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Study on growth and development of horses from East Bulgarian breed

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Abstract

This study investigated the growth and development of a warmblood sport horses from the East Bulgarian breed, recognized 73 years ago. The study was conducted in the state stud "Kabiuk", Bulgaria. Body measurements were analyzed for 427 foals at age 6 month, one, two, three, and seven years over a 30-year period (1993-2023). Eight body measurements were evaluated, including height at withers, body length, chest girth, and cannon girth. The research aimed to examine the exterior characteristics of modern East Bulgarian horses and assess the influence of sire lineage and family affiliation on these traits. Results showed that by the age of 3 years, the main body measurements were almost identical to those of completely grown animals. The most significant growth occurred between 6 months and 1 year of age, with height at withers increasing by 22.38 cm (16.50% growth intensity). The progeny from the Ladykiller and Gagne Si Peu sire lines demonstrated above-average performance for the four main indicators. Family affiliation analysis revealed that only descendants of Longuza and Likuyushta families had above-average values for height at withers. The tallest horses were offspring of Limnos stallion, followed by Zemen and Calido I. The study provides insights into the growth patterns and genetic influences on conformation in the Eastbulgarian breed, offering valuable information for strategic breeding planning and selection to optimize genetic characteristics. These findings contribute to the ongoing improvement of sport characteristics of the East Bulgarian horse, supporting its prominence in various equestrian disciplines in Bulgaria.

Keywords: equine growth, conformation traits, body measurements, equestrian sport genetics, morphometric analysis, East Bulgarian horse, sire line influence.

INTRODUCTION

The question of exterior and constitution of horses is essential not only for breed selection, but also for their productivity and adaptability to different work and sport-related conditions. The variation in the exterior characteristics of different breeds reflects not only evolutionary processes, but also the human efforts in genetically improving specific traits in horses. Exterior and constitution are not only the key to the individual evaluation of horses, but also to the development of breeds as a whole.

The research by Takaendengan et al. (2008) on morphometric characteristics of the Minahasa breed, highlights the importance of a

scientific approach to animal breeding. At the same time, research and publications by various authors such as Komosa & Purzyc (2009), Dolis et al. (2011), Barzev (2011), Schacht (2011), Higgins & Martin (2012), Oravcová et al. (2013), Kost'uková et al. (2013) highlight the necessity of continuing study and analysis of the exterior, to ensure optimal performance and health of horses. In all breeding programs, including equine breeding, a great attention is paid to the exterior in relation to the search for optimal selection criteria (Presinger et al., 1991; Vassilev & Sabeva, 1996; Zhelyazkov et al., 2002; Sabeva & Kaschiev, 2010; Zapryanova, 2014).

The East Bulgarian horse is a Bulgarian (EBB) warmblood breed intended for sport activities, with an established genealogical structure that was recognized 73 years ago. Until the early 1990s, performance evaluation was carried out only during horse racing and steeplechase. In the last three decades selection has been directed towards producing elite horses for the disciplines of equestrian sport. Even today the sport characteristics of the breed continue to improve, as evidence by the fact that the East Bulgarian horse is currently one of the most widely used breeds in Bulgaria across various equestrian disciplines (Sabeva & Popova, 2020). The aim of the present study is to investigate the exterior in modern representatives of the East Bulgarian horse breed and to examine the effect of sire lineal and family affiliation on it.

MATERIALS AND METHODS

To study the growth and development of foals at different ages were used records for body measurements of horses collected at the state stud "Kabiuk", near the town of Shumen; data provided by the "East Bulgarian Horse" Association covering a 30-year period (1993 - 2023), as well as data from own measurements. Eight body measurements were taken and records for 427 healthy foals of the East Bulgarian horse breed at the age of 6 months, one, two, three and seven years were analysed. According to the breeding program of the East Bulgarian breed (Sabeva & Popova, 2020), measurements of horses older than 7 years were not included. Animals were measured on flat terrain, while observing all requirements during body measurement procedure. The following body measurements were taken: Height at withers - along the vertical line from the ground to the highest point of the withers; Height of

back - along the vertical line from the ground to the lowest part of the back; Height of croup - along the vertical line from the ground to the highest part of the croup; Body length - from the top of the shoulder joint to the top of the ischium; Width of chest - the narrowest part of the chest behind the shoulder; Depth of chest - The vertical line from the lowest part of the sternum to the highest part of the withers; Chest girth - the circumference of the chest along the vertical line behind the shoulder blade; Cannon girth - the circumference of the anterior left cannon bone at the thinnest part. The following instruments were used to take the body measurements of the animals: Stock of Lidtin - for measuring the heights and greater lengths, depths and widths of the horses; measuring tape - for measuring girths.

