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Performance Characteristics of Czechoslovak Trotters with Respect to their Age

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In recent years in Czechoslovakia more and more races of trotters have been organized; this is the reason why the importance of trotter breeding has been growing. The basic stocks of trotter mares in the Czech and Slovak Federal Republic have increased; it is therefore necessary to objectivize racing performance characteristics as a basic prerequisite of successful and efficient selection.

In Czechoslovakia racing performance of trotters is given by the best racing time achieved in the horse's life, converted per 1km distance. In this form it is used as the main criterion of selection, breeding work and heredity control. No exacter evaluation of the characteristics of racing performance of Czechoslovak trotters with respect to the effect of horse age has been available up to now; this is the objective of the present study. The results are to be used for current selection work and first of all for exacter determination of breeding classes of the present implementation of heredity control in trotter breeding. This criterion should be further objectivized in future and new methods of heredity control should be developed (using first of all the BLUP method); it is also necessary to test the correction for the effect of age as a constant effect.

Literary documentation, concerning trotter performance in Czechoslovak conditions, is scarce because the small herds of trotters kept in Czechoslovakia have not been able to provide enough data for analyses.

Trotter performance belongs to the complex of characteristics and traits with low to medium heritability, as documented also by a number of researchers.

The proper evaluation of the best racing times which is performed in trotter breeding in this country and in most foreign countries does not mostly include previous corrections; in this form it is used as a criterion of the estimate of breeding value of the horse.

Besides the best racing time, other characteristics of trotter performance are evaluated, having different degrees of heritability. A survey of these characteristics is presented by Hintz (1980). The sum of prizes won, or of their logarithms, and average times can be mentioned for illustration. Their comparison (including the best time achieved in the Netherlands) is given by Minkema (1975, 1976a, 1976b). Rönningen (1975) offers a comparison of the heritability of yearly prizes, average prize per start, percent of wins and the best time achieved in Swedish conditions.

The effects on trotter performance were investigated as follows: age, sex, track quality, racing year, starting position and racing season.

Katona, Osterkorn (1977) published slower times of younger animals. They mentioned a time difference of 3.2 sec between two-year and ten-year German trotters. Younger horses had also worse values of the best times. There was recorded a time difference of 34.7 sec between three-year and twelve-year North Swedish trotters. The percentage of won races was considerably higher in older trotters. Jelínek (1984) wrote about a similar development of the age performance curve as about an orientation finding of the quality analysis of trotter mares in the CSFR.

The effect of age on the best times achieved by trotters in Belgium was demonstrated by Leroy et al. (1989); he found out that the peak performance was attained at the age of 7.5 to 8 years. The effects of sex, distance and track quality are also very important, and they must be evaluated first of all in the Czechoslovak conditions.

Rönningen (1975) mentioned that stallions reached the best times faster by 1.6 sec in comparison with mares; this was also reflected in the finish time better by 1.2 sec as commented by Katona, Osterkorn (1977). All these facts are confirmed by the higher yearly sum of prizes won (Rönningen, 1975).

Katona, Osterkorn (1977) evaluated the effects of track quality, distance and temperature; the finish times of trotters were found to be influenced by the track quality, the difference being 3.65 sec for fast tracks, unlike slow tracks. At the same time there was recorded an advantage of 2.25 sec in races at the distance to 1900 m, in comparison with the races to 2200 m and longer. An advantage o 1.9 sec was observed at the temperature

lower than 0 °C, in comparison with the temperature higher than 30 °C. The effect of the starting position on the value of finish time was not demonstrated in the races described by the above-mentioned authors.

Material and Methods

The racing track at Velká Chuchle-Prague is under reconstruction; this is the reason why the selection of data to be used was restricted to the time period after 1980. If the performance characteristics from earlier periods were used, there would be an unobjective increase in variability and the results would not be exact enough.

The small population of horses that could be used is a limiting factor of the methodical procedure and of the objectivity of some findings; in some cases the conclusions are hard to define or are of orientation nature, and if they are to be applied to breeding practices, it will be necessary to perform other investigations when greater sets of input data will be collected.

