

Reproduction performance of vixens of the silver fox (*Vulpes vulpes* L.) exhibiting different behaviour types

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The study was conducted on 295 vixens of the silver fox, coming from two farms located in the Wielkopolskie voivodeship. The vixens were subjected to two tests: the pencil test and the feeding test and on the basis of test results, they were classified to individual behaviour types. The aim of the study was to determine the effect of behaviour type in vixens of the silver fox on their reproduction performance. Significant differences were found in the analysed reproduction performance traits of vixens with different behaviour types. Gentle-type females had a higher number of pups in the litter at birth and at weaning in comparison to vixens showing the other types of behaviour. Moreover, gentle females much earlier entered into oestrus, resulting in earlier whelping. Reproduction performance traits in trustful vixens defined on the basis of the feeding test were markedly superior to those of fearful females. Trustful vixens earlier entered into oestrus, they had earlier whelpings and they gave birth to and reared a much greater number of pups in the litter. The mentioned analyses confirmed the opinion that gentle vixens (the pencil test) and trustful females (the feeding test) were characterised by superior reproduction performance indexes.

KEY WORDS: silver fox / behaviour / pencil test / feeding test

Reproduction performance in the foundation stock as well as the quality of the produced pelts has a decisive effect on profitability of fur farming. The level of production traits is influenced by genetic factors, feeding, management conditions, physiological condition, as well as behaviour of animals and their stress resistance. Finding methods of a simple, rapid and repeatable test defining the emotional condition of animals may facilitate an easier and more effective selection based on different behaviour types in animals. Animals which are curious, trustful or indifferent towards humans are more suitable for breeding, since they

have better reproduction and production parameters (e.g. prolificacy, number of reared young), and first of all, they adapt more easily to cage housing. Already the presence of humans in the vicinity of foxes may influence the level of their reproduction performance [1]. In the recent years, the studies have been conducted to provide insight into the psychology of farmed foxes [11]. Many authors have described the psychological condition of animals and their behaviour in different periods of their lives [12, 13, 14, 16, 19, 21], classifying them to specific groups in terms of types of behaviour, caused by the action of diverse factors, e.g. the presence of humans. Tests are not always easy to conduct on farms keeping large numbers of animals [10], due to the fact that their application is frequently highly labour- and time-consuming. The aim of this study was to determine the effect of behaviour types in vixens of the silver fox, defined on the basis of a modified pencil test and a feeding test, on their reproduction performance.

Material and methods

The experimental material comprised 295 females of the silver fox coming from two farms located in the Wielkopolskie voivodeship, Poland. In December, behaviour type of vixens was determined based on the pencil and feeding tests. The modified pencil test [7] included observations of the reaction to a stick inserted into the cage. The observer inserted a stick (of 120 cm in length and a diameter of 2.5 cm) for approx. 10 s to the cage (180 cm x 120 cm x 100 cm) to such a length (50-70 cm) that a fox could make a maneuver in the cage, e.g. retreat or escape. The reaction of the animal to the test was observed. Based on the reaction of vixens to the stimulus 4 groups of animal behaviour were distinguished: aggressive, gentle, indifferent and fearful, to which all the observed animals were classified. The following criteria of evaluation were adopted, according to which females were classified to individual groups:

- aggressive – a violent reaction occurred, animals rushed towards the stick and bit it, they produced vocalisations: barking and growling, movement in the cage was rapid and dynamic, vixens expressed willingness to jump towards the intruder, tried to bite or were actually biting the cage and deterred the intruder;
- curious – vixens showed no flight reaction, but rather the opposite - curiosity was observed, resulting in sniffing of the stick, while some animals behaved like dogs – trying to bite the stick gently (some wagged their tails, similarly to dogs), clearly there was no fear of humans manifested, the animals approached to the wire fence and showed submissive behaviour, manifested in frequent urination;
- indifferent – they showed no reaction to the stimulus, did not change their position, remained indifferent to the stick inserted into the cage and to the presence of humans;
- fearful – animals responded with immediate flight and distancing behaviour, when they most frequently fled to the opposite end of the cage and leaning with the limbs onto the wire fence they were trying to escape and urinated, leaning on trembling hind legs, which they alternately bent and straightened.

The feeding test included observations of the type of reaction to feed placed in the trough located on the front wall of the cage. The feeding observer stood for approx. 1 minute

in front of the cage and recorded the reaction of animals:

- the fox, which in the presence of humans approached the trough and ate the feed was defined as trustful;
- the fox, which within 1 minute did not approach the trough and did not start to eat the feed, was classified as fearful towards humans.

