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VARIATION IN SOME REPRODUCTIVE TRAITS OF MINK (*NEOVISON VISON*) ACCORDING TO THEIR COAT COLOUR

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Abstract

The objective of the study was to analyse reproductive traits in different colour types of mink according to some factors. The size of litters born and reared was compared among 7 groups of colour types (Mahogen, Palomino, Pearl Cross, Sapphire Cross, Silver, Scanblack and Scanbrown). Significance of individual factors and the level of reproductive traits were analysed by multifactorial analysis of variance using the least squares method. The model accounted for the fixed effects of year of whelping, female coat colour and age, number of matings, whelping season, and female age × coat colour and female age × number of matings × coat colour interactions. The level of reproductive traits within individual colour types was dependent on female age and number of matings. However, it was not possible to establish a definite pattern for the number of times females were mated in different colour groups. At the same time, the effect of this factor on the level of reproductive traits was different for year-old and older females. In the majority of colour groups of year-old females, the level of reproductive traits was significantly lower when females were mated only twice. Increasing the number of matings among year-old females resulted in a greater number of kits born and reared. Regardless of colour type, two-year-old females were characterized by higher prolificacy compared to primiparous females. However, except for the Silver variety, there were no significant differences in the level of reproductive traits according to the number of matings. Whelping time had no significant effect on reproductive performance of the mink within individual colour types.

Key words: mink, colour types, reproduction

Reproductive use of all fur animal species, including mink, is one of the most important parts of breeding due to production profitability. Mink are a species with a complex sexual cycle that makes reproduction difficult under farm conditions. Despite many relevant studies, researchers have not determined the optimum mating time, mating system or diapause length for females. What is more, it appears that some reproductive aspects may vary according to the colour type of animals.

The most important reproductive parameter is litter size expressed as the number of kits born and reared. Mink are characterized by large variation in the number of

offspring born. Average litter size is 5–6 kits, but sometimes it exceeds 10 kits or is less than 3 kits. Offspring from families with low prolificacy are excluded from further breeding (Lohi, 1993; Sulik and Felska, 2000).

Many authors (Bielański et al., 2003; Socha et al., 2003; Sulik et al., 2007) have observed considerable variation between mink colour types in both prolificacy and the number of kits reared. This may be due to the fact that the mutations that produce new colour types may also adversely affect body function by reducing viability or prolificacy, an extreme example being embryo death and death of newborn kits. These phenomena may be caused by genes controlling a certain colour type that are at the same time lethal in the homozygous system (Rozempolska-Rucińska et al., 2001).

Current prices on the fur market are largely determined by pelt colour. Breeders who farm mink with different coat colours should be aware that the determinants of the level of reproductive traits may differently affect females of different colour types by influencing the number of kits born and reared.

The aim of the present study was to determine the level of prolificacy in different colour types of mink according to selected factors.

Material and methods

Breeding records from a farm in the Polish Zachodniopomorskie province were investigated. Observations included 1626 mink of the foundation stock, with about 58% of year-old females and 42% of two-year-old females. Animals represented 7 colour types (Table 1). Farmed females were mated several times: twice (36.90% of mink), three times (28.84% of mink), four times (23.68% of mink), and five times (10.58% of mink). Whelping periods corresponded to weeks of the year and four seasons (16, 17, 18 and 19) were distinguished. The percentage of whelpings in consecutive seasons was 6.1%, 48.6%, 40.0% and 5.3%, respectively. The peak of whelping was in the 17th and 18th week of the year, i.e. in the last week of April and in the first week of May.

Table 1. Reproductive parameters of female mink with regard to colour type

Colour type	No. of females	No. of kits			
		born		reared	
		$\bar{x}$	SD	$\bar{x}$	SD
Mahogen	135	7.33	1.45	7.03	1.41
Palomino	54	6.65	1.22	6.46	1.30
Pearl Cross	84	7.26	1.50	6.86	1.55
Sapphire Cross	298	6.01	1.63	5.58	1.80
Silver	797	6.72	1.96	6.47	1.93
Scanblack	154	6.71	1.60	6.48	1.57
Scanbrown	104	7.40	1.36	7.20	1.40

The analyses account for the number of kits born and the number of kits weaned per litter. These parameters were also used to determine the percentage of kits reared according to colour type. Table 1 presents herd characteristics in terms of female reproduction results.

