

Norwich Terriers, 2-23

Title: Norwich Terrier Coat Color: Explaining Grizzle

“GRIZZLE”

By Sally Hohn (Hedgerow Norwich Terriers)

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I’ve wondered a lot about “grizzle”
Which no one will ever define.
Webster’s ideas about “grizzle”
Certainly do not fit mine –
At least when one speaks about NORWICH.
(for Norfolk the same would hold true)
If someone would only explain it!
A postcard to Hedgerow will do ...

Is “grizzle” a hair with a red tip
That changes to black as it grows?
Or one that starts out with a black tip
And grows BLACK, RED, BLACK?
HEAVEN KNOWS!

I’ve wondered a lot about “grizzle”
Are black hairs just mixed in with RED?
Until I find out about “grizzle”
I’ll register puppies as RED!

Red is the dominant color of Norwich. In fact, these terriers were developed specifically to be small red ratters. In the early years, red was the “correct” color, and until the 60’s the black saddled type was a bit controversial. Coat color possibilities allowed by the Norwich Terrier breed standard include, “All shades of red, wheaten, black and tan or grizzle.” The genetic explanation for the grizzle-colored Norwich has only recently been explained.

Coat color is determined by melanin, a substance produced by cells in the skin. There are two forms of melanin: eumelanin and pheomelanin, and each has a “default” color. For eumelanin, black is the default. The second form of melanin is pheomelanin (yellow). Unlike eumelanin, pheomelanin pigment doesn’t appear in distinct colors. Rather it occurs in shades ranging from off-white to dark red. In Norwich, “yellow” is our RED color.

The placement and pattern of coat pigment can be modified by various genes. The *ASIP* (Agouti Signaling Protein) gene affects color in dogs, however, *ASIP* expression was not fully understood until recently. In 2021, Bannasch et al. published the results of their work identifying new allele types that better define many dogs, including Norwich terriers. They found variations

in two regions of the *ASIP* gene which determine how black pigment is expressed in the coat and explaining five distinctive dog color patterns.¹

Like Sally Hohn, I’ve wondered a lot about grizzle. The first A-allele tests for canine coat color had **two** alleles pertinent to our Norwich: *AY* and *at*. A dog that tested *AY/at* might be red or he might be grizzle. For our Norwich terriers, the old A-locus testing identified nearly every Norwich as *AY/AY* (red), *AY/at* (red or grizzle), or *at/at* (black saddle). But this test could not distinguish between the varying amounts of black seen in primarily red dogs.

There were twenty Norwich terriers included in the Bannasch study. In addition, one of the authors, a geneticist (Robert Loechel), separately analyzed 30 cheek swab samples that I collected, along with photos, from Norwich Terrier Club of America members to represent the variety of color variations seen in our breed. Today, thanks to this team of researchers, we have a complete analysis of the A locus and an answer to the “grizzle” puzzle. Eight *ASIP* alleles were identified of which **three** are relevant to Norwich. These are called DOMINANT YELLOW (*ASIP^{DY}*), SHADED YELLOW (*ASIP^{SY}*), and BLACK SADDLE (*ASIP^{BS}*). The important new finding is that there are two kinds of “yellow.” (This means we have two genetic kinds of red in Norwich.) We also know the order of dominance. Because the expression of *ASIP* promotes pheomelanin synthesis, *ASIP* alleles associated with yellow are dominant to those associated with black. In fact, shaded yellow is far less common than dominant yellow by about ten-fold. Coat color tests are now available (VetGen). It should be mentioned that grizzle in Norwich is different from the “grizzle” that occurs in sighthounds and some other breeds.

So, what about grizzle? The newly identified allele *ASIP^{SY}* explains grizzle. A grizzle Norwich is a shaded yellow carrying the black saddle. In the study, all grizzle Norwich tested as *AY/at* by the old tests but were SHADED YELLOW (*ASIP^{SY}*) carrying BLACK SADDLE (*ASIP^{BS}*) in the new test. The table summarizes the old legacy and the new A alleles.

Color Phenotype	A-allele, NEW		A-allele, OLD
Red	<i>ASIP^{DY}/ ASIP^{DY}</i> <i>ASIP^{DY}/ ASIP^{BS}</i> <i>ASIP^{DY}/ ASIP^{SY}</i>	Dominant Yellow (DY) Dominant Yellow (DY) carrying Black Saddle (BS) Dominant Yellow (DY) carrying Shaded Yellow (SY)	<i>AY/AY</i> <i>AY/at</i>
Grizzle	<i>ASIP^{SY}/ ASIP^{BS}</i>	Shaded Yellow (SY) carrying Black Saddle (BS)	<i>AY/at</i>
Black and Tan (saddle)	<i>ASIP^{BS}/ ASIP^{BS}</i>	Black Saddle (BS)	<i>at/at</i>

ASIP is just one part of the picture for Norwich terriers. Every dog carries several coat color genes, and it is the interplay of the genes that control both color and distribution of pigment to give the complete coat picture. One additional locus was examined. The study found the MFSD12 red dilution mutation in our breed. Dogs with two copies of this mutation will have their red pigment reduced to the point where the dog is buff colored (wheaten). Also, the study verified that two color variations are caused by previously reported mutations. A true pinkie is *ee* at MC1R (E locus). An uncommon dilute color called “blue” is *d1/d1* at MLPH (D locus). One color or shade is not preferred. Norwich terriers should be appreciated for their variety of acceptable and beautiful coat colors, without the artificial coloring and chalking seen in the show ring.

¹Bannasch, D.L., Kaelin, C.B., Letko, A. et al. Dog colour patterns explained by modular promoters of ancient canid origin. *Nat Ecol Evol* (2021). <https://doi.org/10.1038/s41559-021-01524-x>

Sally Hohn passed away in 1995 from complications of bulbar-spinal polio. Despite this disabling disease she lived an active life from her wheelchair, whelping and caring for litters of Norwich terriers with her sister Bonnie. Her poems were published in the Norwich & Norfolk News in the mid-80's.

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