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VARIANCE ANALYSES FOR BIOMETRIC MEASURES OF THE PANTANEIRO HORSE IN BRAZIL

ANALISE DE VARIANCA PARA MEDIDAS BIOMETRICAS DO CAVALO PANTANEIRO NO BRASIL

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ADDITIONAL KEYWORDS

Body conformation. Correlations. Fixed effects. Linear measures.

PALAVRAS CHAVE ADICIONAIS

Correlações. Efeitos fixos. Medidas lineares. Conformação corporal.

SUMMARY

Data were available on 1034 animals registered in the genealogical registration book of the Brazilian Pantaneiro Horse Breeders Association (ABCCP) from 1991 to 2000. Fifteen linear measures were analyzed using GLM, PRINCOMP and CORR procedures of SAS. In general, the effect of the factors studied were important ($p < 0.01$) causes of variation for all the 15 traits except for month of birth that wasn't significant ($p > 0.05$). Sex is significant ($p < 0.01$) for most traits. Sex did not affect the back loin length. The factor sub-region and breeder within sub-region were significant ($p < 0.01$) for all measures, except head width, which wasn't significant. This may present a preference for type of animals for breeder within sub-region. Of all the traits, body length and chest width were significant ($p < 0.01$) for age. The month of registration wasn't significant for the wither height, croup height and head width. The year of

registration wasn't significant for wither height, back height, croup height, midback height and shin bone perimeter. Of the traits examined, the variance coefficients in general were low. The correlation between heights were in general high. The correlation between height and others measures were medium, except for with body width which was higher (0.52). Body width and the other widths had a tendency to have higher correlations. The variation must be carefully monitored along with inbreeding coefficients to ensure that the decrease in variability does not adversely affect the beneficial characteristics of this breed.

RESUMO

Foram efetuadas análises com dados de 1034 cavalos registrados na Associação Brasileira dos

Criadores de Cavalos Pantaneiros (ABCCP), no período de 1991 a 2000. Utilizando-se os procedimentos GLM, PRINCOMP e CORR do SAS foram avaliados os efeitos de sexo, sub-região, idade, ano e mês de nascimento, ano de registro e pelagem sobre quinze medidas lineares tomadas no dia do registro. Em geral, todos os fatores estudados influenciaram significativamente ($p < 0,01$) as quinze características corporais com exceção do mês de nascimento ($p > 0,01$). Sub-região e criador dentro de sub-região influenciaram significativamente ($p < 0,01$) todas as medidas, com exceção da largura da cabeça. Estes resultados provavelmente demonstram uma certa preferência por parte dos criadores para determinados tipos de animais. Idade influenciou apenas comprimento do corpo e perímetro torácico. O mês de registro não influenciou a altura da cernelha, a altura da garupa e largura da cabeça. O ano de registro não influenciou a altura da cernelha, altura do dorso, altura da garupa, altura do costado e perímetro da canela. Das características examinadas, os coeficientes de variação foram geralmente baixos. As correlações entre as medidas de alturas foram geralmente altas e positivas enquanto a correlação entre altura e outras medidas foram médias, exceto para largura da anca (0,52). Os coeficientes de variação juntamente com os de consanguinidade precisam ser cuidadosamente monitorados visando assegurar que a diminuição da variabilidade não afete as características benéficas da raça.

INTRODUCTION

The Pantaneiro horse constituted an economically and socially important factor in the Pantanal Mato-Grossense, as it is essential in the management of cattle and able of support long treks on marshy or flooded land. The Pantaneiro horse had its probable origin from Iberian horses introduced by Spanish

settlers, specially in the 16th and 17th centuries. In the 18th century, with the opening of a route from São Paulo to Cuiabá, through Goiás, were the horses introduced in the Pantanal by Portuguese settlers. These came from the Brazilian coast, the main region of Portuguese colonization (Santos *et al.*, 1992). In 1972 with the creation of the Brazilian Pantaneiro Horse Breeders Association (ABCCP), the study and conservation work with this ecotype was started and afterwards intensified with initiatives from other governmental and non-governmental institutions. The ABCCP standardized the breed through by uniting the different phenotypes and it still has an open book for the registration of horses. In the Pantanal, there is an estimated population of 119000 horses, mainly crossbred animals. Of these, there are about 1600 mares and 300 males registered in the ABCCP, and the bulk of these are in the Poconé sub-region, whose breeders collaborated in the creation of the ABCCP. This work evaluates the factors which affect the 15 linear biometric measures taken at registration.