The level of reproductive traits was analysed by multifactorial analysis of variance using the least squares method. The model accounted for the fixed effects of year of whelping, female coat colour and age, number of matings, whelping season, and female age × coat colour and female age × number of matings × coat colour interactions. The calculations were made using SAS statistical package (SAS Institute Inc., 2000). The values of the analysed traits are shown as least squares while providing standard errors that determine the reliability of estimation.

In the analysed years, the management and feeding conditions on the farm remained unchanged. The herd was fed in accordance with standards for carnivorous fur animals. Animals were also subjected to necessary preventive and veterinary treatments.

Results

Tables 2–4 show reproductive results for different mink colour types according to some factors.

Table 2. Reproductive performance of mink with regard to female age and colour type*

Age of females	Colour type	Born		Reared	
		lsm	se	lsm	se
Year-old	Mahogen	7.43 a	0.40	7.10 ac	0.41
	Palomino	6.11 b	0.53	5.88 ab	0.54
	Pearl Cross	6.58	0.41	6.36	0.41
	Sapphire Cross	6.66	0.40	6.17	0.40
	Silver	6.20 b	0.13	5.99 b	0.13
	Scanblack	6.48	0.36	6.26	0.36
	Scanbrown	7.27	0.34	7.14 c	0.35
Two-year-old	Mahogen	7.51	0.46	7.18	0.47
	Palomino	7.47	0.76	7.18	0.77
	Pearl Cross	6.56	0.62	6.22	0.63
	Sapphire Cross	6.88	0.42	6.68	0.42
	Silver	7.27	0.13	6.89	0.13
	Scanblack	6.81	0.33	6.49	0.33
	Scanbrown	7.66	0.34	7.41	0.35

* Means in columns within age, marked with different letters differ significantly ($P \leq 0.05$).

Statistically significant differences were found between prolificacy as well as the number of kits weaned from primiparous and two-year-old females mink of two colour types: Palomino and Silver. The prolificacy of older females representing

these two varieties was higher by an average of 1 kit compared to year-old females (Table 2). For the other colour types analysed, no significant differences were found between reproductive parameters of females of the same colour type at different age.

There were considerable differences in prolificacy and in the number of kits weaned between primiparous mink of particular colour types (Table 2). Depending on colour type, the average number of kits born ranged within year-old females from 6.11 to 7.43, with the highest number of kits born characteristic of the Mahogen and Scanbrown varieties. Significantly the highest prolificacy was found in Mahogen mink, and significantly the lowest in Palomino and Silver mink. Significant differences were also noted for the number of kits weaned. The highest number of kits was weaned by Scanbrown and Mahogen varieties, and the lowest by Palomino and Silver mink. The lowest number of dead kits was found for Scanbrown mink, which led to significantly the highest number of kits weaned, despite the fact that there were no significant differences in the prolificacy of primiparous Scanbrown mink compared to the other colour types. Sapphire Cross primiparas were characterized by the highest mortality (0.5 kit/litter on average), which was twice or even three times that of mink from the majority of colour types studied (Table 2).

There were differences in prolificacy and in the number of kits weaned from two-year-old females within particular colour types (Table 2). The number of kits born ranged from 6.56 (Pearl Cross) to 7.51 (Mahogen). The highest number of kits was weaned by Scanbrown, Mahogen and Palomino mink. Despite differences in the reproductive parameters of different colour varieties of two-year-old mink, no statistically significant differences were found for the analysed reproductive traits.

Tables 3 and 4 present the level of reproductive parameters according to number of matings and age of females.

