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Genetic efficiency parameters of Slovak warm-blood horses

Abstract

The efficiency of 249 3- and 4-year old horses were analysed in this work during efficiency tests throughout the period 1993 – 2004. The ascertained average mark of 796 points for the whole population of 3-year old horses presents I. class, whereupon the highest mark of 8.32 points was reached in 2002 presenting the Elite class. The total mark moved within the bounds of 7.10 to 8.96 points, during variability of 4.86 %. The total mark of the population of 4-year old horses moved within the bounds of 7.00 to 8.60 points, during variability of 4.69 %, the average mark being 7.90 points presenting I.class. If we rate the average mark for „Type and sex type" throughout the period from 1993 – 2004 respecting the age of horses, we can claim that the 4-year old horses recieved higher marks /7.85 points/ than 3-year old horses /7.81 points/. The estimated coefficient of performance hereditary is 0.10. A higher positive relation was ascertained /$p \leq 0.001$/ between breeding values and estimation coefficients /riding, free jumping, show-jumping/ and the total mark/index.

Key Words: horses performance test, parameter estimation, jumping performance, Slovak warm-blood horse

Zusammenfassung

Titel der Arbeit: **Genetische Parameter von Leistungsprüfungen der Pferderasse – Slowakisches Warmblut**
In der Arbeit wurde die Leistungsfähigkeit von 249 drei- und vierjährigen Pferden während der Leistungsprüfungen in den Jahren 1993 – 2004 analysiert. Die festgestellte durchschnittliche Gesamtnote stellt für die ganze Population von dreijährigen Pferden mit einem Wert von 7,96 Punkten die I. Klasse dar, wobei sie im Jahre 2002 mit 8,32 Punkten den höchsten Wert erreichte. Dies stellt die Klasse "Elita" dar. Der Wert der Gesamtnote bewegte sich im Bereich von 7,10 Punkten bis 8,96 Punkten, bei einer Variabilität von 4,86 %. Die Gesamtnote bei der geprüften Population von vierjährigen Pferden bewegte sich im Bereich von 7,00 Punkten bis 8,60 Punkten bei einer Variabilität von 4,69 %, wobei ihr durchschnittlicher Wert 7,90 Punkte für die I. Klasse war. Wenn wir die durchschnittliche Note für den "Typ und Geschlechtsmerkmale" in der gesamten geprüften Zeit von 1993 bis 2004 – unter der Berücksichtigung des Alters der Pferde - insgesamt bewerten, so können wir feststellen, dass vierjährige Pferde höhere Punktebewertungen (7,85 Punkte) erreichten als dreijährige Pferde (7,81 Punkte). Der geschätzte Koeffizient der Erblichkeit für die gesamte Leistungsfähigkeit beträgt 0,10. Bei der Korrelationsanalyse wurde eine höhere positive Beziehung (p<-0,001) zwischen den Rassewerten und den Leistungsziffern "Leistungsfähigkeit"("Reiten", "Freisprung", "Parcours") und der Gesamtnote festgestellt.

Schlüsselwörter: Körung, Zuchtwertschätzung, Springleistung Slowakisches Warmblut, Pferd

Introduction

The efficiency of sport and racing horses is conditioned not only by the quality of his genofond but also by a large number of external factors. The dominant factors are mainly nutritin, quality of rearing, the standard of zootechnical care and, last but not least, also the quality of rider and trainer. Taking in consideration the small population of horses and a long generation interval in Slovakia, no breeder can rely on the way of screening his breeding horses. Various statistic methods of estimating breeding values, which clearly accentuate the road towards breeder´s success, help to determine the assumed profit of other types of farm animals.

Efficiency of horses is the main demand in all breeds with whatever purpose of use. And efficiency tests of breeding material are important for preserving and increasing the efficiency of horse-breeding (POPLUHÁR et al., 2002).

