Application of hormonal stimulation of reproductive function in female silver foxes

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Abstract. This article presents monitoring of reproductive qualities of silver-black foxes of the Savvatyevsky breed type for five years. All analyzed females were divided into 3 groups depending on the date of mating. The study showed that females that ovulate at the beginning of the rut, i.e. before March 15, have the best reproductive indicators. At the same time, among females not mated before March 26, there is the smallest number of successful whelpings and the smallest number of surviving puppies. To stimulate the reproductive function of females with an estrous cycle disorder (females that did not come into heat before March 26, hormonal stimulation with the drug "Follimag" was used. It was found that in the group of females with hormonal stimulation, compared with females without stimulation, there were 4.7% more successfully whelped females, fertility was higher by 0.6 puppies.

1 Introduction

In Russia, caged fur farming products constitute the main raw material base of the fur market and, despite the economically unstable situation in the country, consumer demand for fur products remains quite high. Fox farming ranks third in terms of skin production, which is due to the interest in this type of fur on the part of clothing designers. The modern domestic gene pool of caged foxes is represented by 85% silver-black fox, 12% - Vyatka and red Roshchinskaya fire foxes, and 3% are other color types [8]. At the leading international fur auctions, Kopenhagen Fur and Saga Furs, more than 15 color types of fox are sold, which indicates the high potential of this type of fur animal in the countries of Norway and Finland [5-6]. To fully saturate the fur market with domestic fox skins, it is necessary to improve the rutting technology, taking into account the biological characteristics of the animals. Foxes are monoestrous animals and produce offspring only once a year [7]. Fur farms suffer economic losses every year due to the presence of a certain proportion of females in their herds that do not produce offspring due to disturbances in the sexual (estrous) cycle [2]. Fur farm specialists face an important task - to promptly identify such females and achieve normalization of their sexual cycle using zootechnical and pharmacological methods [3, 9-10]. One of the ways to increase the

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reproductive capacity of farm animals is to use the achievements of endocrinology, in particular hormone-containing drugs that stimulate the growth and maturation of follicles in the ovaries of females, ovulation of eggs and the development of corpora lutea [1, 4, 11-12].

2 Materials and methods

The study was conducted at the LLC "Zveroplemzavod Savvatevo", located in the Tver Region, Kalininsky District, Savvatyevo village. The population of silver-black foxes of the Savatevsky breed type was analyzed as the object of the study. Based on the results of the rut and whelping in the period from 2020 to 2024, data on the number of unfertile females, females that were empty, had unsuccessfully and successfully whelped, or aborted females were studied. In addition, stillborn and puppies that died before registration were taken into account in the analysis. Based on the collected information, the number of females from which offspring were not obtained was calculated, and graphical models were developed.

In order to more thoroughly analyze the reproductive indicators of females, three groups of animals were formed, taking into account the date of mating during the rut. The females of the first group were covered before March 15, the second group - from March 16 to March 25, and the third group includes females covered after March 26.

In addition, two groups of females were formed, 60 heads each, using the pair-analogue method, taking into account their age and estrous cycle disorders (females that did not come into heat before March 26). In the experimental group, the females were injected subcutaneously with the drug "Follimag" at a dose of 200 international units per head. In the control group, hormonal stimulation was not performed. The method of variation statistics was used to process the obtained results, and the calculations were performed in the Excel program.

3 Results

Annual monitoring of the reproductive qualities of the herd directly affects the economic efficiency of fur farms. Since it allows identifying potential problems and adjusting further selection work. Table 1 shows the reproductive indicators of females, both adults and young, taking into account the date of fertilization in 2020.

