

LINEAR TYPE TRAIT ANALYSIS IN THE VARIETIES AND STUDS OF THE OLD KLADRUB HORSE

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INTRODUCTION

Old Kladrub horse - important genetic resource in the Czech Republic

Linear type trait classification - developed and verified in 1995, is an inevitable tool of the breeding programme for retaining specific conformation traits for next generations.

Linear type traits and conformation were analysed and published by Jakubec et al. (1997, 1998, 1999 and 2000) and Schlote et al. (2002).

MATERIAL AND METHODS

A qualified classifier described 32 linear type traits of 494 horses from 1995 to 2000

The traits of the linear scoring system are described in tab. 1

The following model was used (GLM procedure - SAS, 2005):

$$Y_{ijklmn} = \mu + VAR_i + STUD_j + SEX_k + YEARB_l + AGE C_m + (VAR \times STUD)_{ij} + e_{ijklmn},$$

where:

Y_{ijklmn} = observation of a linear type trait

μ = overall mean

VAR_i = fixed effect of the i -th variety

$STUD_j$ = fixed effect of the j -th stud

SEX_k = fixed effect of the k -th sex

$YEARB_l$ = fixed effect of the l -th year of birth

$AGE C_m$ = fixed effect of the m -th age at classification

$(VAR \times STUD)_{ij}$ = fixed effect of the ij -th interaction variety x stud

e_{ijklmn} = random residual error

The differences between the least squares means were tested at the significance level (error probability) of * $P < 0.05$, ** $P < 0.01$ and *** $P < 0.001$

The frequency of animals within the factors and effects is shown in tab. 2

RESULTS AND DISCUSSION

The estimated parameters characterize the specific properties and variation of the Old Kladrub breed in its current state (tab. 3)

The coefficients of variation are the most important measure of variation:

1. 13,25 – 19.99 % (12 traits)

2. 20 – 24.99 % (10 traits)
3. 25 – 29.99 % (7 traits)
4. 30 – 40.14 % (3 traits - height at withers, chest girth, forelimbs-side view)

The classifier used a very high number of scores of the scale

Table 4 shows the means of the linear type trait scores of the grey and black variety and the studs of the National Stud of Kladruby nad Labem on one hand and the private breeders on the other hand

Significant differences were found between both varieties in 13 of 32 traits and between the Kladruby and private studs in 12 of 32 traits. From 2005 a new uniform breeding objective for both varieties was formulated with the aim to breed sire lines and dam families in both colours

Highly significant and significant interactions variety x stud were recorded in only 7 traits.

Significant differences between stallions and mares were recorded in 13 of 32 traits (tab.5). The differences are the result of the sexual dimorphism and the more intensive selection of stallions.

In tab. 6 the significance of the year of birth and the age at classification are recorded. Significant differences between the years of birth were found in 18 of 32 traits and between the age at classification in 13 of 32 traits. Both factors are not important for the selection with respect to the linear type traits. The classification, performance recording and selection are carried out in the population of four year old horses born in the given year

Tab. 1.

Number	Trait	Scores	
		1	9
	Front		
1	Height at withers	Low	High (transformed from measured values)
2	Head profile	Concave	Convex
3	Neck length	Short	Long
4	Neck tethering	Low	High
5	Neck topside	Concave	Convex
6	Withers length	Short	Long
7	Withers height	Low	High
	Body		
8	Topline length	Short	Long
9	Topline vault	Weak	Straight
10	Loin length	Short	Long
11	Loin vault	Weak	Straight
12	Shoulder length	Short	Long
13	Shoulder slope	Straight	Sloping
14	Chest girth	Low	High (transformed from measured values)
15	Chest length	Short	Long
16	Chest width	Narrow	Broad
17	Chest depth	Shallow	Deep
18	Breast width	Narrow	Broad
	Rear		
19	Croup length	Short	Long
20	Croup width	Narrow	Broad
21	Croup shape	Sloping	Straight
22	Croup profile	Roofy	Vaulty
23	Tail tethering	Low	High
	Limbs		
24	Forelimbs-front view	Narrow	Broad
25	Forelimbs-side view	Back at the knee	Over the knee
26	Canon bone circumference	Low	High (transformed from measured values)
27	Foretoes-side view	Sloping	Weak
28	Forehoof side view	Sloping	Weak
29	Forehoof width	Narrow	Broad
30	Forehoof size	Small	Large
31	Hind limbs-side view	Sickle hocked	Straight
32	Hind limbs-back view	Narrow	Broad

Tab. 2.

