

# Saluki Coat Color DNA Study

*an update and information page for the owners of Saluki who have contributed DNA brushes to the study, and a summary of a wider study of Salukis collected independently, after this study*

*This pdf was a webpage posted 20 August 2009. It was updated 14 December 2014 and then updated and converted to a pdf in Nov 2020.*

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## The Initial Study

We are grateful to [Margot Keast](#) of Australia and [Casey Gonda](#) of the U.S. for jointly coordinating the samples, photos, consent forms, etc. for this initial study. I was approached by a few Saluki owners in various countries about the same time and asked that the groups work together on one project. I asked that they attempt to collect DNA brushes from Salukis registered in various countries, in all the colors recognized by at least one country, with the exception of the color they call blue. That color is not yet understood in Afghans and so I assumed it would not yet be in Saluki either.

We also thank the dogs and their owners who contributed to the study. The dogs donated DNA via cheek brushes and posed for the photographs. The owners paid for the testing through contributions to this initial study. Our other research funds paid for the testing done in the wider, later study.

Both initial batches of DNA brushes arrived in Saskatoon at our lab on August 19, 2009. Further samples arrived through the end of September. Note that the sample size was small, given the variety of coat colors in Salukis worldwide. Therefore one should not assume that a specific color of dog that resembles one shown on this webpage is always or only the genotype of the dog shown. A good example is the two different genotypes for the two cream dogs.

Call names that were provided will be used, not the registered names of the dogs. Generic information is posted on this site. Some specific information was emailed to the owner of each dog.

We completed DNA testing of this set of Saluki for the known alleles at the loci: A, E, K, B, and S. No further dogs will be included in this full color study, at this time.

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The stated coat colors of dogs sampled were:

- sable
- fawn
- red
- gold
- cream
- black
- black-and-tan
- brown-and-tan
- grizzle
- brindle

Some dogs had white markings and others did not.

Note that there is a very good powerpoint presentation saved as a downloadable pdf file produced for AKC (see link at the bottom). Apparently AKC considers sable and grizzle as markings. On this website, white markings will be discussed as "markings".

# Grizzle

One of the challenging questions asked was what gene causes the coloration known as **grizzle** in Saluki, shown by Taz at the top of the page. The term grizzle is used in a few breeds, often hound breeds, but may not refer to the same phenotype in those breeds, as it does in Saluki.

The definition of grizzle that Casey and Margot agreed upon is: "Grizzle: A pattern that is present at birth and remains throughout life, which comprises a dark overlay covering the top and sides of the body and outside of the limbs, from the top of the head to the tip of the tail. The darker color on the head gives the impression of a 'widow's peak' between the eyes where it contrasts with the lighter color of the face. The underside of the dog and inside the legs comprise the lighter base color. The overlay color may be Black, Grey/Silver, red or Chocolate and can vary in intensity with the seasons and age. The base color may be various shades of red, fawn, golden, cream or silver."

So we wondered if the body coloration caused by individual reddish and black hairs intermingled or are the individuals hairs composed of alternating bands of red (phaeomelanin) and black (eumelanin) pigments, or are the hairs phaeomelanin with eumelanin tips as I'd interpret "overlay", or ??? The AKC powerpoint presentation by Walls, Hinsch and Stoner-Townsend say that all grizzles have banded hairs.



Uno, above, is a Canadian dog who was added to the wider grizzle portion of the study, as were several other Saluki. He would be called a deer grizzle by some and a fawn grizzle by others.

Glitz (below) was part of the original set of samples. She was reported as a black grizzle.





Flame, above, is one of the grizzle dogs in the original set of samples. She was described as a red grizzle.



Taz, above, is a Canadian dog who was added to the study to help address this interesting coloration.

Tyghar is another grizzle Saluki. His body shot is shown in the brindle section.

Mariah is yet another grizzle Saluki. She is shown in the section on brown below, as an adult and pup.

The six grizzle Saluki illustrate the wide range of shades in this pattern. All of them have the widow's peak facial pattern. All except Tyghar who is also brindle, are  $k^y/k^y$ . None have an  $a^y$  allele. None are  $e/e$ , although Uno and Tyghar both have one  $e$  allele.

