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

2006
Volume 9
Issue 2
Topic
ANIMAL HUSBANDRY

CHOLEWA R. , PAWLICZAK-MAJ K. , SZWACZKOWSKI T. 2006. GENETIC AND ENVIRONMENTAL EFFECTS ON BODY WEIGHT AND FUR HIGHT IN NUTRIA (*MYOCASTOR COYPUS* L.) **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 9, Issue 2.
Available Online http://www.ejpau.media.pl/volume9/issue2/art-24.html

GENETIC AND ENVIRONMENTAL EFFECTS ON BODY WEIGHT AND FUR HIGHT IN NUTRIA (*MYOCASTOR COYPUS* L.)

Ryszard Cholewa[1], Kinga Pawliczak-Maj[1], Tomasz Szwaczkowski[2]
[1] *Department of Fur Animal Breeding, August Cieszkowski Agricultural University of Poznan, Poland*
[2] *Department of Genetics and Animal Breeding, August Cieszkowski Agricultural University of Poznan, Poland*

ABSTRACT

The objectives of the study were to estimate chosen effects (sex, color variety, farm and partitution) on body weight and hair layer hight characters as well as correlations between these traits. Furthermore, heritabilities of traits studied were also estimated. The research was carried on three reproductive farms keeping animals in four basic coat varieties: standard, Sapphire blue, Greenland and white. In the experimental group 919 young nutrias were included and the following steps were executed:

– body weight was measured,
– hight of underfur and guard hairs.

Estimation of heritability was based on unitrait animal model. Standard errors of heritability estimates were approximated based on second order polynomials. The package program DFREML was employed. Correlation coefficients were estimated in the SAS system. Heritability estimates of hair traits were high. The highest estimate (h^2 = 0.623) was obtained for lateral guard hairs height. The estimates of other three traits were slightly lower and ranged from 0.49 (lateral underfur) to 0.58 (dorsal underfur). Higher heritability was estimated for fur characters than for body weight. Linear correlations were estimated between all traits. Some of the estimates were close to zero. The highest correlation was recorded for the height of the same hair types.

Key words: genetic effects, nutria, traits.

INTRODUCTION

Nutria breeding is highly dependant on the fur market needs, where the prizes are dictated by trends, weather conditions in winter season and activity of anti-fur movements. Independently from the market situation attention must be given to the quality of the product. Best quality class (extra and I) and the biggest (length 1 and 2) pelts have always been inquired and paid good prize. Middle Eastern European countries were traditionally top nutria pelts producers, producing in the 1980s about 5mln pelts per year, 70% of which were exported. Although this indexes are nowadays much lower, periodical increase in the market demands for this skins can be observed. It seems that existing difficulties in nutria breeding are temporal. It is even possible to say with certain dose of hope about perspectives of development in this area. The importance of meat production, for consumption by people with higher nutritional needs, has also increased over last years. Production level of nutrias, described by quantity and quality of skins and meat depends on both genetic and environmental factors. High production can be achieved in optimal environmental conditions. Feeding system, which depends on breeders abilities and component accessibility, is very important. Many studies have been carried in this field [4]. Similar role is played by the housing system. This factor however is generally more unified than diversified feeding resources [6]. The effect of restricted water access on fur quality and reproduction of these animals was studied by Szuman and Cholewa [13]. After optimization of environmental conditions breeding program should be set up after the breeding goals were defined. In the available literature there were no reports of genetic parameters of fur characteristics in nutria. The objectives of the study were to estimate chosen effects (sex, color variety, farm and parturition) on body weight and hair layer hight characters as well as correlations between these traits. Furthemore, heritabilities of traits studied were also estimated.

MATERIALS AND METHOD

The research was carried on three reproductive farms keeping animals in four basic coat varieties: standard, Sapphire blue, Greenland and white. On two farms several experimental mating groups (harem) were established with one male mated to on average seven females. These animals with known birth date were reproduced to give several litters during 3 years. The same activity was undertaken on the third farm. From organizational reasons the experimental groups of animals were kept in separate sector in order to make them easily accessible and not to interfere with other farm functions.
In the experimental group (212 females and 31 males) the following steps were executed:

– animals were marked according to the key by cuts on the feet webs,
– evidence and documentation of experimental animals,
– body weight was measured,
– hight of underfur and guard hairs was measured, was prepared.

