Afghan Hound Coat Colors and DNA Tests

a brief explanation of how currently available DNA tests can help predict some coat colors

This pdf was formerly a webpage that was part of a series on Dog Coat Color Genetics. It was first mounted before April, 2006 and last updated on February 22, 2017 by Sheila Schmutz. The pdf ws created in November 2020.

By mid-October 2009, the original set of dogs and the official Saluki Coat Color Study was completed. The research phase to address the gene/s causing grizzle was completed in spring 2010. This research lead to the study of **domino in Afghans** as well. The manuscript describing this was published in Journal of Heredity in Fall, 2010. A free PDF copy of the manuscript is available for download. Note that the Afghan photos and Table showing the Afghans in the domino/grizzle study are also available under Supplementary Data (see gray bar at the right of the Journal of Heredity page). Additional Afghans are included on this page from previous research.

- A New Mutation in MC1R Explains a Coat Color Phenotype in 2 "Old" Breeds: Saluki and Afghan Hound Dayna L. Dreger & Sheila M. Schmutz, Journal of Heredity 2010; doi: 10.1093/jhered/esq061

Prior to this, Afghans were also used extensively in the study of the K Locus, the *Beta-Defensin 103* gene. The original study mapped this gene and a subsequent study reported the mutation that causes black versus fawn. The mutation causing brindle is also at this locus but is very complex so a DNA test for this is not offered by any diagnostic lab thus far.

- Kerns Julie A., Edward J. Cargill, Leigh Anne Clark, Sophie I. Candille, Tom Berryere, Michael Olivier, George Lust, Sheila M. Schmutz, Keith E. Murphy, and Gregory S. Barsh 2007. Linkage and segregation analysis of black and brindle coat color in domestic dogs. Genetics 176: 1679-1689.
- Candille S.J., C. B. Kaelin, B. M. Cattanach, B. Yu, D. A. Thompson, M. A. Nix, J. A. Kerns, S. M. Schmutz, G. L. Millhauser, and G. S. Barsh. 2007. A beta-defensin mutation causes black coat color in domestic dogs. Science 318:1418-1423.

The E Locus

All colors are acceptable in Afghan Hounds in most countries, but nevertheless people have preferences. DNA testing for the *E* alleles in Afghan Hounds allows breeders to better predict the colors of pups from particular matings. All 3 typical *E* alleles (E^M, *E, e*) have been shown to exist in Afghans. However, like Salukis, they have the allele E^G. The dominance hierarchy is*:* $E^M > E^G > E > e$.

Afghans may be red from two different genetic mechanisms. These are virtually indistinguishable when one looks at red dogs. One genotype which causes red is a^y at the agouti locus. Because a^y is dominant to the other alleles at this locus, one copy is enough to cause this type of red. It is called fawn in many breeds. In most breeds, such red dogs are *E*/-, a^y/- or E^M/-, a^y/- depending of whether or not they have a melanistic mask. But some fawn afghans have E^G as one or both alleles. Fire. left and Claudia, right are fawn with a mask.

Photo by Stephanie Hunt-Crowley

The second genotype which could cause a "red" coat color in Afghans is *e/e* at the *MC1R* gene. This may be more rare but we have not tested enough Afghan Hounds to be sure of this yet. The one Afghan that we have studied with this genotype so far is cream, not red (see photo right). Dogs which are *e/e* can not be brindle or domino, even though they may carry the alleles for these patterns at other genes. They also never have a mask, or in fact a single black hair. All of those patterns include black and black pigment and can not be produced in dogs that are *e/e* because the mutation in the *MC1R* gene prevents any eumelanin pigment in hair. However the nose and pads and eye rims of such dogs can still be black because pigmentation at these locations is affected by the *B* locus or *TYRP1* gene.

A black mask only occurs in Afghans that carry at least one E^M allele. It is typical for such dogs to have black ear fringe also. Although a mask is not visible on black or blue Afghans but only on fawn, cream and brindle Afghans, it can occur in dogs of all these colors. Kaschmir, at the left, is cream because he is a dilute red but he has a striking black mask. E^M is the "top dominant" allele in this series. The E^M allele is very common in Afghan Hounds.

Among 46 Afghan Hounds genotyped for the *MC1R* alleles, none carried the E allele.

In 2019, Hédan et al. published that the mutation that caused dogs that were expected to be red, were cream instead is in the *MFD12* gene. Cream dogs are homozygous for this mutation. Because it only pales phaeomelanin, such dogs can still have a black mask instead of a pale gray mask.

Hédan B, Cadieu E, Botherel N, Dufaure de Citres C, Letko A, Rimbault M, Drogemüller C, Jagannathan V, Derrien T, Schmutz S, Leeb T and André C. Identification of a Missense Variant in *MFSD12* Involved in Dilution of Phaeomelanin Leading to White or Cream Coat Color in Dogs Genes 2019, 10, 386; doi:10.3390/genes10050386

The A Locus

The A locus is the *Agouti Signal Peptide* gene (*ASIP*). There are four common alleles at this locus with a dominance hierarchy of: $a^y > a^w > a^t > a$. It would appear that only a^y and a^t exist in Afghans.

