Ann. Anim. Sci., Vol. 18, No. 1 (2018) 209–224 *DOI: 10.1515/aoas-2017-0031*

DE GRUYTER
OPEN

EFFECT OF SOME FACTORS ON CHAMPIONSHIP RESULTS AND PERFORMANCE IN HUCUL HORSES

Jadwiga Topczewska[1♦], Wanda Krupa[2]

[1]Department of Animal Production and Poultry Products Evaluation, Faculty of Biology and Agriculture, University of Rzeszow, Zelwerowicza 4, 35-601 Rzeszów, Poland
[2]Department of Ethology and Technological Basis of Animal Production, Faculty of Biology, Animal Sciences and Bioeconomy, University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland
♦Corresponding author: j.topczewska@gmail.com

Abstract

The objective of the study was to determine the effects of some factors on the breeding and performance championship results of Hucul horses. The study material were results of the national finals of the breeding and performance championships for Hucul horses held during 2009–2015. These included breeding champion, the Hucul path as well as the endurance-condition tests. The one-way ANOVA and GLM procedure (multivariate ANOVA with interaction effects) were employed to estimate the impact of the analysed variables on the results of the breeding and performance assessment. The current results were, for the Hucul path and endurance-condition tests, significantly lower than for 2013. Individuals that were held in the foothills and mountain areas attained significantly higher scores at the breeding and performance championships. Strong impacts of breeding environment on levels of inbreeding were only observed in cases where the scores in respect of horse movement were at walk (η^2_p=0.13; P=0.04), trot (η^2_p=0.17; P=0.003) and the results for Hucul path (η^2_p=0.18, P=0.002). By far the strongest impact on the assessment for type (η^2_p=0.36, P=0.000) and conformation (η^2_p=0.32, P=0.006) was exercised by the interaction of age with male line and breeding environment, but in case of rating for movement at walk and trot, it was for the interaction of age with inbreeding and the breeding environment, namely η^2_p=0.31, P=0.04; η^2_p=0.33, P=0.01 respectively. Dependencies between components of assessment for Hucul horses were correlated at low and medium levels.

Key words: Hucul horses, performance value, breeding environment

The Hucul horse represents an animal breed protected by FAO's Animal Genetic Resources Conservation Program. They have been reared for hundreds of years in Eastern Carpathians, although their origin remains entirely unclear (Purzyc, 2007;

Komosa and Purzyc, 2009; Georgescu et al., 2011). Hucul horses originate from various breeds and types that arrived in the region of Hucul horses from different countries. Undoubtedly, the prevailing environmental conditions have played key roles in the consolidation of the breed's characteristic traits (Starzewski, 1927; Purzyc, 2007). The harsh climate and scant nutrition have resulted in the Hucul horse displaying excellent adaptation to harsh conditions, efficiency of feed use, good health, strength, and good performance qualities (Starzewski, 1927; Purzyc, 2007). They are revered for their longevity, fertility, equable character and suitability for varied forms of use (Purzyc, 2007; Trandzik et al., 2007; Komosa and Purzyc, 2009). They are still predominantly held in the Eastern Carpathian region, including other areas in Poland, Romania, Ukraine, Slovakia, Hungary, Czech Republic and Austria (Komosa and Purzyc, 2009). Breeders from Germany, Finland and several other countries have also indicated interests in them (Fornal et al., 2013). Poland currently holds the largest population of Hucul horses, with the mare population reaching about 1500 (PZHK – Polish Horse Breeders Association).

The unification of assessments for the breeding and performance values of Hucul horses has been continued since the 1990s, with the breeding program being aimed at preserving the genetic diversity of the male and female lines at a suitably large level (Hucul Horse Breeding Program, 2014). The performance value assessment is of great significance, not only for the cultivation of the breed's traits, but also due to the fact of its relatively small population and threats from increased inbreeding. The inclusion of the Polish Hucul horse in the Genetic Resources Conservation Program has resulted in, amongst others, the obligation to successfully complete the performance test, which includes their exterior and Hucul path. The true test, however, is the performance value for Hucul horses aged 4 and older at the performance championships in which their endurance-condition tests are assessed besides the values for their exterior and path. The final events are organized in September in Regietów at a Hucul horse stud. The results of the National Performance Championships, which is in keeping with the Breeding Program for Hucul Horse (2014), serve as the criteria for the categorization of stallions and mares. There is, however, dearth of comprehensive analysis of performance tests for Hucul horses in scientific publications, hence it is difficult to conclude, in definite terms, if they are adequate tools for breeding selection.

The objective of the study was to determine the impact of selected factors on the results obtained at the breeding and performance championships for Hucul horses. An attempt was made to verify the hypothesis which states that the breeding and performance championship is not a sufficient selection tool or test for the performance value of Hucul horses.

