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POPULATION STUDIES OF CZECH HUCUL HORSES

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SUMMARY

Population studies were carried out analysis Czech Hucul breed based on pedigree information of animals registered in the Studbook. Pedigree records collected from the year 1834 to 2013 comprised information on 9455 animals used in the analyses. The pedigree depth of the analysed individuals was up to 19 generations. The mean value of inbreeding coefficient was 5.35% (with maximum value 30%). The proportion of inbreed animals was high (98%). The average rate of inbreeding in the reference population was lower than 1%, and the respective estimates of effective population sizes were 54. The presented paper is indicating that genetic diversity in the Czech Hucul breeds is still relatively high and conservation programs should be continued.

Key-words: inbreeding, rate of inbreeding, effective populations

INTRODUCTION

Small populations such as Czech Hucul breeds bear the risk of inbreeding and reduction in genetic diversity within the population. The mating of related animals (inbreeding) was previously aimed at strengthening the required characteristics and traits in the population and at the concentration of appropriate genes in the population. Another aim was to increase offspring uniformity. However, it was observed at the same time that an increase in the inbreeding coefficient caused an increase in mortality, fertility and adaptability of farm animals (Falconer and Mackay, 1996). Preservation of endangered species is one of the most important goals for the present biological science. Conservation programs are needed to preserve breeds in which a significant part of given species' genetic diversity still presents negative effects of inbreeding. The populations of Czech Hucul horses are small sized, which has led to an increase in the population inbreeding coefficient of these breeds, especially in the 1990 when these populations were close to the import of genes from other populations. The increase in inbreeding coefficient may bring about undesirable inbreeding depression manifested in characteristics associated with fitness and reproduction and in other characteristics related.

The objective of the present paper was to estimate the inbreeding trend and the effective population size using pedigree data.

MATERIAL AND METHODS

Data

Data from pedigrees of the registered horses in the Czech Studbook of the Hucul contained information from the year 1823 to 31st June 2013. Data were provided by the Studbook Board of the Hucul (n=9455). The pedigree analysis was performed on one reference population. The reference population was defined as the whole active populations - individuals (stallions and mares) born in the years 1996-2010 (n=501).

Pedigree analysis

Pedigree completeness in the analysed breed was assessed with complete generations equivalent. The number of equivalent generations traced was computed as the sum over all the known ancestors of the terms according to $(1/2)^n$,where *n* is the ancestor's generation number, which is equal to one for the parents, two for the grandparents, etc. (Maignel et al., 1996). Pedigree completeness may influence the accuracy of inbreeding estimated values.

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Inbreeding coefficient (F_X) of each individual was estimated by a tabular method (Falconer and Mackay, 1996) based upon VanRaden's method (1992). The pedigree depth was 19 generations for the calculation of inbreeding coefficients.

Average relatedness coefficient of each individual (AR) is computed as the average coefficient integrating the row from the individual in the numerator relationship matrix. This coefficient indicates, with what probability, that a randomly selected allele in the population occurs in a selected individual or in a group of individuals (Goyache et al., 2003).

RESULTS AND DISCUSSION

The numbers of animals registered in the Studbook between years 1900 and 1966 were stable, between 1 to 7 individuals per year (54% stallions and 46% mares) (Figure 1). There was a moderate increase of the registered individuals between the 1966 and 1996. The maximum level of the registered animals in the Studbook was in 1996. In recent years, the numbers of the registered individual have been decreasing.

The mean number of stallions and mares registered in the Studbook were 47 and 81 in the period 1990-2013, respectively. The maximum level of the registered stallions (90) and mares (143) was in 1997.

