
Straight body length	130,8±0,91	10,33		126,61±0,61
Cannon bone girth	17,07±0,09	0,98	17,00±0,11	16,95±0,13

Recently, however, the trend is the opposite and is related to the precision of the resource use upon animal production. An analysis of the milk sector in USA (Hodgson, 1973) showed a 70% increase of the cows milk yield in the period from 1950 to 1970, 131% increase in the use of concentrated feeds for milk production, and a 28% general increase in the feed. The latter was explained with the enlargement of the animals and the use of larger breeds. A study of the Austrian dairy population (Ledinek et al., 2019) revealed that in the case of Holstein and Brown Cattle breeds, the highest economic efficiency is reported with reference to cows weighing from 550 to 700 kg, and regarding the Simmental - to 750 kg. Upon weight increase of the Holstein cows from 550 to 750 kg, the milk yield increases with 10,6%, and from 750 to 900 kg, it decreases with 23,5%, and, in parallel, both groups increase the consumption of dry matter with respectively 13,6% and 14%, and the total intake of energy with respectively 13,9% and 14,4%.

Along with the decrease of the feed use efficiency, the excessive increase of the milk yield is also connected to a plunge in the viability, the length of use and an increase of the infertility and morbidity rates. Data of the USA Council of Dairy Cattle Breeding (CDCB, 2020) regarding the period 1957-2017 indicate that the milk yield of the Jersey cattle breed cows increased 2,56 times and at the same time the length of productive use of the animals was reduced with 1/3 - from 38,32 to 28,94 months, and the longevity index decreased from 97,17% to 84,94%.

Taking the negatives of the milk selection into account, and the fact that it is invariably linked to enlargement of the animals, the milk yield is not among the major selection features observed by the Bulgarian Rhodope Cattle and Jersey Association upon the breed selection. The main goal of the milk productivity selection in the first breeding programme (Nikolov et al., 2000) was «increasing the levels of the milk protein and enhancement of the technological properties of the milk through an increase of the protein content and maintenance of the milk fat levels». When it comes to the exterior, the breeding programme provides for keeping the size, lightness and mobility of the animals from the mountainous and semi-mountainous regions, and increasing the size of the animals from the plain regions to the one characteristic for the European Jersey. Due to the fact that during the period analyzed there were no bull - producing herds in the plain regions, the exterior parameters of the animals were generally unchanged.

The dynamics of the exterior parameters throughout the last ten years has also been low. The measurements taken by us in the main bull - producing herd of the breed in the Research Center for Animal Husbandry and Agriculture - Smolyan (RCAHA) are similar to the measurements taken by Karamfilov in 2009 (Nikolov, 2012). A certain decrease in the head length and retaining its biggest width were reported which both make it closer to the Jersey type. The wither height was 1,21 cm more but we cannot claim that there has been an enlargement tendency



because of the smaller chest girth, cannon bone girth and athwart body length which, at the last measurement, were respectively 4,11, 2,17 and 0,05 cm smaller.

The size of the Bulgarian Rhodope Cattle makes it similar to the medium Jersey type which has a wither height requirement at 36 months from 109,2 to 129,5 cm. Currently there are 4 intra-breed types within the breed which are subdivided by size - micro, mini, medium and large type with the medium considered to be the main one.

More attention should be paid to the dorsal line as our height measurements indicated differences in the heights at the lumbar, sacrum and tail base - 4,14, 2,27 and 1,85 respectively are considerably bigger than the differences in the wither height (+1,21) and the back (+0,22) which leads to a increased height at the croup. The increase of the differences between the height at the lumbar and the rump (+3,63) and between the sacrum and the latter (+1,76) exhibits a rise in the sharpness of the croup which is regarded as negative with reference to the ease of calving.

The athwart body length is smaller when compared to the one reported in the previous study. However, the body is long enough and the athwart body length is approximately 18,1% bigger than the wither height.

In comparison with the parameters indicated in the previous study, the values of the croup are roughly similar. The difference in the width at the rump is mostly due to the differences in the measurements since there are three types of measurements taken at this part of the body - between the most medial, most caudal and most lateral spots. Probably the difference in the measurement points is the reason why there is a more significant difference in the measurements regarding the smallest width at rump.

