ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2002
Volume 5
Issue 2
Series ANIMAL HUSBANDRY

JAKUBCZAK A. 2002. EVALUATION OF PASTEL FOX BREEDING RESULTS IN POLAND - REPRODUCTION **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 5, Issue 2.
Available Online http://www.ejpau.media.pl

EVALUATION OF PASTEL FOX BREEDING RESULTS IN POLAND - REPRODUCTION

Andrzej Jakubczak

Department of Biological Basis for Animal Production, Agricultural University of Lublin, Poland

ABSTRACT

The evaluation of pastel fox breeding results was carried out through the estimation of selection differentials and genetic and phenotypic trends in some performance traits. The observations covered common fox females, reared during 1978-1997, from which a total of 4155 offspring were obtained with pastel colour of coat. The analysis of reproduction indices demonstrated that the average percentage of whelping females oscillated around 65.63%. The average number of born offspring ranged between 2.56 and 4.42 per a female of the herd.

Additionally, coefficients of heritability and genetic correlation for reproduction-related traits were estimated with the REML method. Genetic trends were computed using BLUF90 programme, applying a multi-trait animal model. The coefficients of heritability were 0.060 for the number of the born pups, and 0.026 for the pups raised from the litter.

Selection differentials calculated for the reproduction-related traits were close to zero, which may speak in the advocacy of practical application of stabilising selection towards these traits. Positive values of genetic trends were obtained only for the number of the weaned young.

Key words: pastel fox, selection differential, genetic trend.

PRINT

INTRODUCTION

The history of the pastel fox - the original Polish variety - goes back to 1972, when a silver-coloured female gave birth to a litter that consisted of silver individuals as well as beige ones. The vixen, together with her offspring, was purchased by the farm in Jeziora Wielkie, Poland. The variety of such a characteristic conformation was named “Pearl of Jeziora”, to eventually become "pastel fox", by analogy to pastel nutria or mink. During the initial years of pastel fox breeding (1972-1975), the primary objective was to increase the frequency of brown-coloured animals in the shortest possible time. Organised work on the new variety was begun by Professor J. Maciejowski in 1976 [11]. At that moment the herd consisted of 13 pastel males and 9 females. Moreover, some of silver foxes were carriers of the brown-colour allele. Those days no selection of the pastels was carried out, except for inevitable sanitary culling.

The selection of the pastel-coloured animals in order to obtain foxes with desired fur traits was begun on the farm in 1981. Generally speaking, the primary traits to be improved included: colour type (darkening the colour), hair-coat structure, body conformation traits, fertility, prolificacy, and maternal solicitude as well as a gentle disposition.

This study was aimed at an evaluation of the outcomes of the breeding works of pastel fox carried out during 1978-1997, with particular consideration to reproduction-related traits.

MATERIALS AND METHODS

The material for the study was collected from the fur animal farm in Jeziora Wielkie near Poznan, Poland. The observations covered common fox females of various colour varieties, farmed between 1978 and 1997, from which a total of 4155 pastel-coloured offspring were obtained. A total of 1066 litters were analysed, which produced at least one individual with pastel colour. In each subsequent year, the breeding stock was set up on the farm. Only those pastel foxes were culled from the stock that were infertile, ill, or with visible body malformations. The culled animals were replaced with young foxes of satisfactory conformation traits. The animals were fed according to current standards for carnivorous fur animals feeding, and were remained under standard (for common foxes) prophylactic veterinary care.

The farm documentation provided the information on the reproduction performance of the breeding stock, as well as the juveniles weaning results. The following were included in the evaluation of female reproduction: origin (in order to analyse pedigrees, and to determine the degrees of kinship and herd inbreeding), age, colour variety of the male and female, date of service and date of whelping, litter size at birth and the number of raised per litter, as well as the number of whelping females, those destroying their litter, infertile, and aborting. To determine the earliness of whelping, a notion of “whelping season” was introduced as a number of weeks elapsed form the beginning of the calendar year of the whelping.

