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Original Paper

Heritability estimates and genetic trends for performance test traits in the Old Kladruber horses

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The Old Kladruber horse is an important Czech genetic resource. The objectives of this paper were estimate coefficients heritability and determinate genetic trends for evaluated traits. The data set for evaluation was composed of edited records of performance test for stallion and mare in years 1995–2014. Each horse had three to five performance evaluations for the suite of traits. Together eight evaluated traits was assessed: rideability, overall Impression, walk, trot, Canter and driveability of carriage – dressage test and obstacle driving test. The statistical model included fixed effects for sex, age, year*place, variety, stud, classifier, permanent environment and additive genetic effect. The heritability estimates were in range from 0.06 to 0.23. Genetic trends were constant over the analysed period, annual genetic change were close to zero in all traits except type and gender expression and trot.

Keywords: Old Kladruber horse, performance test, genetic trend, genetic resource

1 Introduction

Old Kladruber horse is an important Czech genetic resource and origin of this breed dates back to 400 years ago. Horses was bred especially for ceremonial purposes and the Baroque type of the breed has been conserved until now. The population is bred in grey variety and black variety. In recent years horses are selected mostly on type of galakarossier and the primary goal of the breeding program is conservation of the gene pool with respect to conformation, gaits and sport performance, especially for carriage driving and dressage.

Organized selection programs has resulted in positive responses in several horse breeds. With increasing performance in equestrian disciplines is mostly related increasing genetic trend. Positive genetic trend has been achieved in Swedisch warmblood horses (Viklund et al., 2011), Selle Francais (Dubois and Ricard, 2007), British sport horses (Steward et al., 2010) or in Lusitano horses (Vincente et al., 2014).

No genetic analyses of performance test data of Old Kladruber horse have yet been conducted. Estimated breeding values would allow maintaining the characteristics of the breed with regard to conservation of the Old Kladruber horse. The objectives of this paper were estimation heritability coefficients, prediction breeding values and provide information about genetic trends evaluated traits in performance test.

2 Material and methods

2.1 Data set and Pedigree

Performance test of Old Kladruber stallions and mares are two days. Together eight traits are assessed: rideability, overall impression walk, trot, canter, driveability of carriage – dressage test and obstacle driving test. Rideability and gaits are assessed under saddle and driveability of carriage is assessed in harness. Each trait is scored between 1 (very poor) and 10 (excellent).

The data set was obtained from the studbook of the Old Kladruber Horse and Central Register of Horses. The data set from performance test comprised 704 individuals from the period of 1995 through 2014. Evaluations of the horses were obtained from the all of the judge, each animal had three to five evaluations per test (not just only average mark). With a repeated measurements, 2,326 observations were in the data set. Including four generations of ancestors, 1363 horses were included in the pedigree file.

2.2 Estimation of genetic parameters and breeding values

Estimates of heritability coefficients were estimated by single trait models. Variance components were analysed with Gibbs sampling algorithm using GIBBS1f90 software (Misztal, 2002). Breeding values prediction were calculated according to the following equation:

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$$Y_{ijklmnop} = \mu + Sex_i + Age_j + Variety_k + YearPlace_l + Stud_m + Classifier_n + PE_o + Animal_p + e_{ijklmnop}$$

where:

$Y_{ijklmnop}$ – the measurement variable
μ – the population mean
Sex_i – the fixed effect of the gender (stallion, mare)
Age_j – the fixed effect for four age groups (4, 5, 6, 7+)
$Variety_k$ – the fixed effect of colour variant (white, black)
$YearPlace_l$ – the fixed effect of year and place of performance test (1,..., 50)
$Stud_m$ – the fixed effect of the stud (National Stud Kladruby nad Labem, private studs)
$Classifier_n$ – random effect of classifier (1,..., 20)
PE_o – the random effect of the permanent environment of the horse $\sim N(0, I\sigma^2_{pe})$
$Animal_p$ – the random effect of the additive genetic effect $\sim N(0, A\sigma^2_a)$

Breeding values were standardised (Relative breeding values – RBV) on a scale with mean 100 and standard deviation of 20 points.

The genetic trends were calculated from the means of the RBV results for individuals born in the same year. The annual genetic trend was defined as the genetic progress in genetic standard deviation units per year and computed by linear regressions of average RBV on birth year divided by 20 (genetic standard deviation). Annual genetic trend was computed for horses born 1991 to 2009.

3 Results and discussion

3.1 Statistical description of traits and heritability coefficients

Means, standard deviations, ranges of point scale and coefficients of heritability are presented in Table 1. Mean scores for the traits were in the range from 6.8 to 7.8 and the standard deviations were in the range from 0.8 to 1.1. To the model equation were gradually included the effects of age horses, sex, year*place of performance test, variety and stud. Fixed effects explained from 31% to 46% of the total variability. Most of variability (from 15% to 22%, depending on analysed trait) explained the effect of the year*place of performance test. Other effects explained from 1.5% to 3%. Reason for inclusion fixed effects of variety and stud is in history of Old Kladruber horse breeding because both variants were raised separately from 1945 to 2005. Vincente et al. (2014) indicated in the study of the Lusitano horses, preliminary analyses of the fixed effects for morphological and functional traits accounted from 14 to 35% of the phenotypic variability.