MATERIAL AND METHODS

Data from 1034 animals registered in the genealogical registration book of the Brazilian Pantaneiro horse Breeders and Association (ABCCP) in the period of 1991 to 2000 were analyzed. Correlations and principal component effects of 15 linear measures (withers height, back height, croup height, midback height, head length, neck length, back - loins length, croup length, shoulder bone length,

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head width, chest width, hip width, shin bone perimeter and thorax perimeter) were analysed using GLM, PRINCOMP and CORR procedures of SAS (1996). The following effects were included in the model; month and year of registration, age, sex, open or closed book (type of register), and sub-region.

The model used was a linear model as follows:

$$Y_{IKLMNop} = \mu + O_i + T_k + A_l + M_m + S_n + I_o + e_{IKLMNop}$$

Where:

$Y_{IKLMNop}$ = dependent variable, one

of the fifteen linear measurements on the animals;

μ = overall mean associated with dependent variable;

O_i = i^{th} fixed effect of sub region of origin ($i = 1, \dots, 21$);

T_k = k^{th} fixed effect of Herd Register type ($k = \text{Open or Closed book}$);

A_l = l^{th} fixed effect of year of registration ($l = 1972, \dots, 2000$);

M_m = m^{th} fixed effect of month of registration ($m = 1, \dots, 12$);

S_n = n^{th} fixed effect of sex of animal ($n = 1 \text{ ou } 2$);

I_o = a^{th} fixed effect of age of animal at registration ($a = 0, \dots, 19$);

Table I. Analysis summary for linear measurements on the Pantaneiro horse. (Resumo de análise de medidas lineares no cavalo Pantaneiro).

	Month	Year	Age	Sex	Registration book	sub-region	Mean	CV	SD
V1	**	**	ns	**	ns	**	54.04	4.02	2.17
V2	**	**	*	**	ns	**	54.54	4.15	2.26
V3	**	**	ns	**	ns	**	44.85	5.14	2.3
V4	**	**	*	**	ns	**	47.8	6.51	3
V5	*	**	ns	**	**	**	141.69	5.22	7.39
V6	**	**	ns	**	ns	**	20.3	8.23	1.67
V7	**	**	**	**	ns	**	32.6	7.75	2.52
V8	**	**	**	*	ns	**	44.1	5.39	2.37
V9	**	**	ns	**	ns	**	49.29	10.79	5.31
V10	**	**	**	**	ns	**	161.26	3.2	5.16
V11	*	**	*	**	ns	**	17.51	4.14	0.72
V12	**	**	*	**	**	**	138.21	1.58	2.18
V13	**	**	*	**	**	**	139.09	1.7	2.36
V14	**	**	ns	**	**	**	135.5	2.01	2.72
V15	**	**	**	**	ns	**	58.82	4.7	2.76

** $p < 0.01$, ns - not significant, CV - coefficient of variation, SD - standard deviation V1= head length; V2= neck length; V3= croup length; V4= shoulder bone length; V5= body length; V6= head width; V7= chest width; V8= hip width ; V9= back loin length, ; V10= thorax perimeter; V11= shin bone perimeter; V12= withers height; V13= croup height; V14= back height; V15= midback height.

$e_{IKLMNop}$ = random residual associated with each observation.

RESULTS AND DISCUSSION

Month and year of registration, sex and sub-region were, in general, significant sources of variation for the traits studied (**table I**). Month and year of registration are related to the quality of pasture, nutritional state of the animals, general management and variations made by different technical staff. Age was not significant for head, hip, dorsal lumbar and body lengths and head width. This may indicate that the animal initial growth is in bone length followed by a *filling out* process.