The number of matings had a significant effect on the reproductive results of year-old females representing most colour types studied (Table 3). The analysed factor had no significant effect on reproductive parameters only in the case of Silver and Scanbrown varieties. Significantly the lowest values of the analysed traits in the case of double mating were found for Mahogen, Palomino, Pearl Cross (also triple mating) and Scanblack varieties. These varieties showed a characteristic relationship: the greater the number of matings, the greater the average number of kits reared by year-old females. Regardless of the number of matings, the percentage of kits reared was high. The highest rearing index of over 98% was characteristic of Scanbrown primiparas, while rearing percentage exceeding 95 was found in Palomino, Silver and Scanblack varieties. The lowest rearing percentage within particular colour types of year-old females was noted for Pearl Cross and Scanblack females mated twice and for Mahogen and Sapphire Cross mink mated five times.

In the case of two-year-old females, the number of matings had a highly significant effect on reproductive performance of Silver females only (Table 4). Significantly lower prolificacy and number of kits weaned were characteristic of females mated three times compared to reproductive parameters of Silver females mated using other systems. The analysed factor did not significantly affect the reproductive parameters of the other colour types studied. The highest mean number of kits reared was obtained for Mahogen, Sapphire Cross and Scanbrown females mated twice, and the lowest for

Palomino. Sapphire Cross and Scanblack females reared the smallest number of kits when mated five times. The lowest rearing percentage within particular colour types of two-year-old females was obtained by Silver, Scanblack and Scanbrown females mated five times and by Palomino and Pearl Cross females mated twice.

Table 3. Reproductive performance of year-old mink with regard to colour type and number of matings*

Colour type	No. of matings	Born		Reared		Rearing percentage
		lsm	se	lsm	se	
Mahogen	2	6.71 a	0.27	6.44	0.27	95.95
	3	7.66	0.47	7.24	0.48	94.53
	4	7.49	0.56	7.35	0.57	98.09
	5	9.31 b	1.18	8.26	1.20	88.79
Palomino	2	4.54 a	0.96	4.50 a	0.98	99.24
	3	7.12 b	0.37	7.04 b	0.38	98.90
	4	6.69 b	0.45	6.36	0.46	95.07
	5	7.74 b	0.75	7.52 b	0.76	97.15
Pearl Cross	2	6.69 a	0.48	5.83 a	0.49	87.22
	3	5.87 a	0.68	5.85 a	0.70	99.61
	4	7.83 b	0.31	7.38 b	0.32	94.28
	5	7.84 b	0.37	7.63 b	0.37	97.37
Sapphire Cross	2	5.90	0.84	5.34	0.85	90.43
	3	6.43	0.16	5.91 a	0.16	91.93
	4	6.23	0.21	5.81	0.22	93.24
	5	5.80	0.34	5.05 b	0.35	87.17
Silver	2	6.14	0.14	5.98	0.14	97.44
	3	6.01	0.19	5.76	0.20	95.97
	4	6.13	0.28	5.91	0.28	96.50
	5	6.20	0.60	6.05	0.61	97.51
Scanblack	2	5.55 a	0.27	5.36 a	0.27	96.74
	3	7.04 b	0.42	6.89 b	0.43	97.81
	4	7.34 b	0.49	7.29 b	0.50	99.43
	5	7.94 b	0.75	7.88 b	0.77	99.29
Scanbrown	2	7.24	0.33	7.12	0.33	98.40
	3	7.74	0.38	7.59	0.39	98.11
	4	6.83	0.84	6.77	0.85	99.24

* Means in columns within particular colour types, marked with different letters differ significantly ($P \leq 0.05$).

Whelping date did not significantly affect the analysed reproductive traits of mink within particular colour types (Table 5). However, differences were noticeable in prolificacy and in the number of kits weaned. The most favourable reproductive parameters were found for Scanbrown females whelped at 18 weeks and for Mahogen and Scanblack mink which were the last to whelp in the 19th week. The lowest prolificacy

was noted for Palomino females that were the last to whelp, for Scanblack females that were the first to whelp, and for Pearl Cross females that gave birth at the 19th and 18th week. Despite the lack of significant differences for particular colour types, the most favourable whelping dates were determined based on reproductive performance. The highest prolificacy was noted for Pearl Cross females whelping at the 16th week, for Palomino and Sapphire Cross females whelping at the 17th week (the last week of April), for Silver and Scanbrown females whelping in the first week of May, and for Mahogen and Scanblack mink whelping in the 19th week (Table 5).