When the progeny reached the age in which their parents were formed into harems, the same measurements were taken on them:

– body weight,
– hight of underfur and guard hairs, 919 young nutrias were included.

The measurements took into account the pedigree, sex, color variety, date of birth, date of establishing of the harem and date of parturition.

Detailed characteristics of nutrias in about 6.5 month of life included the following traits:

– body weight (g),
– dorsal underfur,
– lateral underfur,
– dorsal guard hairs,
– lateral guard hairs.

Animal size

With reference to conformation traits related to meat and fur production were scored. The size of animals (young stock) was scored. Body weight measurements enabled the analysis of their growth rate.

Hair coat characters

Scoring of fur traits included the live measurement of hair hight (both underfur and guard hairs). The hair hight measured on the farm enabled the scoring of important coat characteristics in animals of different color varieties. Statistical description (averages and standard deviations) of these data set was listed in Table 1.

Table 1. Description of the data set

Trait		Means ($\bar{x}$)	Standard deviation (s)
Body weight (g)		3547.0	(± 618.4)
Height (mm) side	guard hairs	76.8	(± 9.9)
	underhair	14.2	(±2.7)
back	guard hairs	68.7	(± 9.8)
	underhair	12.6	(± 2.5)

Estimation of heritability was based on unitrait animal model. For body weight the following linear model was applied:

$$y_{ijklm} = \mu + s_i + f_j + w_k + o_l + a_{ijklm} + e_{ijklm}$$

where:
y_{ijklm} is the observation on the ijklm-th individual,
μ is the overall mean,
s_i is the fixed effect of the i-th sex,
f_j is the fixed effect of the j-th farm,
w_k is the fixed effect of k-th parturition,
o_l is the fixed effect of the l-th color variety,
a_{ijklm} – is the random additive genetic effect of ijklm-th individual,
e_{ijklm} is the random error connected to the ijklm-th observation.

In the analysis of fur traits, body weight was included as covariate. The linear model was as follows:

$$y_{ijklm} = \mu + s_i + f_j + w_k + o_l + b(\bar{x} - x_{ijklm}) + a_{ijklm} + e_{ijklm}$$

where:
y_{ijklm} is the fur characteristics of the ijklm-th individual,
$\bar{x}$ is the average body weight of the analyzed individuals,
b- is the partial regression coefficient,
a_{ijklm} is the random additive genetic effect of the ijklm-th individual,
μ, s_i, f_j, w_k, o_l, a_{ijklm} e_{ijklm} – as above.

The covariance components were estimated by the use of Derivative Free Restricted Maximum Likelihood algorithm [9], [11].

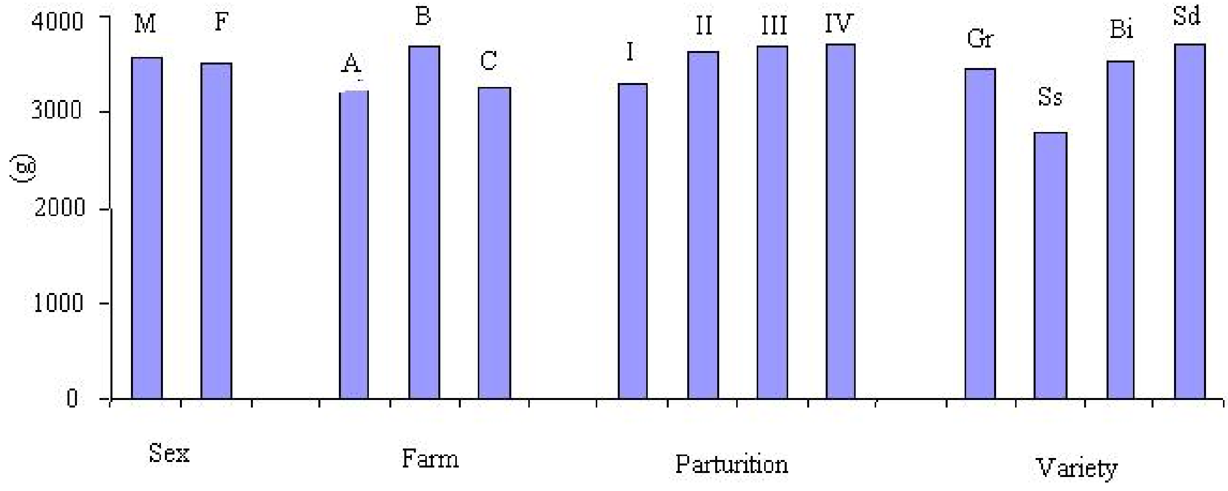
Standard errors of heritability estimates were approximated based on second order polynomials [7]. The package program DFREML was employed [8]. Correlation coefficients were estimated in the SAS system (2004).