The Bulgarian Rhodope Cattle cows' udders are suitable for machine milking but are not proportionally developed (table 2) The front teats are longer than the rear ones with over 1,5 cm and they are also over 5 cm more widely positioned.

Table 2. Exterior measurements of udder in the Bulgarian Rhodope Cattle Breed, cm

Measurement	X±Sx	SD	Measurement	X±Sx	SD
Udder measurement, teats					
Length of front	7,50±0,19	2,16	Space between front and rear	10,68±0,23	2,50
Length of rear	5,93±0,15	1,69			
Space between front	12,93±0,28	3,16	Diameter of front	2,78±0,09	0,99
Space between rear	7,91±0,24	2,67	Diameter of rear	2,56±0,05	0,52

Along with the exterior measurements, the body proportions are also generally preserved (table 3).

The reduction in the head length and the lack of change in the biggest width have lead to a certain increase in the forehead width.



As a whole, the body proportions dynamics in RCAHA is towards a decrease in the extension, increase in the massiveness and retaining of the compactness. The croup heightening leads to the build increase, and the more significant

increase in the chest width, when compared to the croup width at the rump, to increase in the chest-pelvic index.

Generally, the animals retain the proportions which are typical for the dairy

Table 3. Body construction indexes of cows from the Bulgarian Rhodope Cattle Breed

Index	2020 X±Sx	RCAHA	
		2009	2020
		X±Sx	X±Sx
For head size	32,06±0,14	32,70±0,16	31,87±0,15
For forehead width	48,86±0,25	47,76±0,47	48,83±0,37
For leg length	43,29±0,21	35,17±0,61	43,38±0,19
For body extension	119,22±0,41	121,14±0,68	118,76±0,52
For build	104,26±0,21	104,32±0,25	105,45±0,29
For massiveness	143,09±0,44	146,57±0,74	144,07±0,55
For bones development	14,03±0,06	14,14±0,08	13,98±0,10
For compactness	120,23±0,51	121,22±0,74	121,46±0,64
Chest	58,43±0,36	56,03±0,65	58,84±0,46
Pelvic-chest	86,48±0,66	80,19±0,93	85,94±0,98
For croup sharpness	384,16±4,24	286,34±4,05	424,92±4,43

breeds - the body depth is bigger than the width (71,3% more with reference to the chest), and the body gets wider from the chest towards the croup, and the croup width at the rump is 16,1% bigger than that of the chest.

The exterior of the animals changes with the age. The size changes more considerably during the period of growth and development, the croup proportions - upon sexual maturity of the animals, and the udders of the heifers - during the last months of the pregnancy and after birth.

It is obvious from the exterior profiles presented in fig. 1-4 that the growth of the Bulgarian Rhodope Cattle breed continues until their fourth year, however, the different parameters change with a different intensity. There is an increase in the body length, most of the body heights as well as in the chest and croup parameters (table 4). The udder values are more constant.

At 2 years old, the animals have wither height of averagely 118,9±1,77 cm, and at 4 years old it is 122,2± 3,37 cm (fig. 1). The change in all heights is similar during this period with an increase of 2,29% for the sacrum height and up to 3,72% for the rump height.

Although the difference is negligible, the values of the height of the older animals are lower than those of the four-year-old ones. This may be partially explained by the relative drooping of the back line which forms as the animal grows older, however, the disproportional and divergent dynamics is more likely to be connected to the individual properties of the animals measured.

Generational differences are excluded as an explanation since the variations of the exterior measurements taken at four and seven years fall within the statistical error possibility.



Table 4. Influence of the age on the exterior measurements of cows from the Bulgarian Rhodope Cattle breed, (F- criteria and degree of reliability)

Measurement	F	Measurement	F
Head measurements		Chest measurements	
Length	0,342	Length	2,338*
Biggest width	1,436	Width	1,287
Smallest width	3,364**	Depth	1,756*
Forehead length	0,574	Girth	2,258*
Face length	1,037		
Body heights		Udder measurements, teats	
At the wither	1,818*	Length of front	2,045*
At the back	1,292	Length of rear	1,578
At the lumbar	2,033*	Space between front	1,582
At the sacrum	2,268*	Space between rear	1,912*
At the tail base	2,468*	Space between front and rear	1,526
At the rump	1,324	Diameter front	0,981
		Diameter rear	1,235
Croup measurements		Other measurements	
Length		Athwart body length	2,779**
Width of croup behind hips	3,364**	Straight body length	2,729**
Width at hip joints	1,019	Cannon bone girth	1,088
Width at rump	2,396*		