Factor	Effect	Frequency	Percent
Variety	Grey	255	51.62
	Black	239	48.38
Stud	Kladruby n.L.	201	40.69
	Private farmers	293	59.31
Sex	Stallions	63	12.75
	Mares	431	87.25
Year of birth	1985	11	2.23
	1986	15	3.04
	1987	21	4.25
	1988	30	6.07
	1989	28	5.67
	1990	40	8.10
	1991	30	6.07
	1992	31	6.28
	1993	42	8.50
	1994	45	9.11
	1995	45	9.11
	1996	37	7.49
	1997	31	6.28
	1998	33	6.68
	1999	42	8.50
	2000	13	2.63
Age at classification	3	45	9.11
	4	212	42.91
	5	78	15.79
	6	43	8.70
	7	48	9.72
	8	25	5.06
	9	22	4.45
	10	21	4.25

Tab. 3.

Number	Trait	Mean	SD	CV (%)	Minimum	Maximum	Utilized scores
Front							
1	Height at withers	5.98	1.85	30.97	1	9	9
2	Head profile	5.44	1.44	26.51	3	9	7
3	Neck-length	5.16	1.16	22.46	2	7	6
4	Neck tethering	5.99	0.97	16.26	3	9	7
5	Neck topside	6.04	1.68	27.83	1	9	9
6	Withers length	4.99	1.48	29.69	1	9	9
7	Withers height	4.41	1.20	27.29	1	9	9
Body							
8	Topline length	5.57	1.28	23.02	3	9	7
9	Topline vault	4.60	0.78	16.96	1	7	7
10	Loin length	5.98	1.14	19.06	3	9	7
11	Loin vault	4.43	1.05	23.71	1	9	9
12	Shoulder length	4.52	0.78	17.25	3	7	5
13	Shoulder slope	3.85	1.04	26.97	1	7	7
14	Chest girth	6.40	2.32	36.25	1	9	9
15	Chest length	6.14	1.04	16.88	3	9	7
16	Chest width	5.15	1.24	24.10	3	9	7
17	Chest depth	6.03	1.19	19.72	3	9	7
18	Breast width	5.14	1.29	25.10	2	9	8
Rear							
19	Croup length	4.15	0.93	22.33	1	7	7
20	Croup width	5.89	1.16	19.63	3	9	7
21	Croup shape	4.47	1.06	23.60	1	7	7
22	Croup profile	4.70	1.35	28.64	1	9	9
23	Tail tethering	5.05	1.10	21.89	1	9	9
Limbs							
24	Forelimbs-front view	5.06	0.81	16.01	3	9	7
25	Forelimbs-side view	4.03	1.62	40.14	1	7	7
26	Cannon bone circumference	6.18	1.49	24.17	1	9	9
27	Foretoes side view	4.56	0.90	19.66	1	7	7
28	Forehoof-side view	4.89	0.95	19.46	1	9	9
29	Forehoof width	5.05	1.02	20.21	3	7	5
30	Forehoof size	4.98	0.66	13.25	3	7	5
31	Hind limbs-side view	4.40	0.91	20.67	1	7	7
32	Hind limbs-back view	4.94	0.78	15.80	3	9	7

Tab. 4.