RESULTS

Body weight

The averages within fixed effect classes were presented on Figure 1. In general, differences in body weight between varieties and sexes were registered. Body weight of Greenland variety in the farm A was similar to standard variety for both sex groups. Sapphire blue variety differed from others with respect to body weight. However the effect of variety on body weight was not significant. Sexual polymorphism was observed. Generally, males were heavier than females but this tendency was not confirmed by statistical analysis. Exceptionally the Greenland females were heavier than males of the same variety. The animals kept on farm B were heavier then ones from farms A and C, except from white variety. On the farm C standard females were the heaviest and their weight exceeded the averages of animals from other farms. Traits included in the actual conformation scoring standards in Poland are highly related to the market value of the pelts.

Fig. 1. Avarages of body weight (g) for levels of statistical factors studied



The estimates of heritability were presented in Table 2. Generally, the heritability was low. It must be recalled that this genetic parameter is a function of both genetic and environmental variance. It seems that in this case low heritability is determined by high environmental variability.

Table 2. Heritability estimates of traits studied (standard deviations of these estimates – in parenthesis)

Trait	Heritability estimates	Standard deviation of heritability estimate
Body weight	0.135	0.057
Lateral underhair	0.623	0.084
Lateral guard hairs	0.489	0.115
Dorsal underhair	0.476	0.085
Dorsal guard hairs	0.583	0.118

Hair coat characters

The hair coat characteristics within the fixed effects were given on the Figures: 2 (dorsal guard hairs height), 3 (lateral guard hairs height), 4 (dorsal underfur height), 5 (lateral underfur height).

Fig. 2. Averages height of guard hairs on the side (mm) for levels of statistical factors studied

