Stalking the Elusive White Factor

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The white factor. Some of my dogs have it. Do any of yours? And just what is the white factor anyway?

Let's deal with the last question first. A good deal of time and effort could be spent exploring the color genetics of the Shetland Sheepdog. Few breeds offer such a wide variety of coat color as does the Sheltie. My primary source for information was Clarence Little's "The Inheritance of Coat Color in Dogs." It is a complex book, but it is worth the effort required for comprehension. I would also like to thank Jan and Peggy Haderlie of SumerSong Shelties; without their Illustrated Color Inheritance Chart I might still be lost.

The gene that concerns us here is the S locus. This locus affects the distribution pattern of colored or of white areas on the canine body surface. A locus is a gene base or site in a chromosome. The various forms of a gene which occupy the same locus are called alleles of one another.

There are four allele in the S locus. They are:

1. S – self or completely pigmented body surface;
2. s^i – Irish spotting, with few and definitely located white areas;
3. s^p – piebald spotting;
4. s^w – extreme piebald spotting.

Alleles come in pairs. When a dog has two different alleles, this state is called heterozygous. When the alleles in a pair are identical, this condition is known as being homozygous. In an allele pair, one allele is *epistatic*, or it conceals one or more other allele; the other allele is *hypostatic*, meaning it is concealed by the other allele. The (s^w) allele is the hypostatic member of any heterozygous allele pair. A dog who is white factored has the allele pair (s^is^w); that is, it carries one allele for the Irish spotting, and one allele for extreme piebald spotting known as the white factor. A color headed white carries the allele pair (s^ws^w).

The color headed white Sheltie may also carry the (s^p) allele, the piebald allele which gives the dog the genetic designation (s^ps^w). The physical expression of this allele pair is almost identical to the (s^ws^w) pair expression. However, a color headed white having the (s^ps^w) combination may have more body color than the homozygous (s^ws^w) white Sheltie.

The sable headed white bitch pictured in *Photo B* may be an example of a color headed white who carries the (s^p) allele, the piebald allele. She displays a bit more body color than the tri-headed white pictured in *Photo A*, but as she is more than 50 percent white, she most definitely fits the description for competitive elimination stated in the Shetland Sheepdog Standard.

In the Shetland Sheepdog, the allele of the S locus which seems to be the most prevalent is the (s^i) allele, the Irish spotting allele. Most Shelties show some white spots or streaks in one or more of the following locations: (1) muzzle, (2) forehead star or blaze, (3) chest, (4) belly, (5) one or more feet, (6) tail tip. The full white collar so prized by breeders is a result of spots which have fused together. Thus the explanation for partial collars; they are spots which have refused to fuse, and fully extend themselves.

The (SS) allele pair is rarely, if ever, seen today. This pair produces a completely self-colored coat, with no white whatsoever. Most non-white factored Shelties have the (s^is^i) genetic designation. The (S) allele has probably gone the way of the brindled Sheltie. I suspect that this disappearance is because a self-colored Sheltie did not appeal to breeders, and therefore they were eliminated from the breeding programs. The S locus may be affected by genetic modifiers which may affect the extent of white in the (s^i) allele and in the (s^p) allele.

Now let's return our attention to the first question asked. Do any of your dogs have the white factor? This may not be as easy a question to answer as you think.

Most breeders use the evidence of a white stifle or a tiny line of white extending up the stifle to justify an assumption of the presence of the white factor. However, the presence or absence of the stifle marking is not conclusive. In truth, it may be downright deceiving. The dogs pictured below illustrate this very nicely.

Which dog is white factored? Most Sheltie breeders would immediately point to the bitch pictured in *Photo C*. They would be wrong. Both of her parents are homozygous for the (s^i) allele, therefore she cannot be white factored.

$(s^is^i) \times (s^is^i) = (s^is^i)$
sire dam bitch

The dog pictured in *Photo D* is white factored. He completely lacks any indication that he carries the (s^w) allele. Then, how do we know that he is white factored? His dam is a color headed white. In fact, she is the sable headed white previously pictured. Therefore,

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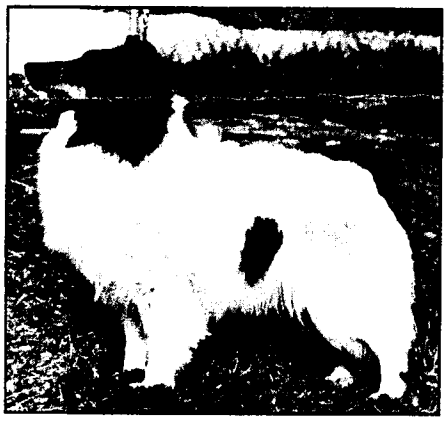

PHOTO A
Tri-headed white Sheltie bitch exhibiting the homozygous (s^ws^w) allele pair.