Table 4. Reproductive performance of two-year-old mink with regard to colour type and number of matings*

Colour type	No. of matings	Born		Reared		Rearing percentage
		lsm	se	lsm	se	
Mahogen	2	8.64	0.68	8.43	0.70	97.57
	3	7.43	0.56	7.16	0.57	96.33
	4	7.71	0.31	7.22	0.32	93.73
	5	7.36	0.40	7.11	0.40	96.55
Palomino	2	6.57	0.56	6.13	0.57	93.23
	3	6.74	1.67	6.72	1.70	99.64
	4	7.31	11.67	7.26	1.70	99.40
Pearl Cross	2	8.12	0.96	6.76	0.98	83.25
	4	6.51	0.75	6.26	0.77	96.26
	5	8.38	0.84	7.89	0.85	94.20
Sapphire Cross	2	6.78	0.64	6.78	0.65	100.0
	3	6.81	0.43	6.51	0.43	95.67
	4	6.36	0.75	6.33	0.76	99.47
	5	4.31	1.67	4.26	1.70	98.99
Silver	2	7.47 A	0.14	7.07 A	0.14	94.60
	3	6.14 B	0.20	5.90 B	0.20	96.13
	4	7.53 A	0.18	7.16 A	0.19	95.12
	5	7.38 A	0.26	6.96 A	0.26	94.27
Scanblack	2	6.76	0.51	6.75	0.52	99.82
	3	7.53	0.51	7.22	0.52	95.95
	4	7.49	0.32	7.25	0.33	96.86
	5	7.14	0.36	6.43	0.37	90.10
Scanbrown	2	8.09	0.49	7.87	0.49	97.38
	3	7.10	0.41	6.82	0.42	96.09
	4	7.92	0.45	7.47	0.46	94.29
	5	7.27	0.56	6.83	0.57	93.94

* Means in columns marked with different letters differ highly significantly ($P \leq 0.01$).

Whelpings at both 16 and 19 weeks (prolonged gestation) did not significantly affect the size of litters from the colour types of mink studied (Table 5). Delayed whelpings (19th week of the year) had a positive effect on reproductive performance of Mahogen and Scanblack varieties, but they adversely affected reproductive results

of Palomino, Pearl Cross and Silver varieties. In the case of earliest whelping, the best reproductive performance was achieved by Palomino, Pearl Cross and Sapphire Cross varieties. The highest prolificacy was found for Silver and Scanbrown females whelping in the first week of May (18th week).

The lowest kit mortality within particular colour types (excluding Sapphire Cross) was found for females that were the last to whelp (19th week). The highest mortality within Mahogen, Palomino, Silver, Scanblack and Scanbrown mink occurred in the groups of females that were the first to whelp (16th week).

Table 5. Reproductive performance of mink with regard to colour type and whelping date

Colour type	Whelping season	Born		Reared	
		lsm	se	lsm	se
Mahogen	16	7.38	1.23	6.92	1.25
	17	7.13	0.29	6.81	0.30
	18	7.31	0.38	6.94	0.38
	19	8.06	0.68	7.89	0.69
Palomino	16	7.40	0.81	6.80	0.82
	17	7.44	0.48	7.07	0.49
	18	7.19	0.60	6.99	0.61
	19	5.25	1.33	5.13	1.31
Pearl Cross	16	7.23	0.67	6.91	0.68
	17	7.02	0.46	6.57	0.47
	18	6.03	0.54	5.46	0.55
	19	6.20	1.26	6.01	1.24
Sapphire Cross	16	6.71	0.49	6.51	0.50
	17	7.07	0.36	6.79	0.37
	18	6.63	0.34	6.30	0.35
	19	6.68	0.57	6.10	0.58
Silver	16	6.84	0.28	6.34	0.29
	17	6.72	0.12	6.43	0.12
	18	6.89	0.13	6.67	0.13
	19	6.50	0.25	6.33	0.26
Scanblack	16	5.99	0.48	5.28	0.49
	17	6.56	0.28	6.27	0.28
	18	6.62	0.28	6.53	0.29
	19	7.41	0.98	7.40	1.00
Scanbrown	16	7.22	0.70	6.98	0.71
	17	7.19	0.34	6.99	0.34
	18	8.17	0.39	7.95	0.39
	19	7.28	0.70	7.17	0.71