Material and methods

The material for the study were results of the national finals at the breeding and performance championships for Hucul horses held during 2009–2015. The data analysed were obtained from 143 horses (238 starts) that were 4–15 years of age,

35 stallions (64 starts), 100 mares (159 starts) and 11 geldings (15 starts). Twenty eight (2011) to 39 (2013) horses participated in the final competition within the period analysed. Since the results of the final classification are taken account of in categorizing stallions and mares, some of the Hucul horses could compete more than once during the period. As such, there were 33 individuals that competed twice, 14 in three competitions, 6 four times and 4 individuals five times. The horses represented 7 sire lines (Goral, Gurgul, Hroby, Ousor, Pietrosu, Prislop, Polan) and 14 families (Agatka, Bajkałka, Czeremcha, Góralka nowosądecka, Laliszka, Nakoneczna, Polanka, Reda, Sroczka, Wołga, Wrona, Wyderka, Goral, Gurgul). A summary of the championship results according to years was also provided. The coefficient of inbreeding for the horses assessed ranged from 0 to 0.25. Horses with zero inbreeding coefficient, 0.01–0.02; 0.03–0.04; 0.05–.06; >0.07. The studied population area was divided into 6 regions. The regions were delineated, taking account of the specific environmental conditions (temperature, precipitation, soil fertility) that affect the duration of the vegetative season, the value of the pasture sward as well as the feed obtained, namely 1. south-central, 2. south-west, 3. north and east, 4. west, 5. central, and 6-south-east.

Guidelines for assessing the performance value of Hucul horse

The Breeding Program for Hucul Horse (2014), provides that the test for performance value of Hucul horses aged 4 and above is to achieve a positive score at the National Breeding and Performance Championships (NB and PCh). This (NB and PCh) includes exterior assessment (breeding champion), the Hucul path as well as the endurance-condition tests. The exterior rating is done in a standing position (assessing the type and conformation in dimensions) and of walk and trot on the show arena, triangle with dimensions 30 × 40 × 30 metres. The exterior assessment for Hucul horses regarding the type is understood to mean the occurrence of primitive traits relative to the sex, propriety of conformation that takes into account breed typical traits such as length, shape and height of the withers, the muscularity and bonding of loins. Assessments of movement pay attention to the regularity of steps, the activity and engagement of the rump, including its regularity. The walk ought to be sliding and rhythmic, with a moderate stride length. The trot ought to be extensive, active and flexible. The condition of the horse, its presentation and preparation for the exhibition is also subject to evaluation. The assessment also includes the horse's overall impression. Analysis of the points awarded by independent judges in assessing the varied components of horses exterior indicated only slight variations. Information concerning the pedigree, date of birth, including those of the breeder and owner are only made public after the scores for all components of the exterior have been submitted by all judges. Only persons with appropriate certifications are elected and granted approval by the keeper of the Stud Book of breeds as a member of the Judges Board. The final result is the sum of averages for each element being assessed, namely type, conformation, walk, trot, and overall impression. The Hucul path is used to assess the character and skill to overcome obstacles that may occur in mountainous terrains. The final competition takes place over a distance of 5000 m, with about 30 natural or artificial obstacles. The Hucul horse breeding program (2014) contains

a detailed description of 12 mandatory obstacles to be set on the route as well as a list of other non-mandatory supplementary obstacles. The endurance-condition testing is conducted over a distance of 15–20 km, with an optimal speed of 8–10 km/h. The total obtainable score for all components assessed is 210 points, consisting of 50 points for exterior and movement, and 80 points each for the other 2 elements. The final outcome, however, is the sum of the points, having accounted for the conversion factor for each element. The most valued of the results is the Hucul path, with a conversion factor of 1.25, followed by the exterior factor (0.8) and least being the endurance-condition trials (0.75).

The competitions, about 7 to 9 in total, to assess the performance value of Hucul horses are held in Poland from June to September as eliminations. Fifty best horses gain qualifications to partake in the final competition. The Hucul path was in 2009–2015 conducted over a distance ranging from 3150 m in 2010 to 5215 m in 2009, with 21 and 35 obstacles being set in 2009 and 2013, respectively. The distance, pace, standard time, the sequence of the obstacles as well as bonus points for the proper jump over the obstacles were provided by the Grand Jury at the technical briefing prior to the competition. The endurance-condition testing took place over a distance ranging from 15 km in 2012 to 23 km in 2011. The horses have to undergo a veterinary examination within 20 minutes of crossing the finish line. The pulse rate which should not exceed 64 beats/minute, movement (points were awarded for proper movement, without objections, while irregular movements and lameness resulted in their elimination) as well as the average speed were assessed.

Statistical analysis

The calculations took into account the impact of sex, age, individual inbreeding coefficient, male line, female family, and environment. A summary of the championship results, including age was presented. The normal distribution was examined using the Shapiro-Wilk test. The normal distribution showed results of exterior evaluation (breeding championships). The Tukey test was applied to estimate the significance of differences between the means in this case. Contrastingly, results obtained for the Hucul horse path as well as the endurance-condition test in the performance championship did not display a normal distribution. The significance of differences between means for such data was estimated using the Kruskal-Wallis nonparametric test.

The Individual Inbreeding Coefficient (Fx) was, for Hucul horses competing in 2009-2015, determined relying on their full pedigrees available in the championship catalogues as well as in PZHK pedigree database (www.pzhk.pl). Information dating back to at least 5 generations has been collated for each individual. The main Hucul Stud Book is a closed book, while horse's origin is verified through studies of blood groups, hence pedigree information contained in PZHK database is considered reliable. The CFC 1.0 software was used to calculate the inbreeding coefficient for every horse in the pedigree file. This software uses an inverted matrix algorithm based on the work of Colleau (2002) and further developed by Sargolzaei et al. (2006).