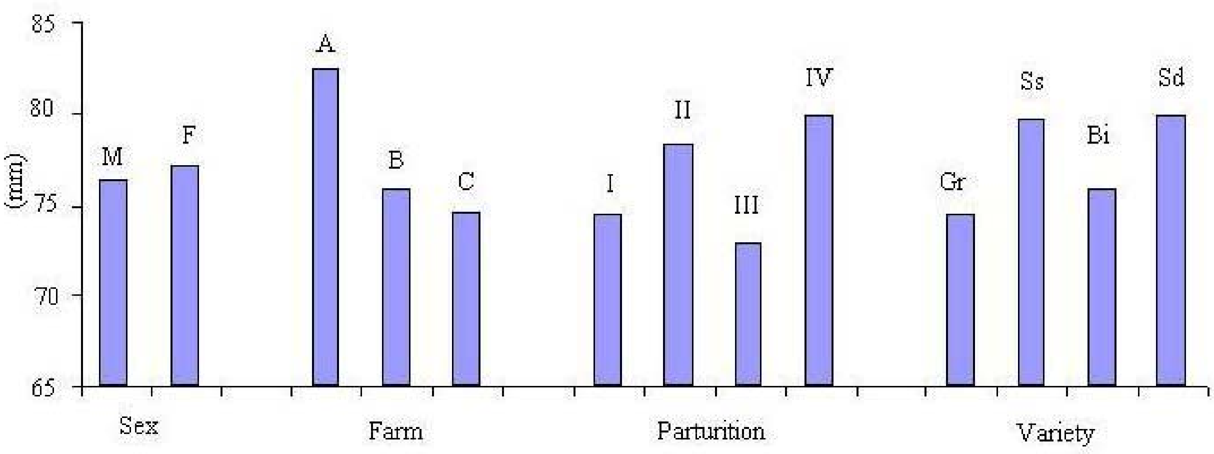


Fig. 3. Averages height of underhair on the side (mm) for levels of statistical factors studies

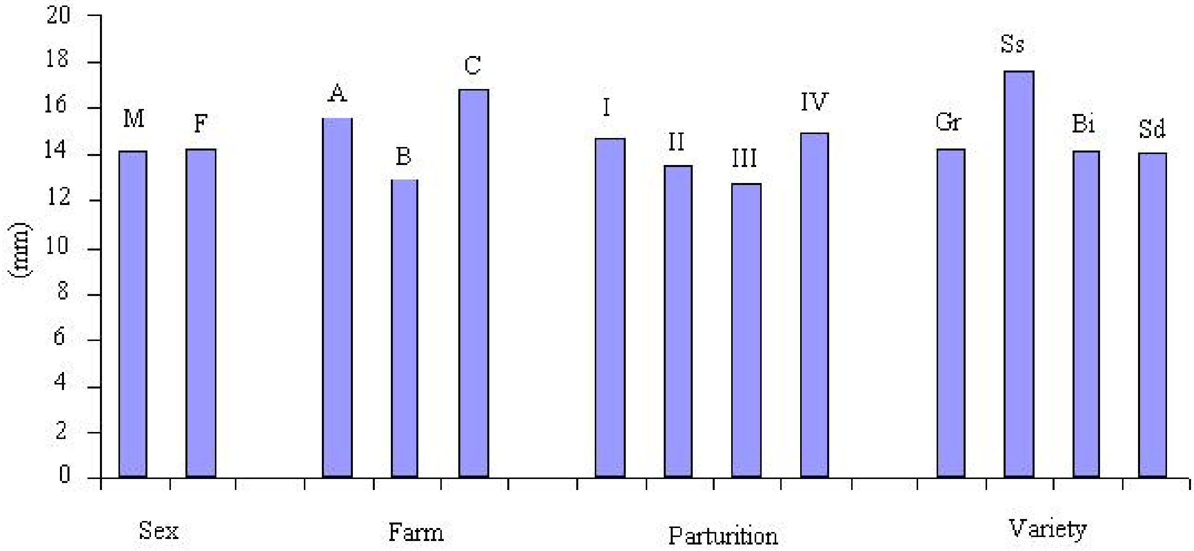


Fig. 4. Averages height of underhair on the back (mm) levels of statistical factors studied

