

Best Breeding Practice for Collie Eye Anomaly

Collie Eye Anomaly presents a unique set of challenges to breeders seeking to minimize the likelihood of producing puppies with varying degrees of permanent vision damage. In spite of breeders' efforts over many years to restrict the numbers of pups adversely affected, in some CEA-affected breeds the gene frequency remains quite high (percentage of the population carrying the faulty gene, without necessarily showing a visual deficit).

Collie Eye Anomaly behaves in the main, similarly to PRA and other **simple autosomal recessive conditions**. It shows a few important differences however, which in some ways make control harder but in other ways easier – and therefore it requires a slightly more complex set of rules. The most common expression of this multi-faceted complex is **choroidal hypoplasia (CH)**, a defect of the choroid and retina at the back of the eye that varies in severity, in terms of any threat to vision. In fact, in some of the affected breeds this is the only sign recognised. What makes CEA harder to sort out and select against, is firstly the fact that the great majority of animals in which CH has been confirmed on an eye exam appear to show minimal visual effects, and secondly that the DNA test available through genetics laboratories differentiates between animals *affected by*, *unaffected by* or *carrying* the gene for choroidal hypoplasia (CH) only, **not** the more serious CEA signs such as colobomas ('pits') on or near the optic nerve, detached retinas, retinal haemorrhages or more extensive developmental weaknesses in the wall of the eye.

Selection in other simple homozygous recessive conditions is based on the **genetic status** of individual animals being reliably determined by DNA testing to be either **affected** (homozygous affected), a **carrier** (heterozygous unaffected) or **clear** (homozygous unaffected). 'Clear' means genetically clear and we need to reserve the term for that group of dogs, alone. To avoid further confusion, breeders who have gotten into the habit of using the word 'clear' to describe a dog that is reported normal on an ACES exam (i.e. the indirect ophthalmoscope exam reveals no defects) will need to accept from here on that due to the well known 'go-normal' phenomenon and difficulties recognising fine blood vessel changes in an unpigmented tapetal fundus, being 'normal' or unaffected on an eye exam does not necessarily *guarantee absence of the choroidal hypoplasia gene*.

The currently available DNA test for 'CEA' detects only those dogs carrying one or two copies of the abnormal coding on canine chromosome 37, resulting in choroidal hypoplasia in either the 'carrier' or 'affected' state. Full expression of the CEA Complex is believed to depend on the influence of additional **modifying genes**, the location of which is as yet undiscovered. This does not mean that a DNA test for CEA is limited in its application – quite the opposite. An ACES exam tells us a lot for both adults and pups, but breeders need help in knowing when to rely on eye examinations alone and when to call upon the information offered by a carefully targeted series of DNA tests.

Breeders who submit their adult breeding animals for ACES examination, then endeavour to breed only from 'normal' parents (unaffected on an eye exam) or perhaps a mildly CH-affected parent to a clinically unaffected partner, in general have been rewarded with above average results when they submit full litters of pups for ACES litter screening. Not only does this help in the choice of future stock to be retained, it also avoids the unwitting sale of a puppy with a serious visual fault, to an unsuspecting new owner.

The question breeders ask is “Why do I need to submit pups for an eye exam, when I can simply submit cheek swabs and find out their CEA status that way?” Obviously, there is no point spending money on DNA testing of pups or adults that already show clinical evidence of choroidal hypoplasia – by definition they must be genetically affected. In a litter where both parents are ‘normal’ but may be carriers of the gene, then DNA testing gives very useful information as it will separate homozygous affected and heterozygous unaffected or carrier pups, from their more valuable **homozygous unaffected** littermates.

Where DNA testing for CEA *really* becomes useful is in confirming the true status of a clinically normal adult – to determine whether it is in fact a homozygous unaffected and genetically ‘clear’, or a heterozygous unaffected ‘carrier’. Both of these can be bred from under pre-set guidelines and either way, vision will be normal and likely to remain so.

Breeds affected: Australian Shepherd, Border Collie, Rough Collie, Smooth Collie, Lancashire heeler, Nova Scotia Duck Tolling Retriever, Shetland Sheepdog.

Any national litter registration restrictions to be applied in these or any other similarly affected breeds would need to be deliberated by the relevant breed clubs before the ANKC is asked to conduct an appropriate breed survey.