The coefficient of Pearson correlation was calculated to study the relationship between scores for exterior components (type, conformation, walk, trot, overall im-

pression), results of Hucul path as well as for endurance-condition tests. The current study adopted the use of univariate analysis of variance (ANOVA), as the use of a two or three factor model calls for the existence or lack of interaction effects. Since the studies were the first of its kind concerning the assessment of the performance values of Hucul horses, the conduction of both analyses seemed reasonable to the authors. It enabled the identification of the impact of varied factors such as breeding environments, or age without the eventual influence of other factors, which is only possible using the GLM procedure. The GLM procedure (multivariate ANOVA with interaction effects) was employed to estimate the impact of the analysed variables on the results of the breeding and performance assessment. The impact of selected non-variable (fixed) factors as well as their interaction with the individual elements of the exterior evaluation, namely type, conformation, walk, trot, overall impression, including the results of Hucul path and endurance-condition tests were estimated in accordance with the linear model.

The impact of explanatory variables on the values of phenotype traits being studied was evaluated. The article summarizes those that significantly explained values of the phenotype trait being analysed.

The following linear models were applied:

1. $y_{klo}=\mu+L_k+F_l+(LF)_{kl}+\varepsilon_{klo}$
2. $y_{kjo}=\mu+L_k+E_j+(LE)_{kj}+\varepsilon_{kjo}$
3. $y_{ljo}=\mu+F_l+E_j+(FE)_{lj}+\varepsilon_{ljo}$
4. $y_{nmo}=\mu+S_n+I_m+(SI)_{nm}+\varepsilon_{nmo}$
5. $y_{njo}=\mu+S_n+E_j+(SE)_{nj}+\varepsilon_{njo}$
6. $y_{mko}=\mu+I_m+L_k(IL)_{mk}+\varepsilon_{mko}$
7. $y_{mjo}=\mu+I_m+E_j(IE)_{mj}+\varepsilon_{mjo}$
8. $y_{ikjo}=\mu+A_i+L_k+E_j+(ALE)_{ikj}+\varepsilon_{ikjo}$
9. $y_{imjo}=\mu+A_i+I_m+E_j+(AIE)_{imj}+\varepsilon_{imjo}$

where:

$y_{klo\ ..+}y_{ikjo}$ – phenotypic value of traits;
μ – overall mean;
A – fixed effect of age (i=aged 4–15);
E – environmental effect (j=1, 2, …6);
I – inbreeding effect (0.0; 0.01 – 0.02; 0.03-0.04; 0.05-0.06; >0.07);
L – male line effect (1, 2, …7);
F – female family effect (1, 2, …14);
S – sex effect (mares, stallions, geldings);
$(LF)_{kl}, (LE)_{kjl, \ ....+}(AIE)_{imj}$, – effect of interaction between the factors;
$\varepsilon_{kjo\ ...+}\varepsilon_{imjo}$ – measurement error.

Analysis of the impact of two factors, namely, level of inbreeding and age (interaction) on evaluations of the various constituents of the exterior and performance value of Hucul horses did not indicate any significant impact (P>0.05).

The model obtained from the interaction gives measurements for the intensity of the effect, namely the Partial Eta Squared – η^2_p (Olejnik and Algina, 2003), which

indicates what percentage of the variation explains a given variable or the interaction variable for a given trial and its level of probability P.

The coefficient of the Partial Eta Squared is given as:

$$\eta^2_p = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

where:

SS_{effect} – the sum of the squares for a given effect;

SS_{error} – the sum of squares for an error.

The calculations were performed using the STATISTICA 12.5 software.

Results

One hundred and forty-three horses participated in a total of 238 starts at the finals of the National Breeding and Performance Championships for Hucul horses during the period covered by the analysis. 57.1% (2011) to 91% (2010) of participating horses completed all three events of the championships successfully. The numerically dominant group were mares, with 159 starts, stallions – 64 starts, with the remaining being taken by the geldings. The average age of the horses concerned was 7, ranging from 7 to 15 years of age. The average inbreeding coefficient for evaluated horses was 0.04%.

Analysis of results of the breeding championships for Hucul horses have shown that type and overall impression were assessed very high, while the conformation and movement were assessed lower (Table 1). The Hucul horses covered by the study achieved on average 40.61±0.12 points for the exterior, 48.88±1.75 points for the Hucul path and 45.50±1.1 points for endurance-condition tests (Table 1). Analysis of the ratings for the exterior of Hucul horse during 2009–2015 did not indicate any trends (Table 2). The results for the Hucul path and endurance-condition test were significantly lower than for 2013 (Table 2).

Table 1. Results of breeding and performance championships at the national finals for Hucul horses during 2009–2015 (± SE)(points)

Trait	$\bar{x}$± SE	Min-Max
Type	8.45±0.04	6.00–10
Conformation	7.84±0.02	6.20–8.80
Walk	7.81±0.03	6.40–9.00
Trot	7.82±0.03	6.50–9.00
Overall impression	8.69±0.03	7.20–10
General assessment	40.61±0.12	33.50-45.40
Hucul path	48.88±1.75	0–80
Endurance-condition test	45.50±1.71	0–80
Sum	134.98±2.66	34.60–202.90

$\bar{x}$ – mean; SE – standard error of mean.

