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Phenotypic variability and characterization of the body conformation of Brazilian Sport Horse, Breton Postier and Brazilian Donkey equine breeds

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ABSTRACT

This study aimed to characterize morphologically equines of the Brazilian Sport Horse (BSH), Breton Postier (BP) and Brazilian Donkey (BD) breeds, in order to discriminate morphological patterns within and between herds, classifying horses according to body indices. Hipometer, ruler angles and tape measure were used to register linear and angular body measurements in the animals. It was identified evidence of different morphological patterns (P<0,05) between and within the evaluated breeds. The animals of the BSH breed were mostly classified as mediolineus shape, the BD breed as longilineus, and BP breed as brevilineus shape.

Keywords : equines, measures, body measurements, morphology

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I. INTRODUCTION

Of the world's equine population, 57% are located in America, with the Brazilian population stated as the fourth largest in the world, estimated at around 7,986,023 heads (FAO, 2010). Although businesses involving the breeding and service of equines represent a prominent position in the national scope, since mobilizes annually high values of money and generates millions of direct and indirect jobs in Brazil, the resemblance of horse production is still distorted and biased, demanding acknowledgement of the importance of the equideoculture chain (ESALQ, 2006).

The identification of variability in body shape characteristics, as well as the identification of which of these characteristics are more favourable to sport performances and for policing horses, besides generating technical support for the choice of horses suitable for sport and policing, are also intended to generate subsidies for the structuring of a breeding program for equines.

In a breeding system of equine of pure breeds, such as the herd of the Polo Regional da Alta Mogiana, Colina, SP, Brazil, which harbors pure herds of Brazilian Sport Horse (BSH), Breton Postier (BP) and Brazilian Donkey (BD), the morphological characterization of these breeds could allow to discriminate morphological patterns within and between the herds, thus identifying the degree of phenotypic variability and comparing the suitability of the evaluated animals in relation to the existing breeding patterns (KOMOSA et al., 2013).

The general objective was to characterize morphologically equines from the Brazilian Sport Horse, Breton Postier and Brazilian Donkey breeds, belonging to the flock of the Polo Regional da Alta Mogiana, and, specifically, aimed to discriminate morphological patterns within and between the breeds, classifying the equines according to their indexes.

II. MATERIALS AND METHODS

The evaluations were carried out at the Polo Regional da Alta Mogiana Research Station, located in Colina, São Paulo State, Brazil.

Body measurements were collected on 204 equines. Of these, 158 were of the Brazilian Sport Horse Breed, 20 Breton Postier breed, 22 Brazilian Donkey breed. Overall, 380 body measurements were collected at the ages: at birth, weakly for the first month of age, monthly until the sixth month of age, and then with 12, 24, 30 and 36 or more months of age.

The linear and angular measures, relevant in the corresponding references, were collected according to previously used methodologies (CABRAL et al., 2004a; PINTO et al., 2005; GODOI et al., 2013), considering the following measures, with respective descriptions:

Height at the withers -the vertical distance from the highest point of the interscapular region, defined by the spinous processes of the 5th and 6th thoracic vertebra, to the ground;

Height at the rump - vertical distance from the highest point on the sacral tuberosity to the ground;

Distance olecranon-ground - the vertical distance from the tuberosity of the olecranon to the ground;

Neck length - the linear distance between the cranial portion of the lateral side of the atlas wing and the midpoint of the cranial border of the scapula;

Distance shoulder-fetlock - distance from the central area of the scapulohumeral joint to the middle third of the lateral face of the metacarpophalangeal joint of the thoracic limb;

Forearm length - distance from the central area of the humeroradial joint to the lateral third of the carpal joint;

Arm length - the distance between the outer tuberosity of the humerus and the tuberosity of the olecranon;

Front pastern length - distance from the lateral mid-third of the carpal joint to the middle third of the lateral side of the metacarpophalangeal joint of the thoracic limb;

Front cannon bone length- distance from the middle third of the lateral side of the metacarpophalangeal joint to the lateral aspect of the proximal interphalangeal joint of the left thoracic;

Leg length - distance from the medial-lateral point of the femorotibial to the lateral-medial third of the tarsal joint;

Rear cannon bone length - distance from the medial-lateral third of the tarsal joint to the middle third of the lateral aspect of the metatarsophalangeal joint of the pelvic limb;