From breeding documentation kept on each farm both current information and data from previous seasons were collected concerning reproduction of vixens, taking into consideration the number of serviced, sterile and whelped vixens, the number of vixens destroying their litters, as well as the dates of service and whelping, together with the number of whelps at birth and reared in the litter.

The distribution of behaviour types among animals from both farms according to the empathic and feeding tests was evaluated using the χ^2 test. The effect of the type of behaviour in vixens of the red fox on certain breeding performance parameters was evaluated using a two-way analysis of variance based on a constant model (farm, behaviour type). The significance of differences between groups of animals with different behaviour types was determined using the Duncan test. Calculations were performed using the SAS statistical software package [20].

Results and discussion

The distribution of behaviour types in foxes from the analysed farms based on the pencil test is presented in Table 1. Jointly (on both analysed farms) the highest proportion in individual behaviour types was recorded for fearful females (43.73%), while the lowest proportion was of aggressive vixens (9.15%), at a considerable percentage of curious females (29.49%). A different percentage distribution of individual behaviour types among vixens in the pencil test was reported by Filistowicz et al. [4] and Gronek et al. [7]. In both cited studies the highest percentage was found for vixens with an indifferent type of behaviour (79.20% and 34.00%).

Table 1 – Tabela 1

Number (n) and percentage (%) of silver fox females with different types of behaviour in the pencil test in the tested farms

Liczba (n) i udział procentowy (%) samic lisa pospolitego o różnych typach zachowania w teście ołówkowym w badanych fermach

Type of behaviour Typ zachowań	Farm A Ferma A		Farm B Ferma B		Total Łącznie	
	n	%	n	%	n	%
Aggressive Agresywne	10	9.61	17	8.90	27	9.15
Curious Łagodne	30	28.85	57	29.84	87	29.49
Indifferent Obojętne	16	15.38	36	18.85	52	17.63
Fearful Bojaźliwe	48	46.16	81	42.41	129	43.73

The proportions of individual behaviour types among vixens on the farms were similar (Tab. 1). On farms A and B the highest percentage was recorded for fearful females (46.16 and 42.41) and curious females (28.85 and 29.84), while the lowest proportion of females aggressive (9.61 and 8.90). No significant differences were found between the proportions of both types of behaviour among foxes on the analysed farms ($\chi^2=0.027$). Values of reproduction performance traits for females depending on their behaviour type determined on the basis of a modified pencil test (Tab. 2). Results for the analysed farms did not differ from values reported by Filistowicz et al. [4]. Those studies showed that calm (curious and indifferent) vixens of silver foxes had better reproduction indices than fearful and aggressive females. In this experiment, vixens with a gentle type of behaviour entered into oestrus much earlier both on farm A and B, and thus they whelped earlier in relation to aggressive, indifferent and fearful females. On both farms, the mean values of service and whelping dates were earliest for curious vixens and came on days 50.61 and 103.43 of the year, while they differed significantly ($P\leq 0.01$) in relation to aggressive, indifferent and fearful females. Behaviour type of vixens did not have an effect on the duration of pregnancy. Curious females were characterised by a higher number of pups born and reared in the litter both on farm A and B. Considerable differences were observed particularly in relation to aggressive and curious (Tab. 2) animals. Joint results for the number of born and reared pups were similar on both farms.

The distribution of behaviour types for females of silver foxes on the analysed farms based on the conducted feeding test is presented in Table 3. It results from the mentioned table that a much greater percentage (for both farms jointly) was recorded for fearful females, amounting to 69.83%, while only 30.17% females were classified as trustful. The percentages of trustful vixens and fearful vixens were very similar, amounting to 30.77% and 29.84% (trustful vixens) and 69.22 and 70.15% (fearful females). No significant differences were found between the proportions of both types of behaviour among foxes on the investigated farms ($\chi^2=0.734$). The percentage of trustful vixens in this experiment was higher than that reported by Rekila et al. [17, 18, 19].