**P<0,01; *P<0,05;

The body length alters more significantly at the age from 2 to 4 years when the athwart body length increases by 5,54% (P<0,01) - from 138,3±5,31 to 146,1±1,37 (fig. 2). The body becomes deeper and wider which is noticeable from the chest and croup parameters. The chest girth increases from 167,6±3,21 to 175,0±6,67 cm (fig. 2) - a 4,65% (P<0,05) rise.

The chest develops relatively proportionally (fig. 3, 4). From the age of two to four years, the length increases with 5,38% (P<0,05) which is similar to the

change in the athwart body length. The depth alteration is the least noticeable - 2,82% (fig. 3). The width climbs with 7,24% (fig.4) but no significantly reliable change of the parameter is reported.

The values of the croup length and its width at the rump are less affected by the age - respectively 5,41% and 5,12% (P<0,05) when compared to the width at the croup behind hips - 8,78% (P<0,01), however, no reliable differences in the width at the hip joints are reported despite the considerable alteration of 10,2%.

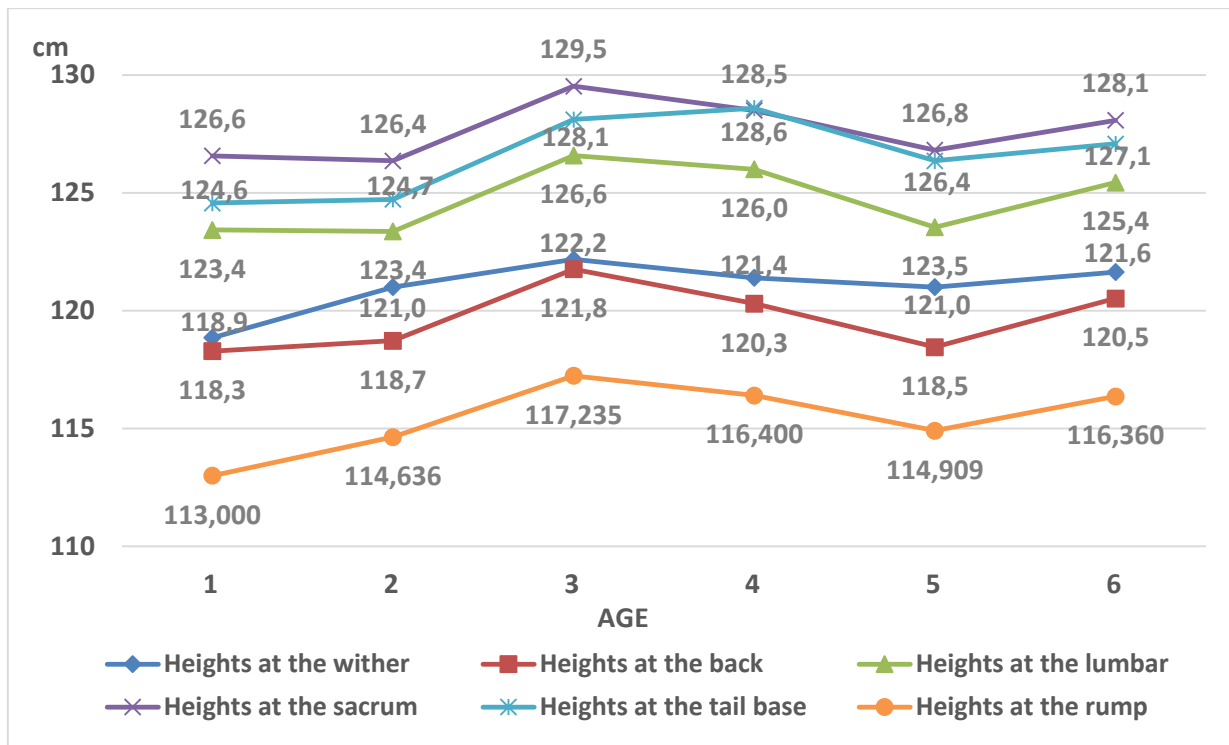


Figure 1. Body heights of Bulgarian Rhodope Cattle Breed cows at different age

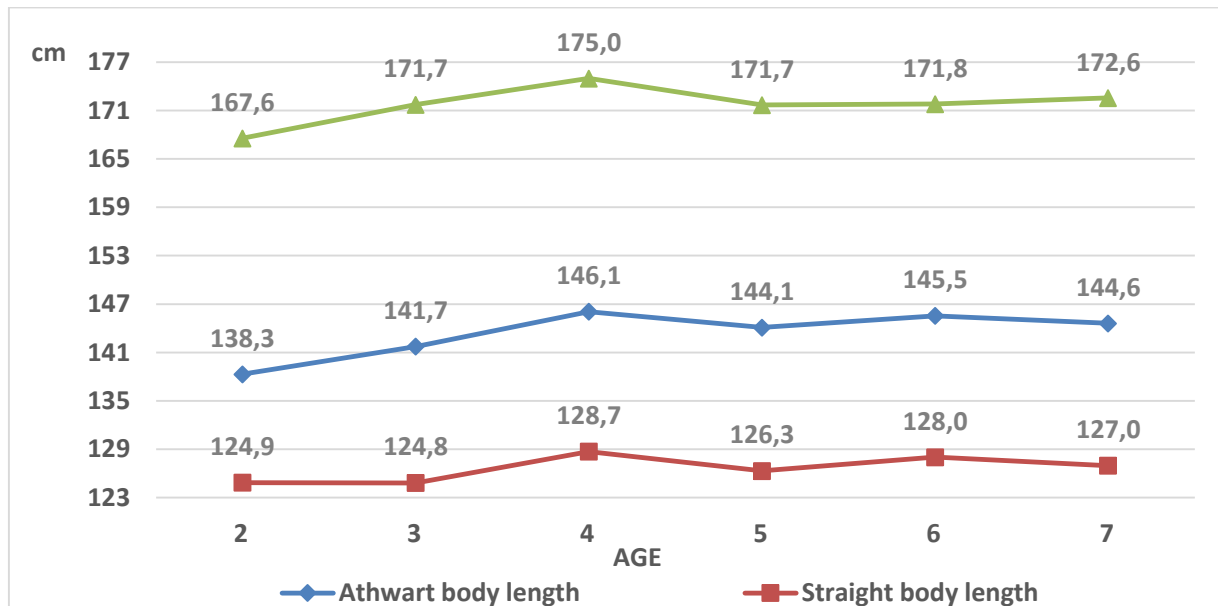


Figure 2. Athwart and straight body length and chest girth of Bulgarian Rhodope Cattle Breed