GOŠČÍK (1993) characterizes the efficiency of horse´s ability to perform and repeat a certain performance at a reasonably stable level. One ceratin performance is the criterion of efficiency, which can ascertain through :

1. trainer´s watchfulness (measuring height, lengh, etc.)

2. physiological ways (determinating the functional capacity of individual organs).

However, during jumping performances, the situation is more complicated. Studies in Canada, using highspeed cinematography, show that the chest limbs play a very important role in provoking initial vertical power and that they are indispensable. The supporting action of the front limbs change in a moment from a forward movement to a vertical impulse. During the jump, hind limbs take part in a synchronized and symmetrical action and enable the coordination of movement during the jumping phase (GOŠČÍK, 1993).

MISAŘ and JISKROVÁ (2001) state that the profitable qualities of horses are influenced not only by the surroundings but also by the polygene genetic information. Therefore, profitable qualities of different phenotypical values stand out in the consequences of various genotype values and different influences of surrounding conditions (SCHWARK et al., 1992; VON LENGERKEN and SCHWARK, 2002; SWALVE, 2002).

According to GELINGER (2001), the efficiency tests of sport stallions in Sweden are done at the age of 4-5 years old. The testing takes only one week but is usually repeated half a year after the first testing. The test includes performance with a rider, walking, riding and jumping ability. Later on, free jumping is also tested. Many studies had similar statements (SCHWARK et al., 1988; DIETL et al., 2004, 2005; EKIZ et al., 2005; POSTA et al., 2007).

MISAŘ and JISKROVÁ (2001) add, that the results of the efficiency tests form the ases for determing the breeding value estimation and include the genetic efficiency potential of horses and influences of non-genetic characteristics effecting the level of efficiency.

According to DUŠEK et al. (2002) the quotient conditioned by hereditary out of the total phenotypical changeability expresses the heritability.

In his studies, GELINGER (2001) writes that the correlation between trotting and efficiency in dressage competitions had a higher value (0.66) while walking had the lowest value. All the genetic correlations between jumping characteristics in SPT and in competitions were high (0.74 – 0.88). The genetic correlation between jumping with a rider and jumping competitions was the highest.

Apart from the system of estimating breeding values in Germany, BUGISLAUS et al. (2004) watched the heritability of individual characteristics applied throughout the estimation of breeding values.

The Swedish Warmblood Association also comments on the relatively low heritability of jumping techniques and jumping as so (0.15 – 0.2).

KOENEN (2002) mentions that the genetical rates for efficiency characteristics are based upon various results: Belgium, France and Ireland use only results from sport competitions, Denmark and Sweden use only results from performances, while

Germany and Netherland use both results from sport competitions and results from performances.

GROOT (2002) draws attention to the fact that the basic knowledge of genetic parametres is the hypothesis for effective selection, rating of various breeding plans and for prediction of valuable breeding candidates for selection. Due to GROOT (2002), the horse´s performance is predetermined by its build. Using information about the horse´s build, indirect choice for efficiency characteristics can be useful even though the heritability of these characteristics is low (0.19 – 0.47) and can be measured later on during life. In the KWPN (Royal Warmblood Studbook of the Netherlands) breeding scheme mares are classified at the age of 3 years and older before being entered into breeding books. PETZOLD (1991) described the application of rthe BLUP-method for the evaluation of the breeding value in horse breading of Europe. JAITNER and REINHARDT (2003) mention that on the German Equistrian Federation´s suggestion, a new sytem of horse estimation was developed and introduced. The estimation is done yearly using the BLUP – Animal method, which uses not only data of horses active in sport but also results of their own efficiency tests, which are registered by the breeding association. The authors continue to describe the estimation of horses in Germany, which is in detail and thoroughly worked out. This estimation goes into deep details because 15 characteristics (estimated during efficiency tests) enter this estimation of breeding values, which serves for genetic estimation.