Reproduction performance of trustful females was much better than that of fearful vixens (Tab. 4). Trustful females earlier entered into oestrus, resulting in earlier whelpings. Differences in dates of service and whelping between trustful and fearful females turned out to be significant on farm A ($P\leq 0.01$) and farm B ($P\leq 0.001$). Behaviour type of vixens did not influence the duration of pregnancy. Trustful vixens gave birth to and reared much higher numbers of whelps in the litter. Differences in the number of reared pups between trustful and fearful vixens turned out to be significant ($P\leq 0.01$) both on farm A and B. Jointly for both farms, the differences between trustful and fearful females in terms of dates of service and whelping were significant ($P\leq 0.001$), similarly as it was the case for the number of reared young ($P\leq 0.01$). Results of investigations indicating better reproduction indices for trustful and curious females in comparison to fearful and aggressive vixens are consistent with the results of experiments reported by other authors [3, 5, 6, 8, 15]. Calm animals (curious and trustful) are easier to keep on farms [9]. A study by Belyaeva [2] showed a correlation between aggressive behaviour of females and the date of oestrus. The author of that study stated that vixens with a curious temperament started the reproduction season earlier. Results in this study confirm this rule in the analysed population (farms A

Table 2 – Tabela 2

Mean values (\bar{x}), standard deviation (SD) of reproductive traits of silver fox females with different type of behaviour

Wartości średnie (\bar{x}), standardowe odchylenia (SD) cech reprodukcyjnych samic lisa pospolitego o różnym typie zachowania

Cechy Traits	Ferm A – Ferma A				Ferm B – Ferma B				Łącznie – Total				
					Type of behaviour – Typ zachowań								
	1	2	3	4	1	2	3	4	1	2	3	4	
Date of mating Data krycia	\bar{x} SD	61.40 ^a 4.41	51.38 ^{ab} 1.93	59.00 4.40	59.41 ^b 1.96	56.29 3.77	50.27 ^b 2.04	56.77 ^b 2.59	54.18 1.73	57.45 ^B 2.96	50.61 ^{BCD} 1.51	57.04 ^C 2.17	56.57 ^D 1.13
Date of birth Data wykotu	\bar{x} SD	114.40 ^c 4.39	104.28 ^{cd} 1.96	111.20 4.38	112.16 ^d 1.92	108.92 4.25	103.01 2.27	109.86 2.90	107.30 1.91	110.36 ^E 3.19	103.43 ^{BEFG} 1.59	110.05 ^F 2.35	109.71 ^G 1.18
Length of pregnancy Długość ciąży	\bar{x} SD	53.00 0.49	52.92 0.21	52.20 0.49	52.71 0.13	52.14 0.46	52.13 0.24	52.00 0.31	52.47 0.21	52.36 0.35	52.39 0.17	52.02 0.25	52.59 0.13
Number of kits born Liczba szczeniąt urodzonych	\bar{x} SD	4.10 ^e 0.29	4.81 ^{ef} 0.18	4.35 ^f 0.39	4.40 0.20	3.80 ^A 0.49	4.62 ^{Ai} 0.22	4.07 ⁱ 0.30	4.17 0.20	3.90 ⁱⁱ 0.40	4.65 ^{ij} 0.18	4.20 ^j 0.29	4.25 0.14
Number of kits weaned Liczba szczeniąt odsadzonych	\bar{x} SD	3.94 ^g 0.39	4.55 ^g 0.19	4.12 0.41	4.20 0.22	3.30 ^J 0.48	4.21 ^J 0.22	3.87 0.19	3.85 0.30	3.65 ^I 0.42	4.36 ^I 0.20	4.01 0.31	3.97 0.14

Type of behaviour: 1 – aggressive, 2 – curious, 3 – indifferent, 4 – fearful

Typ zachowania: 1 – agresywne, 2 – łagodne, 3 – obojętne, 4 – bojaźliwe

a, b, c, d, e, f, g, h, i, j – averages indicated by the same letters in a row differ significantly at $P \leq 0.05$ – średnie oznaczone tymi samymi literami w wierszu różnią się istotnie przy $P \leq 0.05$

A, B, C, D, E, F, G, H, I – averages indicated by the same letters in a row differ significantly at $P \leq 0.01$ – średnie oznaczone tymi samymi literami w wierszu różnią się istotnie przy $P \leq 0.01$

J – averages indicated by the same letters in a row differ significantly at $P \leq 0.001$ – średnie oznaczone tymi samymi literami w wierszu różnią się istotnie przy $P \leq 0.001$

Table 3 – Tabela 3

Number (n) and percentage (%) of silver fox females with different types of reaction to the feeding test in the silver fox foundation stock in the tested farms

Liczba (n) i udział procentowy (%) samic lisa pospolitego o różnych typach reakcji na test pokarmowy w badanych fermach

Type of behaviour Typ zachowań	Farm A Ferma A		Farm B Ferma B		Total Łącznie	
	n	%	n	%	n	%
Trustful Ufne	32	30.77	57	29.84	89	30.17
Fearful Bojaźliwe	72	69.22	134	70.15	206	69.83