Rear pastern length - distance from the middle third of the lateral side of the metatarsophalangeal joint to the lateral side of the proximal interphalangeal joint of the left pelvic limb;

Forearm perimeter - circumference measurement in the median region of the ulnar radius;

Carpal perimeter - a measure of circumference in the median region of the carpus;

Metacarpal perimeter - a measure of the circumference in the medial region of the metacarpal bones;

Thoracic perimeter - a measure of the circumference in the narrower portion of the thorax, caudally at the withers, in the dorsal portion of the last thoracic vertebrae and ventrally in the caudal third of the sternum;

Smaller trunk - the distance between the greater tuber of the humerus and the coxal tuber of the ileum;

Greater trunk - the distance between the greater tuber of the humerus and the ischiatic tuberosity;

Calcaneus height - distance from the distal prominence of the calcaneus to the ground;

The angular measurements considered are defined by the intersection of lines based on anatomical points, as described by Godoi et al. (2013):

Shoulder-arm angle - the caudal angle formed by the intersection of the line between the dorsal portion in the cartilage of the scapula and the central area of the scapulohumeral joint with the line between the central areas of the scapulohumeral and humeral-radial joints;

Humeral radial angle - the cranial angle formed by the intersection of the line between the central area of the scapulohumeral joint and the central area of the humeral radial joint with the line between the central area of the humeral radial joint and the lateral middle third of the carpal joint;

Metacarpophalangeal angle - cranial angle formed by the intersection of the line between the lateral middle third of the carpal joint and the point of the middle third of the lateral face of the metacarpophalangeal joint with the line between the point of the middle third of the lateral face

of the metacarpophalangeal joint and the lateral face of the proximal interphalangeal joint of the left thoracic;

Scapula-ground angle - the caudal angle formed by the intersection of the line between the dorsal portion in the cartilage of the scapula and the central area of the scapulohumeral joint with the line of the horizontal plane;

Coxal-ground angle - the cranial angle formed by the intersection of the line between the ventral midpoint of the lateral face of the coxal tuberosity and the medial region of the major trochanter of the femur, in the coxo-femoral joint with the horizontal plane;

Coxo-femoral angle - the cranial angle formed by the intersection of the line between the coxal tuberosity and the coxo-femoral joint with the line between the coxo-femoral joint and the femorotibial joint;

Femoral-tibial angle - the caudal angle formed by the intersection of the line between the coxo-femoral joint and the femorotibial joint with the line between the femorotibial and tarsal joints;

Tibial-metatarsal angle - the cranial angle formed by the intersection of the line between the femoral-tibial joint and the tarsal joint and the line between the tarsal and metatarsophalangeal joints;

Metatarsophalangeal angle - the cranial angle formed by the intersection of the line between the tarsal and metatarsophalangeal joints and the line between the metatarsophalangeal and proximal interphalangeal joints.

Measurements of mass (body weight) were obtained using equine weighing tape, linear measurements using a hypometer and a tape measure, and angular measurements using an arthrometer.

After the collection of the body measurements, the indexes were estimated in order to compare the relationships between the measures of length, perimeter and mass, reported by Cabral et al. (2004b) and described below:

Body index - relates the length of the body to the thoracic perimeter, classifying the animals into longilineus, mediolineus and brevilineus, defined by the ratio between body length and thoracic perimeter;

Dactyl-thoracic index - relates the perimeter of the cannon bone to the thoracic perimeter and indicates the relation between the mass of an animal and the limbs that support it, classifying the animals as hypermetric (heavy horses), eumetric (average horses) and hypometric (light horses), being defined by the ratio between the perimeter of the metacarpal and the thoracic perimeter;

Cannon bone load index - relates the perimeter of the third metacarpal bone to the weight and indicates the ability of the limbs to displace the body mass, defined by the ratio between the perimeter of the metacarpus and the weight.

Analyzing the adequacy of various body shape indexes, Komosa et al. (2013) defined five indexes, which are described below:

Scapula index - the ratio between arm length (distance between the outer tuberosity of the humerus and the tuberosity of the olecranon) and height at the withers;

Lower trunk index - the ratio between the distance between the outer tuberosity of the humerus and the coxal tuberosity of the ileum and height at the withers;

Major trunk index - the ratio between the distance between the outer tuberosity of the humerus and the ischial tuberosity and the height at the withers;

Cannon bone index - the ratio between the perimeter of the metacarpal and the height at the withers;

Height to length index – the ratio between the height at the withers and the length of the body

III. STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The data were submitted to data consistency and descriptive statistics were elaborated. The body measurements were compared by means of the T-test, considering significant differences if $P < 0.05$.