The estimation of strong individuals, in accordance to the quality of their descedants, is the best coefficient of their real breeding value. But, at the moment, it is the hardest, most difficult and the least revised way. The problem is, that stallions and mares can be evaluated at an older age through their descendants and it is not always possible to secure the same conditions, which would help to correctly deduct and bring to order the conclusions about breeding values (HALO et al., 2004, SWALVE, 2002). The aim of this work is the analysis and evaluation of the efficiency test results of Sloavak warmblood horses.

Materials and Methods

On the basis of results and efficiency results of descendants, siblings and half-siblings we estimated horse´s genetic parametres and breeding values. The results from efficiency tests of Slovak warmblood stallions done during the period 1993 – 2004 were used to process all the above mentioned data. The basic data were the points for each individual efficiency coefficient of 149 stallions, which took part in efficiency tests during the mentioned period of time.

The following traits were used:

a, type and sex type

b, exterior – figure, carriage, overall looks

c, efficiency – rideability, movements-walk, trot, gallop, free jumping, showjumping

d, total mark – outcoming classification

Only horses, which fulfilled the following requirements, were analysed:

- they were registered by the Central register office

- they had two-sided known and confirmed origin

- they had complete data of efficiency tests

- their precise data of origin and date of birth were available
Used were Microsoft EXCEL programme for processing all data. Individual data were modificated and completed in Microsoft ACCES programme.Similar statistical-analytical processing was in progress in the SAS programme (The SAS Systeme v.8.02).

Used were a modal equation to analyse factors, which influenced the coefficients of stallions taking part in the efficiency tests:

$Y_{ijklm} = \mu + PL_i + L_j + P_k + V_1 + R_m + E_{ijklm}$

where:

Y_{ijklm}	= evaluated coefficient (a certain / particular coefficient)
PL_i	= firm / solid breeding effect
L_j	= firm figure effect
P_k	= firm sexual effect
V_1	= firm age effect
R_m	= firm effect of the year when efficiency tests took place
E_{ijklm}	= residual effect

Used were a modal equation to estimation genetic parametres and breeding values, which influenced the coefficients of stallions and mars taking part in the efficiency tests:

$Y_{ijklmn} = \mu + PL_i + L_j + P_k + V_1 + R_m + A_n + E_{ijklmn}$

kde:

Y_{ijklmn}	= evaluated coefficient /a certain / particular coefficient/
PL_i	= firm / solid breeding effect (i = 1 .... 7)
L_j	= firm figure effect (j = 1 .... 17)
P_k	= firm sexual effect (k =1, 2)
V_1	= firm age effect (l =1, 2)
R_m	= firm effect of the year when efficiency tests took place (m = 1 .... 12)
A_n	= accidental effect animal (n = 1....1209)
E_{ijklmn}	= residual effect

A single-mark Animal Model was used for estimating genetic parametres and breeding values.
Used were BLUP Animal modelom for estimation genetic parametres and breeding values.