Table 4 – Tabela 4

Means values (\bar{x}) and standard deviations (SD) of reproductive traits of silver fox females with different types of reaction to the feeding test

Wartości średnie (\bar{x}) i standardowe odchylenia (SD) cech reprodukcyjnych samic lisa pospolitego o różnych typach reakcji na test pokarmowy

Traits Cechy		Farm A – Ferma A		Farm B – Ferma B		Total – Łącznie	
		Type of behavior – Typ reakcji					
		Trustful Ufne	Fearful Bojaźliwe	Trustful Ufne	Fearful Bojaźliwe	Trustful Ufne	Fearful Bojaźliwe
Date of mating Data krycia	\bar{x}	52.78 ^A	59.56 ^A	44.50 ^D	57.64 ^D	47.44 ^G	58.32 ^G
	SD	1.75	1.16	1.89	1.24	1.39	0.92
Date of birth Data wykotu	\bar{x}	105.80 ^B	112.25 ^B	97.97 ^E	110.14 ^E	101.05 ^H	110.94 ^H
	SD	1.77	1.17	2.16	1.39	1.51	0.97
Length of pregnancy Długość ciąży	\bar{x}	53.00	52.64	52.25	52.26	52.54	52.40
	SD	0.19	0.13	0.24	0.16	0.17	0.11
Number of kits born Liczba szczeniąt urodzonych	\bar{x}	5.19	4.63	4.46	4.17	4.62	4.21
	SD	0.26	0.18	0.24	0.15	0.18	0.12
Number of kits weaned Liczba szczeniąt odsadzonych	\bar{x}	4.90 ^C	3.88 ^C	4.09 ^F	3.53 ^F	4.19 ^J	3.63 ^J
	SD	0.30	0.19	0.24	0.15	0.20	0.13

A, B, C, F, J – averages indicated by the same letters in a row differ significantly at $P \leq 0.01$ – średnie oznaczone tymi samymi literami w wierszu różnią się istotnie przy $P \leq 0,01$

D, E, G, H – averages indicated by the same letters in a row differ significantly at $P \leq 0.001$ – średnie oznaczone tymi samymi literami w wierszu różnią się istotnie przy $P \leq 0,001$

and B), since curious vixens were the first to start the reproduction season (with their type defined both in the feeding and pencil tests).

Summing up the recorded results it needs to be stated that:

– trustful females (the feeding test) were characterised by higher prolificacy than fearful females; moreover, they entered into oestrus much earlier and gave birth to the offspring earlier;

– reproduction performance of curious females (identified by the modified pencil test) were characterised by much better indices in comparison to aggressive, indifferent and fearful vixens;

– this study confirms an opinion that females of the curious - trustful type of behaviour, determined both in the pencil and feeding tests, were characterised by better reproduction performance indices.

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Użytkowość reprodukcyjna samic lisa pospolitego (*Vulpes vulpes* L.) o różnym typie zachowań

Streszczenie

Badania przeprowadzono na 295 samicach lisa pospolitego, pochodzących z dwóch ferm zlokalizowanych w województwie wielkopolskim. Samice poddano testowi olówkowemu i pokarmowemu, i na tej podstawie zakwalifikowano do poszczególnych typów zachowań. Celem badań było określenie wpływu typu zachowań samic lisa pospolitego na wyniki ich użytkowania reprodukcyjnego. W analizowanych cechach użytkowości reprodukcyjnej badanych samic o różnym typie zachowania stwierdzono istotne różnice. Samice o typie łagodnym charakteryzowały się większą liczbą szczeniąt urodzonych i odsadzonych w miocie, w porównaniu do samic wykazujących pozostałe typy zachowań. Ponadto samice łagodne wchodziły znacznie wcześniej w ruję, czego następstwem były wcześniejsze wykoty. Cechy użytkowości reprodukcyjnej samic uznanych za ufne na podstawie testu pokarmowego były zdecydowanie lepsze niż samic bojaźliwych. Samice ufne wcześniej wchodziły w ruję, wcześniej następowały ich wykoty oraz rodziły i odchowywały znacznie więcej szczeniąt w miocie. Badania potwierdziły pogląd, że samice o łagodnym (test olówkowy) i ufnym (test pokarmowy) typie zachowania charakteryzowały się lepszymi wskaźnikami użytkowości reprodukcyjnej.

SŁOWA KLUCZOWE: lis pospolity / behavior / test olówkowy / test pokarmowy