Discussion

Within both year-old and two-year-old females, colour type had a significant effect only for primiparas (Table 2). Likewise, Socha et al. (2003) reported that female coat colour has an effect on prolificacy, but within particular colour types, reproduc-

tive performance was inferior to our results. Also the values obtained by Bernacka et al. (1998), Rozempolska-Rucińska et al. (2000), Socha and Markiewicz (2001) and Socha and Kołodziejczyk (2006) for the reproduction of standard (Scanblack) mink were lower.

It is concluded based on the results given in Tables 3 and 4 that females should be mated a different number of times depending on age and colour type. Double matings within primiparous Mahogen, Palomino, Pearl Cross (also triple matings) and Scanblack females proved unfavourable because of the lowest prolificacy. There is no justification for quadruple or quintuple mating of Palomino and Scanblack primiparas. The lack of significant differences between triple, quadruple and quintuple mating is evidence that triple mating is sufficient in the above varieties to produce significantly the highest number of offspring. Triple mating also proved the most favourable for year-old Sapphire Cross mink due to significantly the highest number of kits reared. The effect of number of matings on reproductive results of different colour varieties of female mink was investigated by Sulik et al. (2007), who concluded that the most favourable number of matings in terms of litter size cannot be conclusively determined for all colour types together.

Rearing percentage is the most reliable indicator of reproductive performance in females. It reflects the viability of newborn kits but also the milking capacity and maternal care of the female. Rearing percentage on the experimental farm was exceptionally high (Tables 3 and 4) compared to the results of different authors (Dąbrowska, 1993; Rozempolska-Rucińska et al., 2000; Socha et al., 2003). The lowest rearing percentage in Mahogen and Sapphire Cross primiparas (Table 3) mated five times can be attributed to the extended period of diapause and delayed implantation of blastocysts. Berglund (1986) concluded that most prenatal losses occur during the period between fertilization and embryo implantation in the uterus, with the risk of mortality increasing when this period is lengthened. Therefore, the unfavourable effect of quintuple mating as a result of prolonged gestation period can be attributed to high embryo mortality before uterine implantation (Elofson et al., 1989). It can be assumed that the findings of the above authors are not universal for all colour types of mink because comparison with our results (Tables 3 and 4) shows that they largely depend on age and colour type.

In the case of two-year-old females, triple mating was considered to negatively affect reproductive performance in Silver females only (Table 4). Females of the other colour types showed no significant differences in reproductive parameters (Table 4). This goes to show that mating two-year-old females more than twice has no economic justification and only increases the costs of labour. Likewise, the findings of Lorek et al. (1994) confirmed that it is justified to mate mink on two oestrus dates as this improves conception rate expressed as litter size. Also Maciejowski and Jeżewska (1993) reported that double mating of females ensures good reproductive results. However, it should be noted that within colour types, the lowest percentage of kits reared was obtained in Pearl Cross and Palomino females mated twice (Table 4). This may be indicative of the lower viability of young mink. For this reason, in the case of the above colour varieties it seems more favoruable to increase the number of matings in two-year-old females. The results obtained in the present study are in many respects

different from those reported by Møller (1997), who states that each additional mating may affect litter size, increasing it by 0.2–0.3 animals. This relationship can be observed for some colour types of year-old females (Table 3), but this premise did not hold true for the analysed colour types of two-year-old females.