The gene causing grizzle had not been previously reported. Our research suggests that a unique mutation in one of the genes known to affect coat color, *MC1R*, is primarily responsible for this pattern. A single copy of this mutation, which we named  $E^G$  seems sufficient to cause this pattern. (Uno has only one). However, this mutation interacts with the *ASIP* gene for the grizzle pattern to be visible. This is shown by Bertha and Chief, both of whom have the  $E^G$  mutation but not the required  $a^1/a^1$  genotype at the A locus.

A similar pattern in Afghan hounds is called "domino" after a famous show dog by that name. Domino and grizzle are both caused by this same gene interaction.

- [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) 101:644-649.
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## Cream, Red, Fawn, Sable

There are two different genetic mechanisms by which a dog can be primarily pigmented with phaeomelanin. Phaeomelanin is the reddish pigment and eumelanin is the blackish pigment.

The first mechanism is an *e/e* genotype at the MC1R gene or E locus. In dogs, this is "clear red", in that there is never a single black hair on such a dog. However the shade of red can vary from cream to deep dark mahogany red in various breeds. Pansy is an example of a cream Saluki with an *e/e* genotype. Not all Saluki with an *e/e* genotype will be cream or very pale, although this is the case in some breeds. Pansy and the two Saluki siblings Cygfa and Torc were the only dogs in the original study group that had this *e/e* genotype. However among those 15 Salukis, *e* was a rather common allele.



The genotype *e/e* is epistatic or masks the colors normally produced by several other loci including A and K. For example, Pansy is not fawn. She does not have an *a<sup>y</sup>* allele. As a pup, Pansy showed some reddish pigment on her ears.

The second genetic mechanism for a reddish coat is having an *a<sup>y</sup>* allele at the A locus or ASIP gene and also being *k<sup>y</sup>/k<sup>y</sup>* at the K locus or beta defensin 103 gene, and at least one *E* or *E<sup>M</sup>* allele at the *MC1R* gene. Such dogs can have a few black hairs on their body and can have some black tipped hairs, especially as pups. Among the 15 Saluki in the initial study, the *a<sup>y</sup>* allele was not common.



Bertha, above, is another Saluki that is cream. However Bertha does not have an *e/e* genotype, or even a single *e* allele. Her genotype at *MC1R* is  $E^G/E^G$ . Because Bertha has an  $a^y$  allele, she is not grizzle.

At the time of this study, we did not know why Pansy and Bertha were cream and not a darker shade of red. In 2019, Hedan et al. published a paper about a mutation in the *MFSD12* gene, that explained this. A mutation in this gene causes the paling of phaeomelanin pigment, but not eumelanin. Torc and Cyga, shown below, are siblings shown in this paper. They both received an *e* from each parent and also an  $a^y$  allele from each parent.





Chief (above left) is a red Saluki of the fawn/sable type. He has an  $a^y$  allele and is  $k^y/k^y$ . He has a genotype of  $E^G/e$  at *MC1R*. Although Chief is fawn, he has pale ear fringes.

Several people in Saluki circles seem to consider that sable dogs would always have dark tipped hairs and an "overlay" of some eumelanin color. Although this is true in some, Chief and Simba (above right) demonstrate it is not true in all. Alternatively the term sable is used only for dogs with black ear fringes, even though other dogs have a fawn/sable  $a^y$  allele. Simba was reported to be a fawn Saluki. He has one  $a^y$  allele and is  $k^y/k^y$ . He is  $E^G/e$  at *MC1R*.

Ali, below, is a Saluki that is sable, or black fringed red, as it is sometimes called in this breed. This is because Ali has an  $a^y$  allele and is also  $k^y/k^y$ . Ali shows at least a hint of an "overlay" from her black tipped hairs and she has black ear fringes. Ali is  $E/E$  at *MC1R*.



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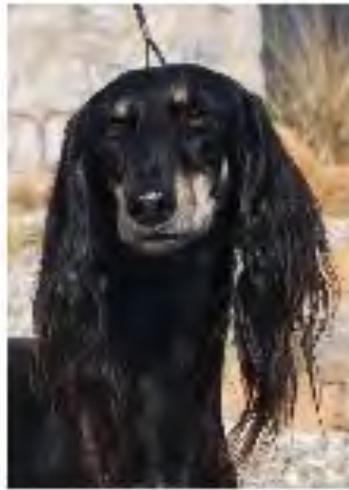
## Tan Points

Some dogs in some breeds have three stratified sections of pigmentation. They have eumelanin on their backs - either black, brown or grey and then phaeomelanin on their legs and often on their eyebrows and muzzle although we are concentrating on body pigmentation here. Finally these dogs have white or no pigmentation on their feet and belly area.