Statistical processing was done in Excel.

RESULTS AND DISCUSSION

The traits and characteristics of individuals are genetically determined. For successful breeding of animals which resulted in desired type and productivity, it is necessary to know the main principles of individual development and to use them in commercial production conditions. Knowledge of the peculiarities of growth during particular age periods makes possible some changes in body proportions and their development through specific feeding and rearing conditions (Borisenko et al., 1984).

In the horses of the studied breed, the main linear dimensions - height at the withers, length of the body and cannon girth in horses at the age of 3 years are almost identical to those of completely grown animals (Table 1).

At 6 months of age, the height at the withers of horses of the East Bulgarian breed reaches 82.24%.

Table 1. Dynamics of body measurements in horses of the East Bulgarian horse breed up to seven years of age (LSM±SD).

Measurements	Age				
	6 months	1 year	2 years	3 years	7 years
	N=64	N=205	N=205	N=194	N=47
Height at withers	135.61 ±3.87	157.99 ±4.56	157.99 ±4.56	161.17 ±4.02	164.89 ±4.21
Height of back	131.58 ±4.12	151.10 ±4.62	150.61 ±8.57	153.66 ±4.75	156.15 ±3.81
Height of rump	138.13 ±4.39	159.08 ±4.44	159.08 ±4.44	161.13 ±3.86	162.83 ±4.06
Body length	126.22 ±5.28	156.53 ±6.36	155.80 ±11.78	161.21 ±6.12	167.23 ±6.62
Depth of chest	54.78 ±2.92	68.45 ±3.78	68.45 ±3.78	71.54 ±3.81	74.60 ±3.09
Width of chest	29.58 ±2.42	38.03 ±3.39	38.03 ±3.39	40.66 ±3.21	43.53 ±3.68
Chest girth	137.20 ±5.97	172.93 ±7.71	172.92 ±7.72	180.06 ±6.54	189.28 ±7.26
Cannon girth	17.02 ±0.76	20.01 ±0.87	20.01 ±0.87	20.35 ±0.89	20.78 ±0.86

From 6 months to 1 year of age horses of the East Bulgarian breed, the growth is intensive, and the height at the withers increased by 22.38 cm, and the intensity of growth is estimated at 16.50%. During the same period, the height at the back grew to a lesser extent, compared to the height at the withers - by 19.52 cm, and the intensity of growth was 14.84%. The height at the withers changes accordingly, increasing by 20.95 cm, and the intensity of growth is intermediate between that of the withers and the back – 15.17%.

Sabeva & Kaschiev (2010) reported that the arithmetic means, standard deviations and coefficients of variation of the four main body dimensions of East Bulgarian horses in the last two generations were as follows: at 2 years of age - height at withers reached 156.62 cm, body length was 153.79 cm, chest girth – 176.79 cm and cannon girth 19.83 cm. At the age of three years the same body parameters were 161.48, 159.28, 186.28 and 20.38 cm, respectively.

The present study shows that over the past 13 years, height at the withers, length of body at

the withers, and girth at the withers of 2-year-old horses have increased by approximately 2 cm, while the values for girth at the chest has decreased. The measurements of the 3-year-old horses were relatively the same, except for the length of the body, which increased by 2 cm, and the chest girth decreased by 6 cm.

The length of the body between 6 months and 1 year of age of the East Bulgarian breed increased by 30.31 cm, and the intensity of growth was 24.01%, respectively. The more intensive growth in length, compared to height, is typical for post-embryonic ontogenesis in herbivores.

