

San Clemente Island Goat Color Definitions

Credits: This document relies heavily on the work of and consultation with Dr. Phil Sponenberg and his understanding of goat color genetics. It was influenced by Cris Waller's paper on Nigerian Dwarf color genetics and brought to life by Laurel Sherrie's artwork. Many thanks to the San Clemente Island Goat breeders who provided pictures and pedigrees.

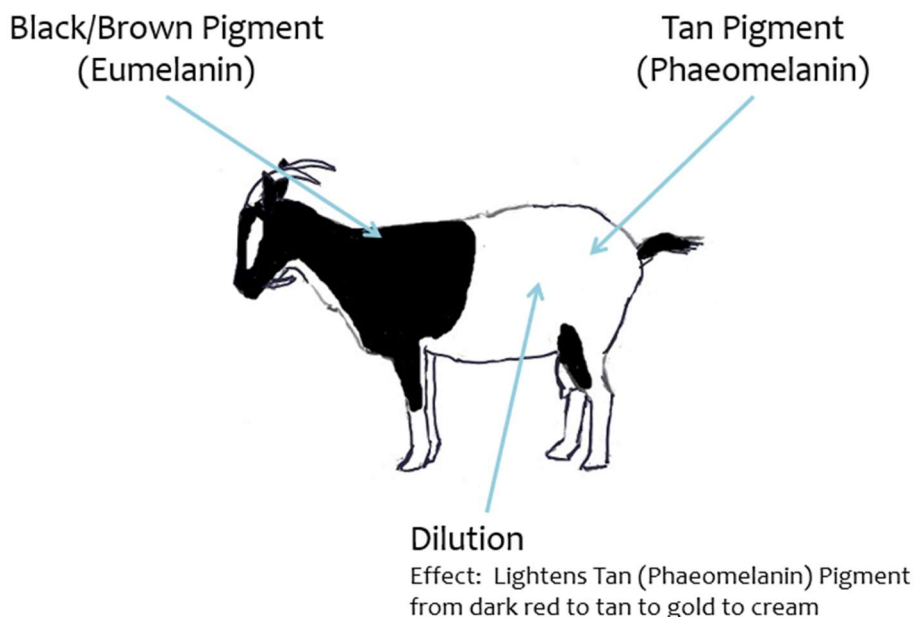
Introduction

SCIGBA Board members wrote this SCI goat color white paper to provide a foundation to more accurately describe our beloved goats. The SCIGBA Board is extremely grateful to Dr. Phil Sponenberg for sharing his expertise and time helping us understand the science and translate it to a description that all breeders can understand and embrace. The goal is for our SCI community to gather data that advances our understanding of goat color genetics. The information in this document is subject to change based on new findings and information. Stay tuned and feel free to contribute your findings to the SCIGBA.

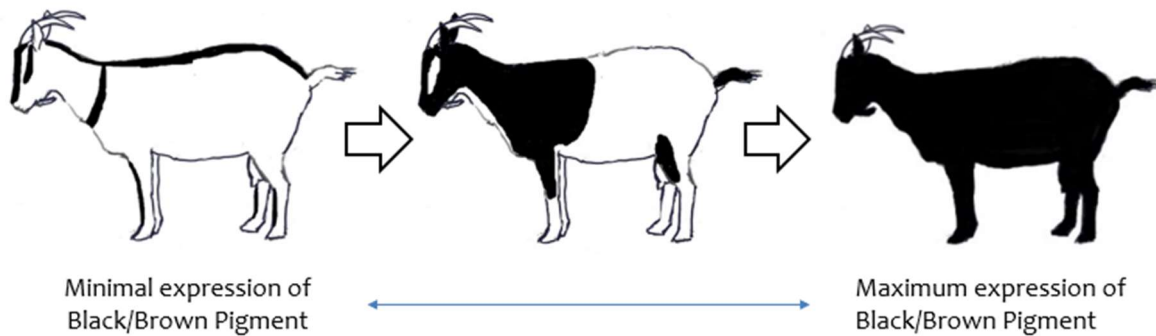
What factors make up a goat's "color"?