Dogs that are "eumelanin-and-tan" would have an  $a^1/a^1$  genotype at the A locus or *ASIP* gene and also  $k^y/k^y$  at the K locus or *beta-defensin 103* gene and would have at least one *E* or  $E^M$  allele and no  $E^G$  allele.



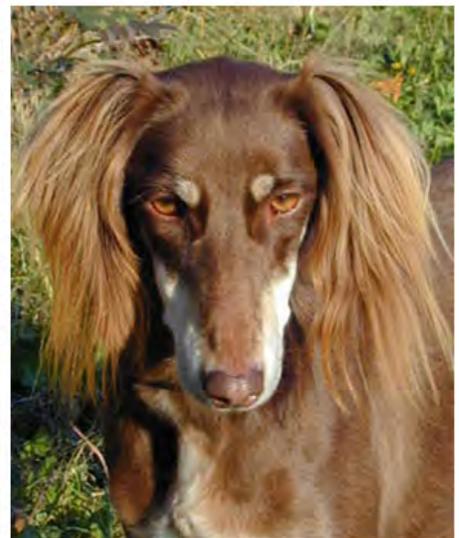
Oasis is a Saluki that is black-and-tan. Her tan points are more evident against black than are those of Flirt who is chocolate brown, but they occur in the same places. The tan of Oasis is a deep phaeomelanin color. Although she does have one *e* allele and one *E* allele, that is not the explanation of this depth of tan. Why some dogs have a deep tan color and others a pale cream isn't known yet.



Smurf is a Saluki that is called black-and-silver. This is because his "tan" looks like a pale "silver" color. This is apparently very typical in Salukis. He is *E/E* at *MC1R*. Smurf's face shows the eyebrow spots in tan or silver, typical of a dog with tan points.

## Brown or Chocolate

Brown is a color that is sometimes confused with red. However, it is an alteration of eumelanin, not a pheomelanin color. Tan, as used by dog people in terms like "black-and-tan" is a pheomelanin color. In some breeds brown is even called red, unfortunately. In some breeds it is called chocolate or liver. Flirt (below) was described as chocolate with tan points.....another way of saying brown-and-tan.



Flirt is brown-and-tan with white undersides. Her tan is not that easy to see although it is quite evident on her tail in the photo of her full body. Her face shows the classic "eyebrows" of a dog with tan points.

There are 3 different alleles that cause brown in dogs:  $b^s$ ,  $b^d$ , and  $b^c$ , in that order of incidence. Flirt is  $b^s/b^s$ . Although there are 3 alleles causing brown in dogs, only the  $b^s$  allele and the  $b^d$  allele were detected in this group of Salukis.

In addition, all dogs with a  $b/b$  genotype (any two  $b$  alleles) have brown nose leather and pads. No dog with a  $b/b$  genotype ever has any black pigmentation anywhere. For tan points to show the dog must be  $k^y/k^y$  and Flirt has this genotype. Such dogs would also be  $a^1/a^1$ .



Mariah (previous page) is another Saluki that is homozygous  $b^y/b^s$ . Therefore her fringes and the tips of her hairs are brown, not black. Mariah did not have an  $a^y$  allele. She is not a chocolate-and-tan like Flirt, because she has an  $E^G/E$  genotype at *MC1R* and is therefore grizzle.

In her pup photo (right), Mariah's brown on her head and tail and nose show more clearly than on her adult photo. However brown and red are not that different in color to make it obvious that her hairs have brown tips over her back.

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## Black



The original locus for black versus brown described by Little was the *B* locus. Contrary to Flirt and Mariah above, Rasho is  $B/B$ . A single  $B$  allele would cause black instead of brown pigment. Rasho has a  $K^B$  allele which makes his alleles at the *A* locus, one of which is  $a^y$ , not show. His other allele is  $k^y$ . At the *MC1R* gene or *E* locus, Rasho has an  $e$  allele and also the top dominant allele  $E^M$  for melanistic mask.