In the present paper all trotters and starts in the CSFR from the beginning of the 1980 racing season to the end of the 1988 season were investigated (trotter carrier beginning at the age of two years), that means the data on eight racing seasons. The proper evaluation of the trotter population included the following performance factors at different degrees of objectivity and respecting the frequencies of data: sex, age, race-course, and partially distance and track quality. The effects of years, trainer, stallion, rider, starting position could not be included into this evaluation. Neither were evaluated the trotter starts on other race-courses (outside Prague and Bratislava). One start of the horse (variant a) and the best racing time in a year (variant b) were taken as the basis of evaluation. The objective of our evaluation was to find out the effect of age on the racing performance of trotters, given by 1km time, in the conditions of the Czechoslovak races. At the same time a relationship between the best and average 1km time in trotters was estimated from the three best times.

The test population of trotters comprises 210 horses with 6160 starts.

The horses were chosen as follows to evaluate the relationship between the average of the three best 1km times and the best lifetime 1km time, applying different correlations:

a) All horses in Prague and Bratislava from the given eight-year period, regardless of age, with at least ten starts.
b) Horses with at least ten starts in Prague (the starts in Bratislava are not included).

c) Three-year, four-year and five-year horses, respectively, with at least ten starts at their age, regardless of the race-course.
d) Three-year, four-year and five-year horses, respectively, with at least ten starts at their age, only on the race-course in Prague.

The average 1km time was determined from the three best starts of the horse and the best 1km time, and then the correlations were calculated from a generally known formula of correlation coefficient (r) and the significance of this coefficient was tested.

The effect of age on performance was evaluated in two variants: with respect to individual starts and with respect to the best starts in the given year. The horses with the performance longer than two years in 1980 were excluded from the test population in order to prevent the distortion of age curves.

Each start was evaluated in relation to the day of life of the given horse: a difference was calculated between the date of birth and the date of realized performance. Quadratic regression curves were fitted through the points representing the age-corrected performances (with respect to the type of correlation field) according to different classifications of the population. The least-squares method guarantees the optimum fitting of these curves in the correlation field, and its calculated minimum (derivative) determines the peak of phenotype performance in the given type of classification of the population in both demonstrated variants. This method of calculation is described by R e k t o r y s et al. (1973).

The strength of prediction closeness between the growing age and the respective racing performance, characterized by the corresponding regression curve, was quantified in form of correlation index as the square root of determination index.

I. Closeness of relations between the average of the three best times and the best time in the horses which had at least ten starts

Method of classification	Number of evaluated horses n	Correlation coefficient r
a) Whole population	164	+0.97++
b) Prague	113	+0.97++
c) Three-year horses	64	+0.97++
Four-year horses	88	+0.98++
Five-year horses	66	+0.98++
d) Prague, three-year h.	16	+0.98++
four-year h.	20	+0.98++
five-year h.	28	+0.99++

Correction factors were proposed for individual phases of the age period of trotters in the Czechoslovak conditions with respect to the peak of age performance curve. A defined difference of respective points of the curves from the chosen age of approximate performance peak is a basis of the proposals of these corrections.

The results were confronted with the present scale of classification of mares in breeding classes with respect to performance, and conclusions were drawn.

Results and Discussion

Relationship of the best and average 1km time

The calculated correlation coefficients r, with respect to the classification mentioned in the methodical procedure a - d, are presented in Tab. I.

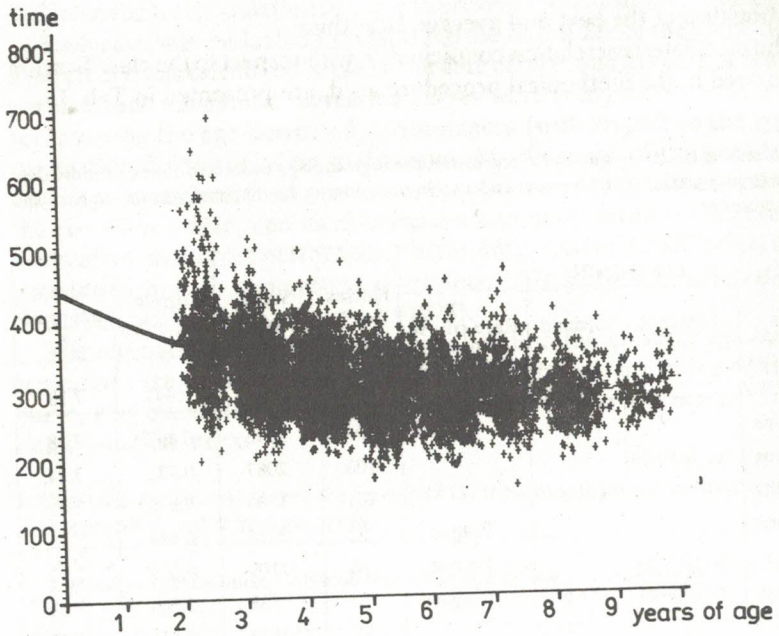
II. The results of fitting quadratic regression through the age corrected times of individual starts (n_1) according to the sex, and also in dependence on distance, ground quality and race-course