IV. RESULTS

Table 1 presented linear and angular characteristics measured, indicating the existence of phenotypic variability in the measurements. The characteristic that presented the greatest variation was the body weight, which can be justified because it is a characteristic dependent on environmental conditions (seasonality, having in the dry period of the year a decrease in the supply of food (forage) and therefore a reduction in the weight of the animals). This fact does not occur so markedly with the other measures.

Among the equine breeds, the Breton Postier presented larger perimeters and smaller lengths comparing to the BSH breed. In general, as expected, the breed group that differed most in linear and angular measurements was the Brazilian Donkey, as it belongs to an asinine species, distinct from the equine species, to which the other breeds evaluated belong (Table 1).

Table 1. Mean, standard deviation and coefficient of variation of linear and angular measurements of adult equine of the Brazilian Sport Horse (BSH), Breton Postier (BP) and Brazilian Donkey (BD).

Characteristic	BSH	BP	BD
	mean±sd (CV)	mean±sd (CV)	mean±sd (CV)
Body Weight	431,4±74,1a (17,2)	466,6±98,0a (21,0)	209,0±35,1b (16,8)
Thoracic Perimeter	176,5±15,6a (8,8)	182,4±14,9a (8,2)	136,5±7,8b (5,7)
Smaller Trunk	148,0±12,7a (8,6)	145,8±10,4a (7,2)	123,5±8,1b (6,6)
Greater Trunk	110,0±5,8a (5,3)	108,7±7,9a (7,2)	91,5±5,5b (6,0)
Height At The Withers	156,1±8,4a (5,4)	146,7±7,5b (5,1)	118,1±4,4c (3,7)
Height At The Rump	156,4±7,6a (4,9)	148,1±5,6b (3,8)	123,9±4,0c (3,2)
Distance Olecranon-Ground	81,8±2,9a (3,5)	73,1±2,9b (4,0)	63,3±3,4c (5,3)
Leg Length	88,8±4,4a (4,9)	81,6±4,0b (4,9)	70,3±3,3c (4,7)
Calcaneus Height	59,0±2,4a (4,1)	55,4±1,7b (3,0)	44,2±3,3c (7,4)
Neck Length	68,9±5,3a (7,7)	60,0±4,6b (7,7)	51,1±3,6c (7,1)
Distance Shoulder-Fetlock	98,0±3,1a (3,2)	91,0±4,5b (4,9)	75,1±2,8c (3,7)
Arm Length	38,6±2,0a (5,2)	35,7±2,5b (6,9)	29,7±1,6c (5,2)
Forearm Length	40,1±2,7a (6,7)	39,3±2,8ab (7,1)	34,2±2,7b (7,8)
Front Cannon Bone Length	30,7±1,7a (5,4)	29,8±1,2a (4,0)	24,3±0,8b (3,4)
Front Pastern Length	12,1±1,0a (7,9)	10,0±1,8b (18,0)	7,7±0,9c (11,7)
Forearm Perimeter	36,7±2,5a (6,8)	37,8±4,3a (11,4)	29,6±2,3b (7,9)
Carpal Perimeter	32,9±1,6a (4,8)	35,6±3,1b (8,7)	26,7±1,0c (3,7)
Metacarpal Perimeter	20,5±0,9a (4,5)	23,9±3,2b (13,4)	16,0±0,7c (4,5)
Rear Cannon Bone Length	37,6±2,6a (6,9)	35,7±1,8a (5,0)	29,4±1,6b (5,5)
Rear Pastern Length	12,1±1,1a (9,2)	10,0±1,2b (12,2)	7,6±0,8c (10,6)
Shoulder-Arm Angle	60,8±4,9a (8,1)	60,4±3,5a (5,8)	61,0±4,9a (8,0)
Scapula-Ground Angle	94,5±5,9a (6,2)	95,6±4,5a (4,7)	96,1±7,6a (7,9)
Humeral Radial Angle	121,4±7,7a (6,4)	126,8±10,1a (8,0)	129,3±15,1a (11,7)
Coxal-Ground Angle	36,6±4,0a (10,9)	40,7±4,3ab (10,6)	41,5±7,5b (18,0)
Coxo-Femoral Angle	85,8±5,6b (6,5)	94,7±18,8ab (19,8)	90,5±8,8a (9,7)
Femoral-Tibial Angle	111,6±10,4a (9,3)	108,9±7,3a (6,7)	121,0±13,1a (10,8)
Tibial-Metatarsal Angle	147,8±7,7a (5,2)	150,0±6,8a (4,5)	149,2±4,0a (2,7)
Metacarpophalangeal Angle	145,1±6,4a (4,4)	140,6±6,9a (4,9)	143,0±6,5a (4,6)
Metatarsophalangeal Angle	153,9±5,7a (3,7)	154,1±7,7a (5,0)	151,5±7,2a (4,7)