Table 2. Results for breeding and performance championships at the national finals for Hucul horses with regards to years analysed ($\bar{x}$± SE)(points)

Year	n	Traits						
		type	conformation	walk	trot	overall impression	Hucul path	endurance-condition test
2009	34	8.31±0.06 a	7.61±0.08 dA	7.75±0.13 a	7.84±0.08 abcAB	8.66±0.11 abAB	41.65±5.35 abAB	32.77±3.51 B
2010	33	8.32±0.13 a	7.79±0.08 aAB	7.90±0.09 a	7.66±0.08 aA	8.56±0.09 aB	57.05±3.79 cdBC	40.44±2.37 B
2011	28	8.56±0.09 a	7.78±0.07 adAB	7.94±0.08 a	7.80±0.08 abcAB	8.95±0.09 cA	63.06±4.52 dC	23.60±3.67 B
2012	31	8.42±0.10 a	7.87±0.05 abcB	7.87±0.08 a	7.82±0.06 abcAB	8.56±0.06 aB	50.22±4.75 abcdABC	40.72±4.26 B
2013	39	8.59±0.09 a	7.99±0.04 cB	7.79±0.06 a	7.95±0.06 cB	8.68±0.06 abAB	38.13±5.00 aA	33.96±3.59 B
2014	37	8.53±0.08 a	7.99±0.05 bcB	7.82±0.08 a	7.88±0.06 bcAB	8.80±0.06 bcAB	51.97±3.66 bcdABC	74.47±2.32 A
2015	36	8.42±0.10 a	7.83±0.05 abB	7.67±0.08 a	7.76±0.05 abAB	8.62±0.07 abB	46.25±3.84 abcABC	66.67±3.79 A

$\bar{x}$ – mean; SE – standard error of mean; the values in the columns with the different letters differ statistically significantly, small letters at P≤0.05; capitals at P≤0.01.

Table 3. Results for breeding and performance championships at the national finals for Hucul horses with regards to breeding environment ($\bar{x}$± SE)(points)

Trait	Breeding environment					
	1	2	3	4	5	6
	$\bar{x}$±SE	$\bar{x}$±SE	$\bar{x}$±SE	$\bar{x}$±SE	$\bar{x}$±SE	$\bar{x}$±SE
Type	8.60±0.06 aC	7.84±0.32 bA	8.38±0.09 acABC	8.35±0.13 acABC	8.07±0.15 cbAB	8.47±0.08 aBC
Conformation	7.91±0.03 aC	7.51±0.11 bA	7.80±0.07 acABC	7.70±0.09 bcAB	7.78±0.06 abcABC	7.89±0.04 aBC
Walk	7.89±0.50 aB	7.36±0.44 bC	7.80±0.51 acABC	7.84±0.56 aAB	7.48±0.41 bcAC	7.83±0.46 aAB
Trot	7.82±0.04 abAB	7.53±0.14 cA	7.83±0.06 abAB	7.77±0.07 abcAB	7.63±0.10 acAB	7.91±0.05 bB
Overall impression	8.79±0.05 cA	8.21±0.14 dB	8.63±0.10 abcAB	8.57±0.09 abAB	8.33±0.10 adB	8.75±0.05 bcA
Hucul path	57.02±2.19 aA	28.22±9.25 cC	32.83±5.79 cC	44.69±5.49 bcABC	33.90±7.09 cBC	51.04±3.38 abAB
Endurance-condition test	48.50±2.21 a	37.09±10.59 a	42.25±6.54 a	44.03±4.57 a	55.66±8.67 a	42.99±3.49 a

Breeding environment: 1 – south-central, 2 – south-west, 3 – north and east, 4 – west, 5 – central, 6 – south-east.
The values in the rows with the different letters differ statistically significantly, small letters at P≤0.05; capitals at P≤0.01; $\bar{x}$ – mean; SE – standard error of mean.

Results of breeding and performance championships with respect to places horses were reared is illustrated in Table 3. The lowest ratings for the exterior were awarded by the judges to horses reared in Silesia. The significantly higher scores obtained by animals reared in the foothills and highland areas (Małopolska and Podkarpacie Provinces) were closest to the usual scores for the period of breed consolidation. Differences that arose due to their breeding environment were statistically significant and were highly crucial for all the traits analysed with the exception of endurance-condition trials.

Analysis of starts that identify their membership of male lines revealed that horses from the Hroby, Pietrosu, Goral and Gurgul were well represented at the championships.

The highest scores in respect of their exterior traits were obtained by Hucul horses representing stallions from the Gurgul line, while the lowest scores were for horses representing the Goral line (Figure 1). The differences between individuals representing the male lines, in all the elements of the breeding championship, were very high and statistically significant (Figure 1). Significant differences were, however, not observed in respect of performance championship (Figure 2), despite the fact that horses representing Polan line scored far lower than the average scores for Hucul path. The highest scores, over the period of analysis, for Hucul path were obtained by horses from Hroby line, while the highest scores for endurance-condition tests were for horses from Pietrosu line (Figure 2).

