Developments in dog genetics – a UK perspective

Dr Tom Lewis
Tom.Lewis@thekennelclub.org.uk
From a late start, things have moved quickly...
DNA tests for many diseases in many breeds...

CANINE DNA TESTING

About the Animal Health Trust DNA Testing Service

The Animal Health Trust (AHT) was one of the first laboratories in the world to offer DNA testing to dog owners. Our first test, for progressive retinal atrophy in Irish Setters, was introduced in 1995. We are proud that our scientists working in the Kennel Club Genetics Centre at the Animal Health Trust have identified the mutations and developed the DNA tests for many of the disorders listed below.

A full list of the canine DNA tests we offer can be found below using the alphabetical index to select tests by breed. Click on the DNA test name for more information, or click 'Buy Online' to order a test. All prices are exclusive of VAT at 20%.

The average turnaround time for canine DNA disease testing is 8 - 10 working days. For further information about canine DNA testing submissions and results, please view our FAQs.

Newly Available

A DNA Test for primary open angle glaucoma (POAG) in the Petit Basset Griffon Vendeen is now available to order from our Webshop.

Discount offers

We offer a 10% discount to breed clubs when more than 20 samples are ordered through our Webshop in a month. Please email dogtesting@ahtrust.org.uk for more details. For all special offers, discounts will be applied at the Check Out from the Webshop.

A

American Staffordshire Terrier

- Urate Stones - Urac Acid Excretion (Canine Hypouricemia) (£40 + VAT - Buy Online)

Australian Cattle Dog

- Primary Lens Luxation (PLL) (£35 + VAT - Buy Online)

Australian Shepherd

- Hereditary Cataract (£40 + VAT - Buy Online)
- Urate Stones - Urac Acid Excretion (Canine Hypouricemia) (£40 + VAT - Buy Online)
- Multifocal Retinal Degeneration, mit1 mutation (Beverdam Sensitivity) (£50 + VAT - Buy Online)

B

Beagle

- Mutadop-Luelling Enzyme (£40 + VAT - Buy Online)
- Congenital Factor VII Deficiency (£25 + VAT - Buy Online)
- Hereditary Cataract, Congenital Deafness and Congenital Factor VII Deficiency (£40 + VAT - Buy Online)

Bedlington Terrier

- Copper Toxicosis (£40 + VAT - Buy Online)
Health Screening:

Chiari Malformation/Syringomyelia Scheme

Hereditary eye disease in dogs

Hip dysplasia in dogs

Elbow dysplasia in dogs

Screening and health schemes for dogs.
An Estimated Breeding Value (EBV) evaluates the genetic value of an individual dog, in relation to the whole of the dog's breed. These EBVs are intended to help breeders reduce the prevalence of hip and/or elbow dysplasia by more accurately evaluating genetic risk.

<table>
<thead>
<tr>
<th>Score</th>
<th>EBV</th>
<th>Confidence</th>
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<tr>
<td>Elbow</td>
<td>-17</td>
<td>38%</td>
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<tr>
<td>Hip</td>
<td>-40</td>
<td>84%</td>
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EBV calculations are using data last updated on the 10th July 2014.

EBVs are computed using available hip and/or elbow scores for the dog and all its relatives. Pedigree information is used to determine the relationships among dogs. This allows the genetic risk of individuals to be evaluated, stripping away any environmental effects. Using EBVs to make mating decisions will be more accurate than using the observed hip or elbow score and will lead to faster progress in reducing the prevalence of disease.

A dog's EBV allows it to be placed on a scale of liability, identifying those individuals at highest risk of passing on the condition and those at lowest risk.
Health Information

You may be aware that some breeds of dog and their crosses can be susceptible to inherited disease. Of course you want to be sure that the dog you choose is as healthy as possible, and you would like to know that it has not inherited any undesirable disease-causing genes from its parents. There is some help in that DNA tests for diseases in purebred dogs are available for some conditions in some breeds, but there are not very many such tests just yet! There are also, however, a number of clinical veterinary screening schemes that dog breeders can use to increase the probability of producing healthy puppies.

