CORRELATED RESPONSES IN LITTER RESULT, BODY SIZE, FUR QUALITY AND COLOUR CLARITY IN BLUE FOXES (*Alopex lagopus*) SELECTED FOR CONFIDENT BEHAVIOUR

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INTRODUCTION

In the 1960's, a tame fox was developed in Russia using genetic selection (Belyaev, 1979.). Simultaneously with increasing tameness, favourable changes occurred in reproductive performance (Belyaev, 1979 ; Plyusnina *et al.,* 1996). Genetic gain in confidence tended to contribute to a decrease in stress hormone levels indicating an increased welfare (Osadschuk, 1992 ; Plyusnina *et al.,* 1996 ; Rekilä, 1999). Based on data from 30 Finnish farms, Nikula *et al*. (2000) found moderate heritability estimates ($h^2 = 0.22$ on an average) in confidence of blue fox and silver fox adults and cubs. In addition, positive genetic and phenotypic correlations occurred between confidence of adult females and litter result as well as between confidence of cubs and skin size and quality. In studies with blue foxes selected for confidence in Finland and Norway, a selection response was achieved (Kenttämies *et al*., 2001). The aim of the present study based on the Finnish selection experiment was to find out if genetic changes in litter result and fur traits coincide with increasing confidence.

MATERIAL AND METHODS

Experimental design. In 1995 to 1998, a selection experiment with blue foxes was done on a private farm. At the start of the study the whelped females of the farm were allotted according to pedigree and reproduction data into similar selection (SL) and control (C) lines. The study continued within closed lines using yearling males and females. Cubs in SL were selected for breeding value (EBV) of confident behaviour (CB) while cubs in C were selected on the basis of an index for production traits as follows: 0.4 x litter size, 0.3 x fur quality (FQ), 0.15 x colour clarity (CC) and 0.15 x body size (BS). In addition, at least one female cub from each dam and one male cub from each sire were included in the C line of the next generation.

Animals. Data comprised 3317 cubs tested for CB and subjectively graded for BS, FQ and CC. CB of cubs was measured in October using a feeding test validated by Rekilä *et al.* (1997). CB denoted the mean of 4 successive tests using a scale from 1 to 2 points where a score of 1indicated a fearful and 2 a confident animal. BS, FQ and CC were subjectively graded before pelting using an ascending scale from 1 to 5 points. A litter result (LR) was available altogether from 660 females, of which 545 selected one year old females were tested for CB as a cub. LR was recorded as the number of cubs at two weeks per mated female.

Statistical analyses. Editing of data and testing of significance of fixed factors were done with program packages WSYS–D and WSYS-L (Vilva 1989 and 1999). (Co)variance components were estimated with REML method applied to multiple trait animal model using VCE4 program and used in Pest program for finding breeding values. In estimating variance and covariance components for CB, BS, FQ and CC the following linear model 1. was used: $y_{ijklm} = \mu + year_i + sex_j + a_k + pe_l + \varepsilon_{ijklm}$ where y_{ijklm} = the trait studied, μ=overall mean, $year_i$ = fixed effect of the i^{th} year (i=1,…,4), sex_j = fixed effect of the j^{th} sex class (1=male, 2=female), a_k = random additive genetic effect of the k^{th} animal, pe_l = random permanent effect of the l^{th} litter, ε_{ijklm} = random residual effect. In addition, the model for BS included the fixed effect for litter size of dam classified into 4 classes. σ^2_a, σ^2_{pe} and σ^2_ε are variance components for additive genetic, permanent environmental and residual effects, respectively. The estimates of heritability (h^2) and litter effect (c^2) were defined as follows:

$$h^2 = \sigma^2_a/(\sigma^2_a + \sigma^2_{pe} + \sigma^2_\varepsilon)$$

$$c^2 = \sigma^2_{pe}/(\sigma^2_a + \sigma^2_{pe} + \sigma^2_\varepsilon)$$

In estimating variance and covariance components for CB tested as a cub and LR of females, the model for CB included overall mean, the fixed effect of year, and random effects of animal and error. The model for LR included in addition the fixed effect of date of the first mating defined as days from the beginning of the year and classified into 6 classes ($d1mcl_i$) and the fixed effect of times of mating (tm_l,l=1,2,3-4).

RESULTS AND DISCUSSION

Least Squares Analyses showed highly significant interactions between year and line in CB, BS, FQ and CC. Greater advances in CB existed in SL compared to C. An opposite situation was found in BS, FQ and CC. Males obtained higher values in CB, BS, FQ and CC compared to females ($p<0.001$) Differences between lines within years in LR tended to be greater in SL compared to C, but differences were significant ($p<0.05$) only in the second selection generation (1997). Average inbreeding rates were similar in both lines (0.25 and 0.26 %).

