Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2002
Volume 5
Issue 2
Series BIOLOGY

STARUN M., SOCHA S. 2002. GENETIC PARAMETERS OF BODY DIMENSIONS OF ONE-YEAR-OLD MAŁOPOLSKI HORSES
Electronic Journal of Polish Agricultural Universities, Biology, Volume 5, Issue 2.
Available Online http://www.ejpau.media.pl

GENETIC PARAMETERS OF BODY DIMENSIONS OF ONE-YEAR-OLD MAŁOPOLSKI HORSES

Monika Starun, Stanisław Socha
Department of Breeding Methods and Fur Animals Breeding, University of Podlasie, Siedlce, Poland

ABSTRACT

The aim of the work was to estimate the basic parameters of body dimensions (biometrical traits) of one-year-old Małopolska horses bred in the years 1982 - 1998 in the Walewice Stud of Horses. The analysis included: height at withers, chest girth, cannon circumference and two indexes: index of chest girth and boniness index. Correlation between the analysed traits was also calculated. The variance components were estimated according to REML method.

The obtained worked out estimates of the traits' heritability were as follows: height at withers 0.305, chest girth 0.270, cannon circumference 0.277. The genetic correlation between the biometrical dimensions was positive and ranged from 0.59 to 0.76, the environmental correlation ranged from 0.47 to 0.59. On the other hand the genetic correlation and environmental correlation between analysed traits and indexes were diversified, both positive and negative.

Key words: horses, Małopolski, one-year-old horse, body dimensions, heritability, correlation, REML method

INTRODUCTION

Małopolski horse as half-bred horses started to form its peculiarity in the XVII century. Present breeding of Małopolski horse is carried out in the state studs of horses (Walewice, Janów Podlaski, Prudnik) and private farms. The breeding material in Walewice Stud is represented by Angloarabian type with big participation of Schagya line. Maciejewski [12] writes that the picture of pedigree structure of breeding material was formed in 1973. The basic herd was selected in terms of utility traits and conformation traits like nobility, beauty, dryness of tissues, effective movement and durability, mild character and height at withers about 160 cm or more. The number of mares during 55 years varied. Year 1945 was the starting point of the stud when the breeding material consisted of 16 mares. After a year there were 84 mares. At present there is 100 mares. According to Sasimowski *et al*. [17] about 80 % of the mares' population have Schagya blood.

Three basic dimensions: - height at withers, chest girth and cannon circumference - are the most often taken measurements, most reliable to draw conclusions about the growth and development of foals. The body conformation indexes are also significant. They express mutual relationship between two dimensions and at the same time give the picture of body proportions and harmony. Because of the availability of the data required to calculations, the most often calculated are: index of boniness and chest girth index. Index of boniness, considered to be one of the most important indexes, depends on the proper feeding and conditions of breeding of foals. Index of chest girth shows general character of the build with particular respect to the capacity of chest. The first year of foal's life has an important influence on forming individual physical traits. The problem of growth and development of foals of Małopolski breed was taken up by Budzyński *et al*. [3] and Budzyński [1, 2]. The problems mentioned above were also the subject of dissertation by Nowicka-Posłuszna and Schmidt [13].

In populations of animals intentional activities (implemented in breeding) and unintentional activities (natural selection) might lead to changes of traits and estimated parameters. The diversification might concern both the same stud in a long period of time and different studs [10]. As genetic parameters are concerned, the diversification might be caused by different methods of estimation. Contemporary methods of estimation seem to be more accurate than the methods used before, e.g, can more precisely single out the additive genetic variability. Accordingly, the verification of the estimated parameters is recommended [7].

In view of the above aspects it has been decided to estimate the genetic parameters (heritability and correlation) of basic biometrical body dimensions and body build indexes of one-year-old horses of Małopolska breed.

MATERIALS AND METHODS

The research material comprised the data from the documentation of the Walewice Stud of Horses, the biggest stud of Malopolski horse.

The data in the present work included the description of young horses and the register of foaling. The analysis included three biometrical traits: height at withers, chest girth, cannon circumference and two indexes: chest index (proportional relation of chest girth to height at withers) and boniness index (proportional relation of cannon circumference to height at withers). The dimensions were measured according to the methodology described by Sasimowski [16]. The present paper does not include any additional calculations.

One-year-old horses having all the dimensions measured were taken into account (886 foals). The horses origined from 265 mares and 40 stallions. On average about 22.1 animals falled to one father and about 3.3 to one mother. The genetic parameters (variance components and genetic and phenotypic correlations) were estimated by the REML method with the multitrait animal model. The computer package of Nuemaier and Groneveld [14] was used. Some elements were estimated by the use of SAS program [18].