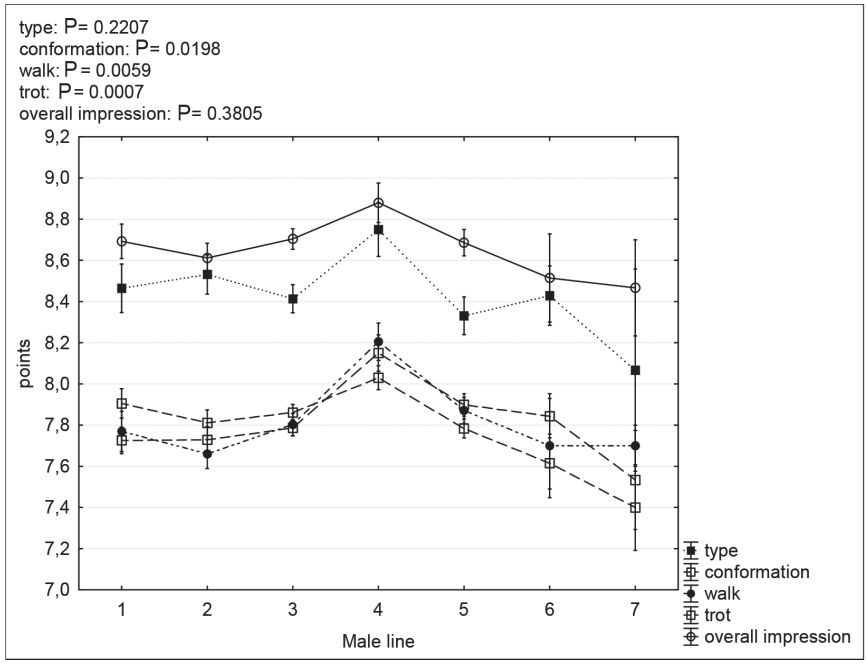

Figure 1. Results of breeding Hucul championship ($\bar{x}$± SE) (Male line: 1. Gurgul, 2. Goral, 3. Hroby, 4. Ousor, 5. Pietrosu, 6. Polan, 7. Prislop)

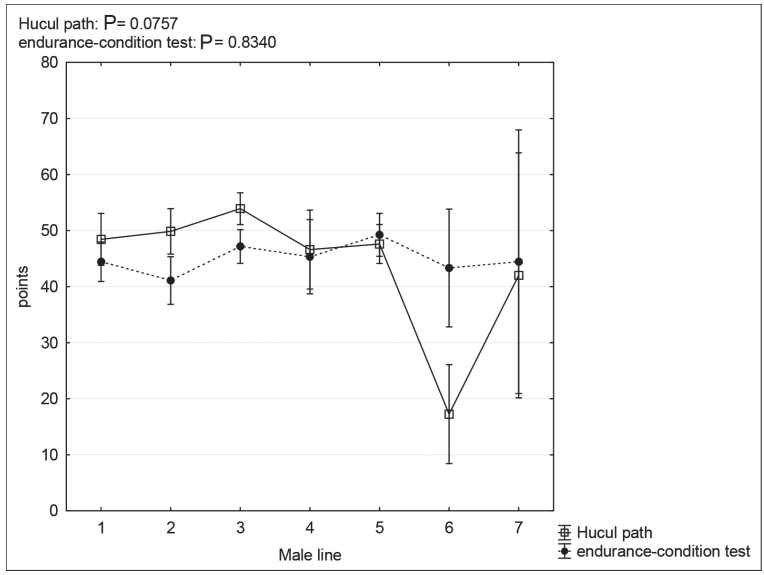

Figure 2. Results of Hucul path and endurance-condition test ($\bar{x}\pm$ SE) (Male line: 1. Gurgul, 2. Goral, 3. Hroby, 4. Ousor, 5. Pietrosu, 6. Polan, 7. Prislop)

The one-way ANOVA analysis applied did not confirm the impact of age and level of inbreeding on the results obtained at the breeding and performance championships for Hucul horses. The differences in results for stallions and mares were not statistically significant as well. Differences were only observed between female families in the walk stage. These factors were, however, taken care of in the two- and tri-variate ANOVA with interaction. Table 4 illustrates the degree of the influence and probability p for the analysed model. The strong impact and the most significant difference in the current study were indicated for interactions of the male lines and female families. They were not observed, however, in respect of components assessed during the breeding championship. It was only in the interaction between coefficients of inbreeding and breeding environment that strong impacts were obtained for the scores for horse movement at walk (η^2_p=0.13; P=0.04), trot (η^2_p=0.17; P=0.003) and the results for Hucul path (η^2_p=0.18, P=0.002) (Table 4). While by far the strongest impact on the assessment for type (η^2_p=0.36, P=0.000) and conformation (η^2_p=0.32, P=0.006) was exercised by the interaction of age with male line and breeding environment, it was, in the case of rating for movement at walk and trot, for the interaction of age with inbreeding and the breeding environment, namely η^2_p=0.31, P=0.04; η^2_p=0.33, P=0.01 respectively (Table 4).