The Brazilian Pantaneiro Horse Breeders Association (ABCCP) insists on a minimum height at registration of 135 cm for females and 140 cm for males. Despite this, two and three year old animals had mean heights lower than the other groups. These animals, still in the growing phase, may be prejudiced if selection is based on their measurements and registration. At the other extreme, the 19 year old animals were lower than those stipulated by the regulations. Reed and Dunn (1977), studying Arab horses observed that the males grow in height up to 5 years of age while females grow to 4 years of age. Santos *et al.* (1999) observed a similar pattern with the Pantaneiro horse, thereby indicating that animals

Table II. Correlations between biometric measures of the Pantaneiro horse. (Correlações entre medidas biométricas no cavalo Pantaneiro).

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14
V1														
V2	0.75													
V3	0.15	0.3												
V4	0.31	0.28	0.05											
V5	0.35	0.37	0.4	0.42										
V6	0.16	0.17	0.04	0.24	0.25									
V7	0.25	0.19	-0.11	0.35	0.25	0.17								
V8	0.32	0.35	0.21	0.35	0.43	0.22	0.38							
V9	0.37	0.41	0.17	0.42	0.42	0.21	0.31	0.57						
V10	0.03	0.04	0.03	0.04	0.06	0.02	0.01	0.04	0.03					
V11	0.19	0.15	-0.18	0.17	0.07	0.13	0.13	0.21	0.22	0.00				
V12	0.33	0.36	0.24	0.25	0.35	0.29	0.11	0.41	0.35	0.05	0.32			
V13	0.26	0.27	0.07	0.18	0.07	0.18	0.08	0.29	0.27	0.00	0.28	0.79		
V14	0.34	0.38	0.26	0.26	0.35	0.29	0.1	0.42	0.38	0.03	0.28	0.91	0.77	
V15	0.36	0.33	0.08	0.4	0.46	0.22	0.33	0.46	0.46	0.04	0.14	0.34	0.26	0.37

V1=head length; V2= neck length; V3= croup length; V4= shoulder bone length; V5= body length; V6= head width; V7= chest width; V8= hip width ; V9= back--loins length, ; V10= thorax perimeter; V11= shin bone perimeter; V12= withers height; V13= croup height; V14= back height; V15= midback height.

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Table III. Types of hair of Pantaneiro horses per sub-region of birth, in the period 01/1991 to 07/2000. (Tipo de pelagens no Cavallo Pantaneiro registrado entre 01/1991 e 07/2000).

Sub-region	nº	Hair Type (percent)							
		grayish white	dun	brown	dark gray	chestnut	roan	black	other
Poconé	457	18.53	9.7	6.89	2.33	2.91	1.65	1.55	0.77
Cáceres	13	0.68	0.1	0.39	0	0	0	0.1	0
Cuiabá	50	2.91	1.07	0.39	0.1	0.19	0.1	0.1	0
Juscimeira	93	4.85	1.55	0.97	0.68	0.48	0.1	0.19	0.19
Barão de Melgaço	5	0.1	0	0.1	0.1	0	0.1	0	0.1
Corumbá	121	5.53	3.01	1.36	0.87	0.29	0.58	0	0.1
Rio Verde MS	34	1.45	0.87	0.29	0.39	0.1	0	0	0.2
Rosário Oeste	68	1.84	2.13	1.84	0.48	0	0	0.1	0.19
Araputanga	16	0.87	0.19	0.19	0.19	0	0.1	0	0
Stº Antônio de Leverger	47	2.52	0.78	0.58	0.1	0.29	0	0.1	0.19
Campo Grande	82	4.27	2.13	0.87	0.1	0.39	0.1	0.1	0
Rio Branco	2	0	0.1	0	0	0	0	0	0.1
Jangada	2	0.1	0	0	0	0	0	0	0.1
Tangara da Serra	2	0.19	0	0	0	0	0	0	0
Total	1031	45.78	22.7	14.26	5.53	4.66	2.72	2.33	2.04

should be registered from 4 to 5 years of age.