Statistical characterisation of the collected data is presented in the form of means and standard deviations. Significance of differences between the means was verified using SAS [17] statistical software package, with analysis of variance in the form of the following model:

$$\mathbf{y_{ijklm} = m + R_i + P_j + W_k + S_l + PW_{jk} + RS_{il} + e_{ijklm}}$$

where:

y - vector of an analysed trait,
m - population mean of the trait,
R_i - fixed effect of birth year,
P_j - fixed effect of the individual's sex,
W_k - fixed effect of dam's age,
S_l - fixed effect of whelping season,
PW_{jk} - fixed effect of the interaction: individual's sex * dam's age,
RS_{il} - fixed effect of the interaction: year of birth * whelping season,
e_{ijklm} - random error.

PRINT

For the estimation of coefficients of heritability and genetic correlations, VCE 4.2.5 computer programme by Eildert Groneveld [7] was used with the REML (Restricted Maximum Likelihood) method, according to the model:

$$\mathbf{y_{ijklmn} = m + R_i + W_j + RS_k + a_l + p_m + e_{ijklmn}}$$

where:

y_{ijklmn} - vector of an analysed trait,
m - population mean of the trait,
R_i - fixed effect of birth year,
W_j - fixed effect of the animal's age,
RS_k - fixed effect of the interaction: age at production * whelping season,
a_l - random effect of the individual,
p_m - random effect of constant environment of the animal,
e_{ijklmn} - random error.

Phenotypic correlations and coefficients of inbreeding were estimated using SAS software package [16]. In order to estimate selection intensity, selection differentials were calculated for the studied reproduction traits, considering the procedure proposed by Maciejowski and Jeżewska [13]. These were calculated as differences between the mean phenotypic values of the trait among the juveniles selected for the breeding stock (so-called replacement) and the mean values of the trait for all juveniles. Phenotypic trends were estimated as the changes in the mean value of the trait in time. Genetic trends, on the other hand, were based on the solutions for the year of individual's birth that describe genetic quality changes in time. The computations were carried out using Ignacy Misztal's [14] BLUPF90 software, taking into considerations the same random and constant factors as for the genetic parameters, applying a multi-trait animal model.

RESULTS AND DISCUSSION

The analysis of reproduction indices (Table 1) revealed that the mean percentage of whelping females oscillated around 65.63% and did not deviate from the means obtained in other farms, except for the years 1981 and 1992, when it reached respectively 49.02 and 50.00%. The poor results in those two years may be attributed to organisational-nature problems that affected the farm, but also to the pathogenic factor of cor pulmonale incidence in 1992. The best percentage of whelping vixens was recorded in 1983, i.e. 78.86%, and in 1994, 77.67%. The average proportion of offspring-killing females their was 24.38%. In this respect, 1988 and 1992 were the poorest years, when respectively 35.40 and 34.62% of dams destroyed their litters. The average percentage of infertile females was 7.65, ranging between 2.74, in 1979, and 27.45%, in 1981. During 1978-1997, aborting females comprised 2.35% on average, which did not deviate from the country average. The highest incidence of aborting dams was recorded in 1985 and 1992, but also the period 1995-1997 appeared poor, when their proportion ranged between 4.29 and 3.47%. Some kind of malfunctioning of the farm recorded in individual years may be explained with accidental environmental factors, including the human factor. The results obtained in this study are comparable to those reported by other authors. Brzozowski [5] reported the same level of whelping females percentage (studies based on the data collected from 27 domestic farms during 1981-1990). Jeżewska [8] stated that the proportion of whelping vixens changed from farm to farm, ranging between 69.3-78.8%, and the fraction of litter-destroying, infertile, and aborting females was respectively 11.8-18.8, 4.5-13.1, and 0.4-3.1%.