Color in goats is expressed in their hair by a combination of **Black/Brown (Eumelanin)** and **Tan (Pheomelanin)** Pigments, affected by certain degrees of **Dilution**, arranged in one or more **Patterns** and overlaid with white **Spotting**.

In San Clemente Island Goats the Black/Brown (Eumelanin), Tan (Pheomelanin) Pigments, and the effect of Dilution are typically visible in the areas shown in the picture below.



Patterns control the distribution of Black/Brown or Tan Pigment



What genes control color in SCI Goats?

The genes controlling color in San Clemente Island Goats are made up of four known genetic locations (called locus). Investigation of color genetics is ongoing and the current understanding does not completely explain all the color variation displayed in SCI goats. The chart below identifies the four known locus – A, B, D and S.

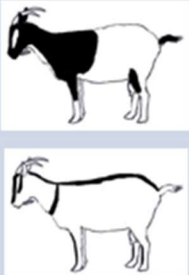

Symbol	Name	Action
A	Agouti	Creates the color Pattern by controlling the distribution of Black/Brown (Eumelanin) and Tan (Pheomelanin) Pigment. There is one accepted Agouti pattern allele present in SCI goats and two that are suspected. The homozygous recessive, which means there is no Agouti pattern, is supported by test breeding and included in the breed color description.
B	Brown	Controls the Eumelanin Pigment that produce black or brown hair in the goat. Two shades of Brown are dominant over Black. <ul style="list-style-type: none"> • Dark Brown (Bd) is the most dominant • Light Brown (B1), the color of Toggenburg goats, is second most dominant • Black (B+) is the next most dominant • Very rare Medium Brown (Bb), liver colored, is the recessive. <p>Based on visual history we assume B1 and Bb are not present in our population of SCI goats. Most SCI goats are thought to be Black (B+). It is possible, but not proven, that some are Dark Brown (Bd).</p>
D	Dilution	Modifies the color of both Eumelanin and Pheomelanin Pigment (independently) and determines how intensely they are pigmented. Dilution of the Pheomelanin Pigment in SCI goats gives a range of tan colors. Tan Pigment dilutes from dark red to tan to gold to cream. There is no evidence of Dilution working on the Eumelanin Pigment in SCI goats. Dilution of Eumelanin Pigment would produce dark to light grey color not a brown color.
S	Spotting	Spots are areas lacking Pigment that can overlay any color or Pattern. Spotting (S+) has several expressions such as frosting on the nose, white feet, or body spots. More than one expression can be present on one animal. Frosting is thought to be a dominant spotting allele.

A locus – Agouti Pattern

There is one accepted Agouti pattern allele in SCI goats called the San Clemente Allele – identified by the symbol Asc. It was named after the SCI goat when SCI goats introduced this Agouti Pattern to the mainland. Other breeds have called it “buckskin” but that is incorrect – the genetic pattern is Asc San Clemente.

Current thinking describes a wide variation in expression of the Asc San Clemente pattern. It can be minimal Eumelanin Pigment so as to hardly have any dark coloring on the front half of the animal at all or near maximum Eumelanin Pigment where the goat appears almost completely dark on its entire body with small amounts of tan on the legs and belly. The genetics controlling this range of expression are unknown. The lack of a pattern at the Agouti locus, scientifically called No Pattern or Self but the registry is calling “Solid Black”, is a completely dark colored goat with no tan on the legs or belly. It has been observed in individual goats.



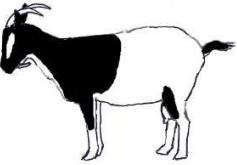
Derived from SCI Goat Patterns at the Agouti locus, in general order of dominance (from Dr. Phil Sponenberg, 1998).