cows at different age

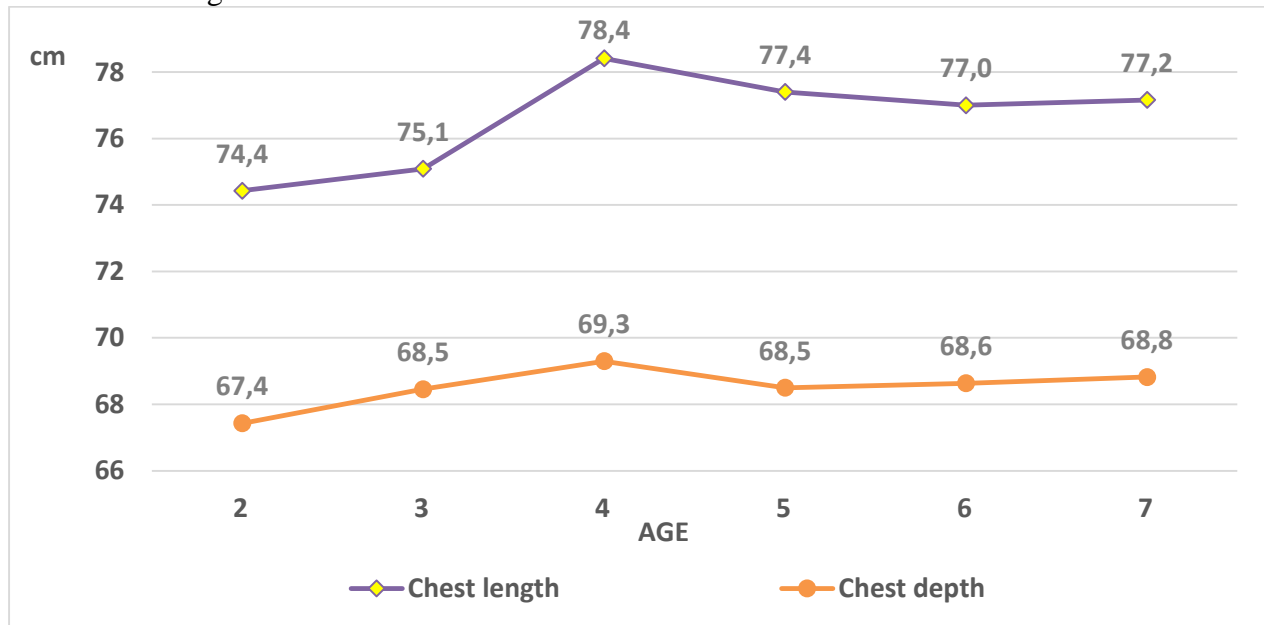


Figure 3. Chest depth and length of Bulgarian Rhodope Cattle Breed cows at different age

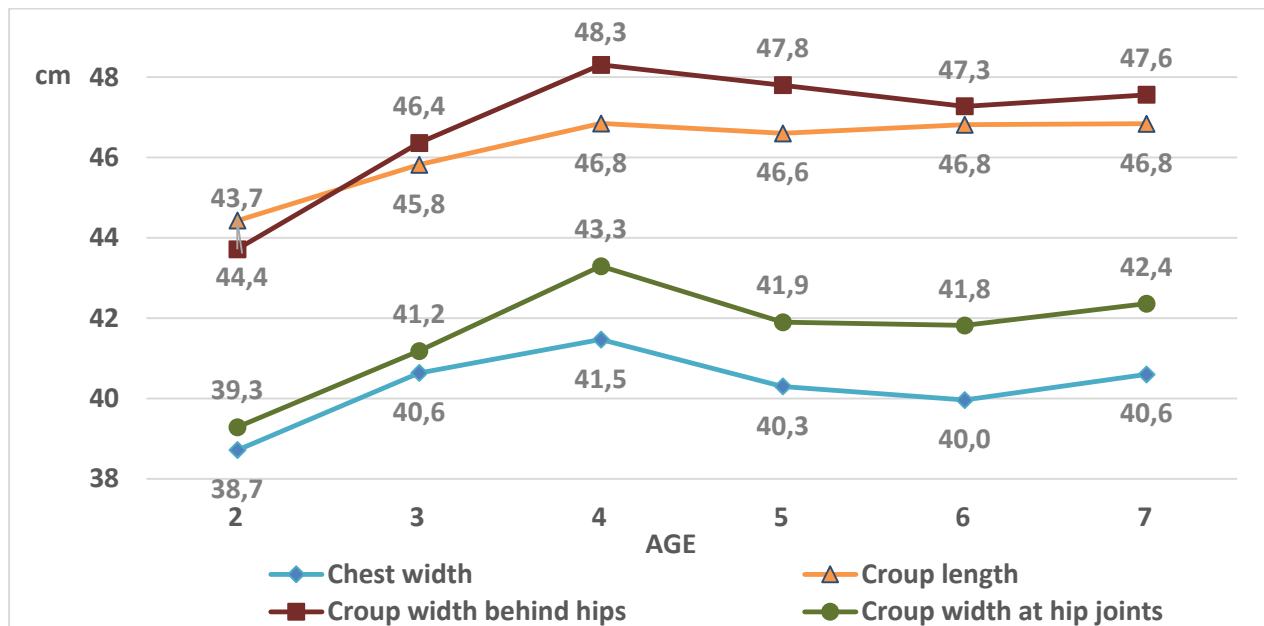


Figure 4. Croup and chest parameters of cows of the Bulgarian Rhodope Cattle Breed at different age



This is explained by the high individual variation of the trait when compared with the other pelvic parameters (table 1). The increase in the width of the croup behind hips and the hip joints is more significant between the age of 3 and 4 years, while the length increases steadily until 4 years old.