PRINT

Table 1. Characteristic of vixens' reproduction indices in subsequent years

Year	Females					Mean litter size per female			
	total	destroying	infertile	aborting	whelping	at birth		at weaning	
	n	**%**	**%**	**%**	**%**	**X**	**CV%**	**X**	**CV%**
1978	87	34.48	6.90	0.00	58.62	3.83	29.56	2.10	34.31
1979	146	39.04	2.74	0.68	57.53	3.08	31.85	1.62	32.56
1980	174	41.95	3.45	1.72	52.87	3.59	38.89	1.94	43.97
1981	204	31.37	27.45	1.47	49.02	2.56	37.59	1.76	40.36
1982	159	9.43	13.21	0.63	76.73	3.36	33.93	2.81	35.73
1983	175	13.71	5.71	1.71	78.86	4.03	29.66	3.15	33.91
1984	325	21.23	5.54	1.85	71.38	3.86	31.13	2.82	39.15
1985	283	23.32	7.77	5.65	63.25	3.80	32.48	2.92	35.35
1986	274	18.25	9.49	1.46	70.80	4.05	30.29	2.52	39.48
1987	273	20.51	6.59	1.10	71.79	3.76	30.51	2.87	38.63
1988	274	35.40	4.38	2.55	57.66	2.64	32.15	1.30	40.53
1989	272	16.54	6.25	1.47	75.74	3.88	29.52	2.66	39.81
1990	249	18.88	8.43	2.01	70.68	3.96	30.32	2.70	37.31
1991	190	24.21	4.21	3.16	68.42	4.33	28.89	2.58	41.10
1992	182	34.62	9.34	6.04	50.00	3.12	33.23	1.43	43.48
1993	115	20.87	4.35	0.87	73.91	4.42	30.72	2.97	40.53
1994	103	17.48	2.91	1.94	77.67	3.98	32.24	2.82	39.03
1995	117	26.50	5.13	4.27	64.10	3.61	33.33	1.78	45.13
1996	144	23.61	8.33	3.47	64.58	3.28	31.92	1.98	39.76
1997	157	29.94	7.64	3.82	58.60	3.21	33.37	2.15	41.76
Razem	3922	24.38	7.65	2.35	65.63	3.62	32.08	2.34	39.09

n- number offemales.

The average litter size at birth during the studied period ranged from 2.56 do 4.42 pups per female, while in 1983, 1986, 1991, and 1993, a vixen yielded more then 4 pups (Table 1). The worst reproduction results were recorded in 1981 and 1988. Mean litter size at weaning ranged between 1.30 and 3.15 in particular years. The worst years for raising pups were 1988 and 1992, when only 1.30 and 1.43 pups were raised per female. According to Lohi [10], an average litter size on Danish silver fox farms during 1983-1993 ranged between 3.48-3.97 pups at birth and 2.92-3.33 pups at weaning. The low prolificacy recorded here in the initial years may have resulted from the adverse effect of inbreeding, as well as from the changes that affected the entire country at that time (feed shortages, ownership changes).

To illustrate the degree of kinship, Fig. 1 presents the structural pedigree, which depicts the common origin of certain group of animals obtained from a single couple of parents.

