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A STUDY OF THE SEX RATIO OF NEWBORN FARMED AMERICAN MINKS (*NEOVISON VISON*) INFLUENCED BY MATING TERM AND DURATION OF PREGNANCY OF FEMALES

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ABSTRACT

The aim of the study was to analyze the sex ratio of the American mink (*Neovison vison)* kits, in relation to a range of factors. The observations were carried out on yearling females of two color varieties, Perl (P) and White Hedlund (WH). The sex of the kits was identified at age of approx. 30 days, and only complete (zero-mortality) litters were selected in this study. The sex ratio of the cubs in the litters was compared to the length of pregnancy they were born from, the date of the first mating, and the interval between the first and the subsequent mating. Along with a longer pregnancy, a later date of mating and a longer interval between the first and subsequent mating, the number of born females in relation to born males increases.

Key words: American mink, reproduction, sex distribution

INTRODUCTION

Poland has recently become the world's third largest producer of mink pelts. Intensive farming systems and the specificity of mink reproduction biology make farmers seek the best methods and systems for obtaining large and strong litters. In terms of farm development, it is also important to early recognize the sex of the newborn kits. The farmers are interested in obtaining more females than males, since the former group of mink is needed for the formation of a strong breeding stock.

The American mink (*Neovison vison*) is a monoestrous species with the heat occurring in March under the moderate climate, such as the one in Poland. In minks there are 2 to 3 ovarian cell maturation cycles per heat, and an effective fertilization of ovulated cells resulting from the first mating may be followed by another ovulation and conception (superfetation), which implies that the female may be mated to different males a number of times within a single sexual activity season [Yamaguchi et al. 2004, Roellig et al. 2011].

Sex distribution of cubs in litters in farm mink has not been thoroughly studied so far. Scarce reports on the subject usually refer to observations on the animals living in the natural conditions. For example, Sidorovich [1993] reported that more females than males are born in the wild mink population of Belarus. On the other hand, Brzeziński et al. [2010] and Craik [2008] caught more males in live traps, even twice as many as females, especially in the spring. A similar number of males and females were caught only in autumn. These observations would imply that more males are born in mink populations living in the wild, which has also been suggested by Zwiernik et al. [2008]. A higher number of males than females was also recorded and for the closely related species – European polecat (*Mustela putorius*) living in the wild [Brzeziński et al. 1992, Barrientos 2015].

Due to a limited access to hidden nests of females living in the natural environment, studies on the sex distribution of wild minks may not reflect the reality. Also estimations of the sex ratio based on hunted animals may be considerably biased. Therefore, the controlled con-

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ditions on breeding farms allow for precise determination of the sex ratio of born offspring. Venge [1953] observed that sex distribution in farmed mink populations depend on such factors as nutrition, date of mating into the heat, or climatic conditions. Our studies allow concluding that more female kits are born in farmed mink litters than male kits. A longer gestation, late mating dates, and longer interval between the first and the subsequent mating, increase the number of born females in relation to males [Felska-Błaszczyk et al. 2018].

The aim of the study was to analyze the sex distribution in the litter of farmed minks in relation to various factors.

MATERIAL AND METHODS

The study was carried out on a mink farm located in the northern part of Poland. We analyzed sex distribution in litters obtained from 1890 Pearl (P) and 1120 White Hedlund (WH) females, all at age 1 year. The sex of the kits was identified within about 30 days after birth; only litters without mortality cases were analyzed. The data on cage cards showed that gestation period ranged from 40 to 69 days. The litters were assigned to groups according to the period of gestation they were born from as follows (gestation length):

- from 40 to 45 days,
- from 46 to 50 days,
- from 51 to 55 days,
- from 56 to 60 days,
- from 61 to 65 days.

In relation to the date of the first mating, we analyzed the sex distribution of cubs with respect to the following periods:

- mating between 1 and 5 March,
- mating between 6 and 10 March,
- mating between 11 and 15 March.

In relation to the interval between the first and the consecutive mating, the mothers were grouped according to the following intervals:

- 1 day's interval,
- 2 days' interval,
- 7 days' interval.

The statistical calculations and analysis was performed using the STATISTICA 13.3 PL package. The statistical description involved the mean (m), standard deviation (SD), coefficient of variability (V%) We used the non-parametric chi-square test to check the differences in the sex distribution.