Details of the various screening schemes, both veterinary and DNA, that are available to breeders in the UK can be found at www.thekennelclub.org.uk/doghealth

Potential dog owners should be aware that, at present, the application of various health screening results to breeding programmes is not always straightforward, and breeders may make choices for various reasons. A responsible breeder though, will always be willing to discuss relevant health issues with you. Breed clubs are often useful sources of breed-specific information.

Schemes or advice relevant to this breed

The following schemes, tests and/or advice are mandatory requirements for Kennel Club Assured Breeders. All other breeders are strongly advised to use these schemes, tests and/or advice.

- BVA/KC Hip Dysplasia Scheme
- BVA/KC/SDS Eye Scheme

It is strongly recommended that both Kennel Club Assured Breeders and non-Kennel Club Assured Breeders should use the following schemes, tests and/or advice:

- BVA/KC Elbow Dysplasia Scheme
- DNA test - prod-PRA

The following other schemes, tests and/or advice are available and should also be considered:

- DNA test - CNM
- DNA test - EIC
- DNA test - SD2
- DNA test - HNPK

The list above is not necessarily comprehensive, other available health tests can be found at http://www.thekennelclub.org.uk/health/breeding-for-health/dna-screening-schemes-and-results/ or for further advice please contact your local breed club.
‘cumulative’ high selection intensities
Mate Select  Mating Inbreeding Coefficient Prediction

Result

Retriever (Labrador)

The Annual Breed Average inbreeding coefficient for this breed is

6.5%

♂ Racmic Black Bramble  ♀ Racmic Elli

Any puppies from this mating would have a coefficient value of

4.1%

More information

Health Tests  Health Tests

How to use this information

Using this result to help make Breeding decisions

The current Kennel Club breeding guidelines state that, where possible, breeders should produce puppies with an inbreeding coefficient which is at, or below, the annual breed average (shown above) and ideally as low as possible.

Breeders should be aware that the inbreeding coefficient is a measurement of risk and does not guarantee that puppies produced will, or will not, have any health related issues. There are other equally important factors to also consider when deciding whether two dogs should be mated together, such as temperament, available health test results, the general health of the dogs etc. Your decision should be well balanced between the inbreeding coefficient and the good qualities of the sire/dam that you are considering.

Go

Mate Select Home

Tools

All results for this session
New mating
Change breed
Health summary for this mating (PDF)

Other services

Breed Information Centre
Health Test Results Finder

About this calculation

The pedigree data used to calculate this result extended back as far as 11 generations with the first 5 generations being fully complete.

The Mate Select computations are based upon data compiled from pedigree records and data submitted from breeders. As such all information and/or data on the site is provided on an 'as is' basis. Every effort has been made to report information accurately, but the Kennel Club assumes no responsibility for the content or the use or interpretation of the information published.
BUT doesn’t address over-use of individuals...

UK breed population

unrelated import

First generation, \( F = 0 \)

Next generation, \( \min F = 12.5\% \)
want to flag up over-use in real time...

*UK breed population*

*unrelated import*
Genetic Contributions a potential solution

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Mean genetic contribution

- 3/8
- 1/8
- 3/16
- 5/16
Summary of major issues:

Multiplicity of health objectives (screening schemes, DNA tests, EBVs)

Excluding all animals with less than perfect results

→ bottleneck → impact on genetic diversity (vicious circle)
Existing solutions – 1) selection index

Selection objectives ($H$) – e.g. hip score, elbow score, atopy
Selection criteria ($I$) - can be the same as $H$

\[ a = \text{relative weights of selection objectives (} H \text{)} \]

\[ b = P^{-1}_{II} G_{IH} a \]

\[ b = \text{optimum selection coefficients for all traits in } I \]

**BUT** – weighting of objectives may vary from breeder to breeder
Both rate of inbreeding ($\Delta F$) and genetic gain ($\Delta G$) related to genetic contributions ($r$):

$$\Delta F = \frac{1}{4} \sum r_i^2$$
$$\Delta G = \sum r_i a_i$$

Algorithms produce a mating list delivering maximum genetic gain within a specified rate of inbreeding (e.g. Meuwissen, Kinghorn etc).