Fig. 1. Structural pedigree of full siblings of pastel colour, born in 1980

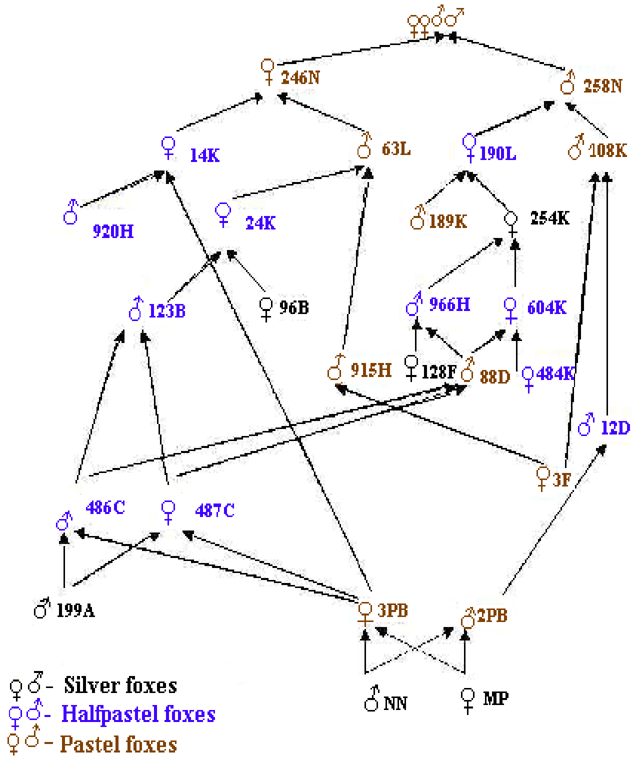
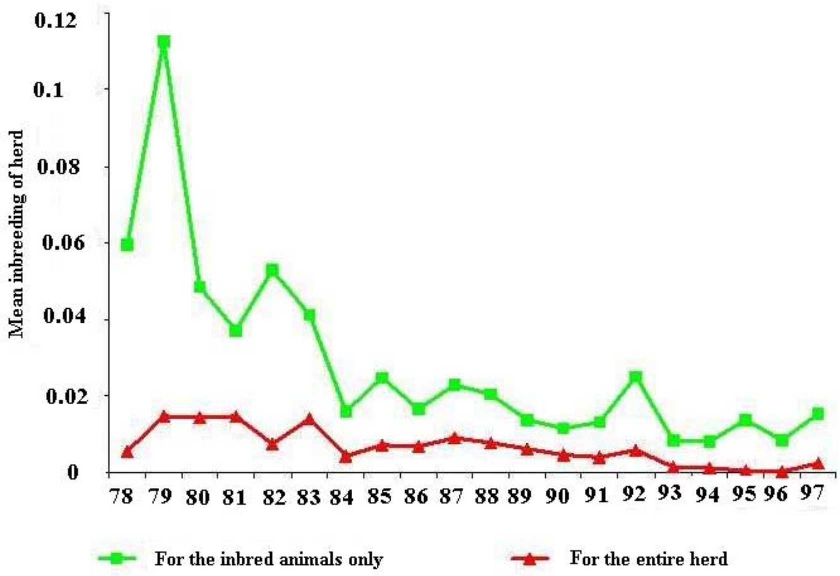


Figure 2 depicts the average inbreeding degree in the herd in particular years for two groups of individuals. In the first group, represented by all the individuals of the herd, the coefficient of inbreeding declined from 0.04769, in 1979, to 0.00194, in 1990. The second group of animals was represented by the inbred animals alone (i.e. whose coefficient of inbreeding was beyond 0), for which during 1978-1983 the highest values of the coefficient were recorded. For this group of foxes, inbreeding was the most extensive in 1979, reaching 11.27%. This confirms the appropriateness of the breeding practice, which had been aimed at loosening the bonds of kinship among the pastel foxes. The results of the computations may have been biased by the lack of pedigree information from before 1972, for this reason the level of inbreeding may be underestimated. Additionally, it was also supposed that this variety prototype parents had not been a product of inbreeding themselves. Casanova *et al.* [6] reports that more complete pedigrees provide us with more accurate information on the inbreeding level. The effect of inbreeding on reproductive performance in fur bearing animals was studied by Bernacka [4]. She observed that maternal inbreeding higher than 0.125 negatively affected the raising of polar foxes. In mink, the negative impact of inbreeding was reported by Berg [2], who stated that increasing the level of inbreeding by 10% resulted in a decline in litter size by 0.2 to 0.4 pups. This author carried out the studies on half-siblings crossing, and observed that the number of life-born declined in subsequent generations [1]. Similar results were observed by Nordrum [16], who studied the degree of inbreeding and its impact on reproductive traits of polar foxes. The results obtained suggest that the failures encountered in the initial period of pastel fox breeding and selection may have resulted from the high level of inbreeding. Hence, the conclusion arises that it was an appropriate idea of loosening the bonds of kinship and its further control at the level that would not threat with negative biological effects.

