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Genetic structure of Krškopolje pig based on pedigree data

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Abstract. Krškopolje pig was persecuted for many years and consequently, population extremely decreased. In the year 1992 when the herdbook was established again, there were less than 30 sows and only 3 boars. Nowadays, the population consists of 150 registered sows and 30 boars. Pedigree data included 730 animals: 162 males and 568 females. Animals born in years 2005-2009 were considered as reference population. The PEDIG program was used for pedigree analyses. Generation intervals were 2 years for sire-son and sire-daughter, and 2.5 years for dam-son and dam-daughter pathways. Average family size for pairs sire-dam was 1.67 progeny with standard deviation (SD) 1.18, while sires as families had 4.08 progeny (SD 5.54). Maximum number of generations was nine. Pedigree completeness was expressed by equivalent complete generations: 3.2 in males and 3.3 in females. Total number of founders was 58. Effective number of founders and ancestors were 20 and 14, respectively. Average coefficient of kinship was 4.9% among males, 4.6% among females and males, and 5.0% among females. Due to incomplete pedigree, coefficients of inbreeding and relationship are underestimated, while effective number of founders and ancestors are overestimated. Sires should have more uniform contribution to the gene pool.

Keywords. Krškopolje pig – Endangered breed – Pedigree analysis – Genetic variability.

La structure génétique du porc Kraškopolje basée sur les données de son pedigree

Résumé. *Le cochon de race Kraskopolje a été persécuté pendant de nombreuses années ce qui a provoqué une forte diminution de sa population. À partir de 1992, lorsque le livre généalogique a été remis en place, il ne restait plus que 30 truies et seulement 3 verrats. De nos jours, la population est représentée par 150 truies et 30 verrats enregistrés. Les données concernant le pedigree sont basées sur 730 animaux: 162 mâles et 568 femelles. Les animaux nés durant les années 2005 à 2009 sont considérés comme la population de référence. Le programme PEDIG a été utilisé pour les analyses de pedigree. L'intervalle choisi entre 2 générations est de 2 ans pour la descendance père-fils et père-fille et de 2 ans et demi pour la descendance mère-fils et mère-fille. La taille moyenne d'une famille père-mère est de 1,67 descendants avec un écart-type de 1,18 ; alors que le père peut avoir plusieurs familles et au total 4,08 descendants (avec un écart-type de 5,54). Le nombre maximum de générations est quant à lui de 9. La profondeur du pedigree est, en équivalent de générations complètes, de 3,2 pour les mâles et de 3,3 pour les femelles. Le nombre total de fondateurs est de 58. Le nombre de fondateurs efficaces et d'ancêtres est respectivement de 20 et 14. Le coefficient de parenté a été estimé à 4,9% entre les mâles, à 4,6% entre les mâles et les femelles et à 5% entre les femelles. Le coefficient de consanguinité a été sous-estimé à cause d'un pedigree incomplet et d'un nombre d'animaux fondateurs et d'ancêtres qui a été surestimé. La contribution génétique des mâles devrait être plus uniforme.*

Mots-clés. *Porc Kraškopolje – Race en voie d'extinction – Analyse de pedigree – Variabilité génétique.*

I – Introduction

The Krškopolje pig or black-belted pig is the only preserved Slovenian indigenous pig breed. It originates from the south-east part of Dolenjska region, the area of Krško-Brežiško field and in the foothills of Gorjanci hills. The breed is adapted to poor rearing environment. It has large appetite, great ability to produce fat, good meat quality, good resistance, good maternal traits, and moderate fertility traits. The first known written record about Krškopolje pig dates from the middle of 19th century. Rohrman (1899) a prepared detailed description of the breed and he

also named the breed as Krškopolje pig. He stressed that pigs in the Krško field are uniform in exterior, color, and also in other traits, and they are distinguishable from other breeds. However, many breeders from that time mixed and crossed the Krškopolje pig with Yorkshire. In the rural survey before the Second World War, Oblak (1938) pointed out that original Krškopolje pig could be found only it the most distant villages. The breed was prosecuted in the past and only the most persistent breeders deserve that breed still exists. The breed was put to the list of endangered Slovenian breeds in the year 1991. The herdbook was established in the year 1992, three family farms were included in gene bank and they started with pedigree and performance recording. At that time, population consisted of less than 30 sows and only 3 boars. After the year 2003, the interest of raising the Krškopolje pigs has increased. Consequently, the breeding herd in the year 2009 consisted of 104 sows and 24 boars.

Nowadays, the analysis of pedigree structure in populations of farm animals are more and more useful and uses tools that allows an overview of genetic background and development of population. It enables the assessment of genetic diversity in population, contribution of founders and ancestors, as well as contribution of genes from foreign populations. The results could be used for gradual change in endangered populations through the balanced contributions of ancestors to the gene pool, uniform family size and use of large number of unrelated sires. The purpose of the study was estimation of genetic diversity in the Krškopolje breed based on the pedigree data by different measures of genetic variability in the population.

II – Material and methods

The pedigree data of Krškopolje breed was provided by Central breeding organization for pigs. Data set consisted of animal identification, gender, sire, dam, birth date, origin, owner, and culling date. Animals born in years 2005 - 2009 were considered as the reference population.