The data in Table 1 indicate that the maximum number of successfully whelped females fertilized at the beginning of the 2020 rut before March 17 is 70.1% of adults and 77.1% of young ones. In the middle of the rut, the number of successfully whelped females decreases, by 10% in adults and by 30.8% in young ones, which is apparently due to the heavy load on males. The minimum number of successfully whelped females at the end of the rut, after March 25 is 54.3% in adults and 25.6% in young ones. At the end of the rut, the quality of sperm deteriorates in males. The number of stillborn puppies is higher in females fertilized at the beginning and middle of the rut than at the end. The number of puppies that died before registration increases in adult females mated at the end of the rut, in young females, the maximum number of puppies that died before registration were mated in the middle of the rut, which is associated with an increase in gastrointestinal disorders with an increase in bacterial contamination of food and bedding.

Fertility is maximum in adult females fertilized at the beginning of the rut, the difference compared to the indicators of females mated in the middle of the rut is reliable ($P > 0.999$). Young females show the same tendency in fertility, but the difference is not reliable. In terms of mating with the main female, both adult females and young females

show a reliable difference both compared to those mated in the middle of the rut and at the end.

Table 1. Reproductive performance of females based on the date of fertilization in 2020.

Groups	Indicators		Date of fertilization		
			Before March 15	From March 16 to March 25	After March 26
Adults	Total females	n ♀	471	403	57
	Successfully whelped	n , heads	330	242	31
		%	70.1	60.1	54.3
	Total puppies	heads	1793	1237	146
	Stillborn	heads	107	70	2
		%	5.9	5.6	1.3
	Died before registration	heads	212	265	45
		%	11.8	21.4	30.8
	Fertility	heads $\bar{x}$±Sx	4.85±0.08	4.26±0.08***	4.71±0.36
	Run to the main female	heads $\bar{x}$±Sx	3.13±0.11	2.23±0.11***	1.73±0.32***
Young	Number of females	n ♀	70	285	82
	Successfully whelped	n, heads	54	132	21
		%	77.1	46.3	25.6
	Total puppies	heads	235	599	105
	Stillborn	heads	19	39	2
		%	8.1	6.5	1.9
	Died before registration	heads	32	132	12
		%	13.6	22	11.4
	Fertility	heads $\bar{x}$±Sx	4.05±0.20	3.72±0.11	3.88±0.35
	Reaching the main female	heads $\bar{x}$±Sx	2.66±0.25	1.52±0.11***	1.01±0.22***

Note: ***P>0.999

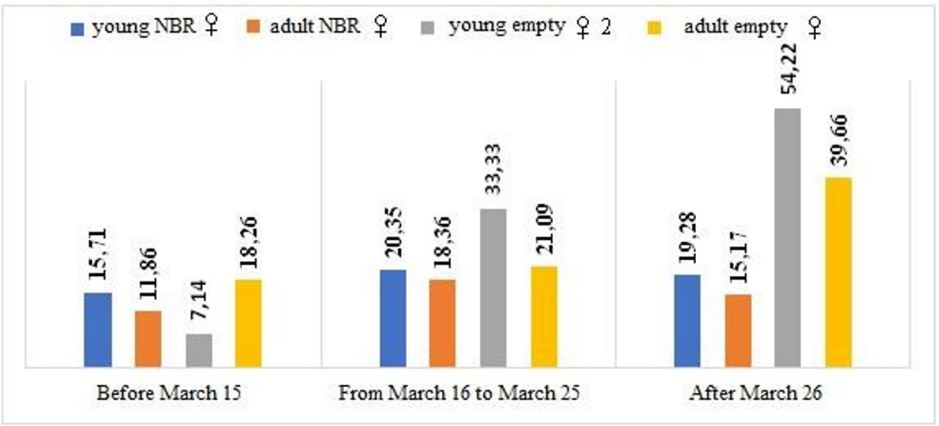

Fig. 1. The timing of female fertilization and the number of females that did not produce offspring in 2020.