PRINT

Fig. 2. Inbreeding of the pastel foxes herd over the period 1978 - 1997



The values of genetic parameters of reproductive traits in the population of Polish pastel foxes are presented in Table 2. Low coefficients of heritability were found for the litter size. The h^2 for the litter size at birth was 0.060, and for the litter size at weaning it was 0.026. Similar results were recorded by Kenttämies [9] for silver foxes. Analysing populations of silver and polar foxes, she found the heritability coefficients to be 0.12 and 0.03 for the litter size at birth and 0.15 and 0.05 for the litters size at weaning. Socha [18], who studied polar foxes, reported the heritability of the litters size at birth and at weaning, respectively, 0.202 and 0.181. Bernacka and Nowaczyk [3], as well as Narucka and Żuk [15] obtained similar results for the heritability coefficients for these traits. The lower values of the heritability coefficients that were obtained in this work may have resulted from a different method of genetic parameters estimation, different population of animals, and most probably from the fact that the degree of kinship was taken into account. Genetic correlation between the litter size at birth and at weaning was high, 0.902, while the phenotypic correlation for these traits was slightly lower, 0.653.

Table 2. Coefficients of heritability (h^2), diagonally, and coefficients of genetic correlation (r_G) – above diagonal, and phenotypic correlation (r_P), below diagonal, for litter size at cirth and at weaning in the population of pastel foxes

Traits	Litter size at birth	Litter size at weaning
Litter size at birth	0.060 ± 0.037	0.9
Litter size at weaning	0.65	0.026 ± 0.022

The breeding results of the work carried out on the studied population of foxes over the years 1978-1997 were evaluated basing on genetic differentials, as well as genetic and phenotypic trends in the traits that had been considered in selection. Selection differentials for litter size at birth were close to zero, in many cases negative (Fig. 3). The most favourable values of the differentials were observed between 1988 and 1993, whereas the lowest values in 1981, when mating of mainly pastel individuals began among one another. With negative selection differentials for this trait, it was impossible to achieve a positive genetic trend, i.e. increased litter sizes. The average litter size at birth declined each year by 0.0875 pups, yet the phenotypic trend remained positive on a stable level, which probably was an effect of positive environmental factors (Fig. 4).

Fig. 3. Selection differeentials for litter size at birth by year

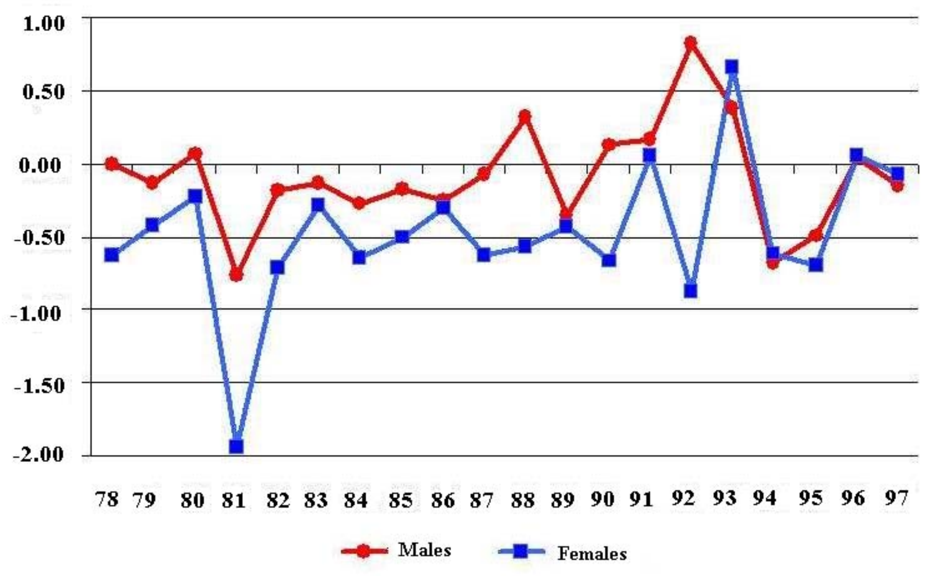
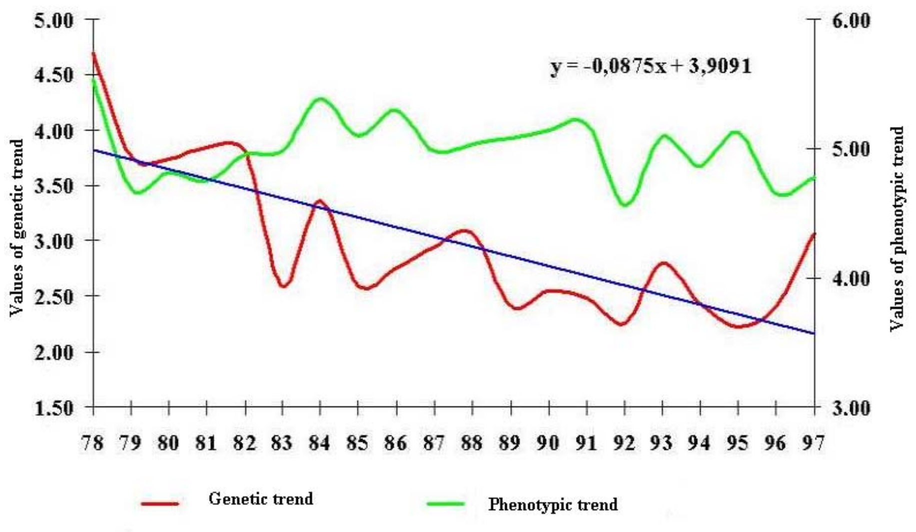