The following fixed effects were included: animal sex, the year and the month of birth. Random effects was additive genetic effect of animal. All the animals come from one stud, therefore the factor called HYS (the herd x year x season) couldn't be applied.

The following linear mixed model was used:

$$Y = \mu + \alpha +_j + \gamma + a + e$$

Where: Y_{ijkln} – vector of an analysed trait,
μ – overall mean, α_i – fixed effect of the animal' sex, β_j – fixed effect of birth year,
γ_{jk} – fixed effect of birth month, a_l – random effect of the individual, e_{ijkln} – random error.

RESULTS AND DISCUSSION

During 17 years (from 1982 to 1998), 886 one-year-old horses (413 stallions and 473 mares) were analysed in the Walewice Stud. As mentioned above the analysis included three biometrical traits: height at withers, chest girth and cannon circumference and two indexes: chest girth index and boniness index. Heritability (additive) and correlation (Fig. 1 and 2) were also estimated. The heritability of the traits was as follows: height at withers was 0.305, chest girth 0.270, cannon circumference 0.277, boniness index 0.265 and index of chest girth 0.245.

Fig. 1. The heritability coefficients and their standard errors estimated by REML method in the Walewice Stud of Horses

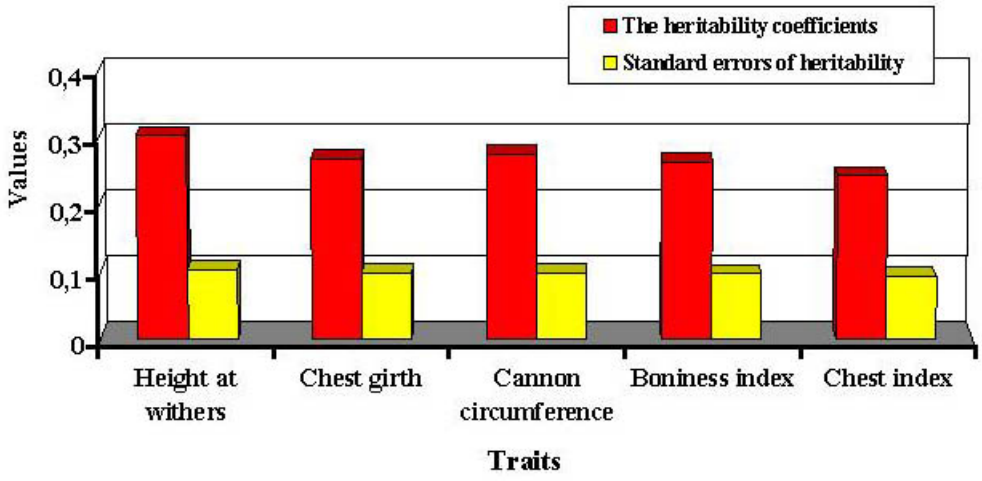
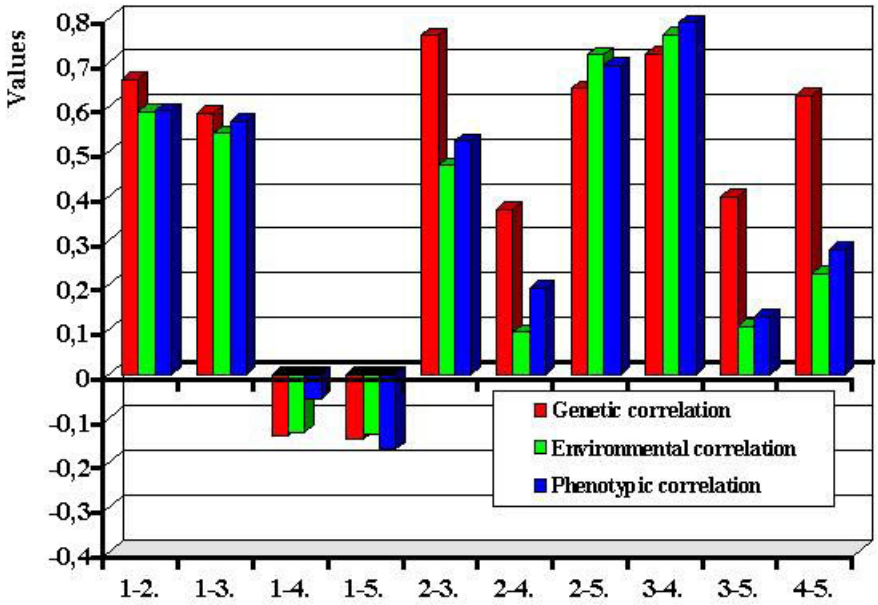