Results

It can state that during the evaluation of warmblood horses, the stallions recieved the highest mark in 1993 for coefficient „Type and sex type", the average mark for this coefficient reached the rate of 8.16 points, similar tendencywas preserved throughout the years 1994, 2000 and 2002, when the diversion from this rate moved between 0.08 to 0.14 points(Figure 1). The highest marks for „Type and sex type" were given to these stallions: Przedswit XVII-24 (8.80 points – 1993), Rif du Madon-67 (9.00 points – 1994), Dante (8.52 points – 2000) and Furioso XXI-24 (8.44 points – 2002).
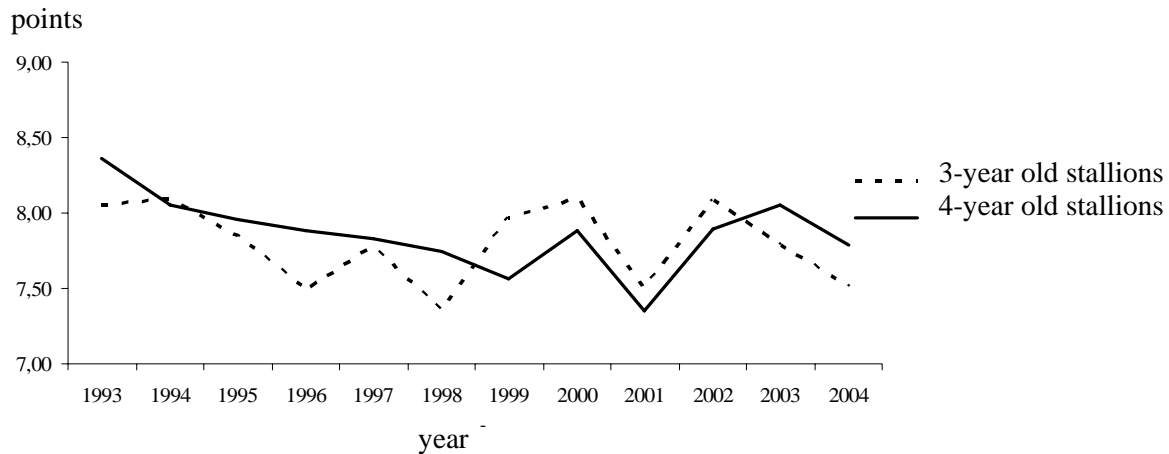
Fig. 1: Evaluation of average marks for „Type and sex type" on 3- and 4-year old warmblood stallions (Bewertung der durchschnittlichen Noten für „Typ und Geschlechtsmerkmale" bei einzelnen Jahrgängen der 3- und 4-jährigen warmblütigen Hengste)

The year 2001 was evaluated the lowest, when the average mark reached the point rate 7.41 points, whereupon the highest mark 7.88 points was reached by the stallion Darling III. and the lowest 6.88 points by the stallion Pado.

All in all, if we evaluate the average mark for „Type and sex type"and „Exterior" throughout the period of 1993 – 2004 and take into consideration the ages of the stallions, it can see that the 4-year old stallions recieved higher point rates (7.85 points) than 3-year old stallions (7.81 points).

Therefore, on the basis of this analysis, it can state that even though the difference between the two following marks is relatively low (only 0.06 points), 4-year old stallions reached better results during evaluation of the coefficient „Exterior" and is well-documented by the average mark 7.75 points and 3-year old stallions recieved 7.69 points. The next and most important evaluated coefficient is efficiency, during which it aimed the attention onto smaller parts, such as rideability, movement, free jumping and show-jumping. The average mark reached the rate of 8.05 points, whereupon the mark for each single year moved in-between 7.74 to 8.39 points (Figure 2).
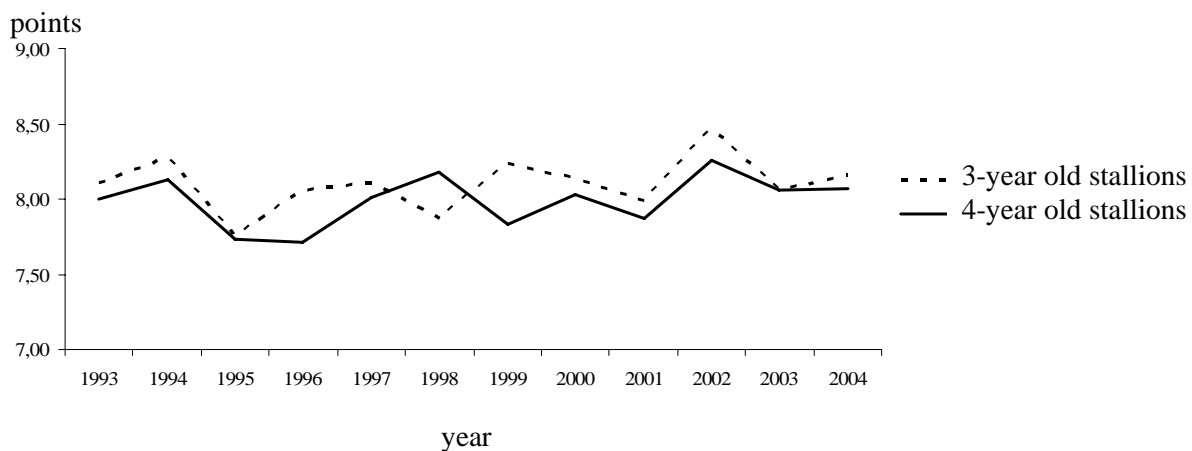