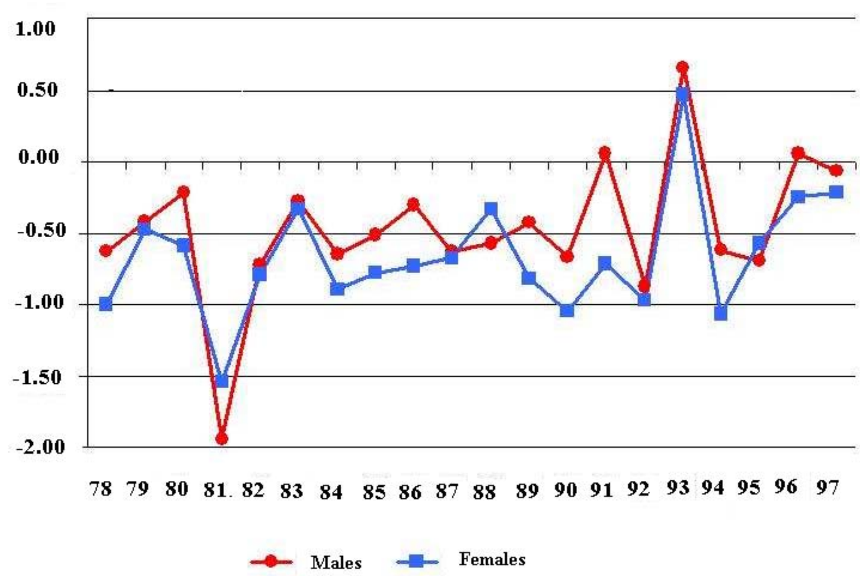
Fig. 4. Genetic and phenotypic trend for litter size at birth



The lowest values of selection differentials for the litter size at weaning were recorded in 1981, and the positive values in 1991, for the males, and in 1993, for both sexes (Fig. 5). Over the entire discussed period, the selection differentials for litter size at birth and at weaning were higher for the male pups than for the females. These higher values for the males may be explained with polygamy.

