

Common Sense Breeding with a Genetic Flavour

By Professor Steve Dean B. Vet Med, DVR, MRCVS

(The World Cairn Terrier Symposium Friday 30 August 2013)



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Common Sense Breeding With A Genetic Flavour

Background of speaker:

Professor Steve Dean, Chairman of the Kennel Club. This, together with his senior position in the veterinary world, allied with the fact that he is a serious breeder and exhibitor of Border Terriers made him a particularly appropriate person to lead off our symposium.

Introduction

Over the past twenty years the way animals are bred has been changing. This has had more noticeable effect on farm livestock but is increasingly changing the way we breed dogs.

What has brought about the change? Stated plainly it is the study and application of genetic science and, in particular, the discoveries unleashed by molecular biology. This sounds complicated yet science has led us to the identification of the very genes that are capable of producing disease and has provided the opportunity to control some inherited diseases in a way we were still dreaming of just two decades ago.

In the 21st century the breeding of dogs has become a public controversy. In fact there has always been controversy but recently this was promoted into the public arena by the BBC. As with any media related reporting, the issues were unclear, unfocussed and over-stressed, but on consideration can be broadly categorised either as inherited disease or as conformational defects. However, the division between the two can be less than clear.

Nevertheless, using modern science we can now control the breeding of dogs to limit or eliminate some genetic defects but at present our efforts are limited to attempts breeding 'healthy dogs' or more precisely dogs free of specific inherited disease.

Traditionally a dog breeder selects breeding stock from bitches in their possession and the available supply of suitable stud dogs. The assessment of the likely breeding pair is based on many factors which may differ from breed to breed but most importantly the choice is determined by the ambition of the breeder. It is perhaps fortunate that we do not all see dogs the same way as this leads to the very genetic diversity that many of our critics demand. However, on those occasions where a breed focuses on a breed line excessively or a particular stud dog becomes over-popular then difficulties may well arise.

The conformation of the head is a major focus for breed type and for some can become an overwhelming feature both in terms of breeding and in the show ring. Common sense suggests that the conformation of the

rest of the body is at least as important. In much the same way, in many breeds a particular coat quality is critical or it may be it is colour and markings that drive choice. However, none of this is a problem as long as a breed pays attention to overall health and soundness in whatever it chooses to aim for.

In genetic terms the traditional way of breeding a dog as described above is selection of stock by phenotype, in other words, largely how the dog appears to the eye and hands. Anybody who has attempted to breed to a standard will agree this is not easy, as there are no guarantees that pairing dogs of very similar appearance will breed more of the same. There are always compromises to be made in terms of selection too with the distance to the stud dog a significant factor.

In genetic terms, difficulty arises from the fact that most of the conformational characteristics we are hoping to reproduce from any given mating are determined by groups of genes acting together (polygenic inheritance) and it is difficult to assemble these genes in a reliable or predictable way and is most often achieved by line- breeding.

The molecular blueprint of a dog

At the centre of nearly every cell in the body (skin surface and red blood cells are exceptions) there lies a nucleus and this contains the genetic material, referred to as 'the chromosomes'. Each chromosome is a collection of molecules laid out in a long spiral form (the double helix). The molecules are sequenced in a regular and pre-determined way with four nucleic acids repeated in sequence along the chromosome. It is portions of these sequences that are termed genes and each chromosome has many genes along its length. A final complexity to be added is the knowledge that chromosomes are paired and the genes on each of the chromosomes pair act together to exert their effect.

For example, the dog has 78 chromosomes (39 pairs) in each nucleus and this has been estimated represent as many as 100,000 genes. The human has only 46 chromosomes but about the same number of genes. Another important fact is that each cell in the same dog contains the exactly the same chromosomes and it is the genes they carry that determine the structure and function of each part of the body. This is fairly surprising given cells vary so much (forming kidney, liver or muscle as just three examples).

It is very easy to get lost in the science but it is the role of the molecular biologist and geneticist to unravel the science and offer advice, so from the complexity of the science, what salient facts can we use to help the dog breeder, without losing ourselves in a morass of molecular technology and acronyms?

Phenotype and genotype

We have already seen how dog breeders use physical appearance (phenotype) to judge the quality of a dog for exhibition or breeding potential.

Of course the experienced breeder also has an insight into a dog's genotype – which is the pattern of the genes on each chromosome, although they may not realise this is what they know. This is because experience of a given breeding line reveals to the observant what strengths and weaknesses exist within a dog's make up and what is likely to arise from any given mating. For example, a high incidence of seizures in a breed-line indicates there is a genetic trait in the line which leads to this disease surfacing from time to time. On a good note, breed lines that live the longest owe much of this to their genetic make-up (genotype).

The common sense approach is to breed away from dogs that produce undesirable defects which may simply mean do not use dogs or bitches for breeding that have the defect or frequently produce dogs with a defect. A breeder might also discard litter-mates as well from the breed-line or, if the practical experience points towards a particular dog or line as the source of the problem this may be entirely avoided in future breeding plans.