Limiting effects				Horses n	Starts n_1	Correlation index	Calculated peak *
Sex	Distance	Ground	Race-course				
Stallions and mares	-	-	-	210	6160	0.441	7.18
Stallions	-	-	-	107	3546	0.467	7.28
Stallions	to 1850 m	-	-	103	2087	0.532	7.34
Stallions	-	G+S	-	101	1186	0.578	7.41
Stallions	-	-	Prague	92	2038	0.444	7.15
Stallions	to 1850 m	-	Prague	89	1109	0.505	7.12
Stallions	to 1850 m	G+S	Prague	81	538	0.566	7.12
Mares	-	-	-	103	2614	0.401	6.24
Mares	to 1850 m	-	-	101	1572	0.455	6.29
Mares	to 1850 m	G+S	-	96	941	0.477	6.45
Mares	-	-	Prague	94	1278	0.377	5.97
Mares	to 1850 m	-	Prague	91	741	0.438	5.89
Mares	to 1850 m	G+S	Prague	80	381	0.469	6.03

Note: * - Calculated peak of age performance curve (derivative of the function)
G - good ground, F - soft ground

1. Graphical representation of quadratic regression in the whole population of stallions and mares

Number of horses 210
Number of starts 6160
Quadratic regression $a+bx+cx^2$
a = 446.47702
b = -44.63586
c = 3.10857
Correlation index = 0.44070
Derivative of the function = 7.18

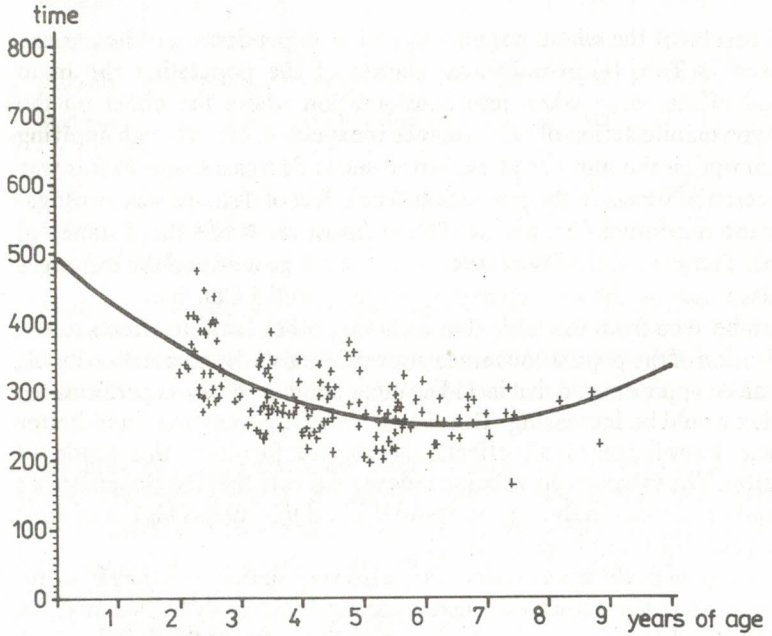


Differences from the age of six years

Difference 6 years - 2.0 years	7.9 s	
Difference 6 years - 2.5 years	6.4 s	
Difference 6 years - 3.0 years	5.0 s	2.9 s
Difference 6 years - 3.5 years	3.8 s	
Difference 6 years - 4.0 years	2.7 s	2.3 s
Difference 6 years - 4.5 years	1.8 s	
Difference 6 years - 5.0 years	1.0 s	1.7 s
Difference 6 years - 5.5 years	0.4 s	

2. Graphical representation of quadratic regression in the set of the best times of mares with finished career of at least two to five years of age

Number of horses 31
Number of starts 148
Quadratic regression $a+bx+cx^2$
a = 496.16403
b = 77.96403
c = 6.14704
Correlation index = 0.62578
Derivative of the function = 6.34



Differences from the age six years

Difference 6 years - 2.0 years	11.5 s	
Difference 6 years - 2.5 years	9.0 s	
Difference 6 years - 3.0 years	6.8 s	4.7 s
Difference 6 years - 3.5 years	4.9 s	
Difference 6 years - 4.0 years	3.3 s	3.5 s
Difference 6 years - 4.5 years	2.0 s	
Difference 6 years - 5.0 years	1.0 s	2.3 s
Difference 6 years - 5.5 years	0.4 s	