Genetic Name	Symbol	Description
San Clemente 	Asc	SCI: Dark front half, tan rear half, tan stripes on dark head, predominantly tan legs. Dark chevron on the rear legs and dark on the top of the tail. Minimal (Mnml) SCI: Predominantly tan body with dark martingale, dorsal stripe and dark stripes on the front of the legs. Predominantly tan head with minimal dark markings. No dark chevron on the rear legs.
No Pattern, Self (Solid Black) 	Aa	Solid Black: Solid black goat with completely black body, head, belly and legs. No tan visible at all. These goats have no pattern so only the Eumelanin pigment is visible. This is a recessive allele and must be homozygous to be expressed. Spotting can still occur.



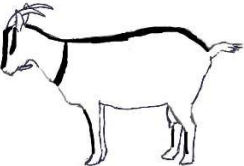
Note: In the above chart the term “tan” refers to the Phaeomelanin pigment which can be red, tan or cream. The term “dark” refers to the Eumelanin pigment and can be either black or brown.

The SCIGBA breed color description and registration database differentiate between the typically expressed pattern (SCI), the minimally expressed pattern (Minimal SCI), and no pattern (Solid Black).


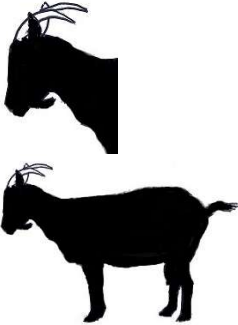
Typical San Clemente Asc Pattern

 <p>Courtesy of Wind Dancer Ranch</p>  	<p>Facial Pattern</p>	<p>Predominantly dark face with a mostly dark muzzle. A tan bar of varying width can extend from the muzzle to the eye then to the poll. This bar may be narrow or so wide as to show the tan color around and under the eye and as far as the ear.</p>
	<p>Body Pattern</p>	<p>The San Clemente pattern is an overlay of dark color (black or brown) on the back of the neck and over the shoulder area (cape). Legs are predominantly tan but have dark stripes of various width usually on the front and above the knee. Dark chevron on the stifle. A dark dorsal stripe may be present.</p> <p>Distinguishing characteristics are a dark top of the tail, a dark chevron marking down the side of the stifle joint sometimes reaching to the hock, and a dark cape that extends from the dorsal side of the neck to across the shoulder area. The cape may be minimally expressed and only cover part of the shoulder or it may cover the whole shoulder and extend into the rib cage. The cape does not fully cover the front of the chest so the goat's tan color is seen when viewed from the front.</p>

Minimal San Clemente Asc Pattern

 <p>Courtesy of Wind Dancer Ranch</p>  	<p>Facial Pattern</p>	<p>Predominantly tan head. Dark facial bars of varying width can extend from the muzzle over the eye to the poll and another from the muzzle across or under the eye to the ear. The muzzle can be dark or tan colored. Facial bars are often very minimal and faint.</p>
	<p>Body Pattern</p>	<p>Minimal San Clemente pattern animals show their tan color over most of their body. Markings tend to be more muted than in the Typical San Clemente pattern.</p> <p>Distinguishing characteristics are a dark dorsal stripe, a dark martingale which is more pronounced on bucks, dark markings on the front of lower legs, and facial stripes. The martingale can cover the front of the chest and be very thin or somewhat thick. It does not extend past the shoulder.</p>


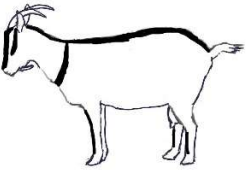
Solid Black (Self) Aa No Pattern

 <p>Courtesy of EB Ranch</p> 	Facial Pattern	Head is completely dark without tan stripes. White spotting may still be present.
	Body Pattern	Completely dark animal with no tan coloring. The dark color is shown over the entire body, belly and legs. Sun bleaching of the hair may make it difficult to distinguish black from brown or make it difficult to distinguish a Solid Black from a Typical SCI pattern with very dark tan hair in on its sides and rump. White spotting may still be present.

The genetics controlling the range of expression of the Asc San Clemente pattern allele are unknown. There could be different known Agouti pattern alleles hiding within the SCI goat community, or there could be a yet unnamed Agouti allele at work, or it could be a so far undiscovered mechanism or interaction. Keeping good color records on SCI goats will provide data for the SCIGBA Registry to work with genetic experts to solve the mystery. Two known Agouti pattern alleles are suspected to possibly exist in SCI goats – the Asb Sable Pattern and At Black and Tan pattern.