Dogs which have the genotype a^t/a^t in the presence of other suitable alleles (at least one E or E^M and k^y/k^y), are **black-and-tan**. Tai and his cloned puppy Snuppy, left, who has been verified as a true clone, are this coloration. Since they have a black mask they have at least one E^M allele.

Scandal is a black-and-tan Afghan. Her face, right, shows the characteristic tan "eyebrow" markings of dogs with this coat coloration. Scandal has the *MC1R* genotype E^M/E^G. Because E^M is the dominant allele, she has a black mask and is not a domino.

Afghans with the a^t/a^t could also be blue-and-tan, black-and-cream, blue-and-cream, or have brindle undersides if the appropriate alleles are present at other genes, to alter this pattern.

Domino Afghans have the genotype a^t/a^t and k^y/k^y but they must also have at least one E^G allele and no E^M allele. Weasel (left) is a domino that is homozygous for the E^G allele allele. Beck (right) is a domino Afghan with an E^G/e genotype. Both are blue-and-cream.

Afghan coats often change color from birth to maturity, so early DNA testing may help to predict their adult color.

The K Locus

Although Little (1957) suggested that e^{br} was another allele in the *E* locus series that caused brindle, recent DNA studies prove that brindle is caused by a complex allele of the *K* locus, K^{br}.

Afghans were one of several breeds of dogs in the study to find the *K* locus at Stanford University. Some three generation families that included black, brindle and red/cream dogs were used to map this gene.

Dogs that are K^{br}/K^{br} or K^{br}/k^{y} are brindle (unless they are *e*/*e*). The dominance heirarchy is $K^{B} > K^{br} > k^{y}$ at this locus. Precious is an example of a full body brindle Afghan pup that is diluted to grey and cream stripes, instead of black and fawn stripes.

All full body brindle dogs must have at least one a^{y} allele. The brindle stripes occur on a fawn body, so to speak.

Photo by Stephanie Hunt-Crowley

Dogs with a single K^{B} allele are black unless they are *e*/*e*. Twinkle is an example of a black Afghan. Twinkle's genotype is $E^{M/}E$, but one cannot see her black mask against her black coat.

Black Afghans could have one K^{br} or k^{y} allele in addition to their K^{B} allele. DNA tests are now available to determine if a dog is K^{B}/K^{B} or k^{y}/k^{y}. The brindle mutation is complex and a DNA test is not available to determine which black dogs might be carrying brindle, even in 2020.

- Kerns Julie A., Edward J. Cargill, Leigh Anne Clark, Sophie I. Candille, Tom Berryere, Michael Olivier, George Lust, Sheila M. Schmutz, Keith E. Murphy, and Gregory S. Barsh (2007) Linkage and segregation analysis of black and brindle coat color in domestic dogs. Genetics (online early May 4, 2007).

- Candille S.J., C. B. Kaelin, . B. M. Cattanach, B. Yu, D. A. Thompson, M. A. Nix, J. A. Kerns, S. M. Schmutz, G. L. Millhauser, and G. S. Barsh. A beta-defensin mutation causes black coat color in domestic dogs. Science (online early Oct. 18, 2007)

The D Locus - is it in Afghans?

The D locus has been shown to be the melanophilin gene (*MLPH*). There appears to be more than one *d* allele. Dogs with a *d/d* genotype are "born blue". We have only tested a single Afghan that was born blue so far and it did not have the common mutation found in Weimaraners, Great Danes, and Grehounds. Until the other mutations are identified, DNA testing cannot be used to detect "born blue" in Afghans.

In 2016, Dr. Rob Loechel at VetGen identified a possible explanation for this coat color in Afghan Hounds. This is not published yet, as far as I am aware

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Progressive Graying

As of 2020, the gene that causes black to become blue and red to become cream over time, has not yet been identified. Many Afghans lighten with age due to a phenomenon called "progressive graying". Little suggests that this is caused by the *G* locus. The black hairs on such dogs turn from black to grey all over their body in their first few years of life.

Progressive graying is different from geriatric graying. In old age, dogs of many breeds get white hairs around their muzzle and eyes. This does not usually begin until at least 8 years of age or so.

Further Reading:

- Schmutz, S. M., T. G. Berryere, N. M. Ellinwood, J. A. Kerns, G. S. Barsh. 2003. MC1R studies in dogs with melanistic mask or brindle patterns. Journal of Heredity 94: 69-73.
- Berryere T.G, J. A. Kerns, G. S. Barsh, S. M. Schmutz. 2005. Association of an Agouti allele with fawn or sable coat color in domestic dogs. Mammalian Genome16:262-272.
- Philipp U, Hamann H, Mecklenburg L, Nishino S, Mignot E, Schmutz SM, Leeb T. 2005. Polymorphisms within the canine MLPH gene are associated with dilute coat color in dogs . BMC Genetics 6:34-. (This article is published in a publicly accessible online journal at http://www.biomedcentral.com/1471-2156/6/34)

For more general information, please see **Genetics of Coat Color in Dogs**
http://munster.sasktelwebsite.net/DogColor/dogcolorgenetics.html

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