Fig. 2: Rating evaluation of average marks for „Efficiency" of 3-4 year old warmblood stallions (Bewertung der durchschnittlichen Noten für die „Leistungsfähigkeit" bei einzelnen Jahrgängen der 3- und 4-jährigen warmblütigen Hengste)

It can say that the efficiency of 3-year old stallions, studied during the mentioned period, reached higher point rates than the efficiency of 4-year old stallions and is well documented in Figure 2. The year 1998 was an exception, when the valuation of the average mark (8.18 points) of 4-year old stallions exceeded the point rates of 3-year old stallions (7.87 points).

On the basis of this rating, one can see that for the coefficients „Type and sex type" and „Exterior", 4-year old warmblood sport stallions reached higher average markings during the period from 1993 to 2004, than 3-year old warmblood sport stallions, even though their efficiency lagged behind the efficiency of the 3-year old.

For the evaluated group of horses: 159 stallions and 90 mares, we have analysed the factors, which had influence on the studied coefficients, evaluated the phenotypical correlation between them and estimated the genetic parametres for these characteristics. Amongst the factors-firm (solid) effects,which had important influence upon the „Type and sex type" and „Exterior", belong: breed, figure and year of efficiency test. The highest level of importance was occupied by figure and year of eeficiency test and is duly documented (Table 1).

Table 1

Factors, which had influence on individual efficiency coefficients (Auf einzelne Leistungskennziffern einwirkende Faktoren)

Efficiency coefficient	Influential factors	F rate	Pr > F
Type and sex type	Breed	4,46	0,0003
	Figure / frame	2,94	0,0002
	Sex type	1,64	0,2018
	Age	0,28	0,5998
	Year of efficiency test	3,7	< 0,0001
Exterior	Breed	3,31	0,0039
	Figure / frame	3,68	< 0,0001
	Sex type	0,77	0,3827
	Age	2,28	0,1329
	Year of efficiency test	5,37	< 0,0001
Efficiency	Breed	2,24	0,0408
	Figure / frame	2,14	0,0079
	Sex type	11,28	0,0009
	Age	2,01	0,1574
	Year of efficiency test	2,59	0,0042
Total mark / index	Breed	2,4	0,0287
	Figure / frame	2,91	0,0002
	Sex type	3,94	0,0484
	Age	0,17	0,6844
	Year of efficiency test	4,31	< 0,0001

$-$ P > 0,05; + P ≤ 0,05; ++ P<0,01; +++ P< 0,001

Efficiency, as the most important coefficient, had statistically proved factors: breed with F rate of 2.24 points, figure with rate of 2.14 points, sex expression with rate of 11.28 points and year of eficiency test with rate of 2.59 points.

Sexual expression and year of efficiency tests highly influenced coefficients of efficiency „Rideability" and „Movement", whilst figure also influenced „Rideability". The coefficient „Free jumping" was, as one and only, influenced by age

factor 97.64 %. We can say that during „Free jumping" only one figure wasn´t documented, Show-jumping was mainly influenced by the breed 92.48 % (Table 1). The analysis of influental factors states that the only coefficient not statistically proved was the horse´s age, whereas the coefficients figure and year of efficiency tests were statistically highly proved. If it were evaluate the phenotypical correlation between individual efficiency coefficients, we find out that the biggest correlation 0.8573 was between the „Type and sex type" and „Exterior". The lowest 0.0948 was between the „Type and sexual type" and particle coefficient „Rideability", which influenced the horse´s efficiency the most 75 %. Efficiency, which up to 82.35 % influences the total marking, had the lowest correlation 0.2727 with the horse´s exterior (Table 2).