SCI Goats Similar to Sable Asb Pattern

Current thinking is goats that match this description are very minimal expressions of the Asc San Clemente pattern. The SCIGBA Registry is distinguishing them as “Minimal SCI” in hopes of doing data analysis in the future to determine if their minimal expression is due to the Asb allele or identify another factor. Breeders are encouraged to keep good written and photographic records to support future analysis.

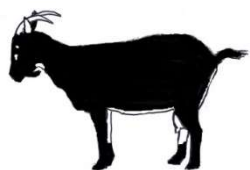
 <p>Courtesy of Wind Dancer Ranch</p> 	<p>From Dr. Sponenberg’s “Genetics of Goat Color” paper (the reference to “white” refers to the palest extreme of tan (Phaeomelanin) Pigment):</p> <p>“The sable allele produces goats that vary from very dark with red phaeomelanin and extensive black shading to stark white. This pattern is extremely variable, and the extent of eumelanin and the depth of phaeomelanin vary separately so that this single allele can produce patterns that are very distinct from one another. Most sable goats have white legs, white belly, and then are shaded to be deeper tan as well as more black over the top. Some have a shaded black back stripe from poll to tail, as well as a black shoulder stripe from withers, along shoulder, to the point of the shoulder and then to the midline. Faces are usually shaded with black, save for pale facial stripes.”</p>
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SCI Goats Similar to Black and Tan At Pattern

Current thinking is goats that match this description are near maximum expressions of the Asc San Clemente pattern. The SCIGBA Registry is encouraging breeders to keep good written and photographic records to support data analysis in the future to determine if the At Black and Tan Agouti allele exists in the SCI population.



Courtesy of Wind Dancer Ranch



From Dr. Sponenberg's "Genetics of Goat Color" paper:

"The black and tan allele produces a pattern that has a black body and head, with tan under the ear, small spots above the eyes, and usually ventrally on the throatlatch, belly, inside of legs, and perineum. The legs have black stripes on the fronts, with the foreleg stripe discontinuous just below the carpus, and extension around the fetlock. The rear black stripe is continuous with the black of the body. Males darken somewhat with age, so that the tan "eyebrows" tend to be small or absent."

One of the key determining factors between a true Black and Tan Pattern and a near maximum expression of the San Clemente Pattern is the underside of the neck. A true Black and Tan Pattern may have some tan under the throatlatch but the rest of the underside of the neck will be black. While a San Clemente Pattern will always have tan on the underside of the neck from the throatlatch down to the chest even if it is just a thin strip.

B locus - Black/Brown Pigment (Eumelanin)

The B locus controls the Eumelanin pigments that produce black or brown hair in the goat. There are several alleles but only two appear to be present in SCI goats. Dark Brown (Bd) is dominant over Black (B+). Currently there is lack of evidence for Light Brown and Medium Brown alleles (B1, Bb) in SCI Goats.



Courtesy of Bella Vita

Most SCI goats are Black at the B locus expressing Black (B+B+) Eumelanin Pigment.

Black color can fade with sun, age, and nutritional deficiencies. It can be hard to distinguish Black from Brown.

It is possible, but not proven, that some SCI goats could be Dark Brown (Bd). SCI goats with Brown at the B locus (Bd) will have a Dark Brown color from first growth that is not a result of aging or sun bleaching.

Currently the SCIGBA Registry does not ask owners to distinguish the B locus color of their goats due to the difficulty in identifying this color.

D locus - Dilution of the Tan (Phaeomelanin) Pigment

Phaeomelanin Pigment controls tan hair in the goat. Tan color varies from dark red to red to dark tan to tan to gold to creme due to Dilution. At the lighter end it can look white.

Note: When identifying the Tan color on a goat's SCIGBA Registration form it is referred to as the "Shade" color. The SCIGBA Registry felt it would cause confusion to ask breeders to identify the "Tan color" of their goat when their goat was a dark red or light cream.