Means in the same line, followed by different letters, differ by the Tukey test, at the 5% level of significance.

The variation in linear measurements according to age and to the breed is presented in Table 2. It was observed a continuous increase in the measurement values according to the age in the linear measurements: thoracic perimeter, body length, height at the withers and height at the rump, for the three breeds considered (Table 2). There was a tendency for greater variation in these measures, for each breed, during the first month of life, compared to the second and sixth months of life.

Table 2. Variation in linear measures according to age, for the Brazilian Sport Horse (BSH), Breton Postier (BP) and Brazilian Donkey (BD).

Breed	Age	TP (cm)	GT (cm)	HW (cm)	HR (cm)
		mean±sd (CV)	mean±sd (CV)	mean±sd (CV)	mean±sd (CV)
BH	at birth	80,4±5,4 (6,8)	70,2±4,5 (6,4)	99,1±4,7 (4,8)	101,6±5,0 (4,9)
	1 week	88,3±5,6 (6,4)	75,2±4,3 (5,7)	100,9±6,2 (6,2)	103,7±4,6 (4,4)
	2 weeks	91,6±4,8 (5,2)	77,8±4,0 (5,1)	103,8±3,4 (3,2)	106,0±3,8 (3,6)
	3 weeks	94,8±5,4 (5,7)	82,8±6,9 (8,3)	105,3±4,6 (4,4)	107,9±4,3 (4,0)
	1 month	98,7±5,6 (5,6)	85,6±5,6 (6,6)	107,4±3,4 (3,2)	109,4±3,4 (3,1)
	2 months	110,4±6,8 (6,1)	96,1±5,5 (5,7)	115,0±3,9 (3,4)	118,0±4,2 (3,6)
	3 months	119,3±5,9 (4,9)	103,3±5,0 (4,8)	121,0±3,7 (3,1)	124,4±3,9 (3,1)
	4 months	128,6±7,2 (5,6)	109,2±6,1 (5,6)	126,6±4,8 (3,8)	129,6±6,1 (4,7)
	5 months	133,6±6,3 (4,7)	113,2±4,5 (3,9)	129,7±4,3 (3,3)	133,1±4,2 (3,1)
	6 to 12 months	153,9±6,9 (4,5)	130,7±6,3 (4,8)	143,0±5,5 (3,9)	146,0±6,3 (4,3)
	24 to 30 months	166,3±11,5 (6,9)	143,8±6,1 (4,2)	151,7±4,9 (3,2)	153,7±4,7 (3,0)
	36 months or more	179,4±15,8 (8,8)	151,2±15,1 (10,0)	157,6±8,7 (5,5)	157,4±8,2 (5,2)
BP	at birth	84,0±0,8 (1,0)	68,8±3,0 (4,3)	94,3±3,1 (3,3)	94,3±3,5 (3,7)
	1 week	92,0±2,8 (3,1)	74,5±10,6 (14,2)	96,0±4,2 (4,4)	97,0±4,2 (4,4)
	2 weeks	97,0±2,6 (2,7)	77,7±6,5 (8,4)	98,7±4,2 (4,2)	100,7±4,5 (4,5)
	3 weeks	100,5±2,3 (2,3)	82,3±6,3 (7,6)	101,8±3,9 (3,8)	104,3±3,6 (3,4)
	1 month	104,5±3,1 (3,0)	87,0±3,9 (4,5)	103,3±2,9 (2,8)	105,8±2,6 (2,5)
	2 months	115,5±6,2 (5,4)	96,5±6,2 (6,5)	109,8±5,1 (4,7)	112,3±4,5 (4,0)
	3 months	123,3±4,1 (3,3)	102,8±6,4 (6,2)	113,0±4,3 (3,8)	116,9±5,0 (4,3)
	4 months	131,0±5,7 (4,3)	104,0±5,7 (5,4)	116,5±4,9 (4,2)	121,5±6,4 (5,2)
	5 months	138,0±5,7 (4,1)	110,0±4,2 (3,9)	120,0±5,7 (4,7)	124,0±5,7 (4,6)
	6 to 12 months	158,5±9,2 (5,8)	135,0±2,8 (2,1)	135,5±3,5 (2,6)	137,5±2,1 (1,5)
	24 to 30 months	165,5±5,4 (3,3)	138,5±7,3 (5,3)	140,3±7,9 (5,6)	144,0±7,2 (5,0)
	36 months or more	189,1±11,6 (6,2)	151,6±9,1 (6,0)	149,3±5,9 (4,0)	149,9±4,0 (2,7)
JB	at birth	-	-	-	-
	1 week	-	-	-	-
	2 weeks	-	-	-	-
	3 weeks	-	-	-	-
	1 month	-	-	-	-
	2 months	-	-	-	-
	3 months	-	-	-	-
	4 months	-	-	-	-
	5 months	-	-	-	-
	6 to 12 months	120,0±3,6 (3,0)	109,2±4,2 (3,8)	111,9±4,3 (3,8)	116,8±4,2 (3,6)
	24 to 30 months	132,5±3,0 (2,3)	120,3±6,8 (5,6)	117,4±4,8 (4,1)	122,9±4,3 (3,5)
	36 months or more	147,0±6,2 (4,2)	132,3±3,2 (2,4)	120,0±2,6 (2,2)	126,3±1,5 (1,2)

