Beyond Basic Pigments and Genetic Fairytales
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Old genetics textbooks tell readers that mammals have three pigments: black, red, and liver/chocolate. Modern science proved this not to be true. Mammals only have two pigments: black and red. Liver/chocolate is modified black pigment. Alpaca breeders should think of *all* alpacas as either black or red. Yes, that includes the white ones! Genetic mechanisms at several loci (genetic addresses) code for the removal of pigment through "stripping" or diluting the base colors. These loci are separate entities from the Agouti locus and Extension locus which govern the expression of the basic pigments. In other words, with one possible exception (more on that later), the alleles coding for white are not found at the same locus as those coding for black and red.

It is therefore not possible for black to be recessive to white. The novice breeder who is not sufficiently familiar with the basic science of color genetics erroneously thinks that it is and thus never gains a true picture of how color and patterns are inherited.

What happens, genetically speaking, when black bred to white produces black? In our example, let's choose the *Dominant White* locus. (We know that other genetic mechanisms also remove pigment, so please do not assume that all white alpacas are dominant whites.) There is a key concept breeders must grasp in order to understand color genetics. Choices at the *Agouti* locus are *black* or *red* (or variants of red). Choices at the *Dominant White* locus are *dominant white* or *not dominant white*. The choices are not black versus white or red versus white. When I read this information in one of the books written by D. Phillip Sponenberg, DVM, PhD on horse color genetics, it was the deciding light bulb moment in my study on the inheritance of color genes.

Let's use the following symbols (Agouti alleles: Sponenberg 2006) to map the partial color genomes of two sets of alpaca parents and their offspring:

A^r – Red with black trim
A^a – Black
Wh^{wh} – Dominant White
Wh^+ – Not Dominant White

Our sire is Wh^+ Wh^+ A^a A^a and therefore black. Our dam is Wh^{wh} Wh^+ A^a A^a. Although she is genetically *black* at the *Agouti* locus, the allele (gene) coding for *dominant white* has "stripped" all black pigment. A cria born to these two alpacas may easily carry the genotype Wh^+ Wh^+ A^a A^a. In this case, each parent passed on one of the *black* alleles and also one of the *not dominant white* alleles. Expressed in words, the cria's genetic code at these loci reads: not dominant white – not dominant white; black-black. The baby is therefore black, but not because, as some breeders think, black is recessive to white. It is black because *not dominant white* is recessive to *dominant white*, and the dam failed to pass on the dominant gene to her cria.

In another example, both parents are Wh^{wh} Wh^{+} A^{r} A^{a}. Both of these alpacas would have white fleeces. At the *Agouti* locus, they are reds with a black recessive. Their cria's genotype and phenotype could very well be identical to those of our first baby.

Similar genetic work-ups can be presented in the cases of dilute whites, extreme piebald whites, and those that are white because of a combination of loci coding for partial removal of pigment (grey sire/ piebald dam combination, for example).

Is black ever recessive to white? Possibly.

Dr. Sponenberg speculates that the most dominant allele at the Agouti locus or one similar to it "also appears capable of making a stark white animal" (*The Complete Alpaca Book*). It takes a very knowledgeable person to study breeding results and differentiate between Agouti locus whites (if they exist) and those produced by alleles at other loci. A blanket statement declaring black to be recessive to white is incorrect and misleading. It conveniently ignores the fact that white fleece color "is an end point that can be achieved through different means" (Sponenberg).

We all occasionally have trouble "letting go" of knowledge we thought was correct. It took a while for dog breeders to dismiss the long held belief that liver/chocolate is a third pigment. It will take time for many alpaca breeders to study and grasp the concept of multiple and separate loci coding for white fiber.

It will also take time for breeders to shed the cherished notion of alpacas "loaded" with black genes. Let's review: recessive black alpacas, whether they boast an entire pedigree filled with black ancestors or are the offspring of two non-black parents, are all A^{a} A^{a} and therefore genetically identical at the *Agouti* locus. Dominant blacks are either E^{D} E^{D} or E^{D} $E^{?}$ at the *Extension* locus.

In the context of color genetics, the word *loaded* implies that a particular animal has more than a "normal" share of genes (alleles) coding for black fiber. Breeding results do not support this claim. I know this is painful for some breeders to admit but *there are no alpacas "loaded" with black genes.* Each alpaca, as Dr. Sponenberg has pointed out on numerous occasions, can only have two alleles at each locus. This is so well documented that no breeder should embarrass himself or herself by arguing otherwise. While it is perfectly fine and even desirable for breeders to differ in their opinions, scientific facts should not be subject to debate.

"People have the right to advertise their animals any way they feel like it," several individuals in the industry have pointed out to me. Do they? Even if it is legal, is it ethical for breeders to tell prospective buyers about their alpacas being "loaded with black genes" after it is explained to them that this is scientifically incorrect? Judging from the emails and phone calls I receive, there is a growing number of alpaca breeders who are hungry for knowledge in the area of color inheritance. Through diligent study, they understand or are starting to understand the concepts I explained earlier in this article. Not all of them will take a tolerant view of advertisements based on genetic fairytales.

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