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Pedigree analysis and monitoring of genetic diversity of nutrias (*Myocastor coypus*) included in the Genetic Resources Conservation Programme in Poland*

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Although nutrias are included in the Farm Animal Genetic Resources Conservation Programme in Poland, the number of females subject to evaluation of breeding and use value has remained under 500 for several years. Small herd size and a growing degree of relationship between individuals increase the risk of inbreeding. The aim of the research was to analyse the pedigrees and monitor the genetic diversity of the nutria population covered by the Farm Animal Genetic Resources Conservation Programme in Poland. The study included 332 nutrias of different varieties – standard, black, Greenland, pearl, amber-gold and pastel – raised on three farms (A, B and C) on which use and breeding value are evaluated. The average coefficient of relationship was 0.0140 for all analysed individuals, and for the three farms as follows: farm A – 0.1289, farm B – 0.0766 and farm C – 0.0282. Among the colour varieties, the highest coefficient of relationship was observed in pearl (0.3136) and the lowest in standard (0.0425). Interactions between farms and between colour varieties of nutria were also observed. However, the average coefficient of relationship in most cases was below 0.01. Among the 332 individuals analysed 16 had a coefficient of inbreeding higher than zero (max. 0.1875, min. 0.0312) – 13 from farm C and 3 from Farm B. These animals represented the black (10 ind.), standard (3 ind.) and Greenland (3 ind.) coat colour variants. Despite the small size of nutria herds in Poland the coefficients of relationship and inbreeding remain low. Based on the results of the study it can be concluded that breeding work has been carried out properly.

KEY WORDS: fur animals / nutria / conservation of genetic resources

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The nutria (*Myocastor coypus*) is a large rodent from South America, brought to Europe at the beginning of the 20th century. The species is treated mainly as a fur-bearing animal, but may also be raised for meat [1, 2, 3].

Nutrias came to Poland in 1926, but nutria farming began to thrive after 1945, reaching its peak in the 1970s and 1980s. Domestic production was then about three million skins a year, of which over 75% were sold at auction houses in Copenhagen, London, Lipsk or Leningrad. Nutria skins from Polish farms were of very good quality. Their prices ranged from 10 USD for standard nutria skins to 20 USD for coloured skins. The farming situation deteriorated in part due to changes in the economic system in the country. After 1990 the demand for nutria skins fell substantially [1, 7].

Currently a regression has been observed in nutria farming for over twenty years. In view of this situation, since 2007 nutrias of the standard, black dominant, amber-gold, white non-albino, sable, pastel and pearl varieties have been covered by a genetic resources conservation programme. In 2008 the Greenland nutria was included in the programme [6, 8].

The main objectives of the programme are to increase the foundation stock of nutrias to a minimum of 500 females in the case of the standard and Greenland varieties and to 200 females of each of the remaining varieties; to preserve genetic variation in the protected populations; and to preserve the breed standard of colour varieties of nutria. In addition, in order to further development of protected populations, measures are taken to promote and popularize breeding of these varieties and to more precisely characterize individual populations and their qualities [4].

Despite implementation of the conservation programme, the number of farms under the control of the National Animal Breeding Centre (KCHZ) has decreased from year to year. After a marked decline in the number of farms, the size of the nutria population remained relatively stable from the 1990s up until 2006. In that year seven nutria breeders were registered, with a total of 1,659 females. In subsequent years, however, more farms were closed down, which led to a reduction in the number of animals. In 2007 there were 1,123 females under the control of the KCHZ, and a year later only 628. Since 2009 the number of females has not exceeded 500. In 2013 there were only three farms operating in Poland, with 139 females of the standard variety, 125 Greenland, 10 pearl, 67 black, 35 amber-gold, 32 pastel, 25 white non-albino and 13 sable [5].

The decreasing size of nutria herds and the increase in relatedness between individuals increases the risk of inbreeding. An increase in homozygosity of offspring due to mating of related individuals may lead to the manifestation of unfavourable recessive alleles and the loss of valuable genes. Such individuals have lower resistance to diseases and parasites. Inbreeding also has a negative effect on breeding traits, such as viability, health, body weight, and growth rate. This type of problem can be solved by measures to curb the loss of genetic variation in the population [10].

The aim of the study was to analyse the pedigrees and monitor the genetic diversity of the domestic population of nutrias covered by the genetic resources conservation programme for livestock animals in Poland.

Material and methods

The study was conducted on nutrias of the standard, black dominant, Greenland, pearl, amber-gold and pastel varieties, raised on three farms (Farm A, Farm B and Farm C) subject to use value and breeding assessment by the KCHZ. Breeding documentation from 2010-2013 (breeding cards of animals obtained from breeders and protocols provided by the KCHZ) were used to analyse the pedigrees of individuals kept on the farms (n=332) and their ancestors (n=138) and to monitor the genetic diversity of the nutrias.

CFC 1.0 software was used to calculate the inbreeding coefficient and relationship coefficient between individuals representing each colour variety and farm, and the interactions between them were analysed. The inbreeding coefficient for a given individual and the average inbreeding coefficient for a group into their ancestral components were calculated using three vectors: *m* (contributions of Mendelian sampling variances of ancestors), *u* (contributions of genes of nodal common ancestors) and *v* (contributions of genes of founders). Vectors *m* and *u* are added to obtain individual or mean values for the inbreeding coefficient. When non-founders have known parents the values of vector v sum to individual or average inbreeding coefficients [11].