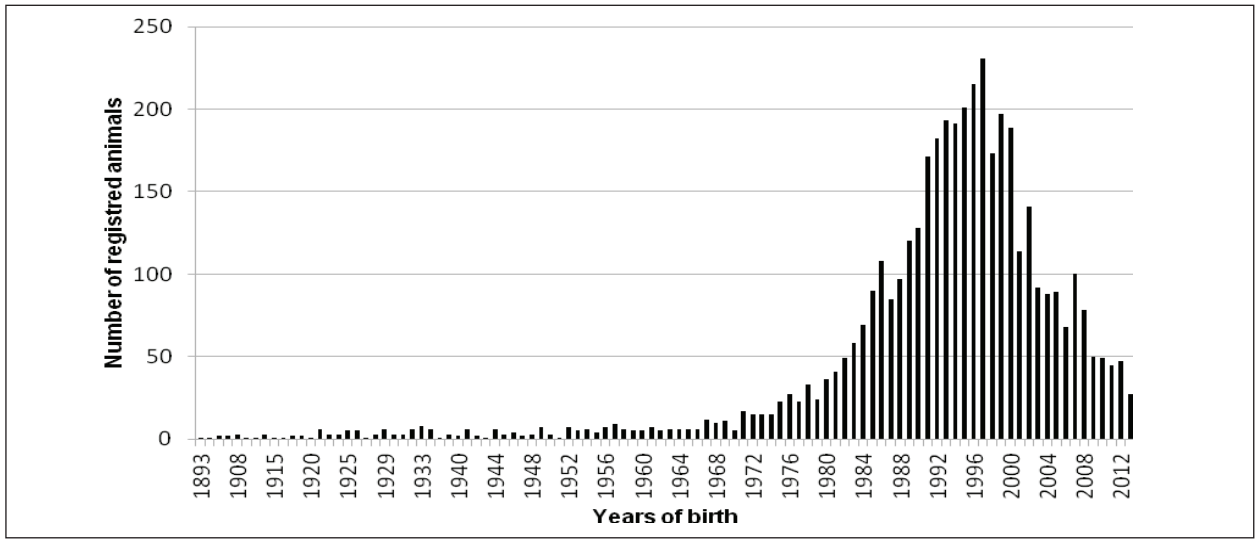

Figure 1. Number of animals registered in the Studbook per year of birth

The average complete generations equivalent was 6.83 and ranged from 0 to 9.02 being similar to the Polish Hucul horses where complete generations equivalent ranged from 3.8 to 7.0. The values computed by us are lower than the values determined for populations of Lipizzaner horse (15.2, Zechner et al., 2002) and Austrian Noriker (12.3, Druml et al., 2009). Pjontek et al. (2012) reported an equivalent number of ancestor generations to be 10.25 for Lipizzaner breed. Similar values were determined in Andalusian horse (8.3, Valera et al., 2005), Spanish Arabian horse (7.9, Cervantes et al., 2008) and German Paint horse (4.77, Siderits et al., 2013).

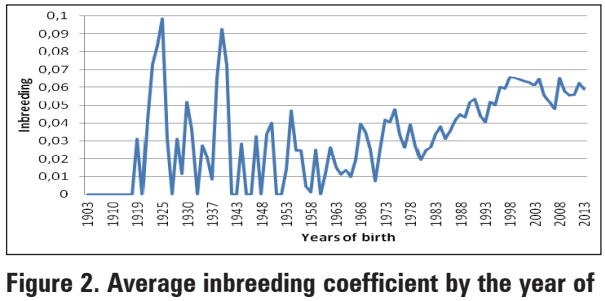

Figure 2. Average inbreeding coefficient by the year of birth

Average inbreeding coefficients in different years are presented in Figure. 2. The highest increase has been recorded since 1925. There was a random change decrease in the values of average inbreeding coefficient due to small number of the registered animals between years 1910 and 1968. Since 1988 a permanent increase has been observed when the 6.25% limit was exceeded in 1998. The average value of inbreeding coefficient in reference population was 5.35% while the maximum value was 30.63%. Average inbreeding coefficients published for Polish Hucul was similar (4.2%, Mackowski et al., 2015). The proportion of inbred animals in reference population reached 98% ($F_X>0$). More than 28% and 4% of the horses had inbreeding coefficients higher than 6.25% and 12.5%. The average values of relatedness coefficient were 0.13 in the reference population. The average relatedness coefficient was found higher than the double of the average inbreeding coefficient, from which an increase in inbreeding coefficient in the next generations may be derived. The average inbreeding value implies a loss of genetic variability that may negatively influence fitness characteristics and increase occurrence of phenotypic defects. The influence of inbreeding depression on performance traits was neither confirmed

by Curik et al. (2003) nor by Wolc and Balinska (2010). However, inbreeding depression was observed in racing performance (Klemetsdal, 1998) and in morphological traits (Gomez et al., 2009). Rate of inbreeding (ΔF) is one of the main parameters of genetic diversity monitoring. Based on the positive values of ΔF in the reference population, an increase in F_X values can be expected in further generations of the Czech Hucul population. The Food and Agriculture Organization of UN (FAO, 1998) stated that the average value of ΔF should not exceed 1%. The estimated average value of ΔF is close to this recommended maximal value. The mean of inbreeding rate for the reference population is close to the value 0.01. The effective population size derived from an increment in inbreeding coefficient reached the value of 54.15. The values of N_e, derived from ΔF, were close to the recommended minimum of N_e (50) for the conservation of genetic diversity (FAO, 1998). The estimated values of N_e were lower than N_e estimated in the other horse breeds including Lipizzaner ($N_e = 102$, Zechner et al., 2002), Austrian Noriker ($N_e = 157$, Druml et al., 2009) and higher than in Lusitano breed ($N_e = 28$, Vicente et al., 2012).

CONCLUSION

A complex pedigree analysis of the Czech Hucul breed has been performed. The results of the analysis of pedigree completeness show a high pedigree completeness level. The moderate values of inbreeding coefficient were estimated due to the high pedigree completeness that increased the accuracy of its computation. However, increased inbreeding level in the analysed time period was observed. This increased inbreeding level is characteristic for small, closed populations as Czech Hucul horse. However, this study indicates that genetic diversity in the Czech Hucul breed is still relatively high and conservation programs should be continued.

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