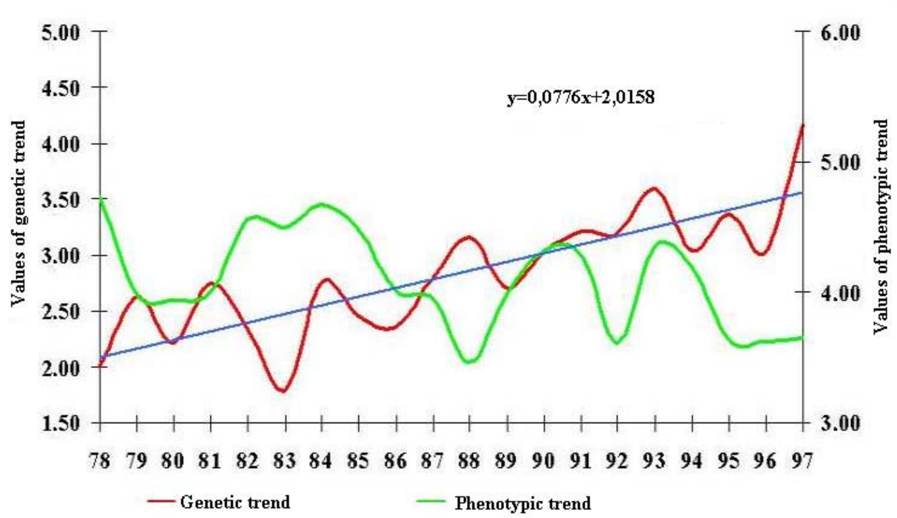
PRINT

Fig. 5. Selection differeentials for litter size at weaning by year



The estimated genetic trend was positive, 0.0776 pups for each analysed year, yet no significant improvement in average litter size at weaning was achieved (Fig. 6). The selection differentials and trends for the litter size at birth and at weaning observed in this study are difficult in making comparisons. This is due to the fact that there are no reports referring to these aspects in the literature, where usually the average litter size at birth and at weaning are reported for subsequent years [5]. Negative selection differentials for prolificacy were caused by the fact that the herd had been built with all pastel colour young foxes irrespective of the size of the litter they had been derived from, and display the luck of selection pressure on the discussed trait.

Fig. 6. Genetic and phenotypic trend for litter size at weaning



Analysing the reproductive performance of Polish pastel vixens, the results of the breeding work (selection differentials, genetic and phenotypic trends), as well as bearing in mind the level of inbreeding of the herd, one may state that Polish pastel foxes do not differ in the level of performance traits from silver foxes, i.e. the form they originated from. The prolificacy of these animals, as well as the quantitative weaning results, do not deviate from the country's average, and certain failures that were observed on the farm in some of the years may be explained with accidental environmental factors, including the human factor.

PRINT

CONCLUSIONS

1. The estimated coefficient of heritability h^2 was 0.060 for litter size at birth and 0.026 for litter size at weaning. Such low values of the coefficients of heritability observed in this study may have resulted from the application of a different method of genetic parameters estimation, from a different population of animals, and most probably from the fact that the kinship among the animals was taken into account.
2. The calculated selection differentials for the reproduction-related traits were close to zero. Low values of these selection differentials for prolificacy resulted from the fact that all pastel-coloured foxes were taken for the breeding stock, the animals that met only basic criteria irrespective of the size of the litter they had been obtained from.
3. Positive values of genetic trends for litter size at weaning confirm the appropriateness of the breeding scheme, whereas their low values may indicate low breeding efficiency. This may result of the fact that too many traits were included in the breeding scheme.
4. It was demonstrated that the degree of inbreeding of Polish pastel foxes gradually declined over the analysed period. This can demonstrate an appropriate mating of the animals, aimed at the reducing the degree of kinship among the pastel individuals.