This works well for many defects and is in fact the approach we use when using an x-ray to assess the hips of large breeds, the scoring of which permits breeders to breed away from the worst affected dogs and concentrate on those with the best hip conformation. However this same strategy does not work so well for the so called autosomal recessive genes. An autosomal recessive gene will only cause a clinical problem when it appears on both of the paired chromosomes. Therefore if one chromosome has the normal gene and one the defective gene the dog will remain healthy because the normal gene is 'dominant'. The dog in this example is however termed a 'carrier' and breeding it to another carrier may produce some puppies that are affected by the disease (25% is the figure normally quoted).

It is fortunate perhaps that the autosomal recessive gene is where molecular science offers the most immediate potential. For we can now detect many of the problematic abnormal 'recessive genes' by a relatively simple test carried out usually using a cheek swab. The simplicity is in the collection of a few cells from an oral sample of the lining of the mouth. This is usually achieved by using a slightly abrasive swab. This sample of cells permit the laboratory to detect the presence or absence of a specific defective gene in their chromosomes. Furthermore, the test will tell us if the gene is present on one or both chromosomes and therefore permit us to distinguish between an affected dog, a carrier and a clear dog.

This is a big advance for breeders who can use the science to guide their choice of breeding stock to avoid known inherited disease, something that

was very difficult to do just a couple of decades ago. A breeder can therefore use even a basic knowledge of the genetics of their breed-line alongside a laboratory test and thus expand their understanding of the genotype of their dogs (i.e. identify clear, carrier or affected).

The elimination of inherited disease

This technology therefore permits us to dream of the day where inherited disease in pedigree dogs can be eliminated and for certain diseases (PRA, liver toxicosis, CLAD) this is indeed a reality. However the dream is not yet a reality for all genetic disease and in some cases we must ask ourselves how important is it that the disease is eliminated. For example, posterior polar cataract is a small blemish in the lens of the eye which rarely affects vision, rarely progresses to a generalised cataract and if it does it occurs very late in the life of a dog when other illnesses associated with old age are likely to be a more serious threat to health and welfare. Deciding to develop a gene test for PPC does not seem to be a primary requirement and furthermore will yield little benefit in terms of health and welfare.

The development of gene tests is not so easily applied for the polygenic diseases (e.g. hip or elbow dysplasias) where many genes act in concert to achieve the detrimental effect. Work continues to find marker genes that can act as reliable indicators of presence or absence of a condition and future development of tests that have value are possible but breeders will need to learn how best to apply them.

It is also a challenge where a breed has more than one significant genetic defect. Cavaliers for example are wrestling with a heart defect (Mitral Valve Disease) and a neurological problem (syringomyelia) and this adds complexity to such an extent that for many this must seem a hopeless situation. Such challenges need considerable expert help and the breed faces a long and painful road with no guarantees of success and the tests they need to apply are expensive (MRI scans and heart testing) and as yet not entirely accurate or specific for the conditions they are designed to detect. Both examples are relatively late onset diseases too, so dogs and bitches may well have been bred from before the inherited problem appears as a clinical problem.

Yet even before a breed is faced with dealing with a gene based disease, the first obstacle is to get the breed to collectively recognise the problem and act. In some breeds for example the umbilical hernia would not be tolerated whereas in others it is considered a 'normal' defect and may even be justified as a traumatic injury at birth. The same applies to conformational defects that cause clinical disease. For example, poor eyelid conformation is accepted in some breeds yet would be penalised in others.

Mutations and in-breeding

It is worth stating that genetic mutation is normal. It occurs spontaneously and is not always detrimental. In fact most living creatures will contain a number of genetic mutations without any apparent ill effect. However, where a mutation is selected and promoted by the breeding practice employed any beneficial or detrimental effect becomes evident. In-breeding (and line-breeding is a form of in-breeding) tends to concentrate genes of the same type and where the effect is detrimental a genetic disease or weakness may arise. Conversely, where genes are beneficial, in breeding 'fixes' a conformational characteristic and this can be behavioural as well as conformational.

Popular sires, small gene pools, excessive in-breeding and a failure to use an out-cross judiciously in a breeding programme, all favour the promotion of significant defects when they arise.

BREED HEALTH SURVEY

The breed health survey is perhaps the best tool to uncover the consequences of excessive conformational defects and genetic disease. Where genotype (the genetic make-up of a dog) produces a phenotype (how the dog looks structurally) that is undesirable then the sensible breeder will tend not to breed from the affected dog. Simple examples are the under-shot jaw, the kinked tail, the umbilical hernia and the undescended testicle. However, as these problems are polygenic, improvement will take many years to achieve and will see many frustrating set-backs.

Breed recognition of a conformational fault that has become part of the breed characteristics is more contentious and the fifteen high profile breeds demonstrate clearly how an obvious abnormality to one dog breeder is accepted as normal for another. Yet nevertheless once recognised as undesirable even the most extreme exaggerations can be quite rapidly improved by selection of the breeding pair to breed for desired traits or characteristics.

Other Tools To Assist The Breeding Choice

In breeding and out crossing

In-breeding brings together similar genotypes and therefore risks compounding the presence of defective genes. Done well, it capitalises on the good aspects of the genetic code and avoid defective genes that will be detrimental to health. The commonsense approach is to line-breed where there are a majority of good characteristics on both sides of the mating but outcross where health improvements are desirable.