During the same period the change in body dimensions is even more pronounced and it is determined mainly by the growth of flat bones. Chest depth increased by 13.67 cm, and the intensity of growth was 24.85%. The width of the chest increases less in absolute terms - 8.45 cm, but more intensively than the depth of the chest, with a relative increase of 28.57%. At this age, the animal's chest parameters are about 90% of those at 7 years' age.

As a result of the intensive increase in depth and width, the volume of the chest also increases, as between 6 months and 1 year of age, the horse's chest girth increases by 35.73 cm, and the intensity of growth is 26.04%. Overall, at 6 months of age, chest girth of the East Bulgarian horses was 72.45%. The girth of the cannon increased by 2.99 cm, and the intensity of growth was similar to the change in heights - 17.57%. In a preliminary study about the influence of some factors, such as sire line, family, year of birth, owner, mother's line and gender, on growth, only gender had a statistically significant influence and it was limited to the index cannon girth in 1-year-old foals ($p \leq 0.001$) and at 2 years of age ($p \leq 0.05$).

After 1 year of age, the growth intensity gradually decreases. From 1 to 3 years of age, the most significant trend is the increase in the parameters such as chest girth, length of the body, followed by the height, width and depth of the chest. The depth and width of the chest have increased almost equally. The cannon girth grows slowly in the period from 1 to 3 years of age. According to heights, the growth at the withers is mostly preserved, while the heights of the withers and the back grown almost equally.

At age of 3 years' horses of the East Bulgarian breed, have parameters height at the withers, body length, chest girth, and cannon girth which reached 97.74%, 96.40%, 95.13%, and 97.93%, respectively, of those at age of 5 years.

An evaluation of the effect of the sire line and family affiliation, with completed growth, on the four main body measurements of horses of the Eastbulgarian horse breed, is presented in Table 2. The results of the present study show that the progeny of stallions from the Ladykiller and Gagne Si Peu lines have performance above the average values for the four main indicators, and those from the Tihany and Cottage Son lines have negative constants only for the cannon girth indicators and chest girth respectively. The descendants of Zenger and Alme Z have a constant above the average only for the height at the withers indicator, Ramzes – for the oblique length of the body, and the descendants of Cor de la Bryere have constants above the average for the height at the withers and length of the body. Regarding the family affiliation of the fathers, only the descendants of Longuza and Likuyushta have values above the average height at the withers for the trait. All other families have negative constants for this trait. The descendants of the families of Longuza, Malta and Nerazdelna have negative constants for the cannon girth indicator, while the rest of the families have positive constants, but close to the average value. The descendants of the Linia, Likuyushta, Malta and Unfamiliar families have values above the average for body length, chest girth and cannon girth, and the Malta descendants exceed all families in chest girth.

Table 2. Evaluation of the effect of sire line and family affiliation on the height at the withers, body length, chest girth and cannon girth at full growth of horses from EBB.

Sire's line	n	withers		Sire's family	n	withers	
		LS ± SE	SD			LS ± SE	SD
Tihani	4	165.08±2.71	1.08	Linia	2	163.37±3.44	-0.63
Zenger	3	166.65±3.98	2.66	Longuza	4	167.50±2.58	3.50
stallions of Arabian origin	2	158.16±3.27	-5.84	Likuyushta	7	165.95±2.07	1.95
Gagne Si Peu	2	165.76±3.22	1.76	Leyla	5	163.79±1.94	-0.21
AdeptusXX	2	156.70±3.60	-7.30	Malta	2	163.35±2.97	-0.65
Ramzes	3	163.06±3.65	-0.94	Nerazdelna	6	162.08±2.09	-1.92
Alme Z	4	164.76±2.45	0.76	Ohota	9	162.52±1.61	-1.48
Cor de la Bryere	2	164.19±3.16	0.19	Unfamiliar	12	163.43±1.70	-0.57