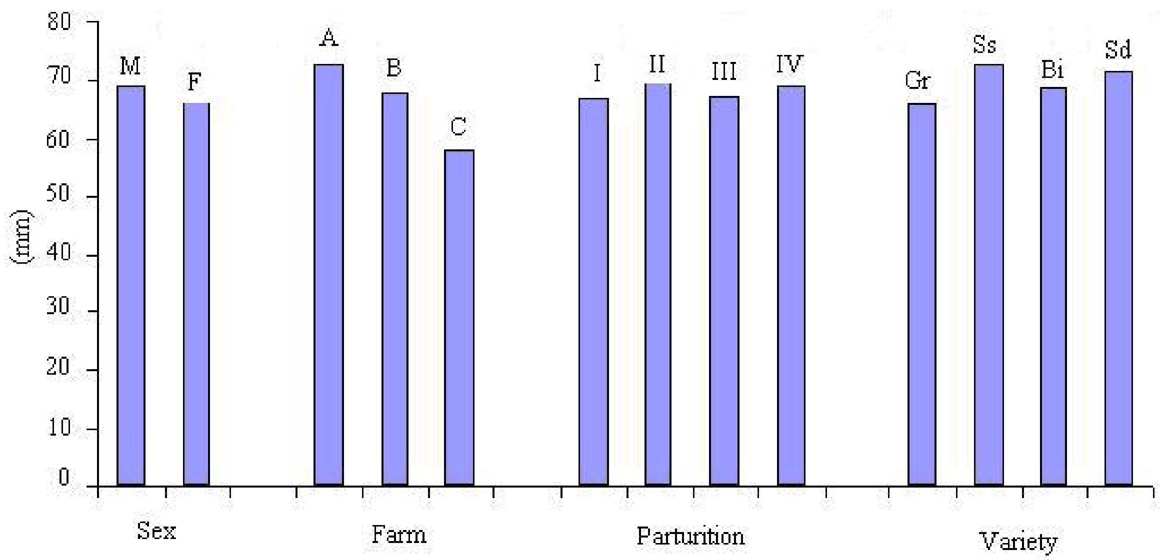
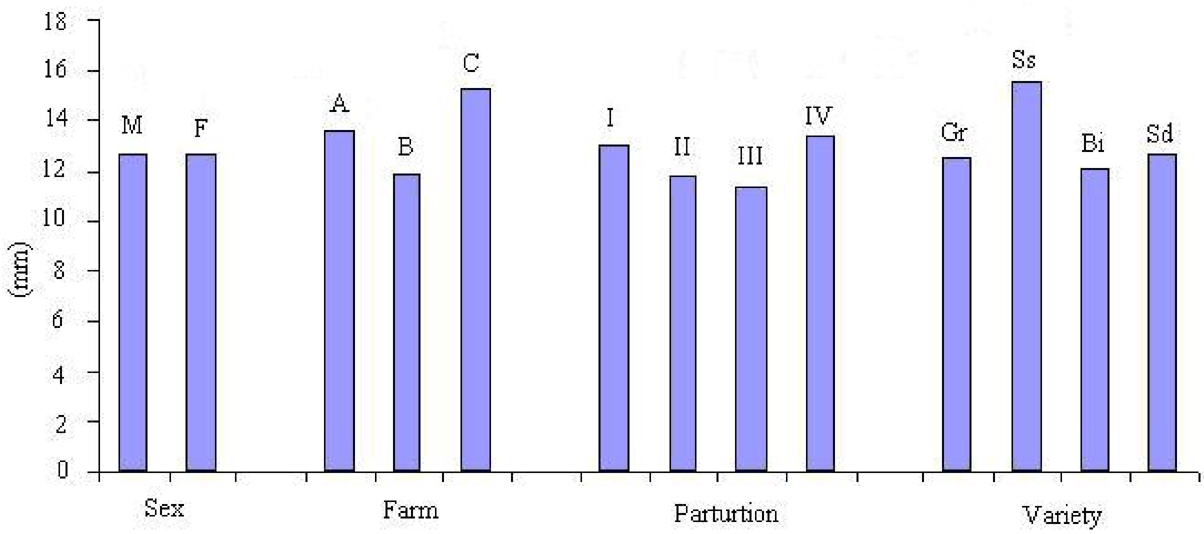


Fig. 5. Averages height of underhair on the back (mm) for levels of statistical factors studies



The height of both hair types was similar for males and females in dorsal and lateral part of fur. Guard hair was shorter in Greenland variety than in other varieties. Underfur of Green-land and white nutrias was lower than one of sapphire blue and standard variety.

The height of both hair types was lower in the dorsal part than in lateral. The Greenland variety was characterized by the shortest hair whereas the hair of Sapphire nutrias was the longest. With respect to hair length standard variety was similar to sapphire blue and Greenland nutrias were similar to white ones. The heigth of guard hairs of animals in farm B was intermediate between the animals from other farms, however the underfur was shorter. This trait was similar for males and females. The breeding practice revealed that nutrias kept without pools could also reproduce and give pelts of good size and quality. They grow and develop similar to animals in other housing systems. Heritability estimates of hair traits were high (Table 3). The highest estimate ($h^2 = 0.623$) was obtained for lateral guard hairs height. The estimates of other three traits were slightly lower and ranged from 0.49 (lateral underfur) to 0.58 (dorsal underfur).