Figure 1 shows data on females fertilized at different times that did not produce offspring. The maximum number of adults that failed to give birth was covered from March 16-25 - 33.33%, the minimum before March 15 - 11.86%. The young ones have a different picture - the maximum number of NBR in females covered in the middle and at the end of the rut and the minimum at the beginning - 15.71%. In terms of the number of voids, both adults and young ones are more common, fertilized at the end of the rut after March 26 - 39.66% and 54.22%, respectively. The minimum number of voids is observed in adult and young females covered before March 25 - 18.26% and 7.14%, respectively. Females fertilized on March 16-25 occupy an average position in the number of voids - 21.09 and

33.33%, respectively. Therefore, in order to increase the number of successfully whelped females and reduce the percentage of young animals lost, preference should be given to females that come into heat early.

Table 2. Reproductive performance of females based on the date of fertilization in 2022.

Groups	Indicators		Date of fertilization		
			Before March 15	From March 16 to March 25	After March 26
Adults	Total females	n ♀	421	248	10
	Successfully whelped	n , heads	370	215	7
		%	87.8	86.7	70.0
	Total puppies	heads	1965	1139	30
	Stillborn	heads	85	49	3
		%	4.3	4.3	10
	Died before registration	heads	237	152	2
		%	12.1	13.3	6.6
	Fertility	heads $\bar{x}$±Sx	5.10±0.08	5.01±0.10	4.3±0.32*
	Run to the main female	heads $\bar{x}$±Sx	3.90±0.10	3.79±0.13	2.5±1.02
Young	Number of females	n ♀	128	155	13
	Successfully whelped	n , heads	106	102	7
		%	82.8	65.8	53.8
	Total puppies	heads	566	518	32
	Stillborn	heads	43	51	3
		%	7.6	9.8	9.4
	Died before registration	heads	91	82	2
		%	16.1	15.8	6.2
	Fertility	heads $\bar{x}$±Sx	5.14±0.16	4.88±0.21	4.57±1.04
	Reaching the main female	heads $\bar{x}$±Sx	3.37±0.18	2.48±0.19**	1.69±0.61*

Note: *P>0.95; **P>0.99

Table 2 shows that the maximum fertility of adult females inseminated before March 15 is 5.1 puppies, the difference is significant compared to females mated after March 26. The same trend is observed between the groups in terms of the output on the main female, but the difference is not significant. The highest results of successfully whelped young females in 2022 are in the group inseminated at the beginning of the rut, followed by females mated in the middle of the rut and at the end. There is no significant difference between the groups in terms of fertility, the output of puppies on the main female is the maximum in individuals inseminated before March 15, the difference is significant with the group mated in the middle of the rut and at the end.

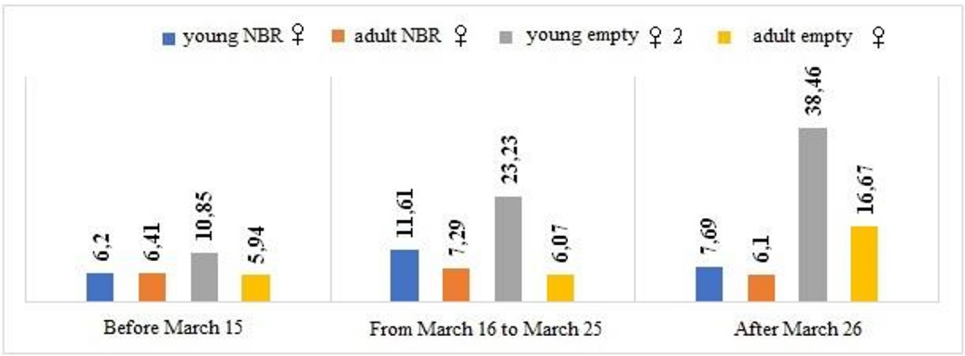

Fig. 2. Female fertilization dates and number of females that did not produce offspring in 2022.

The analysis of the data presented in Figure 2 shows that the number of young and adult females that gave birth unsuccessfully is minimal when they came into heat and were inseminated before March 15. The same picture is observed for the number of those that missed a birth, the maximum number of them were inseminated after March 26, both young and adult.