Number	Trait	Overall mean	Varieties				Significance	Studs				Significance	Signif. of interaction var. x stud
			Grey		Black			Kladruby		Private			
			255		239			201		293			
	LSM		LSM	SE	LSM	SE	LSM	SE	LSM	SE			
	Front												
1	Height at withers	6.13	6.03	0.19	6.22	0.20	0.2733	6.53	0.22	6.72	0.18	<0.0001***	0.4973
2	Head profile	5.65	5.45	0.15	5.85	0.16	0.0031**	5.88	0.17	5.42	0.14	0.0019**	0.9994
3	Neck length	5.49	5.52	0.12	5.46	0.13	0.5950	5.67	0.13	5.30	0.11	0.0020**	0.4525
4	Neck tethering	6.33	6.14	0.10	6.52	0.11	<0.00001***	6.47	0.11	6.20	0.09	0.0072**	0.7290
5	Neck topside	6.59	6.46	0.11	6.73	0.17	0.0901	6.91	0.12	6.28	0.20	0.0002***	0.7205
6	Withers length	4.92	5.08	0.15	4.76	0.16	0.0221*	4.84	0.17	4.99	0.14	0.3076	0.2922
7	Withers height	4.27	4.40	0.12	4.14	0.13	0.0220*	4.25	0.14	4.28	0.12	0.7914	0.9636
	Body												
8	Topline length	5.48	5.41	0.13	5.55	0.14	0.2413	5.42	0.15	5.54	0.12	0.3562	0.3944
9	Topline vault	4.57	4.62	0.08	4.52	0.09	0.2141	4.56	0.09	4.58	0.08	0.7477	0.1765
10	Loin length	5.87	5.88	0.11	5.86	0.12	0.9013	5.93	0.13	5.82	0.11	0.3437	0.8349
11	Loin vault	4.50	4.41	0.11	4.58	0.11	0.0934	4.55	0.12	4.44	0.10	0.2941	0.6921
12	Shoulder length	4.59	4.57	0.08	4.60	0.09	0.7719	4.63	0.09	4.54	0.08	0.2822	0.0314*
13	Shoulder slope	3.93	3.86	0.10	4.01	0.11	0.1319	3.90	0.12	3.96	0.10	0.5593	0.0810
14	Chest girth	6.73	6.92	0.23	6.53	0.25	0.0821	7.25	0.27	6.20	0.23	<0.0001***	0.0290*
15	Chest length	5.94	5.85	0.10	6.03	0.11	0.0635	5.82	0.12	6.05	0.10	0.0296*	0.5523
16	Chest width	5.44	5.57	0.13	5.31	0.14	0.0293*	5.54	0.14	5.34	0.12	0.1187	0.0746
17	Chest depth	5.87	6.00	0.12	5.74	0.13	0.0208*	5.77	0.14	5.98	0.12	0.0850	0.0670
18	Breast width	5.40	5.53	0.13	5.26	0.14	0.0245*	5.52	0.15	5.27	0.12	0.0541	0.0201*
	Rear												
19	Croup length	4.25	4.13	0.09	4.36	0.10	0.0093**	4.32	0.11	4.18	0.09	0.1274	0.4551
20	Croup width	5.75	5.90	0.12	5.61	0.13	0.0084**	5.85	0.13	5.65	0.11	0.0938	0.0803
21	Croup shape	4.57	4.53	0.11	4.62	0.12	0.3698	4.65	0.12	4.50	0.10	0.1600	0.0400*
22	Croup profile	5.06	5.10	0.14	5.03	0.15	0.5741	5.28	0.13	4.85	0.13	0.0021**	0.3746
23	Tail tethering	5.30	5.44	0.11	5.16	0.12	0.0064**	5.39	0.13	5.21	0.11	0.1204	0.1301
	Limbs												
24	Forelimbs-front view	5.17	5.35	0.08	5.00	0.09	<0.00001***	5.26	0.09	5.09	0.08	0.0445*	0.0095**
25	Forelimbs-side view	4.23	4.34	0.16	4.12	0.18	0.1654	4.26	0.19	4.20	0.16	0.7237	0.5314
26	Canon bone circumference	6.25	6.23	0.15	6.27	0.16	0.8120	6.60	0.17	5.90	0.14	<0.0001***	0.0001***
27	Foretoes-side view	4.57	4.68	0.09	4.45	0.10	0.0054**	4.48	0.10	4.65	0.09	0.0544	0.4482
28	Forehoof side view	5.02	5.08	0.10	4.96	0.10	0.1913	4.97	0.11	5.07	0.09	0.3507	0.1251
29	Forehoof width	5.03	5.08	0.10	4.99	0.11	0.3656	4.88	0.12	5.18	0.10	0.0047**	0.5211
30	Forehoof size	4.96	5.04	0.07	4.88	0.07	0.0151*	4.91	0.08	5.01	0.06	0.1185	0.0023**
31	Hind limbs-side view	4.34	4.36	0.09	4.32	0.10	0.6332	4.38	0.11	4.30	0.09	0.3589	0.6699
32	Hind limbs-back view	5.01	5.02	0.08	5.00	0.09	0.8311	5.11	0.09	4.91	0.08	0.0118*	0.8825

Tab. 5.