Table 3. Correlation estimates between performance traits studied

<table>
<tr><th colspan="6">Trait</th></tr>
<tr><th colspan="2" rowspan="3"></th><th rowspan="3">body weight</th><th colspan="3">height of coat</th></tr>
<tr><th colspan="2">side</th><th>back</th></tr>
<tr><th>guard hairs</th><th>underhair</th><th>guard hairs</th></tr>
<tr><td rowspan="2">side</td><td>guard hairs</td><td>0.257</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>underhair</td><td>-0.095</td><td>0.311</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">back</td><td>guard hairs</td><td>0.173</td><td>0.744</td><td>0.161</td><td>-</td></tr>
<tr><td>underhair</td><td>-0.098</td><td>0.238</td><td>0.805</td><td>0.155</td></tr>
</table>

Relationships among the traits

Linear correlations were estimated between all traits (Table 4). Some of the estimates were close to zero. The highest correlation was recorded for the height of the same hair types. These measurements were taken on alive animals on a farm. Native population of nutrias was scored with respect to fur characteristics. The relationship between production traits was studied as well. Because of unfavourable correlations some of the indicators appeared to be of low value for the selection. This refers to the hair height of guard hair and underfur.

Table 4. Number of nutria (n = 919)

Farm	Varieties								Together
	Greenland		Sapphire blue		White		Standard		
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	
A	79	85	9	2	8	11	23	31	248
B	113	177			10	10	131	189	630
C	16	25							41
Together	208	287	9	2	18	21	154	220	919

DISCUSSION

Pelt size depends on animal size, which is well indicated by body weight. Bernau et al. [1] reported high correlation (0.7) between body weight and pelt length. It was also confirmed for Polish population [10]. Body weight is also a good indicator of the quantity of meat produced by an animal.

The meat production of nutrias should not be ignored especially in the periods of low market values of pelts. Rational utilization of the meat should improve farm economical situation and enrich the diet of consumers with valuable replacement of other meat types.

Szuman and Cholewa [13] reported many advantages of without-pool housing system of nutrias. Since then the influence of various environmental effects was intensively studied. Reports on both reproduction [3] and production [2] traits have been given only for Polish population. It can be suggested that there is no direct effect of housing system on pelt size, the only economically important aspect is the fur quality. The research carried in the National Institute of Animal Production in Cracow demonstrated positive effect of without-pool housing system on the production parameters of standard nutrias.

Although, as already mentioned, there were not many studies on genetic background of production traits in nutria, some estimates of body weight heritability can be found for fur animals. The estimated heritability coefficient was lower than the values reported for polar foxes [14]. The literature studies for other livestock show that genetic parameters differ in time and between populations. The heritability estimates of fur characteristics were higher than for body weight. Most of the research was carried on foxes and led to inconsistent conclusions. Wierzbicki [15] reported the heritability of hair length in polar fox of about 0.33 and estimates between 0.197 and 0.239 (depending on a model) in silver fox. From methodological point of view it should be noted that there was no effect of data transformation on the variance components. Socha [12] estimated the heritability of hair length in foxes within wide range (0.04-0.754). Relative high heritability of hair length was also reported by Filistowicz [5].

To sum up, it can be stated that high heritabilities enable high genetic improvement of hair characteristics in the analyzed populations. The impact of selection should also be increased by nonnegative correlations between the traits.

CONCLUSIONS

1. The body weight of males (at the age of 6.5 months) was higher than of females.
2. The hight of both hair types was higher on lateral than on dorsal part of fur. Guard hairs and underfur was lower in Greenland variety than in standards.
3. Higher heritability was estimated for fur characters than for body weight.
4. Dorsal and lateral hair higth was highly correlated within hair types.