Cottage Son	5	166.43±2.64	2.44				
Ladykiller	19	164.77±1.44	0.77				
μ ± SE	46	163.56±1.08		μ ± SE	47	164.00±0.64	
Sire's line	n	Body lenght		Sire's family	n	Body lenght	
		LS ± SE	SD			LS ± SE	SD
Tihani	4	170.74±4.51	5.44	Linia	2	168.85±5.73	3.55
Zenger	3	158.44±6.62	-6.86	Longuza	4	163.94±4.29	-1.36
Arabian origin	2	161.51±5.45	-3.79	Likuyushta	7	165.98±3.44	0.67
Gagne Si Peu	2	167.21±5.35	1.91	Leyla	5	161.54±3.22	-3.76
AdeptusXX	2	149.38±5.99	-15.92	Malta	2	168.21±4.95	2.91
Ramzes	3	167.85±6.08	2.55	Nerazdelna	6	162.87±3.48	-2.43
Alme Z	4	160.78±4.07	-4.52	Ohota	9	163.73±2.69	-1.57
Cor de la Bryere	2	171.77±5.26	6.47	Unfamiliar	12	167.29±2.83	1.99
Cottage Son	5	171.57±4.40	6.27				
Ladykiller	19	167.50±2.40	2.20				
Gagne Si Peu	2	167.21±5.35	1.91				
μ ± SE	46	164.39±2.50		μ ± SE	47	165.30±0.94	
Sire's line	n	Chest girth		Sire's family	n	Chest girth	
		LS ± SE	SD			LS ± SE	SD
Tihani	4	194.27±4.56	7.73	Linia	2	189.47±5.79	2.91
Zenger	3	178.57±6.69	-7.99	Longuza	4	181.40±4.34	-5.17
Arabian origin	2	177.86±5.51	-8.68	Likuyushta	7	189.17±3.47	2.61
Gagne Si Peu	2	195.86±5.41	9.30	Leyla	5	188.07±3.25	1.51
AdeptusXX	2	175.01±6.05	-11.55	Malta	2	190.73±5.00	4.17
Ramzes	3	185.92±6.14	-0.64	Nerazdelna	6	182.98±3.51	-3.58
Alme Z	4	183.39±4.11	-3.17	Ohota	9	182.08±2.71	-4.48
Cor de la Bryere	2	183.95±5.31	-2.62	Unfamiliar	12	188.59±2.86	2.03
Cottage Son	5	185.50±4.44	-1.06				
Ladykiller	19	191.74±2.42	5.18				
μ ± SE	46	185.21±2.23		μ ± SE	47	186.56±1.33	
Sire's line	n	Cannon girth		Sire's family	n	Cannon girth	
		LS ± SE	SD			LS ± SE	SD
Tihani	4	20.14 ±0.65	-0.23	Linia	2	20.65 ±0.83	0.28
Zenger	3	19.47 ±0.96	-0.90	Longuza	4	20.35 ±0.62	-0.02
Arabian origin	2	20.37 ±0.79	0.01	Likuyushta	7	21.03 ±0.50	0.66
Gagne Si Peu	2	21.12 ±0.77	0.75	Leyla	5	20.99 ±0.46	0.62
Adeptus XX	2	18.96 ±0.86	-1.41	Malta	2	19.69 ±0.71	-0.68
Ramzes	3	20.34 ±0.88	-0.02	Nerazdelna	6	19.35 ±0.50	-1.02
Alme Z	4	20.07 ±0.59	-0.30	Ohota	9	20.44 ±0.39	0.07
Cor de la Bryere	2	20.05 ±0.76	-0.32	Unfamiliar	12	20.44 ±0.41	0.08
Cottage Son	5	21.65 ±0.63	1.282				
Ladykiller	19	21.06 ±0.35	0.70				
μ ± SE	46	20.32 ±0.25		μ ± SE	47	20.37±0.21	

In Figure 1 can be seen that the tallest are the offspring of the stallion Limnos (GER) – 164.89 cm, followed by Zemen (164.36cm) and Calido I (GER) (164.34cm), Don Primero (CH), Cardinal Lamberto, Apokalipsis (GER), Quitano (GER) and Shagia Burla. The offspring of the stallions Sakri, Tarzan II, Aramis and Rascalino have an average height at the withers– 164.00 cm. The horses with the lowest value of the trait height at the withers are the descendants of the stallion Count Grannus (GER) – 163.65 cm.