Heritability estimates ranged from 0.06 to 0.23. The highest heritability estimates were found for rideability and canter, 0.23 and 0.17 respectively. For the other gaits, estimates were 0.08 for walk and 0.12 for trot. Suontama et al. (2011) reported same range of heritability for gaits, 0.08 for walk and 0.19 for trot for Finnhorse and Standardbred trotter foals. On other hand, estimates of heritability in other studies were slightly higher. Estimates of heritability for gaits founded by Gerber Olsson et al. (2000) for Swedish warmblood horses were in the range 0.39–0.46; Viklund et al. (2008) published estimates of heritability in the range 0.37–0.45 for Young horse test.

There are three reasons why in the current study of Old Kladruber horse were obtained low estimates of heritability. Higher heritabilities of cited reports are obtained in most cases from station performance test which bring generally higher estimates of heritability. In the current study Old Kladruber horses are evaluated in field performance test. The second reason are relatively low standard deviations in all traits and it may suggest

Table 1 Descriptive statistics, heritability estimates and annual genetic progress for traits evaluated in performance test

Traits	Mean	s.d.	x_{min}	x_{min}	Heritability	Annual genetic progress
Overall impression	7.1	0.9	3	10	0.13	0.0004
Rideability	7.1	1.0	3	10	0.23	0.0016
Walk	6.8	0.9	3	10	0.08	0.0065
Trot	7.1	0.9	2	10	0.12	0.0124
Canter	6.8	0.9	1	9	0.17	0.0083
Dressage test	7.5	1.1	4	10	0.14	0.0095
Obstacle driving test	7.8	1.0	5	10	0.13	0.0045
Type and gender expression	7.1	0.8	3	10	0.16	0.0103

insufficient use of the whole range of score. Genetic variance between individual horses is reduced and it corresponds lower numeric value of heritability. Another reason for obtaining lower estimates of heritability is also pre-selection. Performance tests participate only 30% of the total population of Old Kladruber horses which could significantly affect the additive genetic variance and underestimated heritabilities.

3.2 Genetic trend of Old Kladruber horse

The genetic trends for all traits in Old Kladruber horse are presented in Figure 1, 2 and 3. All genetic trends were