Table 2
Phenotypical correlations of individual efficiency coefficients (Korrelationen des Phänotyps bei einzelnen Leistungskennziffern)

Coefficient	Type	Exterior	Efficiency	Total mark / Index
Type	1	0,8573	0,2837	0,7325
		< 0,0001	< 0,0001	< 0,0001
Exterior	0,8573	1	0,2727	0,7156
	< 0,0001		< 0,0001	< 0,0001
Rideability	0,0948	0,1162	0,7571	0,5739
	0,1498	0,1811	< 0,0001	< 0,0001
Movements	0,2764	0,2311	0,4872	0,4622
	< 0,0001	0,0001	< 0,0001	< 0,0001
Free Jumping	0,1024	0,1142	0,6357	0,4884
	0,0233	0,0172	< 0,0001	< 0,0001
Show-jumping	0,1749	0,1783	0,5820	0,5018
	0,0059	0,0026	< 0,0001	< 0,0001
Efficiency	0,2837	0,2727	1	0,8235
	< 0,0001	< 0,0001		< 0,0001
Total/overall mark	0,7325	0,7156	0, 8235	1
	< 0,0001	< 0,0001	< 0,0001	

$-$ P > 0,05; $+$ P ≤ 0,05; $++$ P<0,01; $+++$ P< 0,001

During the correlation analysis of individual efficiency coefficients and breeding values we estimated a positive relationship between the breeding values and efficiency coefficients „Efficiency" (rideability, free jumping, show-jumping) and the total mark against the coefficient „Type and sexual type", „Exterior" and particle coefficient of efficiency „Movement" (Table 3).

From the ascertained results it were estimated the following coefficients of heritability for individual rated coefficients:

Coefficient	h^2
Type and sex type	0.16
Exterior	0.41
Efficiency	0.10
Rideability	0.52
Movement	0.51
Free jumping	0.57

Show-jumping   0.32
Total mark   0.43

Table 3
Correlations of estimated breeding values of sport stallions and mares and individual efficiency coefficients (Korrelationen der geschätzten Rassewerte bei Sporthengsten und Sportstuten zu einzelnen Leistungs-kennziffern)

Coefficient	BV /breed. values/	Average PB	Type	Exterior	Efficiency	Total mark / index
BV /breeding values/	1	0.84596 <.0001	0.16770 0.2444	0.21980 0.1251	0.33050 0.0191	0.29786 0.0357
Average PB/?/	0.84596 <.0001	1	0.09971 0.4908	0.09798 0.4984	0.27347 0.0546	0.22021 0.1244
Type	0.16770 0.2444	0.09971 0.4908	1	0.88080 <.0001	0.21647 0.1311	0.70479 <.0001
Exterior	0.21980 0.1251	0.09798 0.4984	0.88080 <.0001	1	0.24616 0.0849	0.71044 <.0001
Efficiency	0.33050 0.0191	0.27347 0.0546	0.21647 0.1311	0.24616 0.0849	1	0.80556 <.0001
Rideability	0.36020 0.0102	0.18412 0.2006	-0.08769 0.5448	0.03686 0.7994	0.73238 <.0001	0.44045 0.0014
Movement	-0.03612 0.8034	-0.03523 0.8081	0.23034 0.1076	0.23536 0.0999	0.42439 0.0021	0.40054 0.0039
Free Jumping	0.20779 0.1476	0.23572 0.0994	0.25872 0.0697	0.14652 0.3099	0.52041 0.0001	0.45483 0.0009
Show-jumping	0.38642 0.0056	0.40645 0.0034	0.08373 0.5632	0.15011 0.2981	0.75752 <.0001	0.56212 <.0001
Total mark / index	0.29786 0.0357	0.22021 0.1244	0.70479 <.0001	0.71044 <.0001	0.80556 <.0001	1