With the most elongated body (Figure 2) are the offspring of the stallion Limnos (GER) – 166.24 cm, followed by Quitano (GER) – 165.92 cm, Lord Loxley (GER) – 165.85 cm, Apokalipsis (GER) -165.74 cm, Calido I (GER), and Don Primero (CH). The offspring of the stallions Sakri, Tarzan II, Aramis (GER) and Rascalino (GER) have a body length average for the breed – 165.30 cm. The shortest body have the offspring of the stallion Aligator (Aragon) – 164.25 cm, followed by Loran (GER) – 164.61 cm, Cohinoor (GER) – 164.69 cm, Lamar (GER), Count Grannus (GER), Calato (GER) and Alegro.

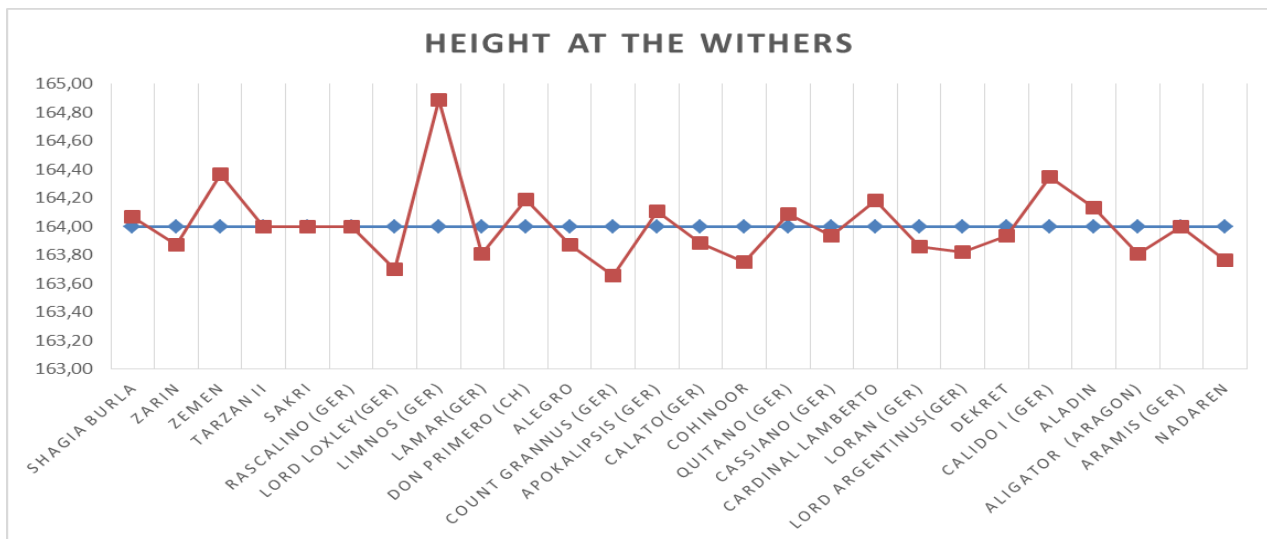


Figure 1. Dynamics of height at the withers in horses of the East Bulgarian horse breed by sires and their deviation from LSM.