REFERENCES

1. Bernau W., 1980. Die Wechselbeziehung zwischchen den Merkmalen Körpermasse und Fellänge beim Sumpfbiber unter besonderer Berücksichtigung des Geschle-chtsdimorphismus. Dtsche. Pelztierzücht. 54 (5), 71-72.
2. Cholewa R., 1983. Einfluss einiger Umweltfaktoren auf die Qualität des Sump-fbiberfelles. 1. Internationales Pelztiersymposium. Sektion: Tierproduktion und Veteri-närmedizin der Karl-Marx-Universität, Leipzig. Bd 3, 130-138.
3. Cholewa R., 1988. Ocena wpływu różnych systemów utrzymania nutrii grenlandzkich na ich barwę okrywy i wysokosc włosów [Coat colour and height of hair in Greenland coypu maintained with and without acces to water basins]. Rocz. AR Pozn. CXLIV, 41-47 [in Polish].
4. Cholewa R., 1994. Pokarm pełnoporcjowy w żywieniu nutrii [Feeding different diets to nutria breeding herd]. Rocz. AR Pozn. CCLXI, Ser. Zootech. 45, 35-39 [in Polish].
5. Filistowicz A., Wierzbicki A., Zwolińska-Bartczak I., Żuk B., 1999. Genetic parameters of conformation and coat traits in fox (*Vulpes vulpes* L.) population. J Appl. Genet. 40 (3), 211-218.
6. Gedymin J., Cholewa R., 1978. Obsada w pomieszczeniach a wyniki produkcyjne na fermach nutrii [Besetzung in den Unterkünften und Produktionsergebnisse auf Nutria-farmen]. Hod. Drobn. Inwent. 12, 13-14 [in Polish].
7. Graser H.U., Smith S.P., Tier B., 1987. A derivative-free approach for estimating variance components in animal models by restricted maximum likelihood. J Anim. Sci. 64, 1362-1370.
8. Meyer K., 2001. Programs to estimate variance components for individual animal models by restricted maximum likelihood (REML) ver. 3.1.0. User notes. Institute of Animal Science, Armidale, Australia.
9. Patterson H.D., Thompson R., 1971. Recovery of interblock information when block sizes are unequal. Biometrika 58, 545-554.
10. Pazdrowski P., 1995. Zwiazek masy ciała z długoscia skóry nutrii [Relation of body weight nutria with lenght of skin]. Diplomwork. Agric. Univ. Poznań. Manuscript [in Polish].
11. Smith S.P., Graser H.U., 1986. Estimating variance components in a class of mixed models by Restricted Maximum Likelihood. J Dairy Sci. 69, 1156-1165.

12. Socha S., 1994. Parametry genetyczne cech okrywy i wielkosc ciała lisa polarnego niebieskiego [Genetic parameters of fur traits and body size in arctic blue fox (*Alopex lagopus* L.)]. Zesz. Nauk. PTZ 15, 19-28 [in Polish].
13. Szuman J., Cholewa R., 1977. Ist die Trockenhaltung des Sumpfbibers noch immer ein Problem? Dtsche. Pelztierzücht. 4, 61-70.
14. Wierzbicki H., Filistowicz A., 2002. Single- and multitrait animal model in the silver fox evaluation. Czech J. Anim. Sci. 47, 268-274.
15. Wierzbicki H., 2004. Breeding value evaluations in Polish fur animals: estimates of direct heritability and portion of litter variation of fur coat and reproduction traits. Czech J Anim. Sci. 49, 474-482.

Ryszard Cholewa
Department of Fur Animal Breeding,
August Cieszkowski Agricultural University of Poznan, Poland
Wołynska 33, 60-637 Poznan, Poland
email: cholewar @jay.au.poznan.pl

Kinga Pawliczak-Maj
Department of Fur Animal Breeding,
August Cieszkowski Agricultural University of Poznan, Poland
Wołynska 33, 60-637 Poznan, Poland

Tomasz Szwaczkowski
Department of Genetics and Animal Breeding,
August Cieszkowski Agricultural University of Poznan, Poland
Wołynska 33, 60-637 Poznan, Poland
email: tomasz @jay.au.poznan.pl