Dependencies between components of assessment for Hucul horses, namely type, conformation, walk, trot and overall impression were correlated at low and medium levels (Table 5). Low dependency between overall impression and results of the Hucul path were also observed in mares (Table 6).

Table 4. The degree of the influence and p-values for the analysed model

Interaction	Traits													
	type		conformation		walk		trot		overall impression		Hucul path		endurance-condition test	
	η^2_p	P-value	η^2_p	P-value	η^2_p	P-value	η^2_p	P-value	η^2_p	P-value	η^2_p	P-value	η^2_p	P-value
L × F	**0.24**	**0.029**	**0.27**	**0.008**	**0.32**	**<0.001**	**0.25**	**0.02**	**0.28**	**0.003**	0.16	0.57	0.17	0.46
L × E	**0.22**	**<0.001**	0.15	0.05	0.13	0.15	0.12	0.20	**0.18**	**0.006**	0.09	0.52	0.11	0.34
F × E	**0.30**	**<0.001**	0.18	0.27	**0.25**	**0.01**	0.18	0.27	0.00	0.06	0.21	0.07	0.18	0.23
S × I	0.02	0.81	0.06	0.11	0.05	0.19	**0.10**	**0.002**	**0.07**	**0.03**	0.05	0.17	0.02	0.82
S × E	**0.16**	**<0.001**	**0.10**	**0.010**	0.07	0.11	0.08	0.06	**0.14**	**<0.001**	0.07	0.11	0.04	0.53
I × L	0.15	0.003	0.15	0.003	0.08	0.34	**0.13**	**0.01**	**0.14**	**0.008**	0.11	0.06	0.08	0.27
I × E	0.13	0,06	0.09	0.35	**0.13**	**0.04**	**0.17**	**0.003**	0.11	0.14	**0.18**	**0.002**	0.06	0.82
A × L × E	**0.36**	**<0.001**	**0.32**	**0.006**	0.17	0.64	0.17	0.63	0.15	0.78	0.23	0.20	0.17	0.69
A × I × E	0.29	0.08	0.25	0.25	**0.31**	**0.04**	**0.33**	**0.01**	0.22	0.43	0.23	0.44	0.28	0.11

S – sex, A – age, I – inbreeding level, L – male line, F – female family, E – environment.

Table 5. Pearson's correlation coefficient between exterior and Hucul path and endurance-condition test

Trait	Type	Conformation	Walk	Trot	Overall impression	Hucul path	Endurance--condition test
Type		0.67**	0.35***	0.33***	0.68**	0.11	0.01
Conformation			0.30***	0.32***	0.61**	0.16*	0.06
Walk				0.45***	0.56**	0.09	–0.04
Trot					0.53***	0.07	–0.01
Overall impression						0.20**	–0.01
Hucul path							0.17**
Endurance-condition test							

***P<0.001; ** P<0.01; *P<0.05.

Table 6. Pearson's correlation coefficient between exterior and Hucul path and endurance-condition test (above stallions, below mares)

Trait	Type	Conformation	Walk	Trot	Overall impression	Hucul path	Endurance--condition test
Type		0.63***	0.22*	0.34**	0.47***	–0.09	–0.11
Conformation	0.74**		0.28*	0.34**	0.57***	0.14	–0.04
Walk	0.39***	0.30***		0.54***	0.59***	–0.08	–0.06
Trot	0.36***	0.33***	0.39***		0.62***	0.06	0.03
Overall impression	0.78**	0.65**	0.50***	0.50***		0.07	–0.07
Hucul path	0.15	0.13	0.11	0.10	0.21**		0.21
Endurance-condition test	–0.01	0.06	–0.06	–0.01	–0.03	0.12	

***P<0.001; ** P<0.01; *P<0.05.

Discussion

The kinship of recorded individuals may significantly modify their performance value. The coefficient of inbreeding for the population understudied was decisively lower than that provided by Maćkowski et al. (2015) for Hucul horses contained in stud records during 1980–2011. Likewise, 288 mares, born between 1934 and 2003, whose career had ended, but participated in studies conducted by Kwiecińska and Olech (2008) achieved higher rates of inbreeding coefficient. Clearly higher inbreeding coefficient of 5.35% for horses held in the Czech Republic were posted by Vostra-Vydrova et al. (2015). Even higher degrees of inbreeding coefficient among Hucul horses reared in Hungary and Slovakia were published by Mihok et al. (2016) and Pjontek et al. (2012). The monitoring of inbreeding levels in small animal populations is undeniably crucial as it can result in reduction of performance or reproductive indicators. This was corroborated by studies on Hucul mares conducted by Kwiecińska and Olech (2008). The issue of increasing homozygosity of the popula-

tion is also applicable to other horse breeds covered by the Genetic Resources Conservation Program (Wolc and Balińska, 2010).

Analysis of the breeding championship results has revealed that conformity and movement were least rated (Table 1). Ratings for the exterior of Hucul horses in studies conducted during basic trials in 2009–2010 by Topczewska and Gibała (2012), were at similar levels. The 2010 results for the Hucul path were, however, slightly higher. While analysing the degree of preparedness of Hucul horses for the tests for valour in 2009–2010, Krupa and Topczewska (2012) revealed that mares were better prepared. It thus justifies the call for the successful completion of basic performance tests to become mandatory for mares designated for the Genetic Resources Conservation Program.