Results and discussion

Analysis of the farm documentation provided results characterizing individuals kept on the farms (n=332) and their ancestors (n=138). The mean relationship coefficient

Table 1
Mean coefficient of relationship between colour varieties of nutria

	Standard	Black	Greenland	Pearl	Amber-gold	Pastel
Standard	0.0425	0.0098	0.0019	0.0047	0.0000	0.0137
Black		0.1503	0.0120	0.0037	0.0000	0.0007
Greenland			0.0819	0.0055	0.0000	0.0006
Pearl				0.3136	0.0320	0.0036
Amber-gold					0.1250	0.0000
Pastel						0.1239

for all individuals analysed was 0.0140. The values within farms were 0.1289 for Farm A, 0.0766 for Farm B, and 0.0282 for Farm C, while the values between farms were as follows: Farm A x Farm B – 0.0039, Farm A x Farm C – 0.0095, and Farm B x Farm C – 0,0035. For most of the colour varieties analysed the relationship coefficient was greater than 0 (Tab. 1).

The values for the relationship coefficient for the farms and colour varieties were low. An exception was the pearl variety, with a coefficient of 0.3136, which should be taken into consideration in future planning of mating. An increase in relatedness between individuals in a herd may contribute to an increase in inbreeding, which has a negative effect on breeding and may substantially reduce the breeders' income, as increased inbreeding raises the risk of manifestation of lethal defects. A solution to this problem is appropriate mating of individuals leading to offspring with increased heterosis, which is beneficial to the condition of the population [10].

Among the individuals analysed only 16 had an inbreeding coefficient above 0, i.e. 13 from Farm C and 3 from Farm B (tab. 2). The higher inbreeding coefficients were noted for 10 nutrias of the black dominant variety, 3 standard nutrias and 3 Greenland nutrias (Tab. 3).

Despite the small size of nutria herds in Poland, the inbreeding coefficient remains low and mating takes place according to established norms. Special care, however, should be taken in the case of the black dominant variety, as most animals of the animals which had a high inbreeding coefficient belonged to this colour variety. The mean inbreeding coefficient for this variety was 0.0149, which indicates that an appropriate distance is maintained in mating related individuals, e.g. mating of half-siblings, cousins or grandparents with grandchildren. If, however, the relationship coefficient was 0.5 or higher, this would indicate an incestuous mating, which in the case of herds covered by genetic resources conservation is inadvisable. Attention should be drawn to Farm C, which had the highest percentage of inbred animals. It should be remembered that an increase in the relationship coefficient causes inbreeding depression, manifested as an increase in mortality, a reduction in fertility, and deterioration of the health of the animals. This can often be observed in small, closed populations, which unquestionably include nutria farms [9].

A lack of rigorous control of origin can rapidly aggravate the current situation, leading to an increase in inbreeding and relationship coefficients. This may occur in the case of unskilled exchange of breeding material between farms in Poland or a lack of matings introducing new blood, e.g. using material from the Czech Republic. The small number of farms in Poland raises the risk of an increase in inbreeding, so it should be a priority to increase the size of nutria herds according to the objectives of the genetic resources conservation programme [4]. As there is currently little interest in nutria skins, promotion of their meat could help to increase the size of the breeding population. As compared to popular species of farm animals, nutria meat is high in

Table 2
Inbreeding coefficient of nutrias depending on the farm

Specification	Number of individuals	Number of inbred individuals	Average inbreeding coefficient	Average inbreeding coefficient for inbred individuals	Maximum inbreeding coefficient	Minimum inbreeding coefficient for inbred individuals
Farm A	47	0	0.0000	0.0000	0.0000	0.0000
Farm B	85	3	0.0022	0.0625	0.0625	0.0625
Farm C	200	13	0.0055	0.0841	0.1875	0.0312
Total	332	16	0.0027	0.0801	0.1875	0.0312

Table 3
Inbreeding coefficient of nutrias depending on the colour variety

Variety	Number of individuals	Number of inbred individuals	Average inbreeding coefficient	Average inbreeding coefficient for inbred individuals	Maximum inbreeding coefficient	Minimum inbreeding coefficient for inbred individuals
Standard	125	3	0.0007	0.0312	0.0312	0.0312
Black	42	10	0.0149	0.0625	0.0625	0.0625
Greenland	91	3	0.0062	0.1875	0.1875	0.1875
Pearl	13	0	0.0000	0.0000	0.0000	0.0000
Amber-gold	33	0	0.0000	0.0000	0.0000	0.0000
Pastel	28	0	0.0000	0.0000	0.0000	0.0000
Total	332	16	0.0027	0.0801	0.1875	0.0312

protein and has low content of fat and cholesterol [12]. Moreover, traditional feeding methods produce meat with a beneficial fatty acid profile for humans [3].

In breeding work carried out on farms it is important to ensure appropriate control of documentation regarding mated individuals. This enables accurate calculation of inbreeding and relationship coefficients. In order to properly carry out this task breeders must be mobilized to work systematically and accurately. The absence of these basic measures may have a detrimental effect on the quality of nutrias raised in Poland. The results of the study indicate that thus far the work of breeders has been conducted properly. Thus it is important that individuals breeding this species continue to be motivated by subsidies for animals and to have an awareness of the support of state institutions.

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