REFERENCES

1. Berg P., 1996. The development and performance of highly inbred strain of mink. Anim. Prod. Review. Appl. Sci. Rep. 27, 195-197.
2. Berg P., 1996. The effect of inbreeding on reproduction and production traits in mink, Anim. Prod. Review, Appl. Sci. Rep. 27, 57-62.
3. Bernacka H., Nowaczyk , 1989. Parametry genetyczne niektórych cech samic lisa polarnego. [Genetic parameters of some traits of polar fox females]. Zesz. Nauk. ATR Bydg. 17, 19-28 [in Polish].
4. Bernacka H., 1986. Badania nad określeniem niektórych parametrów genetycznych oraz wpływem inbredu na wybrane cechy hodowlane i użytkowe lisów polarnych niebieskich. Praca doktorska [Studies on determination of some genetic parameters and on the effect of inbreeding on selected breeding and performance traits of Arctic blue foxes. Doctoral dissertation]. ATR, Bydgoszcz [in Polish].
5. Brzozowski M., 1995. Studia nad rozpłodem lisów w Polsce [Studies on fox reproduction in Poland]. Rozpr. SGGW Warsz. 204 [in Polish].
6. Casanova L., Hagger C., Kuenzi N., Schneeberger M., 1992. Inbreeding in Swiss Braunvieh and its influence on breeding values predicted from a repeatability animal model. J. Dairy Sci. 75, 1119-1126.
7. Groneveld E., 1998. VCE 4.2.5. User's Guide and Reference version 1.1.
8. Jeżewska G., 1987. Fenotypowa i genetyczna charakterystyka odmian barwnych lisa pospolitego (*Vulpes vulpes* L.) hodowanego w Polsce [Phenotypic and genotypic characteristic of colour varieties of fox (*Vulpes vulpes* L.) bred in Poland]. Rozpr. AR Lubl. 105, 1-50 [in Polish].
9. Kenttämies H., 1996. Genetic and Environmental Factors Affecting Fertility Traits in Foxes, Animal Production Review. Appl. Sci. Rep. 27, 63-66.
10. Lohi O., 1985. Mutant color phases of fox. Mating combinations for practice. Dan. Breed. Assoc. 30, 1-16.
11. Lohi O., 1993. Reproduction results - Reproduction problems and Future Challenges for Research with Fur Animals. Zesz. Nauk. Prz. Hod. PTZ 12, 19-25.
12. Maciejowski J., 1983. Stan i perspektywy hodowli lisa pastelowego w Polsce [Current state and prospects for Polish pastel fox breeding in Poland]. Zesz. Probl. Post. Nauk Rol. 302, 91-97 [in Polish].
13. Maciejowski J., Jeżewska G., 1987. Wyniki pracy hodowlanej nad lisem pastelowym w latach 1981-1984. [Breeding results for pastel fox during 1981-1984]. Zesz. Probl. Post. Nauk Rol. 341, 97-109 [in Polish].
14. Misztal I., 1997. BLUPF90 - a flexible mixed model program in FORTRAN 90. http://nce.ads.uga.edu/~ignacy/f90.
15. Narucka I., Żuk B., 1980. Parametry genetyczne reprodukcji samic lisa polarnego (*Alopex lagopus* L.) [Genetic parameters of reproduction for polar fox females (*Alopex lagopus* L.)]. Rocz. AR Pozn. Zootech. 28, 115-119 [in Polish].
16. Nordrum N.M.V., 1994. Effect of inbreeding on reproductive performance in Blue Fox (*Alopex lagopus L.*) Vixens. Acta Agric. Scand. Sect. A, Anim. Sci. 44, 214-221.
17. SAS Institute, SAS User's Guide Version 6.11. 1996.
18. Socha S., 1996. Ocena skuteczności pracy hodowlanej na fermie lisów polarnych niebieskich *Alopex lagopus* L. [Evaluation of breeding efficiency on a farm of Arctic blue foxes *Alopex lagopus* L. Rozpr. WSR-P Siedl. 43, 1-99 [in Polish].

Andrzej Jakubczak
Department of Biological Basis for Animal Production
Agricultural University of Lublin
Akademicka 13, 20-950 Lublin, Poland
Phone +4881 445 66 28
e-mail: jakub@ursus.ar.lublin.pl

PRINT

Responses to this article, comments are invited and should be submitted within three months of the publication of the article. If accepted for publication, they will be published in the chapter headed ‘Discussions’ in each series and hyperlinked to the article.