Fig. 2. The genetic correlation, environmental correlation and phenotypic correlation between the analysed traits for one-year-old horses from the Walewice Stud of Horses



The obtained heritability coefficients of height at withers are lower than those presented by Kaproń and Pluta [8] for Hucul Horses (0.835) and by Kownacki [10], Langlois [11], Dušek and Richter [4], and Varo [19]. However, the coefficients were comparable to those obtained by Kaproń *et al.* [9] for Silesian mares (0.346) and higher than those obtained for Silesian stallions (0.112).

The values of heritability of chest circumference were lower than those presented by Kaproń *et al.* [6], similar to the Kaproń and Pluta [8], Torzyński and Szwaczkowski [15] results and higher than Dušek and Richter [4] results for Kladrubish breed (0.12).

The values of cannon circumference are higher than those obtained by Kaproń *et al*. [6] for Polish Koniks breed (0.16) and Varo [19] for Finish horses (0.13); similar to Kaproń *et al*. [9] results for Silesian mores (0.26) and Dušek and Richter [4] for Kladrubish breed (0.23); lower than Langlois [11] and Kaproń *et al*. [7] results. The values of indexes varied as well, depending on the estimate.

The obtained values of parameters suggest that the genotype significantly affected the values of the traits. Special attention should be paid to additive heritability, the most correct as devoid of other influences.

Kaproń [5], Kaproń *et al*. [7] and Kownacki [10] suggest that variability in heritability level of the same traits is caused by the breeding separation and diversification of applied statistical methods. We observe also significant differences within different genders.

Heritability of the height at withers ranges from 0.11 in the group of Silesian stallions to 0.83 in the group of Hucul mares. The coefficient of the chest girth equals 0.11 in coldblooded horses but 0.86 in the group of Polish Koniks breed. The lowest heritability of cannon circumference is observed in the group of cold-blooded Finnish horses 0.13 and the highest in Thoroughbred 0.78 [5, 6, 8, 9, 13, 19].

Values of heritability coefficients obtained in the present work are classified as medium [5, 9]. The values of heritability met in the literature were higher for height at withers and circumference of cannon and lower for chest circumference [5, 10]. The selection of horses for greater height may limit the expression of genetic variation.

Standard errors of heritability estimates are relatively high – they reach about 30% of the values of the estimators itself - and are due to two factors: the number of analysed animals did not exceed 1000 and particular sub-groups were not often observe.

Genetic correlation between the analysed traits was positive and ranged from 0.587 to 0.761 Environmental correlation ranged from 0.469 to 0.591 (Fig. 2). Therefore it suggests that there is stronger correlation between an action of the same group of genes than the action of the same environmental factors on both traits.

In the present work all correlations between biometrical dimensions were positive, high and statistically significant. The correlation between dimensions and body build indexes varied (positive and negative, statistically significant and insignificant). Three basic body dimensions are highly genetically correlated with each other, what causes the high correlations (from 0.587 to 0.761). It shows that the selection on one of the mentioned traits produces the similar changes in the other traits.

Phenotypic correlations between the traits were also estimated in the present paper. The correlation (Fig. 2) were statistically significant between all the analysed traits (apart from correlation between the height at withers and index of boniness). The correlation ranged from -0.169 (between the height at withers and chest girth) to 0.789 (between the canonn circumference and index of boniness). The majority of the calculated correlations were positive, which means that the increase in value of a trait was followed by the increase of another.

The obtained results may be used as indicators to facilitate the breeding. It should be emphasised that in the present work the coefficients were estimated by the use of one of the most modern method which remarkably eliminate the effect of basic environmental factors. The values of the heritability (about 0.3) show that the influence of the genetic variability on the values of the analysed traits was significant and determinating.

CONCLUSIONS

1. The estimated heritability coefficients ranged from 0.245 (index of chest girth) to 0.305 (height at withers) and were comparable closed to the parameters presented in literature.
2. The genetic correlation between the biometrical dimensions was positive and ranged from 0.587 to 0.761, the environmental ranged from 0,469 to 0,591. The genetic and environmental correlations between the traits and indexes were diversified and were both positive and negative. It results from varied participation of genetic variability in phenotypic variability of conformation traits and build indexes.