PHOTO B
Happy Glen Asti LaQuest
(Photo from LaQuest Shelties)

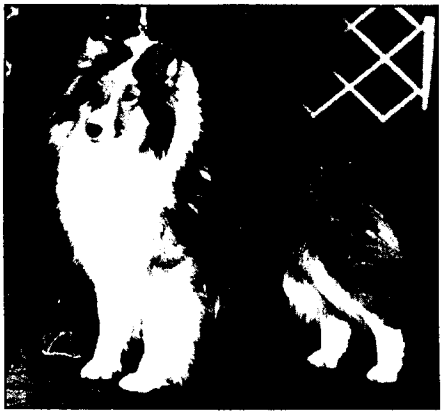

PHOTO C
(Photo courtesy of Cimmaron Shelties)

PHOTO D
(Photo courtesy of LaQuest Shelties)

he must be heterozygous for the (s^w) allele.

$(s^i s^i) \times (s^w s^w) = (s^i s^w)$
sire dam dog

This dog is the perfect example of what Sheltie breeders call the "hidden" white factor. His extremely plain markings would indeed lead one to suspect that this dog might be one of those rare Shelties who carry the (S) allele for self-coloration.

White stifle markings lose any validity for being a completely reliable method for positive identification for the (s^w) allele. Imagine breeding the bitch in *Photo C* to a white factored dog (which incidentally was done). Which of the puppies are white factored? How do you know?

There are other physical indications that a dog is white factored besides the white stifle markings. The white on the tail tip may be quite extensive; the white may extend up to one-half of the tail length. There may also be a thin slash of white which extends from the underbelly up into the ribcage. More reliable indicators are small white body spots. These spots may consist of only a few white hairs or more. These hairs are most often found along the midline of the back. However, it is to be remembered that fetal infection or pressure in the uterus may also cause such white spots. If only one of these signs is present, the dog is not necessarily white factored. If two or more of these indicators are visible, then the probability of the dog carrying the (s^w) allele is almost assured.

The most logical, although not the most practical, method for determining the possibility of a dog being white factored is to breed a dog suspected of the (s^w) allele to a dog who positively carries that allele. If the resultant litter contains a color headed white then the possibility becomes an actuality. Even this method is not infallible.

The dog in *Photo D* was bred to a color headed white bitch. The litter contained no color headed white offspring. The laws of probability state that 50 percent of the offspring should carry the ($s^w s^w$) allele pair.

$(s^i s^w) \times (s^w s^w) = (s^i s^w), (s^w s^w)$
sire dam offspring

So much for the laws of probability.

In a sidelight concerning the two dogs used as examples: in researching the background on the bitch, I discovered that her sire often produces the white stifle markings apparent in the photograph. Several bitches displaying these markings have been bred to white factored studs. No colored headed whites have been produced from these breedings. I believe that an (s^i) allele contributed by this stud carries a minus gene modifier which decreases the amount of color which appears. I maintain that the wide unusual face blaze is additional evidence to support this conclusion, as these extensive facial markings are also produced by this particular stud. This modifier apparently mimics the stifle markings often exhibited by those Shelties who are truly white factored.

In reference to the dog pictured in *Photo D*, it is my supposition that a plus modifier may be at work here. This gene modifier increases the amount of color manifested. The (s^i) allele of this dog derives from a stud who on occasion produces puppies who are fairly plain. As mentioned previously, and as a point of conjecture, this dog's dam, the sable headed white, may perhaps carry the (s^p) allele instead of another (s^w) allele, producing an ($s^p s^w$) allele pair. The (s^p) allele may also carry a gene modifier as well. If anyone can shed any light on this, or provide more information I would greatly appreciate the input.

When breeding a white factored dog, the best rule of thumb is to assume any resulting offspring are white factored. If you are uninformed about a prospective stud dog with respect to the white factor, be sure to ask the dog's owner. He or she should know, or they should be honest enough to admit the possibility if they are unsure. Do some pedigree research. Try to find full body photos of the dog if you cannot visit in person. If the dog shows the white stifle markings the possibility of the white factor should be assumed until inquiries have proven otherwise. Try to find photos of his parents. If either of them show the white stifle markings, and the stud owner is unsure, assume the presence of the (s^w) allele. This course of action may limit your breeding options, but if a homozygous white is anathema to you, it is the surest way to avoid the ($s^w s^w$) allele pair.

How prevalent is the white factor in Shelties? In a rough estimate I concluded between 50 and 60 percent of Sheltie breeding programs have dogs who carry the (s^p) or (s^w) alleles. Among those breeding programs which heavily incorporate the Banchory bloodlines, this percentage may approach 90 percent.

Of those breeders who use white factored dogs, most avoid breeding two (s^w) allele carriers together. On the whole, the breeders who concentrate on an AOAC program tend to be more open minded concerning color headed whites. It does appear, however, that these breeders are more likely to breed two blue Shelties together than two white factored dogs. Perhaps dealing with a possibly deaf and/or blind dog as is possible with a double merle is easier than dealing with a dog who is physically normal, but who is ineligible for an AKC championship. These breeders are also more prone to keep a double merle in their breeding programs than a color headed white.

The ramifications of the white factor on a breeding program depends on the individual breeder. To some, it is ignored; any resulting color headed white is evaluated exclusively on quality. Their color, or lack of it, is considered superfluous. To others, the white factor is considered to be of such importance that breedings of otherwise excellent potential are avoided, so as to eliminate the possibility of ($s^w s^w$) offspring. And there are those breeders who shun the white factor entirely in their breeding programs.

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