Some authors (Komosa and Purzyc, 2009; Topczewska and Krupa, 2011 a; Oravcova et al., 2014) have, however, suggested that contemporary breeding conditions for Hucul horses can result in loss of breed traits such as their suitability for use in difficult mountain terrains. The characteristic traits such as endurance, ability to work under considerable burden, valour in difficult terrains have been shaped under the influence of prevailing conditions of eastern Carpathian Mountains. The herd population held in south and south-east Poland are the most numerous, while their popularity for use in mountain tourism has also led to their being well prepared for work. Results of the studies conducted in respect of evaluations for conformation and Hucul path performance have revealed the dominance of Hucul horse raised in Małopolska and Podkarpacie territories.

Breeding under a milder climate and higher feed quality could result in changes to the breed's characteristic traits not only in aspects of their exterior, but could also lead to reduced performance. It is worthy of note, though, that breeders in territories that extremely differ from those typical for the breed are showing increasing interest in rearing Hucul horses.

In cases of pure line breeding, where the population is rather small, an additional difficulty is the desire to maintain adequate population of both male and female lines. Stallions have greater possibility of transferring traits to their offspring hence the comparison of championship results were undertaken respect of male lines. Likewise, Budzyńska et al. (2003) in analysing the results of basic tests of valour for Hucul horses, conducted in Rudawka Rymanowska, Poland in 2002, highlighted the significance of belonging to male lines. The basic test of valour for Hucul horses, which consists of its exterior and Hucul path rating is mandatory for all horses prior to their admission to the studbook of records. In the analysis of results conducted in 2009–2010, Topczewska and Gibała (2012) showed that horses from both the Hroby and Ousor lines received the highest scores for their exterior traits. The highest scores for Hucul path were, in 2009, obtained by horses from Polan and Prislop lines, but it was the turn of the Pietrosu line in 2010. Adequate preparation for the assessment of performance value is indispensable. This is more so in respect of poorly represented lines or families where possibilities of proper selection were hampered, in consequence. In analysing the scores obtained by horses for successfully overcoming typical obstacles for a Hucul path, Stachurska et al. (2006) noted that some can constitute great difficulties for the horses, thus impacting on the fi-

nal results. Obstacles that looked natural were easier to overcome by majority of horses.

Topczewska and Gibała (2012) indicated that the highest scores for the exterior assessment in the basic test of valour for Hucul horses were obtained by individuals aged 4 years and older, but for the Hucul path in 2009 4-year old stallions and 5-year old mares came out better, while in 2010 3-year-old horses of both sexes fared better. Krupa and Topczewska (2012) also indicated that mares were better prepared for the Hucul path in 2010. While the negative impacts of increased levels of inbreeding on performance and exterior traits in Polish ponies were signalled by Pluta et al. (2016), its impacts on reproductive indicators in Hucul mares were mentioned by Kwiecińska and Olech (2008), with Sairanen et al. (2009) doing same with Standard bred trotters and Finnhorses.

The Partial Eta Squared, according to Portney and Watkins (2009) at 0.01–0.06 level represents weak impact, with 0.06–0.14 and over 0.14 representing mild and strong impacts, respectively. Results obtained from the current study clearly indicate the significance of the horse's living environment on their development (exterior rating) as well as on their performance value. Attention needs to paid, however, to factors difficult to estimate, including the human factor. The level of cooperation between the rider and the horse is equally important during performance tests.

Studies conducted by Topczewska and Krupa (2011 a) on the dependencies between ratings for conformation, movement and results of tests for valour for Hucul horses, with respect to their male lineages showed significant correlation between ratings for the exterior and the results for test of valour for the Hroby line in their type and overall impression, Ousor (trot), Polan (conformation) and Pietrosu (type). Few correlations, in respect of their female family lineage were only observed within Gurgul, Polanka and Wrona families (Topczewska and Krupa, 2011 b). The authors mentioneded, identified only weak links between the ratings for the exterior and the results of the Hucul path. These results are corroborated by findings of the current study (Tables 5 and 6). A tendency towards a positive dependency between components of conformation and movement together with the performance value of Icelandic ponies was observed by Albertsdóttir et al. (2008).

Conclusions

It can be concluded that the breeding environment had the greatest impact on the exterior traits of Hucul horses. Individuals that were held in the foothills and mountain areas attained significantly higher scores at the breeding and performance championships. It is also worthy of mention that the results of breeding and performance assessments were influenced by several factors that acted interactively. The results obtained indicate that regular performance controls will enable the monitoring of the levels of performance traits and will also serve as a useful source of information for an efficient selection process. It would be worthwhile to also take into consideration environmental impacts when choosing sires in areas totally different from those under which the most precious breed traits were developed to avoid any alterations to the Hucul horse model.

References

Albertsdóttir E., Eriksson S., Näsholm A., Strandberg E., Árnason Th. (2008). Genetic correlations between competition traits and traits scored at breeding field-tests in Icelandic horses. Livest. Sci., 114: 181–187.