TP: thoracic perimeter (cm); GT: greater trunk (cm); HW: height at the withers (cm); HR: height at the rump (cm).

Table 3 present values about the morphological patterns for the evaluated breeds. BSH breed presented a lower value of higher trunk index compared to the other breeds ($P < 0.05$). As expected, because the Breton Postier breed was selected for traction, they presented higher values of the cannon bone index than the other breeds evaluated ($P < 0.05$). Considering the height to length index between the different breeds and ages (Table 2), we found a decreasing trend in proportion with the advancing age. That is, when the animals are younger, they are taller than long, with indexes around 1.3, becoming equivalent in height and body length when adults, with relationships around 1.0

Table 3. Mean, standard deviation and coefficient of variation of morphological patterns of adult Brazilian Sport Horse (BSH), Breton Postier (BP), Brazilian Donkey (BD).

Índices	BH	BP	JB
	média±dp (CV)	média±dp (CV)	média±dp (CV)
scapula ndex	24,5±1,1a (4,6)	25,0±1,2a (4,9)	25,2±1,1a (4,3)
minor trunk index	65,3±6,1b (9,4)	69,2±7,2a (10,4)	74,7±4,4a (5,8)
major trunk index	83,0±9,5b (11,4)	88,3±10,0a (11,3)	101,1±5,8a (5,7)
cannon bone index	13,2±0,6b (4,5)	15,7±1,8a (11,2)	13,9±1,1b (8,1)
height to lenght index	95,3±14,5a (15,2)	88,4±14,2a (16,1)	81,8±6,5a (8,0)

Means in the same line, followed by different letters, differ by the Tukey test, at the 5% level of significance.

The estimated body index indicated that animals of the Brazilian Sport Horse breed were mostly classified as mediolineus, the BP animals as brevilineus and the BD animals as longilineus. The dactyl-thoracic index did not show any variation among the studied breeds, all breeds being classified as hypermetric. Little variation was observed among the evaluated breeds as to the load index in the cannon bone, ranging from 5.3 in the BSH, 5.5 in the Bretons to 6.5 in the Brazilian Donkeys.

V. DISCUSSION

Considering the linear body measurements recorded on BSH breed by Godoi et al. (2013), the mean values of the linear measures regarding correspondent ages were similar to those obtained in the present research. However, the standard deviation was higher than that reported by these authors, indicating that the BSH herd of the present study shows greater phenotypic variability in comparison to the herd evaluated by Godoi et al. (2013).