According to Ribeiro (1988), a horse is considered large when its shoulder height passes 160 cm, medium between 150 and 160 cm and small between 150 and 130 cm. The Pantaneiro therefore may be considered small to medium (mean shoulder height 138 cm).

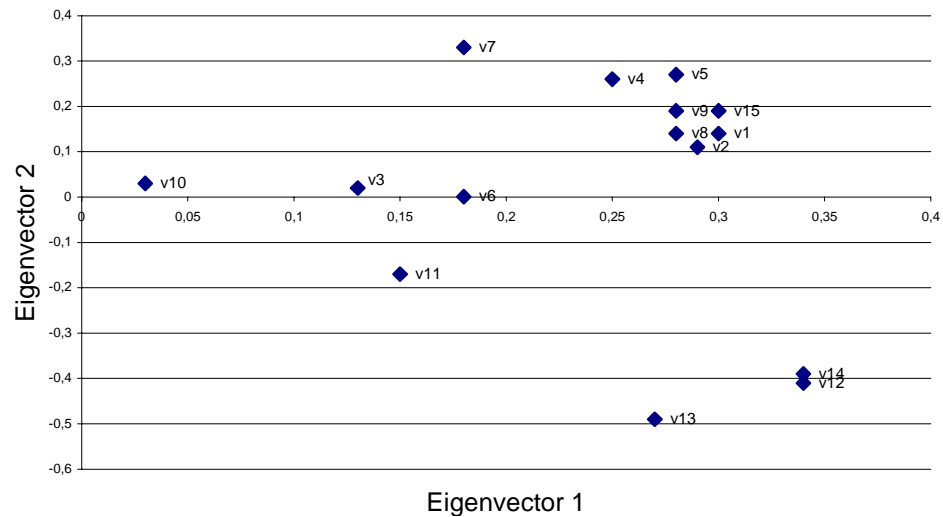
Sex of the animals was significant for all traits. This may be due to sexual dimorphism and secondary sexual characteristics or, for traits such as chest width, due to greater physical exercise.

Zamborlini (1996) stated that a wide, deep and muscular thorax is important in the horse to permit physical vigor. A small thorax is associated with lack of good muscu-

lature and deficiencies in the cardiovascular system. A horse with an excessively large thorax is also not desirable as the center of gravity moves to the front of the horse. When selecting animals this trait should therefore be taken into consideration. A well-proportioned animal should present similar hip and shoulder heights (Ribeiro, 1988).

The nutritional regime of the horses in the Pantanal is especially affected by the rainy season when pastures are flooded (Santos *et al.*, 1993), when the number of forage species in natural pastures is reduced. The linear measures reflect this, with a decrease in several measurements.

The sub-region of the Pantanal affected the linear measurements with animals from the Rio Verde and



V1=head length; V2= neck length; V3= croup length; V4= shoulder bone length; V5= body length; V6= head width; V7= chest width; V8= hip width ; V9= back loin length, ; V10= thorax perimeter; V11= shin bone perimeter; V12= withers height; V13= croup height; V14= back height; V15= midback height.

Figure 1. Graphical representation of the first two eigenvectors for body measurements in the Pantaneiro horse. (Representação gráfica dos primeiros vetores para medidas corporais do cavalo Pantaneiro).

Araputanga regions having the highest measurements, and animals from the Nhecolândia and Rondonópolis sub-regions having the lowest measurements. This may be due to regional preferences on the part of the breeders, type of natural pastures present or genetic ancestry of the animals in the region. According to Abreu *et al.* (1998) the Pantaneiro horse is probably originated from Lusitanian (Celtic Lusitanian, Barb and Andalusia), Arab and Argentine Creole horses. Cothran *et al.* (1998) showed relationships between the Pantaneiro and horses from the Iberian Peninsula (Andalusia and Lusitanian) as well as other Brazilian

breeds, especially the Mangalarga.

The correlations between the various traits were in general low to medium (**table II**), the highest correlation being between hip and shoulder bone length (0.42). The first principal component (**table III**) showed that in general an animal that was large for one measurement was large for the others while the second described short backed animals, which are tall (**figure 1**). These principal components define types of animals and may be used in selection programs.