RESULTS

The analysis of sex distribution in the offspring of dams of both color varieties revealed that much more females were born, with a high, statistically significant difference (Table 1). The coefficient of variability was very high in these varieties, much higher for young males.

More female kits were born, irrespective of gestation length (Table 2). There was a significant ($P \leq 0.01$) difference between the number of female and male kits at the gestation period of 51 to 55 days and 56 to 60 days. For gestation periods 40–45 days and 46–50 days, the differences between sex ratios were significant at $P \leq 0.05$. In the litters obtained from the longest gestations (61 to 65 days), no significant differences were present in the sex distribution.

In terms of mating dates (Table 3), we observed that the difference in sex distributions of Pearl dams' offspring was highly significant only for females mated between 1–5 March and between 6–10 March. On the other hand, such differences in White Hedlund dams were present for those first mated later, past 15 March. No significant differences were found for the other mating periods. As a rule, the later the date of mating, the more female offspring were born in a litter, which was observed for both color varieties. Generally more females were born, and the coefficient of variation was at a much higher level in males. The average litter size remained at a similar level, and the largest litters were obtained from matings taking place between 11 and 15 March of both analyzed color varieties.

The average litter sizes decreased along with an increase in the interval. Statistical differences were noted at a very high level for an interval of 1–2 days (Table 4). In the case of a 7-day time gap, no statistical differences were found. In each case, more females were born than males, with female kits exceeding 55% of the total litter size. Each time the coefficient of variability was greater in males, reaching as high as 74.39% for the 7-day interval.

The analysis of sex distribution in the mink litters indicated that more females were born per litter – irrespective of the studied factors (fur color variety, gestation period, first mating date and the interval between the first and the second mating). The coefficient of variability was very high, though lower in females than in males, which resulted in a lower divergence in the litters, which were more even in number.

DISCUSSION

The analysis of mink litter in terms of sex ratio revealed considerable differences in the variability of the numbers of newly born male and female kits. The coefficient of variability was much higher in the male part of the litter

Table 1. Sex distribution of mink litters in relation to their fur color variety

Tabela 1. Rozkład płci nowo narodzonych norek w zależności od ich odmiany barwnej

Color variant of females Odmiana barwna samicy	Number of litters Liczba miotów	Mean litter size Średnia wielkość miotu	Female offspring Młode samice			Male offspring Młode samce			chi-square chi-kwadrat
			%	m	V%	%	m	V%	
Pearl Perła	1890	6.49	56.62	3.69	44.03	43.38	2.80	51.30	21.72**
White Hedlund Biała Hedlunda	1120	6.81	58.66	3.99	38.43	41.34	2.82	60.09	11.60**
Total – Razem	3010	6.66	57.63	3.84	43.32	42.37	2.81	53.49	32.16**

** differences between the number of females and males in a litter significant at P ≤ 0.01.
** różnice statystyczne między liczbą urodzonych samic i samców na poziomie P ≤ 0,01.

Table 2. Sex distribution of mink litters in relation to gestation period of their origin

Tabela 2. Rozkład płci nowo narodzonych norek w zależności od długości ciąży z której pochodziły

Color variant of females Odmiana barwna samic	Gestation length, days Długość ciąży, dni	Number of litters Liczba miotów	Mean litter size Średnia wielkość miotu	Female offspring Młode samice			Male offspring Młode samce			chi-square chi-kwadrat
				%	m	V%	%	m	V%	
Pearl Perła	40–45	225	6.39	58.11	3.69	21.89	41.89	2.69	43.94	3.90*
	46–50	421	6.81	54.69	3.71	41.11	45.31	3.13	52.69	3.84*
	51–55	642	6.49	55.15	3.59	42.25	44.85	2.89	49.67	13.21**
	56–60	482	6.51	58.11	3.81	50.58	41.89	2.72	62.42	10.86**
	61–65	120	4.81	58.44	2.78	52.29	41.56	2.02	79.58	2.20
	Total – Razem	1890	6.49	56.62	3.69	44.03	43.38	2.80	51.30	21.72**
White Hedlund Biała Hedlunda	40–45	112	6.74	57.86	3.93	22.74	41.54	2.77	44.01	4.20*
	46–50	250	7.37	55.40	4.09	41.13	45.31	3.32	45.59	3.94*
	51–55	451	6.89	55.07	3.82	41.25	44.93	3.08	49.67	12.91**
	56–60	204	6.78	58.21	3.89	50.45	41.79	2.79	63.42	11.86**
	61–65	103	6.28	58.44	2.83	52.29	41.56	1.98	79.58	2.20
	Total – Razem	1120	6.81	58.66	3.99	38.43	41.34	2.82	60.09	11.60**
Total – Razem		3010	6.66	57.63	3.84	39.41	42.37	2.81	58.21	32.16**