Courtesy of Wind Dancer Ranch

Dark red is the darkest expression of Tan (phaeomelanin). It can be very dark bordering on a reddish black.

The SCIGBA Registry distinguishes Dark Red from Light Red.

Note: The SCIGBA Registry decided not to refer to the dark red color as Mahogany because that is a term already in use in the color genetics world. Mahogany is the name of a known Agouti allele (A_m) in other breeds.



Courtesy of Wind Dancer Ranch

Tan has somewhat of a yellow hue and can vary from very dark to light. A "salt and pepper" mix of lighter and darker tan hair or hairs with darker tips is common.

The SCIGBA Registry distinguishes Dark Tan from Light Tan.



Courtesy of EB Ranch

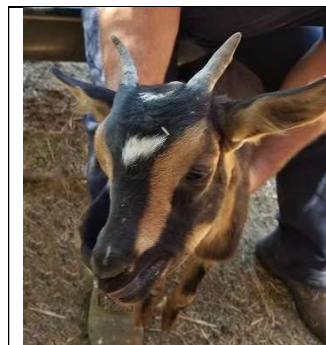
Cream ranges from light gold to white. These goats look white due to the Dilution of their Tan (Phaeomelanin) Pigment, not due to lack of Pigment.



Courtesy of EB Ranch

S locus - Spotting

Spots are areas lacking Pigment (true white) that can overlay any color or pattern. Spotting was documented to have existed in the wild goat herd on San Clemente Island and is an accepted part of the breed color standard.



Courtesy of Wind Dancer Ranch

Star and Blaze

Star: One or more white spots on the head.

Blaze: A white strip or marking down the center of the face.



Courtesy of Miller Park Zoo

Frosting

Mottled white around the nose and ears.

It can be so minimally expressed that a goat only has a few easily overlooked white hairs. Many goats have so little Frosting their owners are not aware they have it.

This is a dominant trait so a frosted goat has at least one frosted parent.



Courtesy of Promised Land

White Belt

The mid portion or barrel of the animal is banded in white all or partially around the body



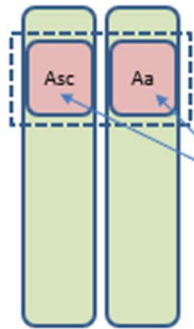
Courtesy of Jules Mack Brin

Spotted Body

Random white patches and spots on a colored animal.

Visual Glossary of Terms

Chromosomes



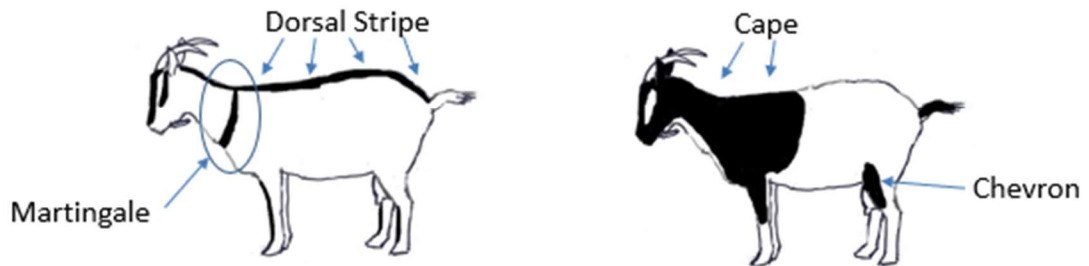
Locus – The location of a particular gene on a chromosome.
Example: A locus – Agouti Pattern

Alleles – Alleles are the “data” or “programming” for a gene.
There are two alleles at each genetic locus.

Example: There are more than 20 Agouti alleles identified in goats but not all alleles exist within every goat breed. SCI goats are known to have the Asc (San Clemente) and Aa (Self) alleles.

Some of the known Agouti alleles in goats

Awt	Ats	Asm
Asb	Asc	Aeb
Abm	Arp	At
Acr	Apk	Afsh
A+	Asg	Als
Ab	Ag	Am
	Aga	Arc
		Aa



References

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