The results indicate that in all classifications there was demonstrated the high and highly significant closeness of the relation between the average time of the three best starts and the best 1km time recorded in trotters. It can be stated that the evaluation of horses according to the best time fully replaces the evaluation by means of average times and it is a corresponding selection characteristic of performance that must be corrected by some fixed effects, like e. g. the effect of age, race-course, ground, if the estimate is to be exact.

a) Variant of classification according to individual starts

The results of the whole population and in dependence on the sex are presented in Tab. II. In individual classes of the population the main expected effects were taken into consideration where the effect on the phenotype manifestation of performance is expected, even though applying this assumption the number of evaluated starts decreases, and in this way the representativeness of the population. The effect of distance was investigated for the maximum distance of 1850 m (most races had the distance of 1600 m). The ground quality means good and soft ground and the test races took place only on the race-course in Prague - Velká Chuchle.

It can be seen from the table that including other limiting effects to the classification of the population increases considerably the correlation index, and it can be approximated that including other limiting effects on performance the index would be increasing. The size of the test population - and better or worse knowledge of all effects - does not facilitate this mode of evaluation. The values of correlation indexes indicate that the closeness lies in a number of cases in the region above 0.5 and this means high statistical dependence (G r o f í k et al., 1987).

The peaks of performance curves are also very similar and they indicate that the mare performance culminates earlier (maximally by one year) in comparison with the stallion performance; to some extent this is influenced by the mare earlier leaving of race-courses due to their future pregnancies. The pattern of the age curves can be seen in Figs. 1 and 2. The graphs of the other curves are available in the author's material.

b) Variant of classification according to the best yearly times

The results of the calculations of quadratic regressions according to the best yearly time are presented in Tab. III. This variant of evaluation did not either offer quite different results. The peaks of stallion curves, if compared

III. The results of fitting quadratic regression through the best yearly times of the horses of the test population (n_1) according to the sex and also in dependence on distance, ground quality and race-course

Limiting effects				Horses n	Starts n_1	Correlation index	Calculated peak *
Sex	Distance	Ground	Race-course				
Stallions and mares	-	-	-	210	707	0.519	6.99
Stallions				107	391	0.554	7.13
Stallions	to 1850 m			103	381	0.536	7.22
Stallions	to 1850 m	G+F		101	352	0.573	7.04
Stallions	to 1850 m	G+F	Prague	81	230	0.561	6.69
Mares	-	-	-	103	314	0.495	6.45
Mares	to 1850 m	-	-	101	305	0.477	6.77
Mares	to 1850 m	G+F		96	285	0.484	6.98
Mares	to 1850 m	G+F	Prague	80	172	0.501	6.45

Note:* - Calculated peak of age performance curve (derivative of the function)

with those of mare curves, are delayed, and they do not vary in principle when different variants of classification are used. But the correlation indexes increased: this means a decrease in variability because worse starts were excluded which could often be distorted by some other (sometimes even subjective) influences.

The increase in the correlation index, and gradual inclusion of other limiting effects, is in good agreement with the calculation of the first variant of classification, i. e. according to all starts.

In order to determine an explicit pattern of performance curves and respective correction factors, it would be necessary to evaluate such a large population of horses where only would those horses be included in which the whole pattern of racing performance is known, at least from two to eight years. To achieve exacter results we tried to select first of all those stallions which have the results of their performance from at least two to seven years in each year. In this case the number of animals dropped to 27 horses with

191 starts. The correlation index increased to 0.632, no other effects being taken into consideration. The peak of performance curve had the value of 7.56 years and it corresponded with the previous results and finding mentioned in the paper by L e r o y et al. (1989).

A similar situation is observed in mares; only five animals with 32 starts could be selected here, the correlation index exceeded the limit of high closeness of the relation and reached the value of 0.840. The reason why such a small population of mares could be selected was that most of the good mares finish their career rather early due to their future pregnancies. Therefore the minimum known performance from two to five years could be considered and the index of correlation decreased. Using this period of racing performance, the population comprised 31 mares with 148 starts and the value of correlation index was 0.626; this index is comparable with the above-mentioned result of stallions and it approaches the limit of high closeness. The peak of age performance is 6.34 years and in this case it is also by one year lower than in stallions.

