

Genetics of the Blue Eye

By Libby Babin (Babinette Shelties)

There is nothing more shattering than to suddenly find a bright blue eye opening in a puppy that by all planning should have nothing but limpid brown eyes. The initial thought is that it is just the "baby blue" and will go away in a few days, but with the passing weeks this blue eye becomes a brighter blue in shocking contrast to the other, brown eye.

Research shows that this sort of blue eye occurs in the approximate proportion of one out of sixteen from parents that carry the recessive genes for this blue eye; *also that the merle gene is not in any way involved with inheritance of this blue eye.* Those two genes are inherited in an entirely different manner, the merle gene being an autosomal dominant and the blue eye being a polygenic recessive.

This blue eye does not appear as frequently as one could expect of the usual recessive quality because it depends on a *polygenic* mode of inheritance; that is, a blue eye does not appear unless there are *more* than one pair of recessive genes in a homozygous or pure state.

The diagram shows the recombinations possible of two pairs of genes in the mating of individuals that are heterozygous for both genes. The genes are labelled Aa and Bb. The capital letters represent the dominant gene for dark eyes and the lower-case letter is the recessive for the blue eye. The puppy must have *four* genes for the recessive quality in order to have a blue eye. The number of genes necessary for a blue eye to occur is theoretical at this point of research. We know that it takes at least *two pairs*.

AaBb x AaBb

A and B – the presence of either of these genes assures brown eyes.

a and b – four of these genes necessary to produce a blue eye.

	AB	Ab	aB	ab
AB	1 AABB	2 AABb	3 AaBB	4 AaBb
Ab	5 AABb	6 AAbb	7 AaBb	8 Aabb
aB	9 AaBB	10 AaBb	11 aaBB	12 aaBb
ab	13 AaBb	14 Aabb	15 aaBb	16 aabb

Notice that out of the sixteen there is only *one* that is homozygous (pure) for the dominant quality, thus cannot produce or pass on genes for anything but brown-eyed offspring and only *one* that is homozygous (pure) for the recessive quality, thus expresses the blue eye. The possibility of this particular pair coming up with that one-out-of-sixteen puppy is there, but

rather slim. The diagram also shows all the other possible combinations of these two pairs of genes. We can see the reasons why one cannot declare an individual free of the recessives by breeding results in just one generation as is possible for a simple recessive. For example, any dog with the pairing of either dominant such as AAbb or aaBB will be incapable of producing a blue-eyed puppy, yet they are passing along recessives for the quality – recessives that may be just the key to bring out the blue eye in the *next* generation. In the mating of AAbb to aaBB the offspring all would be the same AaBb. These, of course, take us right back to the examples in the diagram.

To go on with some of the other genotypes found in the diagram: in the mating of any two individuals with just ONE dominant gene, such as Aabb or aaBb, the results would be the same as a simple autosomal dominant/recessive pair and the expectations would be one out of four, or if one should mate a pair of which one has the one dominant Aabb and the other has two dominants AaBb, the expectations would be one out of eight with the blue eye. The sad part of it is that there is no way of telling *who* carries any of these recessives, as there is no expression of the quality, unless *all four* recessives are there. The shade of brown present is inherited separately and is irrelevant.

Through inbreeding one can purify the desired dominants and eliminate unwanted recessives as long as the quality in question is dependent on just a single pair of genes, but this is NOT so for polygenic characteristics. For this blue eye a strain can be developed, through close breeding, that is purified for both genes but could have the genetic formula of either AAbb or aaBB; the strain will remain static for as many generations, as the family line-breeding is continued. The two dominant genes assure that the blue eye will not occur, but the two bb genes are being pulled along just as consistently to assure the perpetuation of this recessive quality. At the first "outcross" to another family that has arrived at the formula with the opposite dominant, the results will all be dark-eyed and still give no hint of the recessive, but these puppies will all be heterozygous and have the formula AaBb, and we are once again back at the first diagram and with that at least the one-in-sixteen expectation.

All this adds up to the fact that this unwanted blue eye is genetically well-established in the breed; that a line that *never* produces the blue eye can still be carrying the genes for this quality; that it can and does reappear in the most unexpected places. If one wanted to go into serious "housecleaning" to eliminate these recessives, they would wind up "sweeping" out our best studs and bitches, and we still could not be sure of any degree of success. Our best course for breeding success still remains in the careful selection of our breeding stock for the desired qualities of the whole dog and in not getting lost in any *one* detail.

A photocopy of this article was sent to me by Dr. Ken Linacre many years ago. From the ads which accompanied the article, it must have been published in an American Dog Magazine. Any reference to Shelties which is of no interest to Cardigan breeders has been left out. A somewhat abbreviated version of this article appeared in a newsletter of the Cardigan Welsh Corgi Club of Greater San Diego.

Anita Nordlunde, May 2004