Comparing the body measurements on Mangalarga Marchador horse breed of different ages reported by Cabral et al. (2004b), we found superiority in height at the withers of BSH breed from birth to adulthood. On the other hand, in the Breton Postier breed, there is similarity up to the first month of life, verifying from this point lesser height of these, in relation to Mangalarga Marchador breed. Regarding the Brazilian Donkey, its height is inferior to Mangalarga Marchador breed in all ages evaluated.

The scapula index of the three breeds presented lower values in comparison to the indexes presented by Komosa et al. (2013), indicating that the evaluated animals presented proportionally shorter arms in relation to the height at the withers when compared to the horses evaluated by the referred authors.

Higher values of small trunk index are desirable in speed animals, such as Thoroughbreds. However, in Showjumping animals, such as BSH, intermediate values are more adequate. Komosa et al. (2013) presented values similar to those obtained for Brazilian Donkeys.

The values of cannon bone index obtained for BSH and BD were similar to those obtained by Komosa et al. (2013), being the values obtained for BP higher than those presented by these authors.

Godoi et al. (2013) also presented a tendency to reduce the height to length index with the advancing age and reported ratios of 0.97 in BSH horses from two to three years, indicating a longer length compared to height. From the functional point of view, equivalent equines regarding height and body length are more favoured to show jumping in relation to those with greater body length.

BSH horses evaluated by Godoi et al. (2013) were also classified as mediolineum.

The load index in the cannon bone data was similar to those observed in BSH horses (5.1 to 5.3; GODOI et al., 2013) but higher than those reported for the Mangalarga Marchador breed (4,16; CABRAL et al., 2004b).

VI. CONCLUSION

It was evinced the existence of phenotypic variability, as well as different morphological patterns among and between the evaluated breeds Brazilian Sport Horse, Breton Postier and Brazilian Dunkey.

The animals of the Brazilian Sport Horse breed were mostly classified as mediolineus, the Brazilian Donkey breed as longilineus, while those of the Breton Postier breed, as brevilineus. As for the dactyl-thoracic index, regarding the three breeds, most animals were classified as hypermetric.

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V. REFERENCES

[1] **Cabral GC, Almeida FQ, Quirino CR, Azevedo PCN, Pinto LFB, Santos EM.** Avaliação Morfométrica de Eqüinos da Raça Mangalarga Marchador: Índices de Conformação e Proporções Corporais. R Bras Zootec. 2004a;33(6):1798-1805.

[2] **Cabral GC, Almeida FQ, Quirino CR, Pinto LFB, Santos EM, Corassa A.** Avaliação Morfométrica de Eqüinos da Raça Mangalarga Marchador: Medidas Lineares. R Bras Zootec. 2004b;33(4):989-1000.

[3] **ESALQ.** Estudo do complexo do agronegócio cavalo. Brasília: Centro de Estudos Avançados em Economia Aplicada da Escola Superior de Agricultura Luiz de Queiroz 2006. 68p. Report No.: 40

[4] **Food and Agriculture Organization - FAO.** United Nations. [Internet] 2010 [updated 2010 May 2; cited 2010 May 2]. Available from: http://faostat.fao.org/site/573/ DesktopDefault. aspx?PageID=573#ancor

[5] **Godoi FN, Bergmann JAG, Almeida FQ, Santos DCC, Miranda ALS, Vasconcelos FO, Oliveira JEG, Kaipper RR, Andrade AM.** Morfologia de potros da raça Brasileiro de Hipismo. Cienc Rural. 2013;43(4):736-742.

[6] **Komosa M, Frackowiak H, Purzyc, H, Wojnowska M, Gramacki A, Gramacki J.** Differences in exterior conformation between primitive, Half-bred, and Thoroughbred horses: Anatomic-breeding approach. J Anim Sci. 2013;91:1660-1668.

[7] **Pinto LFB, Almeida FB, Quirino CR, Cabral GC, Azevedo PCN, Santos EM.** Análise Multivariada das Medidas Morfométricas de Potros da Raça Mangalarga Marchador: Análise Discriminante. R Bras Zootec. 2005;34(2):600-612.

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