Genetic parameters. The moderate heritability estimate for CB (Table 1) was of the same order as found in the earlier studies with Finnish blue foxes estimated with single trait models (Nikula *et al.,* 2000 ; Kenttämies e*t al.,* 2001). Correlations between CB and LR tended to be slightly positive (r_g = 0.02±0.22, r_p = 0.15)

Table 1 Estimates of genetic parameters in blue foxes selected for confidence[A]

Traits	CB	BS	FQ	CC
CB	**0.18±0.02**	-0.01±0.02	-0.32±0.08	-0.28±0.09
BS	0.34	**0.47±0.02**	0.52±0.03	0.03±0.05
FQ	0.10	083	**0.31±0.02**	0.66±0.04
CC	0	0.59	0.95	**0.14±0.02**

[A] Heritabilities (± s.e.) on the diagonal, phenotypic and genetic correlations below and above the diagonal, respectively.

In the farm study, Nikula *et al.* (2000) obtained a greater positive r_g between CB of adult blue fox females and whelping result (LR) compared to the corresponding r_p. Nearly non-existent or negative r_g appeared between CB and BS, FQ and CC, respectively while the corresponding r_p were positive or non-existent, respectively (Table 1).

Correlated responses. Correlated responses in LR tended to be higher in SL compared to C in spite of the fact that LR was given a 40 % weight in the index when selecting animals in C. (Figure 1).

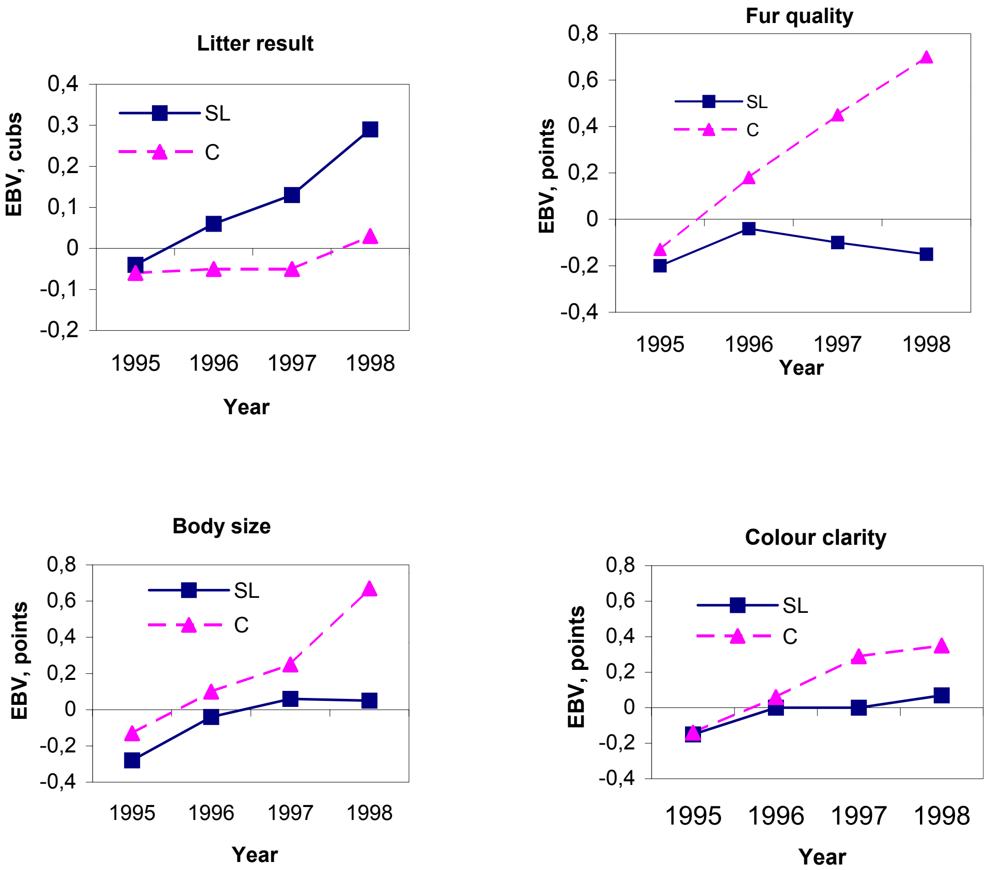

Figure 1. Selection responses in production traits of blue foxes selected (SL) or not selected (C) for confident behaviour

In line with the present study, a noticeable response in litter size was found in the silver fox selected for tameness (Belyaev, 1979 ; Plyusnina *et al.,* 1996).

After the first selection generation a low negative change was seen in FQ of the selected animals while nearly non-existent positive changes appeared in BS and CC. Differences between lines increased during the study, particularly in LR and FQ. In addition in the third selection generation, an increased positive change in body size was found in the C line compared to the SL line.

CONCLUSION

The selection experiment for confident behaviour in blue foxes indicates that selection for only confidence has a positive effect on litter result. However, a negative response was obvious in fur quality while minor changes were observed in body size and colour clarity. Therefore selection for CB is recommended together with fertility index in aiming at genetic improvement in reproductive performance. However, in the breeding for exterior traits, particularly for fur quality, the simultaneous use of an index for improving these traits is necessary.

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