The pattern of age performance curves is also documented by the finding described in the paper by e. g. P e r s s o n (1989); a physiological increase in hemoglobin content was demonstrated in dependence on age, culminating at the age of five years. This dependence was demonstrated in Swedish trotters in a trainer where they were exposed to standardized load and it expresses the oxygen transport capacity of blood because each gramme of Hb binds 1.36 ml of oxygen (Mc M i k e n , 1983).

Correction factors of performance

When proposing the correction factors determined from the pattern of individual curves describing different variants of classification, the hypothesis was used that the peak of performance of Czechoslovak trotters is at the age of about six years; this is the reason why the differences were determined with respect to this age; this is the age which need not be corrected (even though the value of exact calculation is higher).

The curves which were used for estimates of corrections, their description (including calculated differences), are given in Tab. IV. It can be seen from the results that the curves can be used for proposing the minimum factors of performance correction to the expected optimum value in Czechoslovak conditions at the horse age of about six years although the patterns of these curves are rather different. If the results of stallion classification B, C and D are compared, it can be stated that there are no great differences between

IV. Differences between the age and the approximated peak of performance at the age of six years

Calculated difference from six years	Method of classification of the population						
	A	B	C	D	E	F	G
Two-years old	7.91	8.14	8.40	8.84	7.92	8.93	11.52
2.5 years old	6.37	6.58	6.76	7.19	6.16	7.03	9.00
3 years old	5.00	5.17	5.29	5.70	4.61	5.35	6.79
3.5 years old	3.78	3.92	3.99	4.36	3.29	3.90	4.89
4 years old	2.71	2.85	2.86	3.18	2.19	2.67	3.30
4.5 years old	1.80	1.89	1.89	2.15	1.31	1.67	2.01
5 years old	1.04	1.10	1.09	1.28	0.66	0.89	1.03
5.5 years old	0.44	0.47	0.46	0.56	0.22	0.33	0.36

A = whole population, $n = 210$, $n_1 = 6160$, index $r = 0.47$, Fig. 1
B = whole population of stallions, $n = 107$, $n_1 = 3546$, index $r = 0.47$
C = best times - all stallions, $n = 107$, $n_1 = 391$, index $r = 0.55$
D = best times - stallions with the complete curve from two to seven years, $n = 27$, $n_1 = 191$, index $r = 0.63$
E = whole population of mares, $n = 103$, $n_1 = 2614$, index $r = 0.40$
F = best time - all mares, $n = 103$, $n_1 = 313$, index $r = 0.49$
G = best time - mares with the complete curve from two to five years, $n = 31$, $n_1 = 148$, index $r = 0.63$, Fig. 2

them even though the correlation indexes are different. The somewhat lower difference recorded in stallions, in comparison with mares, concerning the theoretical optimum age performance, must be mostly ascribed to the slight distortion of the optimum value resulting from the simplification that it ranged about the age of seven (not six) years practically in all classifications of the test population (Tabs. II and III).

Applying the above described analysis, the correction factors of younger horses with respect to the peak of age performance were determined. Their exact definition - although the correlation index for stallions and mares had the value of 0.63 - cannot be taken over from the mere mathematical expression, it must be made on the basis of collective expert decisions using these data.

It is necessary to determine correction factors because not all horses are used for breeding at the age of six years after their racing career (no matter for which reasons); this procedure would not be desirable especially in

mares considering the breeding aspects. This is the reason why the present requirements for including especially mares into breeding classes according to their performance must be re-evaluated because these classes do not correspond to the quality of the Czechoslovak present population. The differences between the classes of two-year, three-year, four-year and older mares must be smoothed out. For example the difference between the present classes of two-year and three-year mares is 2 seconds; this is half the desirable value. There is a similar situation between the classes of three-year, four-year and older mares. Here it is necessary to mention the valid rules concerning the certification of multiplier and elite stocks where the obligatory shares of individual breeding classes of mares are defined. In many cases the present state need not be favourable for the mares included at a younger age and it can happen that the herd does not meet the requirements for certification although the mentioned state does not comply with the reality.

For the process of heredity control - mainly when using the BLUP method - the differences must be processed by preliminary corrections like the fixed effect of age. These facts were also confirmed by D i s t l et al. (1982), who had to include this effect into the model of calculation.

The above described results have not been in principle influenced by the present dynamics of development of Czechoslovak trotters; but they have partly been influenced by the smaller size of the test population. The findings formulated in the summary of this paper can be taken as realistic.

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