The main hair types (**figure 2**) were grey (45.78 percent), dun (22.70 percent) and brown (14.26 percent),

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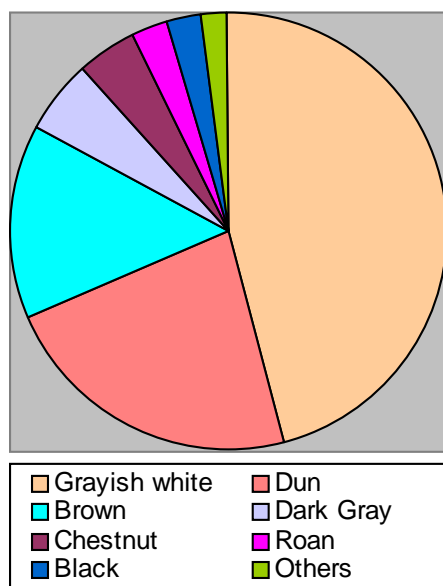


Figure 2. Hair colours for Pantaneiro Horse. (Cores das pelagens do cavalo Pantaneiro).

which predominate in the Poconé, Corumbá, Juscimeira, Campo Grande and Rosário Oeste sub-regions (**table III**) and is in agreement with data from Domingues (1957), Correia Filho (1973) and Santos *et al.* (1995).

Mean weight of the animals was 352 kg for males and 334 kg for females. According to FAO (1988) males are 425 kg and females 325 kg. Animals registered in the rainy season

were lighter (313 kg) than those registered in the dry season (352 kg). During the dry season, there is usually an increase in the environments with favourable conditions for horses, such as borders of permanent and temporary bays. The quality of forrage in these áreas is higher and consequently the animals have a better conformation (Santos *et al.*, 2002). Animals from Jangada, Araputanga, Maracaju and Rondonópolis were heavier than the other subregions.

In the period studied the sub-region Poconé had the greatest number of animals registered, perhaps due to the fact that this is the location of the Breeder's Association as well as the great interest and value given by the breeders of the regions to the conservation of native breeds.

CONCLUSION

Environmental factors may affect the linear biometric measurements of Pantaneiro horses even when limitations are set for registration of the same. Care must be taken to ensure no adverse affects due to inbreeding because of restrictive practices at registration and registration should occur when the animals reach their adult size. The Breeder's Association should expand its efforts to register animals in other sub-regions of the Pantanal.

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The Pantaneiro horse is well adapted to the bioclimatic conditions of this region, and become an important economic and social factor, both for the cattle industry and regional transportation (Santos et al., 1992). The Pantaneiro horse had its probable origin from Iberian horses introduced by Spanish settlers, specially in the 16th and 17th centuries, and by Portuguese settlers in the 18th century (Santos et al., 1992). Table I. Heritability estimates (diagonal) and genetic correlation (below diagonal) on 15 linear measures of the Pantaneiro horse. (Estimativa da heritabilidade (diagonal) e correlação genética (diagonal abaixo) de 15 medidas lineares do Cavalo Pantaneiro). Origin of the pantaneiro horse in Brazil. to several national breeds. The characteristic environment of each region, involving such a series of factors as climate, soil, pastures, and management have a great influence over the phenotype. This environment will permit or not, according to the circumstances that each individual express phenotypically its genotype (Dowdall, 1982). The pantaneiro horse is considered a naturalized breed derived from the breeds introduced in different periods in Brazil by the colonizers and settlers (Domingues, 1968). The Lençóis Desert is located on the equatorial part of Brazil. Due to the high amount of rainfall per season, freshwater lagoons cover the desert. Let me show you the photograph of our photo crew (Dima Moiseenko, our guide, and myself) from up above to give you an idea of the size of the sand dunes. The Lençóis Maranhenses National Park (Parque Nacional dos Lençóis Maranhenses), one of the main natural landmarks of the country, is located in northeastern Brazil. This is not a conventional park – despite abundant rain, there is almost no vegetation. A flat surface occupying about 1,500 square kilometers is covered with large sand dunes reaching up to 40 meters in height.