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Genetic relationship of eye infection and grading traits in Finnish blue fox

R. Kempe and I. Strandén
Biotechnology and Food Research, MTT Agrifood Research Finland, 31600 Jokioinen, Finland

ABSTRACT: The frequency of eye infections in the Finnish blue fox population has increased during the past decade. Eye infection may incur economic losses to producers due to reduced selection intensity. Ethical aspects also need to be considered, since eye infection reduces animal wellbeing. The purpose of this study was to estimate genetic parameters for eye infection (EYE) and to determine the genetic and phenotypic correlations between EYE, grading traits and animal size traits. The data were collected from 2,076 blue foxes. Heritability estimate for EYE was moderate (0.24), suggesting that selection can be used to change susceptibility to eye infection. EYE had a moderate antagonistic genetic correlation (-0.46) with grading density (thick underfur). The genetic correlation with grading size and body condition score (fatness) was estimated without precision, but all the phenotypic size traits had low antagonistic correlation with EYE.
Keywords: blue fox; eye disease ; grading traits

Introduction

Eye infection and/or eye disease, can be very painful for the animal and reduces its wellbeing, and so sick blue foxes need to be culled immediately. This causes economic losses through loss of animals and reduced selection intensity for other selected traits.

Diseases are not included in the blue fox breeding programme and culling against eye infection is currently carried out on very few farms based on the fox's phenotype. The main goals in Finnish blue fox breeding are to increase litter and pelt size and to improve fur quality. Primary emphasis in selection is given to pelt size because of its major economic importance (Rekilä et al. (2000); Peura et al. (2004)). In practice, blue foxes are given as much food as they can eat during the growth period, in order to attain heavy animals with large pelt size (Rekilä et al. (2000); Kempe et al. (2008)). Consequently, most production foxes are extremely fat at pelting time, which may increase the risk of obesity and related health problems (Kempe et al. (2009) and (2010)). Along with larger animal size, the frequency of eye infections has increased in the Finnish blue fox population over the past decade.

Inherited eye diseases are common in all animals (Barnett (1988)). Eye diseases may cause irritation to the cornea or conjunctiva and expose the eye to secondary eye infection. Veterinary examinations indicate that blue foxes have eye diseases like entropion, ectropion, distichiasis, trichiasis and ectopic cilia. In dogs, these eye diseases are considered to be inheritable (Barnett (1988)). On the other hand, primary microbial infections caused by bacteria, viruses, fungi and protozoa have been found in blue fox population.

The factors that have impaired eye health in the Finnish blue fox population are still unclear, but increased animal size and/or fatness as well as certain fur quality traits like density are suspected to be predisposing factors. The objective of this research was to estimate genetic and phenotypic correlations between eye infection, animal size and grading traits.

Materials and Methods

Data. The experiment was carried out at the fur animal research station of MTT Agrifood Research Finland. The data were collected during the growth periods in 2005 and 2006 from altogether 2,076 blue foxes. Live animal grading traits and eye health were evaluated on October and November at the time of grading. Eye health (EYE) was evaluated subjectively as a binary trait: 0=infected, 1=healthy. Live animal grading is performed on the farm and used for indirect selection of pelt character traits. The grading traits were recorded on a scale of 1 (lowest rating) to 5 (top rating) to correspond to the system used in the Finnish blue fox breeding programme. Grading size (gSI) was scored from smallest (1) to largest (5). The most important fur quality traits in live animal grading are density (gDE) and guard hair coverage (gGC). gDE was graded by palpation into five categories, according to underfur thickness or density. Score 5 denoted the thickest fur. gGC comprised several factors: length, evenness and coverage of guard hair. Moreover, animals classified into the higher gGC categories had more guard hairs than the lower categories. Fur colour darkness (gDA) was graded from the lightest (1) to darkest (5) category. Fur colour clarity (gCL) was graded into five classes from reddish (1) to bluish (5), with bluish colour clarity as the most valuable. Body weight was recorded on August and at the time of grading on November (BW_{Nov}). Daily gain (DG, g/d) was calculated for the corresponding period. Subcutaneous fat thickness was assessed by a subjective body condition scoring (BCS) method on a scale from very thin (1) to extremely fat (5) (Kempe et al. (2009)). BCS and animal length were recorded at pelting time. Length from the nose to the root of the tail was determined from the euthanized animal. The original pedigree file had parent information from 21,307 animals and was obtained from the Finnish Fur Breeders' Association. The detailed experimental design is reported in Kempe et al. (2008, 2010).