Number	Trait	Overall mean	Sex				Level of significance
			Stallion		Mare		
	n	494	63	12.75%	431	87.25 %	
		LSM	LSM	SE	LSM	SE	
	Front						
1	Height at withers	6.13	6.30	0.27	5.95	0.14	0.1817
2	Head profile	5.65	5.91	0.21	5.39	0.11	0.0113*
3	Neck length	5.49	5.64	0.17	5.34	0.09	0.0638
4	Neck tethering	6.33	6.66	0.14	6.00	0.07	<0.0001***
5	Neck topside	6.59	7.05	0.25	6.14	0.13	0.0001***
6	Withers length	4.92	4.66	0.22	5.17	0.11	0.0160*
7	Withers height	4.27	3.95	0.18	4.59	0.09	0.0002***
	Body						
8	Topline length	5.48	5.28	0.19	5.68	0.10	0.0275*
9	Topline vault	4.57	4.63	0.12	4.51	0.06	0.2488
10	Loin length	5.87	5.52	0.16	6.23	0.08	<0.0001***
11	Loin vault	4.50	4.71	0.15	4.28	0.08	0.00420**
12	Soulder length	4.59	4.56	0.11	4.61	0.06	0.6010
13	Shoulder slope	3.93	4.09	0.15	3.77	0.08	0.0290*
14	Chest girth	6.73	6.58	0.34	6.87	0.18	0.3779
15	Chest length	5.94	5.64	0.15	6.25	0.08	<0.0001***
16	Chest width	5.44	5.36	0.18	5.52	0.09	0.3711
17	Chest depth	5.87	5.47	0.18	6.28	0.09	<0.0001***
18	Breast width	5.40	5.30	0.19	5.49	0.10	0.3138
	Rear						
19	Croup length	4.25	4.22	0.14	4.28	0.07	0.6100
20	Croup width	5.75	5.38	0.17	6.12	0.09	<0.0001***
21	Croup shape	4.57	4.62	0.16	4.53	0.08	0.5217
22	Croup profile	5.06	5.28	0.20	4.85	0.10	0.0228
23	Tail tethering	5.30	5.53	0.16	5.07	0.08	0.0028**
	Limbs						
24	Forelimbs-front view	5.17	5.14	0.12	5.21	0.06	0.5577
25	Forelimbs-side view	4.23	4.29	0.24	4.16	0.12	0.5730
26	Canon bone cirmcumference	6.25	6.24	0.22	6.26	0.11	0.9085
27	Foretoes-side view	4.57	4.58	0.13	4.55	0.07	0.8352
28	Forehoof side viwe	5.02	5.01	0.14	5.03	0.07	0.9191
29	Forehoofe width	5.03	5.11	0.15	4.96	0.08	0.3020
30	Forehoof size	4.96	5.00	0.10	4.92	0.05	0.3736
31	Hind limbs-side view	4.34	4.34	0.13	4.34	0.07	0.9587
32	Hind limbs-back view	5.01	5.06	0.12	4.97	0.06	0.4326

Tab. 6.

Number	Trait n = 494	Overall mean	Year of birth	Age at classification
			Significance	Significance
	Front			
1	Height at withers	6.13	0.3072	0.4301
2	Head profile	5.65	0.7873	0.0580
3	Neck length	5.49	0.0455*	0.0508
4	Neck tethering	6.33	0.0127*	0.0734
5	Neck topside	6.59	<0.0001***	0.1536
6	Withers length	4.92	0.0019**	0.1964
7	Withers height	4.27	0.5334	0.0267*
	Body			
8	Topline length	5.48	0.1943	0.1226
9	Topline vault	4.57	0.0511	0.2824
10	Loin length	5.87	<0.0001***	<0.0001***
11	Loin vault	4.50	<0.0001***	0.0225*
12	Shoulder length	4.59	<0.0001***	0.0003**
13	Shoulder slope	3.93	0.3873	0.8843
14	Chest girth	6.73	0.7219	0.2755
15	Chest length	5.94	0.0516	0.3779
16	Chest width	5.44	0.0712	<0.0001***
17	Chest depth	5.87	0.0008**	0.0003***
18	Breast width	5.40	0.0362*	0.0002***
	Rear			
19	Croup length	4.25	0.6100	0.0050**
20	Croup width	5.75	0.0008***	0.0001***
21	Croup shape	4.57	0.0048**	0.5603
22	Croup profile	5.06	0.0011**	0.0016**
23	Tail tethering	5.30	<0.0001***	0.1013
	Limbs			
24	Forelimbs-front view	5.17	0.5170	0.0569
25	Forelimbs-side view	4.23	0.3086	0.1346
26	Canon bone circumference	6.25	0.4603	0.0748
27	Foretoes-side view	4.57	<0.0001***	0.0048**
28	Forehoof side view	5.02	<0.0001***	0.0083**
29	Forehoof width	5.03	0.0431*	0.5311
30	Forehoof size	4.96	<0.0001***	0.0214*
31	Hind limbs-side view	4.34	<0.0001***	0.0898
32	Hind limbs-back view	5.01	0.4301	0.2228

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