Farasha, right, is another black Saluki, a daughter of Rasho, shown above. At the *MC1R* gene or E locus, she has an  $E^G$  allele and also the top dominant allele  $E^M$  for melanistic mask. Her mask is not evident on her white muzzle however, since white is the result of the absence of melanocytes. Both Farasha and her sire Rasho, were  $a^y/a^t$  at the *ASIP* gene, so would not have shown grizzle, even if they were not black.



## Brindle

Brindle is typically seen as vertical stripes on the body of the dog in a phaeomelanin color (cream, yellow, red) interspersed with stripes of a eumelanin color (black, brown, gray). It is often easier to see on long coated dogs in young pups before the coat lengthens. The amount of brindling varies widely among individuals. Placement of brindle only occurs on certain areas, typically dictated by the genotype at the A locus.

Due to the complex nature of the brindle mutation, all brindle dogs test as if they have a  $K^B$  allele and a  $k^y$  allele. The current commercially available tests, even in 2020, do not distinguish between dogs that are black from  $K^B$  and carrying a  $k^y$  allele and brindle dogs. Brindle can be detected by another type of assay that is currently available only in the research labs involved in studying the K locus.



Tirgan, left, is a Saluki that was reported as brindle with a black mask. She is  $E^M/e$  at *MC1R* and therefore this fits with her large black facial mask. She is what one would call a "full-body" brindle because her stripes occur on her whole body, not just her tan points. Tirgan has an  $a^y$  allele which is typical of full-body brindles. Her genotype at the K locus is compatible with being brindle.



Tyghar was reported as brindle and grizzle. His genotype is  $E^{G}/e$  at *MC1R* and  $a^{l}/a^{l}$  which explains his grizzle phenotype.

His genotype at the K locus is compatible with being brindle.

We do not have a DNA sample from a black or chocolate dog with brindle points, but such dogs could occur based on the alleles identified in this group of Saluki. Seeing brindle on tan or silver points in dogs that also have white markings can be difficult.

The *e/e* genotype is epistatic to both black and brindle, and also to sable. Not a single black hair or part thereof can occur in dogs with an *e/e* genotype.

## White Markings

Some Salukis have white markings. These can be on the feet or up onto the legs and the underbelly. A few even have a white collar. In some breeds these markings of white collar, white legs and white undersides can be called "Irish Spotting", whereas in some other breeds it might be called "mantle". The mutation causing such markings has not yet been established conclusively. (see the associated white spotting page in this series)

In many breeds there is also a pattern of white markings that are random white spots on the body. This can be called piebald, but in Salukis it is called "parti" or particolored. Gala, below, shows this pattern of white markings. In many breeds that we've studied, piebald is caused by the homozygous presence of a SINE in the promoter region of the *MITF* gene. However, in a few breeds this is not the case, such as Great Danes, Norbottenspets, Icelandic Sheepdogs, Whippets and Saluki. Gala has a genotype of SINE/not instead of SINE/SINE.



Gala is a tricolor and therefore as expected has no  $a^{y}$  allele. Seeing tan points on particolored dogs can be difficult at times. Gala has them only on her face since white is because of the absence of functional melanocytes.



Sweetie, above, is a particolored and she has a genotype of SINE/SINE. Her colored areas are a very pale red but if you look closely, you may be able to see she is pale red with white spots. She has an  $E^G/E^G$  genotype at *MC1R* and has one  $a^y$  allele.

We assume that there is another mutation in another gene involved in white spotting that interacts or interferes with *MITF* in some breeds that causes them to be different. In Great Danes, we suspect these are merle and Harlequin. Neither of these patterns occur in Norbottenspets, Icelandic Sheepdogs, Whippets or Saluki though so this suggests yet another gene must affect white markings in those breeds.

The only other Saluki in this group that had a SINE/SINE genotype was Lola, shown below. As a pup Lola had an interesting colored spot on her belly, typical of a piebald or particolored dog but the rest of her markings are more similar to Irish spotting. This further confirms that Saluki do not fit the common patterns of white markings associated with this mutation.



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

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