Model. Preliminary analyses were performed using PROC GLM in the SAS system for Windows 9.1.3 through the SAS Enterprise Guide, Release 4.1 (SAS Institute Inc., Cary, NC, USA). Environmental effects and the interactions between fixed effects were studied using GLM by excluding random effects other than the residual. Fixed effects were: house (two classes: shed or hall), birth-year (two classes: 2005 or 2006), sex (two classes: male or female), pair in the cage (three classes: male, male-female or female pair), time of birth (four classes: 104-129, 130-144, 145-160 or 161-180 days from beginning of year) and age of dam (three classes: 1, 2 or 3 years). Only statistically significant ($P<0.05$) fixed effects and their interactions were included in the linear animal model used for genetic parameter estimation of EYE, size and grading traits. Genetic correlations between EYE, grading and size traits were estimated with the multiple-trait animal model, three traits at a time. Litter (dam by litter-year interaction), animal and residual effects were the random effects in the model. (Co)variance components were estimated using DMU software (Madsen and Jensen 2012).

Results and Discussion

Of the foxes in this two years' single farm study, 54.8% were healthy (n=2,064), but the frequency of eye infection was as high as 45.2%. The heritability estimate for EYE was moderate (0.24±0.07), suggesting that susceptibility to eye infection has a genetic background in the blue fox. However, whether the eye inflammation is due to eye disease or genetic differences between animals in disease resistance or tolerance remains to be solved in further studies.

Genetic correlations between EYE and the size traits gSI, BCS, length, BW_{Nov} and DG did not differ from zero, as the standard errors of the genetic correlations were high. However, all the correlations seemed to be negative (from -0.13 to -0.33) and by using threshold model it might be possible to get more reliable estimates. All corresponding phenotypic correlations between EYE and the size traits were low and unfavourable (from -0.11 to -0.16). Hence, large phenotypic size and fatness may slightly impair eye health at pelting time in November-December. This may be because very fat foxes have subcutaneous fat deposits and possibly rolls of fat on the face which may aggravate mild eye disease (Kempe et al. (2009)). In dogs, nasal folds and superfluous skin on the head and neck can contribute to the development of eye disease like entropion and predispose to eye infection (Barnett (1988)).

The moderate antagonistic genetic correlation (-0.46) found between EYE and gDE indicates that the thick underfur which is preferred in selection may be genetically connected to impaired eye health. The corresponding phenotypic correlation was low (-0.09). gDE had high genetic correlation with BCS and DG (0.84±0.10 and 0.71±0.13, respectively) and fairly high correlation with BW_{Nov} (0.51±0.18). Therefore, fatness may affect indirectly to EYE through gDE. The corresponding phenotypic correlations between EYE and size traits were moderate (0.36-0.40). This supports the general opinion of fur farmers that fat and large foxes have thickest furs.

The genetic correlations of other grading traits (gGC, gDA, gCL) with EYE didn't differ from zero because the standard errors of the correlations were high. Also the corresponding phenotypic correlations were close to zero in all cases. Indeed the results imply that a relatively large amount of pedigree data is needed to increase the accuracy of genetic correlations in variance component estimation.

Conclusion

The genetic parameters estimated for EYE indicate that the trait is moderately heritable and that genetic improvement through selection shows potential for use in improving eye health status of the Finnish blue foxes. In practise, farms should have an adequate control and culling strategy against eye infections. If the selection needs to be more efficient, then the selection index can be applied. Selection for better eye health may impair some of the grading quality traits such as density due to a mild correlated response to selection. These antagonistic connections can be included in the Finnish blue fox breeding value estimation and by using a multi-trait animal model EYE evaluation can be improved. Further, whether the eye infection is due to eye disease or genetic differences between animals in disease resistance or tolerance, remains to be solved in further studies. Therefore, also the etiology of EYE needs to be studied further.

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