The following breeding advice is offered in relation to **Collie Eye Anomaly** :

- Before a mating is agreed and assuming no prior test results are available, designated samples (blood or cheek swabs) from both mating partners should be submitted for DNA testing through an approved laboratory, with identities of each confirmed by microchip against the registration records. **An exception** arises when frozen semen is to be used, from a sire that is deceased, overseas or otherwise unable to be sampled.
- Ideally, at least one parent of every litter should be DNA Clear for CEA (choroidal hypoplasia) – by testing *or* by parentage.
- **Every effort** should be made to avoid the breeding of adversely affected offspring, showing not only choroidal hypoplasia but also more severe CEA signs including ONH colobomas or a detached retina. The following mating combinations are safest, so long as there is no doubt over the true status of either parent.

- The acceptable mating combinations in those breeds where choroidal hypoplasia status may be predicted using a DNA test, are **Clear to Clear**, **Clear to Carrier** or **Clear to Affected**.

In the case of a **Clear to Carrier** combination, around *half* of the resulting pups in the litter are likely to be recessive carriers of the gene. In the case of a **Clear to Affected**, *all* of the resulting pups will be recessive carriers of the gene. This will not concern future owners so long as all the resulting puppies to be placed as pets are de-sexed to prevent any future breeding.

Any puppy retained or sold for future breeding purposes must have its genetic status confirmed, and ideally should be retained only if confirmed as homozygous unaffected or 'clear'. In the case of a **Clear to Clear** combination, there is no need to go through this process (assuming no doubt exists over parentage) because all of the resulting pups will be **Clear by parentage**.

- Unlike PRA, with CEA it may not always be possible to avoid **Carrier to Carrier** matings. Most of the resulting pups are likely to be visually normal, and the '1 in 4' that may be adversely affected will be picked up in a litter screening exam. Carrying out DNA testing on the whole litter prior to sale will not only separate 'carriers' from 'affecteds', it might also locate a puppy that is **homozygous unaffected** or 'Clear'.

Records of Carrier and Affected progeny must be marked with their heritable disease status, and affected animals (even where the clinical signs are only mild) may not be disposed of without advising the new owner of the animal's heritable disease status.

- While some breeders have been content to mate two '**CH-affected**' parents together and have generally succeeded in not producing pups with signs that are any worse, *every time* we double up on the faulty gene we are immediately producing whole litters of pups with 'double doses' of the genetic code.
- Breeding from two 'CH-affected' parents is therefore less than desirable but is **acceptable** under this voluntary code as part of a long term breeding program, provided that neither parent is *adversely affected* and that all the resulting progeny (which

must also be 'CH-affected') are submitted for an ACES Litter Assessment at 5-8 weeks of age. New owners must be advised of the litter screening test result, and any likely consequences advised by the ACES Panellist in regard to its long-term vision.

CH-affected animals (even only on DNA test) should ideally be mated only to a DNA tested homozygous unaffected or 'Clear', in which case all resulting pups will be heterozygous unaffected 'Carriers' and their registration records must be so endorsed.

CH-affected animals (even only on DNA test) may be mated to a DNA-tested heterozygous unaffected 'Carrier' with the same expectation of producing CH-affected pups and therefore the same cautions that apply to a CH-affected/CH-affected mating. All resulting pups should undergo an ACES Litter Assessment at 5-8 weeks, with any *adversely affected* needing to be desexed prior to sale, or possibly euthanased if the effects are severe.

- Ideally, all juvenile or adult animals retained for breeding purposes (whether clinically 'normal' on an ACES exam or not) should undergo a once-only DNA test to determine its actual **genetic status in regard to the CH gene** – homozygous unaffected (genetically clear), heterozygous unaffected (carrier) or homozygous affected (i.e. affected by CH both genetically and clinically, even if not evident on a detailed eye exam).
- All of the above advice is designed to minimise the risk of a breeder producing puppies adversely affected by CEA signs. These are minimal requirements and are not 100% foolproof. **Breeders looking to the longer term**, who set **higher goals** seeking to drastically reduce the 'CH' gene frequency in the overall breeding population, will adopt a more stringent set of breeding guidelines along the lines of those currently under consideration by each of the relevant National Breed Councils.