REFERENCES

1. Budzyński M., 1973. Growth and development of the Malopolski horses bred on private farms in the Lublin Province in the light of measurement. Rocz. Nauk Rol., B, 95, 3, 7-19 indices [in Polish, with English summary].
2. Budzyński M., 1974. Wskaźniki biometryczne wzrostu i rozwoju źrebiąt małopolskich na Lubelszczyźnie. [Biometrical indicators of growth and development of Malopolska foals in Lublin department]. Koń Pol., 1, 26-27 [in Polish].

3. Budzyński M., Sasimowski E., Tyszkowski R., 1971. Zmiany biometryczne w procesie wzrostu półkrwi w PSK Janów Podlaski. [Biometrical changes in growth process of half-breed in National Horse Stud in Janów Podlaski]. Rocz Nauk Rol., B, 93, 2 [in Polish].
4. Dušek J., Richter L., 1966. Hodnoceni dédivosti vykonnosti a télesné stavby potomstva plemennych hřebcu vo starokladrubském vraném stade. Véd. Pr. Vyskumné Stanice pro Chov Koni Slatińany 1, 197-210 [in Czech].
5. Kaproń M., 1999. Metody doskonalenia koni. [Methods of horses improvement]. Wydawnictwo AR, Lublin [Publication of Agricultural University in Lublin] [in Polish].
6. Kaproń M., Bocian K., Słomiany J., 1992. Genetic Conditions of Exterior Features of Polish Koniks. Ann. UMCS Lublin – Polonia, Sectio EE, vol. X, 25, 171-174 [in Polish, with English summary].
7. Kaproń M., Pięta M., Kaproń H., 1993. Heritability variation of conformation traits in Wielkopolski Horse as affected by the statistical Model used. Anim. Sci. Papers and Reports, vol. 11, 3, 193-199.
8. Kaproń M., Pluta M., 1993. Genetic Conditions of Exterior Marks of Hucul Horses. Ann. UMCS Lublin – Polonia, Sectio EE, vol. XI, 22, 157-161 [in Polish, with English summary].
9. Kaproń M., Strzelec K., Kaproń H., 1993. Genetic Conditions of Exterior Marks of Silesian Horses. Ann. UMCS Lublin – Polonia, Sectio EE, vol. XI, 23, 163-170 [in Polish, with English summary].
10. Kownacki M., 1982. Genetic bases of utility traits in horses. Zesz. Prob. Post. Nauk Rol., 264, 449-465 [in Polish, with English summary].
11. Langlois B., 1973. Caracteres quantitatifs chez le cheval: aspects genetiques. Bull. Techn. Dep. Genetica Animals, I.N.R.A. Paris, 71-76.
12. Maciejewski M., 1979. Stadnina Koni Walewice [The Stud of Horses in Walewice. Koń Pol., 3, 1- 9 [in Polish].
13. Nowicka-Posłuszna A., Schmidt M., 1997. Growth and development of foals obtained by crossing of the Polish konik breed with an English Thoroughbred stallion and a stallion of Wielkopolska breed against the background of pure-bred foals. Rocz. AR Pozn., Zootech., CCXCIX, 49, 87- 93 [in Polish, with English summary].
14. Nuemaier A., Groneveld E., 1998. Restricted Maximum Likelihood Estimation of Covariances in Sparse Linear Models. Genet. Sel. Evol., 30, 3-26.
15. Torzyński G., Szwaczkowski T., 1999. Material genetic additive variability of conformation traits in half- bred horses. Electronic Journal of Polish Agricultural Universities, Animal Husbandry, Volume 2, Issue 2. Available Online, http://www.ejpau.media.pl/series/volume2/issue2/animal/art.- 01.html
16. Sasimowski E., 1984. Przewodnik do ćwiczeń z hodowli i użytkowania koni [Guide to horse bred and utilisation training]. AR Lublin [in Polish].
17. Sasimowski E., Bar B., Majewska I., Palus K., Trusiuk I., 1973. Structure of the horse population in the region of the Malopolski horse, determined on the strength of tentative classification Rocz. Nauk Rol., B, 95, 3, 20 - 40 [in Polish, with English summary].
18. SAS INSTITUTE 2000. SAS User's Guide. Version 8 Edition. SAS Institute Inc., Cary.
19. Varo M., 1965. Some coefficients of heritability in horses. Ann. Agricult. Fenniae, 4, 223-237.

Stanisław Socha, Monika Starun
Department of Breeding Methods and Fur Animals Breeding
University of Podlasie
B.Prusa 12, 08-110 Siedlce, Poland
Phone +4825 643 1239, fax +4825 644 2045
e-mail: socha@ap.siedlce.pl
