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Short Communication

Opportunities for international collaboration in dog breeding from the sharing of pedigree and health data

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ABSTRACT

Pooling of pedigree and phenotype data from different countries may improve the accuracy of derived indicators of both genetic diversity and genetic merit of traits of interest. This study demonstrates significant migration of individuals of four pedigree dog breeds between Sweden and the United Kingdom. Correlations of estimates of genetic merit (estimated breeding values, EBVs) for the Fédération Cynologique Internationale and the British Veterinary Association and Kennel Club evaluations of hip dysplasia (HD) were strong and favourable, indicating that both scoring schemes capture substantially the same genetic trait. Therefore pooled use of phenotypic data on hip dysplasia would be expected to improve the accuracy of EBV for HD in both countries due to increased sample data.

Dog breeding is an international activity (Hedhammar et al., 2011), prompting the proposal to form an international organisation for dog breeding modelled on the International Bull Evaluation Service, INTERBULL[1] (Woolliams et al., 2011; Wilson and Wade, 2012). There are multiple benefits of such an international platform that result in more efficient use of resources. Particularly useful is the potential to pool data across countries to aid breeding decisions, e.g. the pooling of pedigree data, enabling more accurate calculation of inbreeding coefficients and the exchange of phenotypic data for prediction of genetic merit for traits of interest. The benefit of data exchange depends on the degree of genetic connection between populations and the genetic similarity of phenotypes recorded in different countries. As an initial evaluation of these two factors, the aim of this study was to determine the degree of migration between the UK and Sweden for four dog breeds and to estimate the correlation between estimated breeding values (EBVs) for hip dysplasia (HD) in three retriever breeds in both countries.

The registry databases of the UK Kennel Club (UKKC) and Swedish Kennel Club (SKK) were screened for migrant Bearded collies and Labrador, Golden and Flat coated retrievers. Substantial exchange of dogs was observed (Table 1), with the direction of gene flow predominantly from the UK to Sweden in all breeds; 50–70% of UK dogs exported to Sweden were identified in the UKKC database using the original UK registration number (which was retained for approximately 80% of imports), the remainder being identified by registered name. All Swedish dogs exported to the UK were identified in the SKK registry database via a manual search on registered name. Duplicates were removed and three Golden and six Labrador retrievers missing from either database were discarded. EBVs for HD were extracted from the SKK and UKKC databases for the remaining dogs. Bearded collies are not yet evaluated for HD in Sweden, so this breed was not considered in the next step of this study.

In Sweden, EBVs were estimated from radiographic evaluations performed according to the official protocol of the Fédération Cynologique Internationale (FCI).[2] Under the FCI scheme, the shape and fit of the hip joint, the Norberg angle and the presence and extent of secondary arthrosis are considered. Pelvic radiographs are taken with the dog positioned on its back with the hind legs extended, while under anaesthesia or sedation. Radiographs are interpreted by one of three specialised veterinarians contracted by SKK and are scored categorically (from A to E) according to the severity of malformation and signs of disease; A and B represent two levels of non-dysplastic hip joints, while E denotes severe dysplasia. The minimum age for establishing an official diagnosis is 12 months. EBVs were predicted using a linear mixed model described by Malm et al. (2008), including the fixed effects of sex, birth month, chemical restraint used for sedation, age at screening and a combined random effect of clinic and year of examination. Exact reliabilities of breeding values were computed on the basis of prediction error variances of breeding values. The heritability of the FCI hip score ranged from 0.41 to 0.42 for the three breeds.

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[1] See: http://www.interbull.org/.

[2] See: http://www.fci.be/presentation.aspx.

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Table 1
Dogs migrating between the UK and Sweden.

Breed	UK to Sweden		Sweden to UK		Total
	Number of migrants	Number scored[a]	Number of migrants	Number scored[b]	
Bearded collie	32	2	10	8	42
Flat coated retriever	34	22	14	5	48
Golden retriever	114	81	12	6	126
Labrador retriever	274	199	11	7	285

Birth year range: 2000–2012 for UK to Sweden migrants and 1996–2010 for Sweden to UK migrants.
[a] With Swedish/Fédération Cynologique Internationale record on hip dysplasia (HD).
[b] With UK/British Veterinary Association record on HD.

Table 2
Simple statistics for estimated breeding values (EBVs) for hip dysplasia and their accuracies in retrievers in the UK and Sweden.