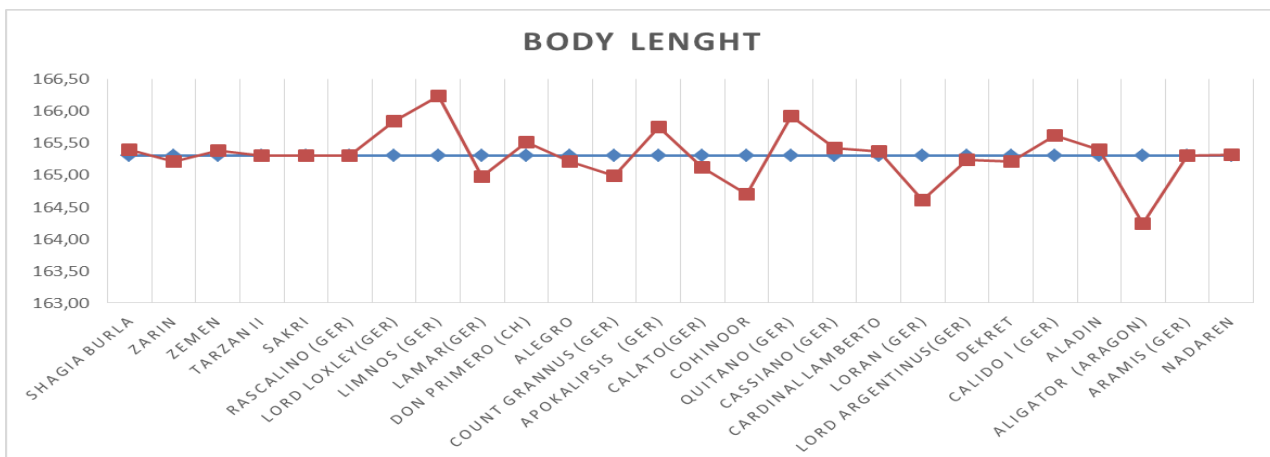


Figure 2. Body length of horses of the East Bulgarian horse breed by sires and their deviation from LSM.

The most massive (Figure 3) and superior in terms of chest girth are the offspring of the stallion Limnos (GER) – 187.96 cm, followed by Lord Loxley (GER) – 187.34 cm, Shagia Burla – 187.18 cm, Calido I (GER) – 187.17 cm, Quitano (GER) – 187.14 cm, Alegro and Zarin, Apokalipsis (GER), Don Primero (CH) and Calato (GER). With the smallest girth of the chest are the offsprings of the stallion Lamar (GER) - 185.21, followed by Cohinoor, Aligator (Aragon), Count Grannus (GER) and Dekret, Nadaren, Aladin and Loran. The horses sired by

the stallions Zemen, Tarzan II, Sakri, Rascalino (GER), Cassiano (GER), Cardinal Lamberto, Lord Argentinus (GER), and Aramis have an average breed value for this indicator of 186.56 cm.

The best-developed bone system (Figure 4) is found in offspring of the stallion Apokalipsis (GER) – 20.47 cm, followed by those of Lord Loxley (GER) and Calido I (GER) – 20.44 cm, Don Primero, Calato (GER), Alegro, Zarin, Limnos (GER) – 20.41 cm, as well as Lord Argentinus (GER) and Zemen.

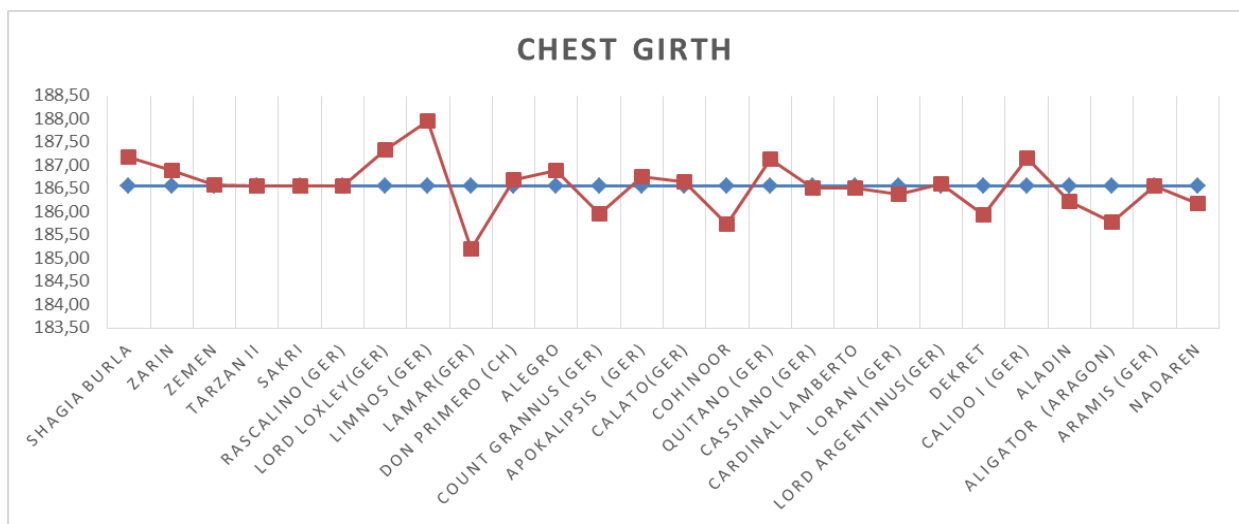


Figure 3. Chest girth in horses of the East Bulgarian horse breed by sires and their deviation from LSM.