Description of population comprises two groups of parameters, the first one is demographic and the second is genetic description. Demographic description includes number of males and females in population, their changes over time, generation interval, and family size. Genetic description which bases on probabilities of gene origin covers pedigree completeness, inbreeding coefficient and coefficient of kinship, contribution of ancestors and founders, equivalent number of known generations (Maignel *et al*., 1996), effective number of founders and ancestors (Boichard *et al*., 1997). The average relatedness (Dunner *et al*., 1998) was computed, as well. It enables choice of animals with smaller contribution and consequently slower increase of inbreeding in population, as well as slower losing of alleles from the gene pool of population. The PEDIG programme package (Boichard, 2002) was used for pedigree analyses.

III – Results and discussion

Demographic description. Altogether, pedigree data comprised of 730 animals (Table 1). The pedigree data in Krškopolje pig is collected for last 19 years, since herdbook was established in 1992. The proportion of animals with unknown parents was 7.94%. The reference population – animals born between years 2005 and 2009 – included 390 animals, 80 boars and 310 sows. There were 47 sires and 121 dams. Ratio between dams and sires was suitable (2.57) in reference population. All animals born in last years have both parents known.

Generation interval. Only progeny which had their own progeny from complete pedigree were included in computation of generation interval. Sires had sons and daughters when they were 2 years old (Table 2). Dams were on average half year older when they had offspring: 2.46 years at birth of sons and 2.65 years at birth of daughters.

Family size. More than family size, the uniformity of family size is important, because it affects maintenance of genetic variability and long-term survival of a population. The family size is

presented by number of progeny per pair sire-dam, per sire and per dam (Table 3). The majority of pairs had only one progeny (61.0%). On average, pairs had 1.67 progeny with standard deviation of 1.18. Boars as families had on average 4.08 offspring with large standard deviation (5.54). Dams had on average less progeny compared to sires, as expected. The average number is 2.03. The variability for dams is also smaller, standard deviation was 1.35.

Table 1. Demographic description of complete pedigree and reference population

Item	Complete pedigree	Reference population
Number	730	390
Boars (Sires)	162	80 (47)
Sows (Dams)	568	310 (121)
Ratio dam / sire		2.57
Proportion of founders (%)	7.95	0.00

Table 2. Generation interval by gender of parents and offspring*

Path	No. of parents	No. of offspring	Generation interval (yr.)
Sire – son	16	37	1.99
Sire – daughter	22	97	2.01
Dam – son	28	39	2.46
Dam – daughter	67	124	2.65

*Only offspring with their own progeny are accounted.

Table 3. Family size*

Family	No.	Avg.	SD	Max.	D1 (%)**
Sire – dam	123	1.67	1.18	8	61.0
Sire	51	4.08	5.54	34	37.2
Dam	102	2.03	1.35	8	45.1

*Only offspring with their own progeny are accounted.
**Proportion of families with only one progeny

Table 4. Inbreeding coefficients

Class	Number	(%)
$0.00 \leq x < 0.05$	139	83.7
$0.05 \leq x < 0.10$	26	15.7
$0.10 \leq x < 0.15$	1	0.6
Nº. of inbred animals	166	22.7
Avg. inbr.	0.024	
Max. inbr.	0.125	

Inbreeding and kinship. Small proportion of inbred animals (22.7%) is consequence of incomplete pedigree (Table 4). The average inbreeding coefficient is underestimated, too. From the year 1992, when identification of Krškopolje pigs was started again, matings of close related animals were avoided and recently, for each farmer's sows the boar is chosen on the basis of smallest relatedness. Coefficient of inbreeding show us, how ancestors of an animal were related, however it does not tell us the relationship of an animal to another one. Coefficients of

relationship were calculated among boars, among sows and between pairs boar-sow (Table 5). Average values are between 0.045 and 0.050, but they are most probable underestimated, too.

Table 5. Coefficient of relationship in the reference population

Pair	No. of pairs	Avg.	SD	Max.
Boar – Boar	3160	0.049	0.050	0.278
Boar – Sow	24800	0.046	0.045	0.307
Sow – Sow	47895	0.050	0.045	0.303

Pedigree completeness. Animals born in years 2005-2009 had at most 9 generation of ancestors known (Table 6). Completeness of pedigree is showed by the equivalent number of known generations. In boars, value for this parameter was 3.18 and for sows 3.29. On average animals in the reference population had 26.6 (boars) and 28.5 (sows) known ancestors.

Table 6. Equivalent number of known generations, average number of known ancestors, contribution of founders and ancestors for boars and sows in the reference population

Item	Boars	Sows	Item	For boars	For sows
Number	80	310	No. of founders	37	40
Max. no. of generations i	9	9	Effective no. of founders	20.6	19.7
Equivalent no. of generations	3.18	3.29	Effective no. of ancestors	13.9	14.0
Avg. no. of known ancestors	26.6	28.5	$N_{50\%}$*	5	5
			C_{max} (%)**	15.2	14.2

*Number of ancestors which contribute to gene pool 50%.
**The largest marginal contribution of single ancestor to gene pool.

Contribution of ancestors. The reference population had around 40 ancestors. The effective number of founders was around 20 and effective number of ancestors was 14. The smaller effective number of ancestors is expected, as showed Boichard *et al*. (1997). Both parameters are overestimated due to incomplete pedigree. Maximal marginal contribution of single ancestor to gene pool was 15.2% in boars and 14.2% in sows; only 5 ancestors contribute 50% to gene pool.

IV – Conclusions

The Krškopolje breed is an endangered population. It was enlarged in recent years; also the number of farmers who wish to raise this breed had increased. Compared to modern pig breeds, it is less productive, but the meat and dried products are tastier. Due to incomplete pedigree, parameters of genetic variability are underestimated (inbreeding, relationship) or overestimated (effective number of founders and ancestors). Contribution of individual animals to next generation should be equalised to preserve the breed for long-term.

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