The chest width and the width of the croup at the hip joints have close absolute

values and follow a similar developmental trend.

The average cannon bone girth value is 17,07 cm and the variation is in a very small extent $\sigma = \pm 0,98$. This parameter changes slightly after the age of 2 years and its increase until reaching 4 years is 1,58% (fig. 5).

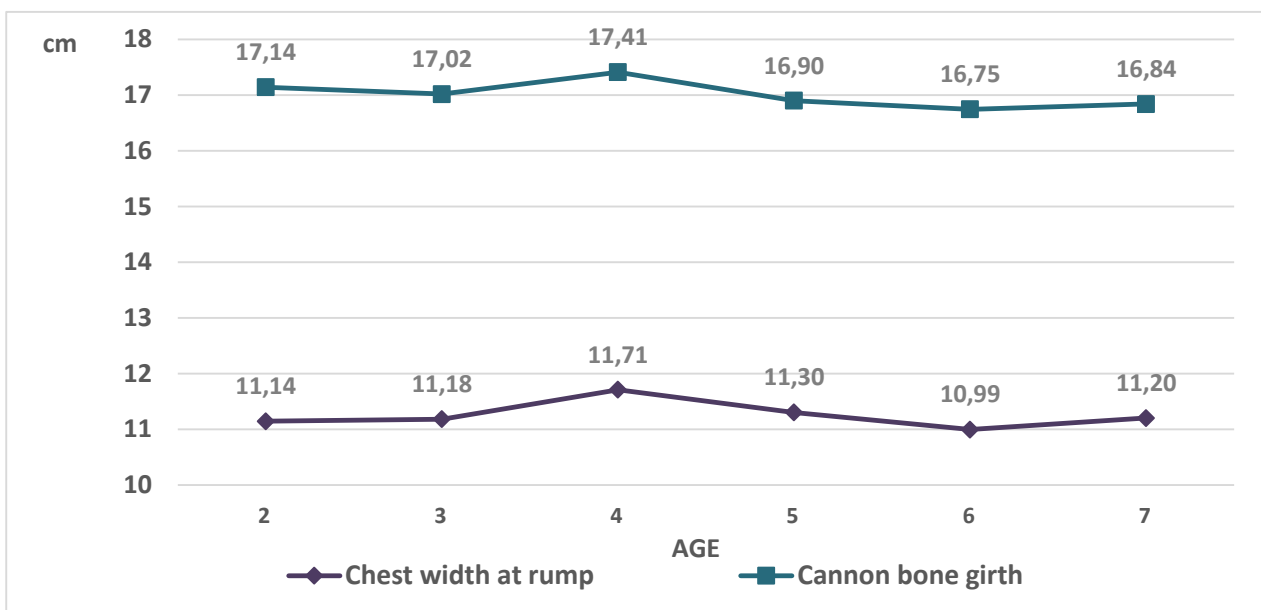


Figure 5. Exterior profile of the cannon bone girth and the croup width at the rump of cows of the Bulgarian Rhodope Cattle Breed at different age

CONCLUSIONS

The main exterior parameters - wither height, athwart body length, chest and cannon bone girth increase until the fourth year of the animals reaching average values of respectively $121,7 \pm 3,40$ cm, $145,1 \pm 0,90$ cm, $173,3 \pm 0,74$ cm and $17,07 \pm 0,09$ cm.

The heifers are fully developed at 2 years old and reach 97,3%, 94,7%, 95,8% and

98,4% of the adult cows' parameters listed above.

The cows are moderately built and have proportions which are specific for the dairy cattle - the body depth is bigger than the width (it is 71,3% bigger at the chest), the body widens from the chest to the croup and the width of the croup at rump is 16,1% bigger than that of the chest.

The enlargement tendency which is



typical for the milk breeds is not observed with reference to the Bulgarian Rhodope Cattle breed whose main exterior parameters are similar to those upon creation of the breed. In the last decade there has been a certain trend for increase of the body heights but judging by the dynamics of the other basic parameters—chest girth (-4,11cm), cannon bone girth (-0,05 cm) and the athwart body length (-2,17 cm) it cannot be claimed that there has been an enlargement of the animals.

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