Research on a population of Finnraccoons (Ślaska and Jeżewska, 2008) has confirmed the occurrence of multipaternity for double mating with two different males and for triple mating with three different males. This is evidence of the presence of maternal half-sibs, i.e. animals born to the same mother and having different fathers. It is possible that this phenomenon also occurs in mink and is one of the important factors affecting reproductive performance in mink.

The fact that whelping time did not significantly affect reproductive results of the mink within particular colour types (Table 5) is of considerable significance for mink breeding. Taking account of the fact that the available literature contains little information on the duration of diapause in different colour types of mink, it would be impossible to make practical use of the significant effect of whelping date in breeding. Different results to ours were reported by Sulik et al. (2007), who concluded that whelping date had a significant effect on litter size. The largest litters were born at the 16th week of the year. This could be due to the fact that other colour varieties of mink than those studied here were investigated. Also according to Socha and Markiewicz (2002) the highest mean number of pups born and reared was observed for the mink females morted within the first period (until 5 March).

In conclusion, the level of reproductive traits within the colour types of mink was dependent on female age and number of matings. Whelping season did not affect reproduction results within particular colour types. Regardless of colour variety, two-year-old mink were characterized by the most favourable level of reproductive traits. However, this may result from selection conducted after the first year of using mink for reproduction. The results obtained demonstrate that each colour variety should be treated individually in terms of the number of matings. In the majority of colour groups of year-old females, the level of reproductive traits was significantly lower when females were mated only twice. Increasing the number of matings increased the mean number of kits reared. In the group of two-year-old females, except for the Silver variety, there were no significant differences in the level of reproductive traits according to the number of matings. Whelping time had no significant effect on reproductive performance of the mink within individual colour types. This demonstrates that mating two-year-old females more than twice has no justification in terms of economics and labour inputs.

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BRYGIDA ŚLASKA, IWONA ROZEMPOLSKA-RUCIŃSKA,
GRAŻYNA JEŻEWSKA-WITKOWSKA

Zmienność wybranych cech rozrodu norek (*Neovison vison*) w zależności od ich umaszczenia

STRESZCZENIE

Celem prowadzonych badań była analiza cech reprodukcyjnych różnych odmian barwnych norek, w zależności od wybranych czynników. Porównywano liczebność urodzonych i odchowanych miotów w grupach 7 odmian barwnych (Mahogen, Palomino, Pearl Cross, Sapphire Cross, Silver, Scanblack i Scanbrown). Istotność poszczególnych czynników oraz poziom cech reprodukcyjnych weryfikowano wieloczynnikową analizą wariancji, metodą najmniejszych kwadratów, uwzględniając w modelu stały wpływ: roku wykotu, umaszczenia samic, ich wieku, liczby kryć, sezonu wykotu oraz interakcji wiek samic × umaszczenie i wiek samic x liczba kryć x umaszczenie.

Poziom cech reprodukcyjnych w obrębie poszczególnych odmian barwnych okazał się uzależniony od wieku samic i krotności kryć. Nie można było jednak ustalić jednoznacznego schematu liczby stosowanych kryć samic w poszczególnych grupach barwnych. Jednocześnie czynnik ten oddziaływał inaczej na poziom cech reprodukcyjnych samic jednorocznych i starszych. W większości analizowanych grup barwnych samic jednorocznych stwierdzono istotnie niższy poziom cech reprodukcyjnych, jeżeli

stosowano wyłącznie dwukrotne krycie samic. Zwiększając liczbę kryć samic jednorocznych, uzyskano wyższą liczbę urodzonych i odchowanych norcząt. Samice dwuletnie, bez względu na odmianę barwną, charakteryzowały się wyższą plennością w stosunku do pierwiastek. Jednak poza odmianą Silver nie stwierdzono istotnych różnic w poziomie cech reprodukcyjnych w zależności od liczby kryć. Termin wykotu nie wpłynął w sposób istotny na wyniki rozrodu norek w obrębie poszczególnych odmian barwnych.