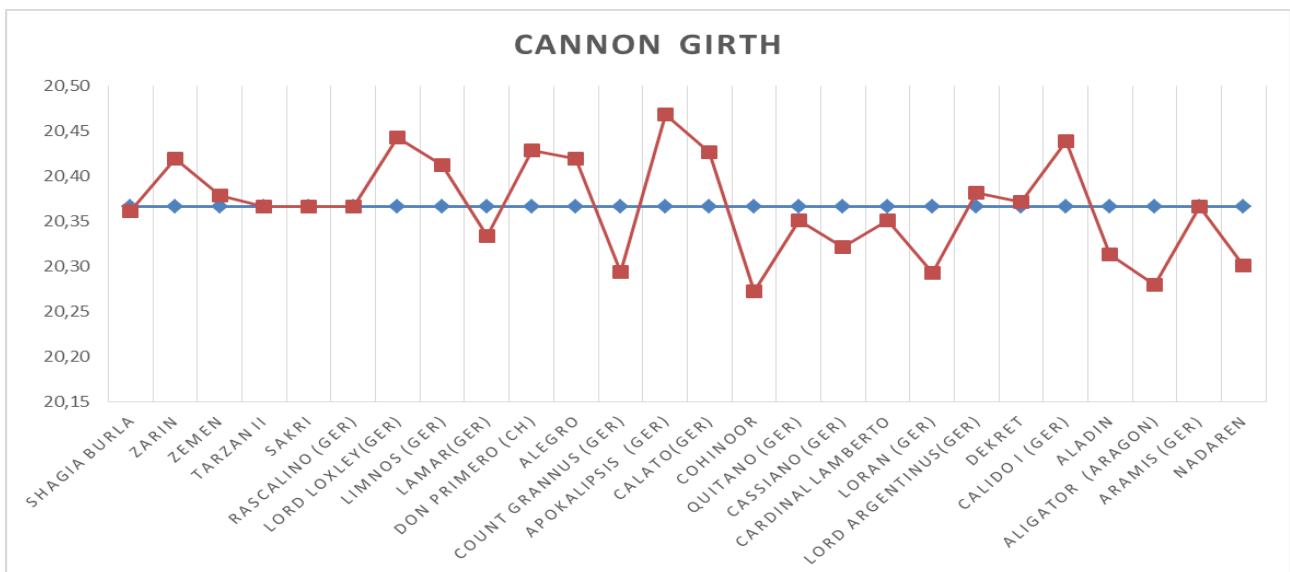


Figure 4. Cannon girth in horses of the East Bulgarian breed by sire and their deviation from LSM.

The most delicate bone system is observed in offsprings of the Cohinoor stallion - 20.27 cm, followed by Aligator (Aragon) - 20.28 cm, Count Grannus (GER) and Loran (GER) - 20.29 cm, as well as Nadaren, Aladin, Cassiano (GER), Lamar (GER), Quitano (GER) and Cardinal Lamberto. The offspring of the stallions Tarzan II, Sakri, Rascalino (GER), and Aramis (GER) have an average breed value for cannon girth of 20.37 cm.

CONCLUSIONS

Horses from the East Bulgarian breed develop well and, by the age of three, reach almost the maximum values of the main exterior parameters. Progeny from stallions of famous lines such as Ladykiller and Gagne Si Peu exhibit above-average productivity in the main four indicators: height at withers, body length, chest girth, cannon girth. Regarding the paternal lineage, only the descendants of Longuza and Likuyushta have values above the average height at the withers for this trait. The tallest offspring are those of the stallion Limnos (GER), followed by Zemen and Calido I (GER). The most elongated offspring are sired by Limnos (GER), followed by Quitano (GER), Lord Loxley (GER), Apokalipsis (GER) and Calido I (GER). The most massive offspring also come from Limnos (GER), followed by Lord Loxley (GER), Shagia Burla, Calido I (GER). The obtained results provide an opportunity for strategic planning in breeding and selection to optimize the genetic characteristics of the breed.

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