** differences between the number of females and males in a litter significant at P ≤ 0.01.
* differences between the number of females and males in a litter significant at P ≤ 0.05.
** różnice statystyczne między liczbą urodzonych samic i samców na poziomie P ≤ 0,01.
* różnice statystyczne między liczbą urodzonych samic i samców na poziomie P ≤ 0,05.

as compared with the female part. According to Venge [1953], Sundell [1962] and Orzack et al. [2015], the male embryo mortality rate is much higher than that of females. In consequence, a prolonged gestation is less favorable for male embryos, which results in litters with fewer males. Krackow and Burgoyne [1998], who experimented on mice, report results coherent with our findings – the authors found that the later the date of mating, the higher proportion of female offspring. Venge [1953] observed in his research that the greater was the litter, the lower was the number of males in it; however, in litters of 8 young and more the proportion of male kits increased again. At 6 or 7 kits, the average number of females was slightly higher.

The hypothesis proposed by Trivers-Willard states that the body condition of parents affects the sex ratio of the litter. More male kits are born if the condition is good, and more females if the condition is poor [Keller et al. 2001]. Myers [1978] expressed a similar opinion and specified that the mortality of male embryos is higher in dams of poor condition, which are more susceptible to stress. This results in a higher proportion of newly born

Table 3. Sex distribution of mink litters in relation to the date of first mating

Tabela 3. Rozkład płci nowo narodzonych norek w zależności od terminu pierwszego krycia samic

Color variant of females Odmiana barwna samicy	Mating date (March) Data krycia (marzec)	Number of litters Liczba miotów	Mean litter size Średnia wielkość miotu	Female offspring Młode samice			Male offspring Młode samce			chi-square chi-kwadrat
				%	m	V%	%	m	V%	
Pearl Perła	1–5	321	6.40	55.06	3.51	44.91	44.94	2.89	53.78	12.76**
	6–10	690	6.51	56.48	3.72	43.98	43.52	2.81	53.13	13.88**
	11–15	620	6.71	57.22	3.79	28.79	42.78	2.79	54.15	3.62
	> 15	259	6.32	60.00	3.79	42.73	40.00	2.45	55.27	3.00
	Total – Razem	1890	6.49	56.62	3.69	44.03	43.38	2.80	51.30	21.72**
White Hedlund Biała Hedlunda	1–5	158	6.72	54.17	3.64	43.22	45.83	3.08	53.01	1.7
	6–10	395	6.89	53.41	3.68	41.12	46.59	3.21	55.16	0.94
	11–15	377	7.35	58.37	4.29	32.15	41.63	3.06	54.27	1.48
	> 15	190	6.29	60.61	3.33	41.22	39.39	2.17	54.28	7.74**
	Total – Razem	1120	6.81	58.66	3.99	38.43	41.34	2.82	60.09	11.60**
Total – Razem		3010	6.66	57.63	3.84	39.41	42.37	2.81	58.21	32.16**

** differences between the number of females and males in a litter significant at P ≤ 0.01.
** różnice statystyczne między liczbą urodzonych samic i samców na poziomie P ≤ 0,01.

Table 4. Sex distribution of mink litters in relation to the interval between the first and the subsequent mating

Tabela 4. Rozkład płci nowonarodzonych norek w zależności od odstępu między pierwszym a drugim kryciem

Color variant of females Odmiana barwna samic	Time interwal, days Odstęp, dni	Number of litters Liczba miotów	Mean litter size Średnia wielkość miotu	Female offspring Młode samice			Male offspring Młode samce			chi-square chi-kwadrat
				%	m	V%	%	m	V%	
Pearl Perła	1	1055	6.94	54.32	3.77	42.05	45.68	3.17	48.88	15.86**
	2	540	6.59	59.94	3.95	41.45	40.06	2.64	56.86	17.02**
	7	295	5.91	56.20	3.31	50.64	43.80	2.61	74.39	3.72
	Total – Razem	1890	6.49	56.62	3.69	44.03	43.38	2.80	51.30	21.72**
White Hedlund Biała Hedlunda	1	689	7.45	54.21	4.04	46.05	45.79	3.41	53.95	11.24**
	2	281	6.87	57.36	3.94	44.44	42.64	2.93	55.56	9.87**
	7	150	6.12	55.13	3.37	38.33	44.87	2.75	61.67	3.12
	Total – Razem	1120	6.81	58.66	3.99	38.43	41.34	2.82	60.09	11.60**
Total – Razem		3010	6.66	57.63	3.84	39.41	42.37	2.81	58.21	32.16**