The data in Table 3 show that in 2024, among adult females that came into heat and were inseminated before March 15, the maximum number of individuals successfully whelped by 8% compared to females inseminated after March 26 and by 3% compared to those inseminated in the middle of the rut.

Table 3. Reproductive performance of females based on the date of fertilization in 2024.

Groups	Indicators		Date of fertilization		
			Before March 15	**From March 16 to March 25**	**After March 26**
Adults	Total females	n ♀	878	288	15
	Successfully whelped	n , heads	538	168	8
		%	61.3	58.3	53.3
	Total puppies	heads	2902	865	40
	Stillborn	heads	110	22	9
		%	3.8	2.5	22.5
	Died before registration	heads	540	123	6
		%	18.6	14.2	15
	Fertility	heads $\bar{x}$±Sx	4.84±0.07	4.63±0.13	5.00±0.53
	Run to the main female	heads $\bar{x}$±Sx	2.57±0.08	2.50±0.14	1.78±0.61
Young	Number of females	n ♀	312	306	60
	Successfully whelped	n , heads	205	205	35
		%	65.7	66.9	58.3
	Total puppies	heads	1074	1012	188
	Stillborn	heads	47	28	7
		%	4.4	2.7	3.7
	Died before registration	heads	203	127	32
		%	18.9	12.5	17.0
	Fertility	heads $\bar{x}$±Sx	4.98±0.14	4.47±0.12**	4.82±0.30
	Reaching the main female	heads $\bar{x}$±Sx	2.59±0.16	2.80±0.14	2.56±0.32

The number of stillborn puppies is maximum in females inseminated at the end of the rut. There is a tendency for fertility and the number of puppies per mother to decrease in individuals inseminated at the beginning of the rut towards the end, but the difference between the groups is not significant. The young females in the group that came into heat before March 15 have 7.4% more individuals that successfully whelped than those inseminated at the end of the rut, and 1.2% less than the females mated in the middle of the rut. The maximum number of stillborn and dead before registration is in the group of females inseminated before March 15 and the minimum is in those mated in the middle of the rut. The fertility of females mated before March 15 is 0.51 heads higher than that of females inseminated in the middle of the rut, the difference is statistically significant, compared to females mated after March 26, the difference is 0.16 heads and is not significant. In terms of the business output of young animals on the main female, the best results are for females inseminated in the middle of the rut and the worst at the end, but the difference between the groups is not significant.

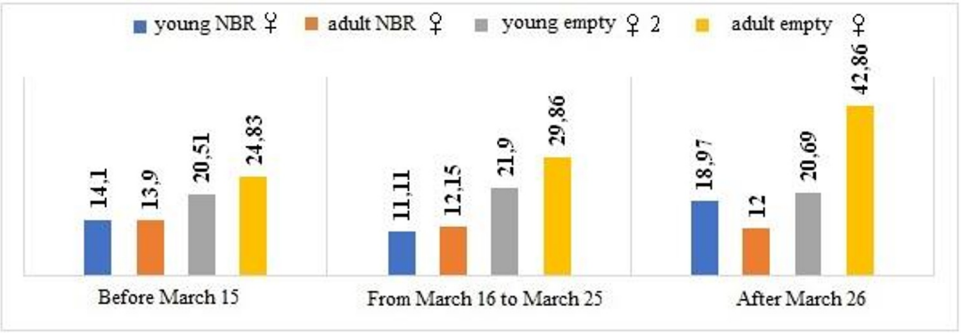

Fig. 3. Female fertilization dates and number of females that did not produce offspring in 2024.

It follows from the data in Figure 3 that the number of unsuccessfully whelped young females is maximum in the group of females inseminated after March 26 and minimum in individuals mated in the middle of the rut, in adults there are more such females in the group mated before March 15 and fewer in the middle of the rut. A different picture is observed for the number of empty females, the maximum number of empty ones is among young females mated in the middle of the rut and the minimum among those mated before March 15, but the difference between the groups is small. In the group of adult females, the maximum number of empty ones was detected mated after March 26 - 42.86%.