**BUT** – requires breed-wide control to effect

Wray & Thompson, 1990

Woolliams & Thompson, 1994
Summary of major issues:

Multiplicity of health objectives (screening schemes, DNA tests, EBVs)

Excluding all animals with less than perfect results → bottleneck
→ impact on genetic diversity (vicious circle)

Effective solutions exist, but rely on small number of stakeholders controlling a large proportion of the population

Need to provide breeders with means to prioritise and balance breeding objectives
Breed Health & Conservation Plans

Provide epidemiological data on most prevalent & severe diseases (VetCompas, KC survey, GISID)

Detail numbers of DNA tests undertaken, proportion of clear/carrier/affected and estimated allele frequencies

Genetic trends in traits for which EBVs are available

Population parameters – actual size, effective population size.
Proposed content – *actual* population size
Assessment of prevalence of disease/breed

Primary practice data (VetCompass)
## Assessment of prevalence of disease/breed

### Kennel Club owner surveys

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<td>0.16%</td>
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### Assessment of severity of disease

#### Generic Illness Severity Index in Dogs (GISID)

**Score 0**
- Short isolated bout & complete return to normal

**Prognosis**
- None required or not necessary as there is minimal impact on health

**Treatment**
- Medical – immediate curative &/or Surgical – single curative minor surgery (not intra cavity)
- Side Effects – none or very minor, short term

**Complications**
- No linked disorders

**Behaviour**
- None disturbed

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**Score 1**
- Medium length isolated bout or successive short bouts & return to normal

**Prognosis**
- Medical – short term curative or medium term manageable &/or Surgical – single curative intracavity surgery/repeated minor surgery
- Side Effects – minor

**Treatment**
- Medical – short term curative or medium term manageable &/or Surgical – single curative intracavity surgery Side Effects – minor

**Complications**
- Predisposition to minor secondary condition

**Behaviour**
- One disturbed

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**Score 2**
- Extended bout & return to normal or successive short bouts and minor long-term impairments

**Prognosis**
- Medical – long term curative or long term manageable &/or Surgical – deep intracavity surgery Side Effects – manageable pain or moderate

**Treatment**
- Medical – long term curative or long term manageable &/or Surgical – deep intracavity surgery Side Effects – chronic intractable pain or major

**Complications**
- Predisposition to moderate secondary condition

**Behaviour**
- Two disturbed

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**Score 3**
- Unremitting or chronic illness of bout(s) with major long term impairment

**Prognosis**
- Medical – prolonged palliative treatment &/or Surgical- major deep intracavity surgery Side Effects – chronic intractable pain or major

**Treatment**
- None available, or

**Complications**
- Predisposition to catastrophic secondary condition

**Behaviour**
- Three disturbed

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**Score 4**
- Imminent death as a direct result of condition or condition-related euthanasia

**Prognosis**
- None available, or

**Treatment**
- None available, or

**Complications**
- Predisposition to catastrophic secondary condition

**Behaviour**
- Four or more disturbed
DNA test statistics

For each DNA test available for each breed:

• Number tested per year, for last few years
• Proportion of breeding animals tested
• Number clear / carrier / affected
• Estimated disease allele frequency and extrapolation to number of carriers in breed
• Advice on use of carriers
Genetic trends (where available)

Improving trend for HD in most breeds...
Genetic trends (where available)

But a worsening trend in some breeds...
EBVs may provide evidence of ‘sub-structure’
Evaluate the historical trend in $\Delta F/Ne$

Lewis et al, 2015
CGE, 2:13
DOI: 10.1186/s40575-015-0027-4
Some rarer breeds are conserving diversity...
...but others are really struggling...
Some common breeds have high ΔF
Effective and actual pop\(^n\) size appear unrelated
Summary

Individual breeds require individual solutions / strategies

Dog breeding is dominated by individuals – but health should be a common aim

Thank you – and any questions?

BHCPs may provide opportunity to get breeders to collaborate and change culture of individualism

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