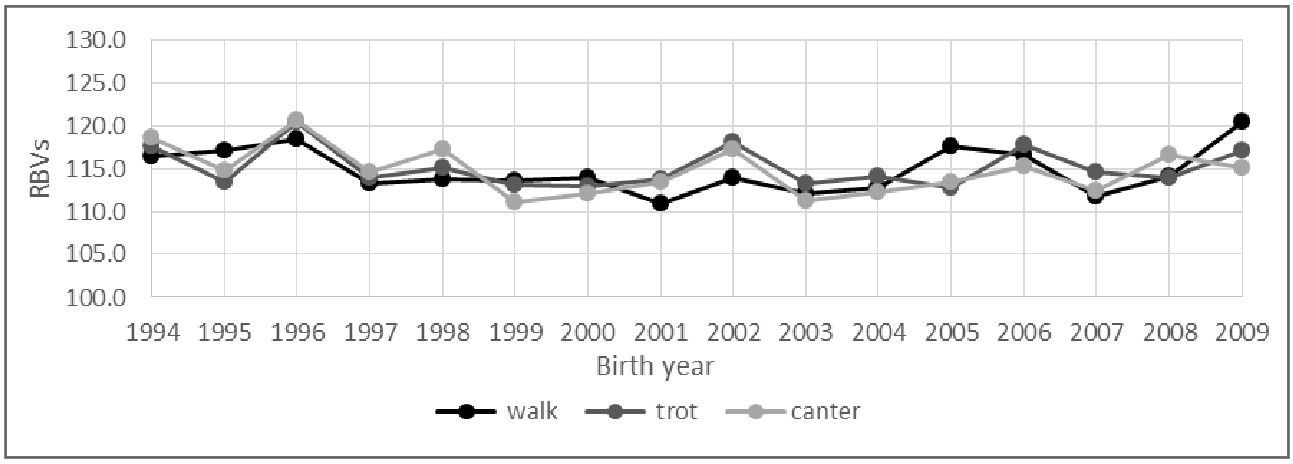

Figure 1 Genetic trend for gaits

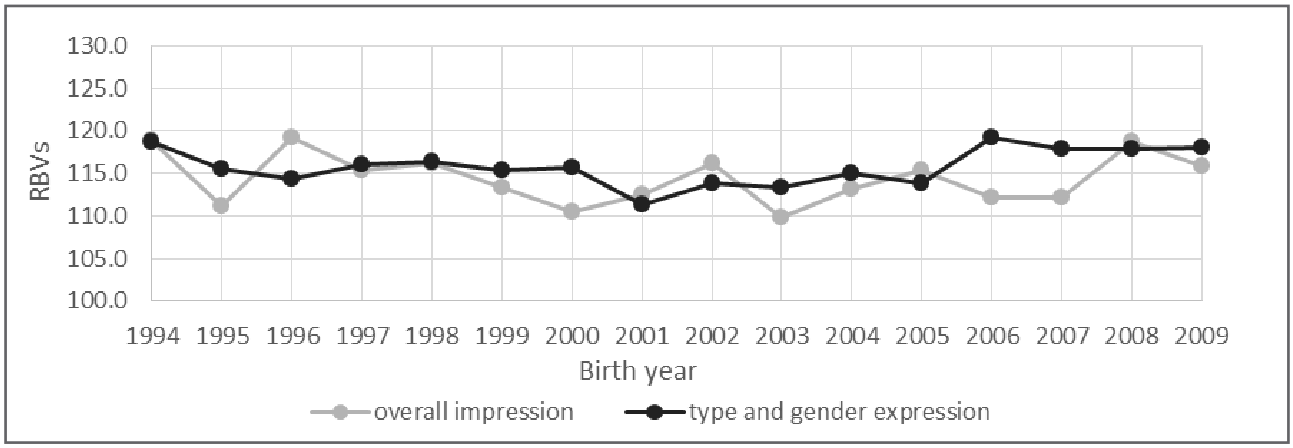

Figure 2 Genetic trend for overall impression, type and gender expression

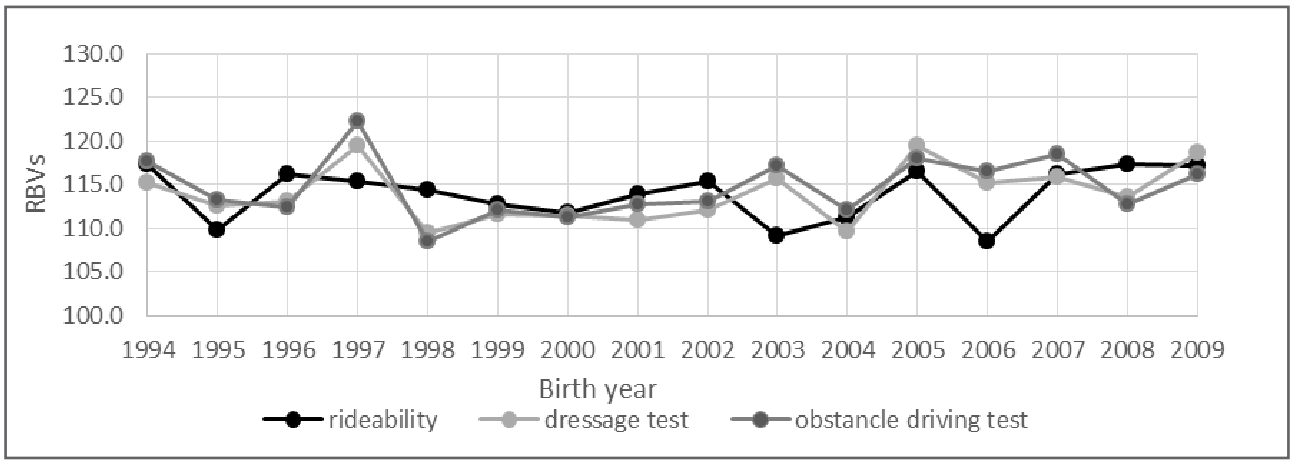

Figure 3 Genetic trend for rideability, dressage test and obstacle driving test

constant across time. From 1991 to 2009 the annual genetic change was close to zero for all traits (Table 1) except type and gender expression (0.0103) and trot (0.0124). Primal goal of breeding program of Old Kladruber horses is conservation of gene pool and maintaining the characteristics of the breed such as type and gender expression or trot (action of the legs, cadence). Increasing genetic change in type and gender expression and trot is undesirable phenomenon in view of conservation gene pool. On other hand if genetic progress is close to zero in other traits, they manage to fulfill a breeding program and conservation Old Kladruber horse in time. Viklund et al. (2011) reported that type is also strongly correlated to withers height. Over 45 years the breeding value for withers height in Swedish warmblood horses increased more than 2 cm which may be a consequence of the fact that owners want to have a good-looking and functional horse. Positive genetic change for trot may be associated with the use Old Kladruber horse in sporting events such as carriage driving and dressage. Vincente et al. (2014) reported quite modest genetic change in morphological traits (0.007–0.011), working equitation trials showed higher genetic change (0.029–0.072) in Lusitano horse population. Lusitano horse population have a little different selection program than Old Kladruber horse – the emphasis is mainly conformation and gaits. In recent years the goal is also improving performances in dressage, working equitation and carriage driving, increasing genetic change is positive factor in Lusitano horse breeding.

4 Conclusions

Heritability estimates were low (0.08–0.23) for all traits in performance test. Genetic trends were constant over the analysed period, annual genetic change were close to zero in all traits except type and gender expression and trot which is undesirable phenomenon in view of conservation Old Kladruber horse on type of galakarossier. Small genetic variability for all analysed traits in performance test suggested that primarily attention must be given to maintaining genetic variability and minimizing the rate of inbreeding in the population. Selection among horses using estimated breeding values would allow maintaining the characteristics of the breed such as type and gender expression or trot which is in accordance with the breeding objective.

Acknowledgments

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