Budzyńska M., Krupa W., Kamieniak J., Sapuła M., Gancarz J. (2003). Exterior and utility characteristics of Hucul horses attending breeding championship. Annales UMCS, sectio EE, vol. XXI, 1: 327–332.

Colleau J.J. (2002). An indirect approach to the extensive calculation of relationship coefficients. Genet. Sel. Evol., 34: 409–421.

Fornal A., Radko A., Piestrzyńska-Kajtoch A. (2013). Genetic polymorphism of Hucul horse population based on 17 microsatellite loci. Acta Biochim. Pol., 60: 761–765

Georgescu S.E., Manea M.A., Dudu A., Costache M. (2011). Phylogenetic relationships of the Hucul horse from Romania inferred from mitochondrial D-loop variation. Genet. Mol. Res., 10: 4104–4113.

Hucul Horse Breeding Program (2014). PZHK – Polish Horse Breeders Association. Warszawa.

Komosa M., Purzyc H. (2009). Konik and Hucul horses: a comparative study of exterior measurements. J. Anim. Sci., 87: 2245–2254.

Krupa W., Topczewska J. (2012). Assessment of the degree of preparation of Hucul horses for trials of performance. Annales UMCS, sec. EE, vol. XXX(2): 21–33.

Kwiecińska K., Olech W. (2008). The inbreeding influence on Hucul mares reproduction results. Annals of Warsaw University of Life Sciences – SGGW, Anim. Sci., 45: 59–63.

Maćkowski M., Mucha S., Cholewiński G., Cieślak J. (2015). Genetic diversity in Hucul and Polish primitive horse breeds. Arch. Anim. Breed., 58: 23–31.

Mihok S., Somogyvári E., Posta J. (2016). Some population genetics parameters of the present Hungarian Hucul Horse population. Acta Agraria Debreceniensis – Agratudományi Közlemények, 69: 15–22.

Olejnik S., Algina J. (2003). Generalized eta and omega squared statistics: measures of effect size for some common research designs. Psychol. Methods, 8: 434–447.

Oravcova I., Sobotkova E., Jiskrova I. (2014). The comparison of selected breedings of Hucul horses bred in the Slovak Republic and Hungary. MendelNet:, pp. 172–177.

Pjontek J., Kadlečik O., Kasarda R., Horny M. (2012). Pedigree analysis in four Slovak endangered horse breeds. Czech J. Anim. Sci., 57: 54–64.

Pluta M., Osiński Z., Cieśla A., Kolstrung R. (2016). Genetic and phenotypic characteristics of Polish Konik horses maintained in the reserve and stable system in control-eastern Poland. Acta Sci. Pol. Zoot., 15: 59–76.

Portney L.G., Watkins M.P. (2009). Foundations of clinical research: Applications to practice. 93rd ed. Upper Saddle River, NJ: Pearson Prentice Hall.

Purzyc H. (2007). A general characteristic of Hucul horses. Acta Sci. Pol., Med. Vet., 6: 25–31.

Sairanen J., Nivola K., Katila T., Virtala A.-M., Ojala M. (2009). Effects of inbreeding and other genetic components on equine fertility. Animal, 3: 1662–1672.

Sargolzaei M, Iwaisaki H, Colleau J. (2006). CFC – A software package for pedigree analysis and monitoring genetic diversity. In: Proceedings of the 8th World Congress on Genetics Applied to Livestock Production, CD-ROM Communication, Belo Horizonte, Brazil, pp. 27–28.

Stachurska A., Pięta M., Jackowski M., Tarnawa-Wójcik A. (2006). Difficulty of obstacles at Hucul path – the events for Hucul horses. EJPAU, 9(4)#09 available online: http://www.ejapu.media.pl/volume9/issue4/art-09html

Starzewski T. (1927). About Hucul horse in Poland. Rocz. Nauk Roln. i Leśnych, Poznań.

Topczewska J., Gibała M. (2012). Performance test results of Hucul horses with regard to genealogical line and age (in Polish). Rocz. Nauk. Zoot., 39: 61–75.

Topczewska J., Krupa W. (2011 a). An attempt to determine the relation between Hucul horses conformation assessment, movement and courage test results. Part I. Stallions line. JCEA, 12: 632–642.

Topczewska J., Krupa W. (2011 b). An attempt to determine the relation between Hucul horses conformation assessment, movement and courage test results. Part II. Mare families. JCEA, 12: 643–654.

Trandzik J.Z., Jakabova R.D., Buleca J., Massanyi P., Hasko M., Kozlik P. (2007). Genetic diversity of Hucul horse, based on microsatellite data in Slovak Republic. http: //www.raumberg-gumpenstein.at/c/index.php?option=com–docman&task=doc–view&gid=2344&Itemid=100014

Vostra-Vydrova H., Vostry L., Hofmanová B., Veselá Z., Schmidová J., Majzlík I. (2015). Population studies of Czech Hucul horses. Poljoprivreda 21(1), Suppl.: 41–43; DOI: 10.18047/poljo.21.1.sup. 8.

Wolc A., Balińska K. (2010). Inbreeding effects on exterior traits in Polish Konik horses. Arch. Tierzucht, 53: 1–8.

www.pzhk.pl (accessed 08.08.2016)

Received: 1 X 2016
Accepted: 3 X 2017