Crossbreeding can also be useful where there is a need to introduce 'healthy' genes and this was typified by the crossing of a Dalmatian and a Pointer to introduce the genes that prevented the formation of bladder

stones which is a common condition in the Dalmatian breed. For the breed purist this was a criminal act but in terms of health it could be very useful especially where there are a high number of affected dogs in a breed. Out-breeding and cross breeding widens gene pools but must be done carefully if new defective genes are to be avoided.

Designer breeds

One important factor has been overlooked where attempts have been made to cross breeds to produce labradoodles, bugs and jack shihs. All very amusing and apparently attractive to the public who seem prepared to pay high prices for such crossbreeds. Apart from having amusing 'breed' names, the assumption is that these crosses will be healthier but the principles of genetics works for crossbreeds as well as for pedigrees and where both breeds carry similar genes. For example, in the case of hip dysplasia in labradors and poodles, mating two high scoring dogs whatever their breed, is just as likely to produce a crossbred offspring with poor hips.

On-line tools

The Kennel Club has provided other tools to help breeders in their choice of breeding pairs. The Health Test Finder allows breeders to see any health test results on specific dogs to aid research into the health of stud dogs and their breed-lines.

Breed Watch is another on-line facility designed for judges but useful for prospective dog owners to check out the conditions to be alert for in their chosen breeds. These are detailed as conformational defects likely to lead to adverse effects in the future.

The latest tool which is still being developed further is Mate Select. This currently allows the breeder to assess the in-breeding of the proposed Sire and Dam and to assess how in-bred their offspring might be in advance of any mating taking place. In the future a greater linkage to health data would make this tool even more powerful and in the future we can expect the advent of Estimated Breeding Values for several breeds. This is a system used to advantage in the livestock sector and will offer breeders the opportunity to assess the value of any dog in terms of breeding potential in terms of reducing inherited disease. It may offer considerable potential for the polygenic types of inheritance.

Assured (Accredited) Breeder Scheme (ABS)

Recently renamed, the ABS seeks to provide the owner of a new dog with assurance that health and good welfare has been taken into account by a listed dog breeder. The system identifies those who are members of breed clubs, who have had success in the show ring and those considered by the peers as being breeders of good reputation. Underpinned by a code of practice this is a public facing system that directs the puppy buyer to a breeder most likely to provide them with a healthy dog.

Conclusion

Molecular science is offering considerable value to dog breeders in controlling or eliminating inherited disease in pedigree dogs. Used sensibly alongside traditional values and personal knowledge the future can be very good for the dogs we breed. We do not have to understand the complex science to use the opportunity offered as this can be translated into simple tests and techniques for the dog breeder to use.

Questions from the floor at the Symposium

Following his presentation, Professor Dean answered questions from the floor.

A selection of them follow.

Q Liver shunt is present in our breed. Are we doing enough by just doing the bile acid test?

A No. But it is all you have at the moment. Yours is not the only breed with this problem – other small breeds have it too. It is thought that small size may have something to do with it. Unfortunately a genetic test is still a long way away and until that is available you need to use the test you have. It also acts as some kind of protection for breeders to be able to give evidence of this test if at some future time a puppy they have sold develops the problem.

Q Do dogs produce twins?

A Yes, but it is not common. In dogs you could have a situation where a single egg will divide and produce another puppy but if it does occur it tends to produce foetal monsters with two tails or something like that.

Q If the percentage of inbreeding should be a compromise between maintaining type and breeding healthy dogs, what is the recommended percentage of inbreeding?

A Current guidance is that you should try to keep the level of inbreeding down to 12 - 12 %.

Q The Kennel Club's Mate Select service puts the Cairn Terrier inbreeding co-efficient at 6.6%, but I did an exercise using a show catalogue to calculate the co-efficient of those show dogs and it came to 9%

A An excellent point. Only 1% of dogs are shown, and 10% bred. The breed average is calculated using all dogs registered with the Kennel Club. We all know that there are a lot of people out there breeding Cairns who we might say we would rather not have breeding Cairns and the natural inclination is to try to get rid of them. But they are creating diversity in the breed. No doubt we would all like to get rid of so-called "puppy farmers" ie someone who breeds for money and pays little attention to health and welfare, but we should not reject all those who breed for money, but who obey all the rules of the ABS. When the KC is accused of having a "puppy farmer" on its ABS list, when we go and look at them they are quite often better than some of those who regard themselves as good breeders.

Some of these Cairns out there that you would look at and say "I don't want one of them" could actually be your salvation because they are your route back to the place you have come away from.

So to answer your question, the inbreeding average of breeding stock is likely to be higher than that of the breed as a whole.

Q Some Scandinavian countries are restricting the use of stud dogs. Is this a good thing?

A I think it is a bad thing. It takes away from people the ability to make up their own minds. There are breeds, however, where the injudicious use of a popular sire has created problems, whereas others get away with it because the popular sire is very healthy. I don't think restricting use is a good thing, but it is important to get people to take the responsibility and give careful thought before deciding.