The drug "Follimag" was used to stimulate ovulation and normalize the reproductive cycle of females that are usually mated after March 26. Hormonal regulation of sexual function is a key aspect in modern fur farming, especially in conditions where the timing of reproduction can deviate from the optimal. The main active ingredient of this drug is follicle-stimulating hormones (FSH), which play a key role in the process of folliculogenesis. These hormones are produced by the pituitary gland and are responsible for the growth and development of follicles in the ovaries, as well as for the synthesis of estrogens. With insufficient production of follicle-stimulating hormones, anovulation may occur, which makes conception difficult.

Table 4. The number of successfully whelped females and born puppies when using stimulation with the drug "Follimag".

Groups	Age groups	n, heads	Successfully whelped females, %	Fertility, heads $\bar{x}\pm Sx$	Output to the main female, heads $\bar{x}\pm Sx$	Stillborn puppies	Died before registration
						%	%
Experience	Adults	30	62.7	4.92±0.35	2.01±0.34	17.3	25.5
	Young	30	47.2	4.58±0.20	2.06±0.16	17.1	13.6
	Total	60	49.5	4.64±0.18	2.05±0.14	17.1	16.1
Control	Adults	30	58.0	4.32±0.24	2.04±0.27	7.5	9.1
	Young	30	52.3	4.12±0.22	1.63±0.20	9.4	10.2
	Total	60	54.8	4.21±0.16	1.80±0.16	8.5	9.6

From the analysis of Table 4 it follows that in the experimental group compared to the control there are 4.7% more successfully whelped adult females, fertility is higher by 0.6 puppies, but the difference is not reliable. In young females, the percentage of successfully whelped is 15.5% less compared to adults in the experiment and 5.7% in the control, since young females did not pass the selection for reproductive indicators. The output of young animals per main female in adult animals is almost the same in the experiment and control, the difference is only 0.03 puppies in favor of the control, and for young females, the output

of young animals is 0.43 higher in the experiment than in the control, but the difference is not reliable. In the experimental group there is a greater number of stillborn puppies, for adult females by 9.8%, for young ones by 7.7%, a total of 8.6% more than in the control. In the experimental group, there is a higher mortality of young animals before registration than in the control group: by 16.4% for adults, by 3.4% for young animals, and by 15.5% for adults and young animals in total. Folliculogenesis is a complex and multifaceted process that includes several stages, starting with the formation of primary follicles and ending with the maturation of eggs ready for fertilization. The drug "Falimag" was developed to enhance and accelerate this process, however, as the results show, its use may not always lead to the desired results. In young and adult females, there is a high percentage of stillborn and dead puppies before registration, which may indicate functional immaturity of the eggs during stimulation. But despite the low rates of puppy survival,

4 Conclusion

- It was found that in the group of females that came into heat and were inseminated before March 15, more cases of successful insemination and birth of young were recorded in both young and adult females over five years.
- It was proven that fertility and the output of young per main female decreases from the group of females inseminated before March 15 to females covered in the middle of the rut to individuals inseminated after March 26.
- It was noted that the number of unsuccessfully given birth females and empty ones increases from the group of females inseminated before March 15 to the group of females covered from March 15 to 25, and the maximum indicators are in females covered after March 25
- The conducted studies on the stimulation of adult females showed that in the experimental group, compared to the control, there are 4.7% more successfully whelped females, fertility is higher by 0.6 puppies, but the difference is not significant.
- The output of young animals per main female in adult animals is almost the same in the experiment and control, the difference is only 0.03 puppies in favor of the control, and for young females, the output of young animals is 0.43 higher in the experiment than in the control, but the difference is not significant.
- In the experimental group, a large number of stillborn puppies, for adult females by 9.8%, for young ones by 7.7%. In the experimental group, there is a large loss of young animals before registration, 16.4% more for adults and 3.4% more for young animals than in the control.

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