** differences between the number of females and males in a litter significant at P ≤ 0.01.
** różnice statystyczne między liczbą urodzonych samic i samców na poziomie P ≤ 0,01.

females. Bakken [1995] demonstrated that the degree of domestication has a considerable effect on sex determination of the offspring. More males are born in Silver foxes, which are more tame compared to other fox breeds.

Largest litters were born from gestations lasting 46 to 50 days, whereas the smallest from gestations 61 to 65 days long. The common opinion is that best pregnancies in terms of litter size last at least 46 days, but not longer than 55 days [Felska-Błaszczyk et al. 2012]. Venge [1953] demonstrated that largest litters were born from gestations ranging between 47 and 50 days, which finds its confirmation in the results of this study. Litters from gestations lasting 39 to 46 days increased, to significantly drop past 53 days of gestation period.

Depending the first mating date, the data presented by Venge [1953] reveal the opposite situation to that in the present study: the later was the date of mating, the larger was the proportion of males in the litter. The most numerous litters occurred if mating had been between March 7 and March 18 and between March 19 and April 2. According to Krackow and Burgoyne [1998], the date of mating influenced the determination of offspring sex in mice. This depended on the rate of embryonic implantation, which was faster for male embryos than in the case of female ones.

Our study shows that the resulting average litter size decreases with an increase in the interval between the first and the subsequent mating. Mink ovulation is provoked and occurs usually 48 hours, but often even within 72 hours post coitum. Such a long period between copulation and ovulation is associated with a long sperm survival period in the female reproductive tract [Amistlavsky and Ternovskaya 2000]. As reported by Amistlavsky et al. [1993] sperm may survive there up to 96 hours after copulation. This sperm survival period in the female reproductive tract is the reason of larger litters produced if the female is re-mated 1 or 2 days after the first mating.

Venge [1953] claimed that the sex distribution of newly born mink is influenced by the color variant; he demonstrated that more males were born in the litters of Standard and Pastel Cross mink, with slightly more females in the Pastels only. He also proved that the largest litters belonged to Standard variety dams.

CONCLUSION

The analysis of sex distribution in the offspring of dams of both color varieties revealed that more females than males are born in farm mink populations. Along with a longer gestation, a later date of mating and a longer interval between the first and subsequent mating, the number of born females compare to born males increases. The study of the sex ratio of newborn farmed American mink was performed only on one mink farm and further studies on other mink farms should be carried out in order to confirm the observed relationships.

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ANALIZA ROZKŁADU PŁCI U NOWO NARODZONYCH NORCZĄT FERMOWEJ NORKI AMERYKAŃSKIEJ (*NEOVISON VISON*) W ZALEŻNOŚCI OD TERMINU KRYCIA I DŁUGOŚCI CIĄŻY SAMIC

STRESZCZENIE

Celem pracy była analiza rozkładu płci norcząt w zależności od różnych czynników. Materiał do badań stanowiły: jednoroczne samice norki amerykańskiej 2 odmian barwnych: perła (P) i biała Hedlunda (WH). Płeć norcząt w analizowanych miotach rozpoznawano w wieku około 30 dni; wybierano tylko takie mioty, w których nie zanotowano żadnych upadków młodych. Analizowano rozkład płci norcząt na podstawie: długości ciąży, z której pochodziły, terminu pierwszego krycia i odstępu między pierwszym a drugim kryciem. W wyniku analizy stwierdzono, że u norki fermowej rodzi się więcej samiczek niż samczyków. Wraz z dłuższą ciążą, późniejszym terminem krycia oraz większym odstępem między pierwszym a drugim kryciem zwiększa się liczba urodzonych samiczek, w stosunku do urodzonych samczyków.

Słowa kluczowe: norka amerykańska, rozkład płci, rozród

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