Breed of retriever	Sweden				UK			
	EBV		Accuracy		EBV		Accuracy	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Flat coated retriever	98.2	11.5	0.69	0.19	−0.05	0.11	0.57	0.12
Golden retriever	93.4	9.8	0.69	0.19	−0.19	0.15	0.69	0.09
Labrador retriever	95.1	10.4	0.67	0.19	−0.38	0.20	0.61	0.09

In UK, EBVs were estimated from radiographic evaluations from the British Veterinary Association and Kennel Club (BVA/KC) hip scoring scheme.[3] Radiographs are taken with the dog in the extended ventrodorsal position while under sedation or anaesthesia, similar to the Swedish practice. Nine different anatomical features are examined by radiography and scored according to the severity of dysplasia and osteoarthritis observed by two scrutineers from a panel of 11. A cumulative total score from zero (indicating no dysplasia) to 106 (extreme dysplasia) is reported. For submission to the BVA/KC scheme, dogs must be at least 1 year of age. EBVs were predicted using the linear mixed model described by Lewis et al. (2010), including the fixed effects and covariates of sex, inbreeding coefficient, year of evaluation and splines to model temporal trends in age at screening and absolute day born (capturing year and season of birth). Animal and litter were included as random effects. Exact reliabilities of breeding values for Flat coated retrievers were computed based on prediction error variances. For Golden and Labrador retrievers, reliabilities were approximated according to Jamrozik et al. (2000), because of the large number of animals. The heritability of the BVA/KC hip score ranged from 0.28 to 0.40 for the three breeds.

Product-moment correlations for all dogs with an EBV from both the UK and Sweden were computed within each breed. EBVs are estimates of genetic merit and, as such, limit the magnitude of product-moment correlations (i.e. product-moment correlations between EBV can only be high if the EBVs have a high reliability). To account for the less-than-perfect reliability, correlations between breeding values were adjusted to achieve an approximate genetic correlation according to the so-called Calo-method (Blanchard et al., 1983). The observed correlation between breeding values was divided by the expected correlation. The expected correlation was computed based on the reliabilities of breeding values in the UK and Sweden. Standard errors of genetic correlations were obtained by non-parametric bootstrapping (Efron and Tibshirani, 1993). According to this approach, a sample of dogs was drawn, employing sampling with replacement, and a genetic correlation was calculated for that sample. This was repeated 100,000 times and the standard deviation of all these 100,000 values can be interpreted as the standard error of the genetic correlation.

Swedish and UK EBVs are presented differently (in Sweden, the mean is set to 100, while in the UK the mean is set to zero), meaning that EBVs from either country cannot be compared directly. The mean accuracy was slightly higher for Swedish EBVs compared to the UK for Flat coated retrievers (0.69 vs. 0.57, respectively; $P < 0.05$) and Labrador retrievers (0.67 vs. 0.61, respectively; $P < 0.05$) (Table 2). An accuracy of around 70% relates to a dog with phenotypic records for itself and a number of its progeny.

[3] See: http://www.bva.co.uk/hip_scheme.aspx.

Table 3
Product-moment and genetic correlations between hip dysplasia estimated breeding values (EBV) in the UK and Sweden.

Breed	Number of dogs	Correlation between EBV	Genetic correlation	Standard error of genetic correlation[a]
Flat coated retriever	48	−0.32	−0.74	0.24
Golden retriever	121	−0.43	−0.87	0.14
Labrador retriever	269	−0.45	−1.03	0.12

[a] Based on 100,000 bootstrap samples.

The estimated genetic correlations were strong and favourable (−0.74 to −1.03; Table 3), indicating that screening systems in both countries capture substantially the same genetic trait. Correlations were negative, again reflecting a difference in presentation of breeding values; in Sweden, high breeding values are desirable, while low breeding values are desirable in the UK. This study demonstrates two important pre-requisites for international collaboration to be of benefit: (1) there has been substantial migration in the four breeds studied, and (2) EBVs for HD in the UK and Sweden are strongly and favourably correlated, despite differences in screening methods.

Pedigree information from other countries is essential for accurate monitoring of inbreeding and giving sound advice to breeders about the suitability of suggested matings. Lack of sufficient depth of pedigree of imported dogs will generally underestimate the degree of inbreeding. Given the presence of ties between the UK and Sweden and the strength of the genetic correlation in both countries, there is an opportunity to improve the accuracies of EBVs from collaborative genetic evaluation of HD, utilising data across borders in a more efficient way.

Conflict of interest statement

W.F. Fikse has no financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper. S. Malm is employed by the Swedish Kennel Club. T.W. Lewis is funded by the Kennel Club Charitable Trust (KCCT). The KCCT played no role in determining the content of the paper or the decision to publish.

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