$-$ P > 0,05; + P ≤ 0,05; ++ P<0,01; +++ P< 0,001

Discussion

In agreement with CHRISTMANN´s opinion (1996) that the most important hypothesis for keeping a horse healthy and efficient is a particular dressage, which teaches the horse to be independently rideable, under control, willing to go forward at a required speed and easily do all basic exercises. It can prove it with the results of the analysis of the efficiency test results where the phenotypical correlation between „Efficiency" and particle efficiency coefficient „Rideability" had the highest value 0.7571 and was on the level of importance < 0.0001, highly statistically documented. HANUŠOVÁ (2003) was dealing with efficiency tests in Germany and due to her, the stallions enter the tests at the age of 4years, the result is corrected, lowered by 5 %, so that they can be compared with 3-year olds. On the basis of the present analysis where we found out that the horse´s age statistically documented (97.64 %) influenced only free jumping in benefit of the 3-year old stallions and that 3-year old stallions averagely reached higher efficiency,mainly in free jumping,the same as 4-year olds. This way of evaluation should be introduced in our country.

As MISAŘ and JISKROVÁ (2001) mention, the results of the efficiency tests are numerical basis for determining the valuation of breeding values and they include the genetic potential of efficiency and non-genetic influences having influence on the level of efficiency.

In agreement with the authors and from the present results it can conclude that breed, horse´s figure and year of efficiency test did have influence on the individual efficiency coefficients „Type and sexual type" and „Exterior" statistically documented. Also the sex had influence on the efficiency-documented. The factor „Horse´s age" was on the level of importance < 0.05 only in the particle efficiency coefficient „Free jumping".

For the rated samples of horses it were evaluated the extent of heritability, which, due to Christmann (2004) expresses with what genetic power will the given characteristics be handed over to the next generation. In the first case it was rated at 0.11 and in the second case it was rated at 0.23. That means, that on the basis of CHRISTMANN´s distribution, we can regard this as insignificant or average. JISKROVÁ (2002) acquired a similar value of efficiency heritability during calculations on a Czech warmblood horse.

CHRISTMANN (2004) states the extent of heritability: 23 % Type and sexual type, 29 % rideability, 40 % free jumping.

According to DUŠEK et al. (2001) the coefficient-heritability of movement – has a higher value (0.5 – 0.6). Estimated coefficient in the present study had a very similar value (0.51). SHADE et al. (1994) mentions in his studies of genetic parametres for jumping efficiency of Hannover stallions and mares, which underwent a 100 day test, these following coefficients of heritability:free jumping 0.41 – 0.57, jumping with rider 0.20 – 0.31. DIETL et al. (2005) estimate values of 0.54 and 0.14 for free jumping respectively ride ability. Our population had the values: free jumping 0.57 and jumping with rider 0.32.

We agree with ALDRIDGE´s (2002) statement, that for the efficiency characteristics, genetic evaluation is established on various results: Belgium, France and Ireland use only competition results, Denmark and Sweden use only performance results, while Germany and Netherland combine competition and performance results. In the present study too tried to evaluate the performance characteristics from performance results of stallions and mares, which had to have aknowledged origin on both sides, because as DUŠEK et al. (2001) claims, the pedigree is an important document and can be used to a certain extent for estimating the breeding value of a horse.

This presented work estimates the main genetic parametres of Slovak warmblood horses, which are the primeval complex of evaluation of the given breed. At the same time it renders phenotypical analysis throughout efficiency tests and points out the genetic trend amongst the mentioned population of horses. Selective criteria will be proposed on the basis of these results for choosing breeding material for Slovak warmblood horses.

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