**TFT Genetics**
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## Part 5: TFT Coat Color – Basic Principles

In this essay I will discuss the basic principles of coat color in TFTs, while in the next essay I will go into a more detailed genetic analysis. Coat color in Toy Fox Terriers is both simple and yet simultaneously complex. There are two (some would say three; others would even say there are four) basic varieties and then some variations of the theme. The two basic varieties are the white, black & tan (often referred to as tri-color) and the white & tan. The third variety is the white & black, in which there is no tan coloration. The fourth variety is frequently referred to as chocolate. It is, in fact, a white, chocolate & tan in which the black pigment found in the tri-colors has been modified to produce the chocolate coloration. In UKC this last variety is not accepted primarily because the modification was first introduced through outcrosses to Chihuahuas. Other characteristics introduced by those outcrosses were so undesirable that the practice was terminated and care was then taken to breed for type. To the breeders at that time, any chocolate coloration indicated that some of the genes introduced from the Chihuahua were still present and therefore those dogs should not be bred. They still appear occasionally and their occurrence may well increase since chocolates are accepted in the AKC standard even though they are still not accepted in the UKC standard.

Variations of the TFT coat color include the degree of body coloration, the location of body spots, and the appearance and degree of ticking in which the underlying skin is pigmented but the overlaying hairs are white. In both the UKC standard and the AKC standard bodies should be over 50% white and heads should be predominately pigmented (black, tan, or chocolate) as long as the predominant head color is the same as the color of the body spots, if any. The concept of predominance also causes some confusion because on some dogs with a lot of body color it may look as if it exceeds 50% when you look from the side or from above. However, if you look at the entire body, including the underside of the barrel they may well have more than 50% white. TFT breeders often have differing opinions as to what is preferred. Some prefer few, if any, body spots. Others either don't care or prefer more extensive body coloration as along as it does not exceed the 50% specified in the standard. Locations of body spots and of white coloration on the heads are more explicit in both standards. Ticking has also been a source of confusion for judges and others because both the UKC and AKC standards are somewhat vague. The UKC standard reads: "Ticking is permitted to some degree provided the white predominates and general good looks are maintained." The AKC standard reads: "Clear white is preferred, but a small amount of ticking is not to be penalized." Thus it is left to the judge's discretion as to what constitutes the maintenance of "general good looks" and what constitutes a "small amount".

Unfortunately, the genetics of TFT coat color is even more confusing. Mating outcomes have sometimes been referred to as a "genetic gamble" because, like games of chance, genetics involves the principles of probability and with a few exceptions no-one can predict mating outcomes with any degree of certainty. However, some general statements can be made that are supported by genetic analysis. A good explanation of coat color in dogs is given in the book entitled: "Genetics: An Introduction for Dog Breeders" by Jackie Isabell, pp. 103-123. The book is published by Alpine Blue Ribbon Books of Loveland, Colorado and is available through Amazon.com; However, even though it is a good explanation it takes a reasonable background in genetics and a lot of head-spinning thinking to make sense of it all]

The most obvious observation to TFT breeders who have been at this a long time, and indeed the most predictable outcome is that if you breed two tri-colored dogs the offspring will all be tri-color, with the exception of the rare appearance of a chocolate. Based on the genetics involved, one would also predict that two chocolates bred together should produce all chocolate offspring. However, when white & tans are introduced into the equation the possible outcomes become less predictable. Breeding a tricolor to a white & tan should, by genetic probability principles, either produce a 50:50 mixture of tri-colors and white and tans, or, alternatively, should produce only white & tans. However, we all are quite familiar with such breedings that have actually produced 3 or 4 tri-colors with 0, 1, or 2 white & tans. In other words, all combinations are possible. This is because we are dealing with small sample sizes when we speak of individual litters. Probability principles are based on the most likely outcomes when sufficiently large samples are used. It's like flipping a coin. If you flip it 10 times you should get 5 heads and 5 tails, but you could get 6 and 4, 7 and 3, 8 and 2, 9 and 1, or even 10 and 0 for either heads or tails. However, if you flip it 1,000 times you are more likely to come close to the predicted value of 500 heads and 500 tails. Some deviation is possible but you probably would not ever get 1000 heads and 0 tails (unless the coin is weighted somehow). So it is when breeding tricolors to white & tans. If both color outcomes are possible then any combination of those outcomes is also possible.

What about the outcome of breeding two white & tan dogs. While it depends to a large extent on the genes in the two individuals it is safe to say that if the two white & tans each had one tricolored parent it would be possible to get both white & tan and tricolored offspring from the mating, although tricolors should occur less often than when a white & tan is mated to a tricolor. If one or both of the dogs had white & tans for both parents then the probability of tricolored offspring becomes even lower. The further back in the pedigree you have to go to find a tricolored ancestor, the less likely you will produce any tricolored offspring. This is largely a theoretical discussion based on the relationships of the genes involved. In practice, many breeders are reluctant to breed two white & tan dogs to one another because they believe that to do so tends to produce offspring in which the coloration is not as rich in intensity as that produced by mating a white & tan to a tricolor.

Finally, we have to consider the extent of body coloration. The degree of spotting, and therefore, the extent of body coloration is a complex situation that appears to rely on what geneticists refer to as quantitative genetics. This means that the extent of coloration is not determined by any one gene, or even a small number of genes. Instead it is determined by the number of genes for spotting pattern inherited from both parents. Let's call these coloration genes. Because of the random nature of gene distribution during the formation of eggs in the bitches and sperm in the male dogs it is possible for offspring to inherit anywhere from zero up to the number of coloration genes present in the parent's DNA. The more such genes inherited from either or both parents, the more body color will be present. To use some arbitrary numbers, let's suppose that one parent has 6 such genes and the other parent has 8. Let's further suppose that each parent has less than the 50% allowable body color. Furthermore, let's suppose that after mating these two dogs 3 puppies are born. Puppy A gets 1 coloration gene from one of the parents and 3 from the other parent for a total of 4. Puppy A therefore, will have less color than either parent. Puppy B gets 3 from one parent and 4 from the other for a total of 7. Puppy B will have more color than one parent but less than the other. Finally, Puppy C gets 5 from each parent for a total of 10. Puppy C will have more color than either parent. Depending on how many coloration genes it takes to exceed the allowable 50% it is possible for Puppy C to have too much color even though both parents are within the breed standard. Given the cumulative, quantitative nature of body coloration, and given the principles of probability it is safe to say that the

chances of producing a puppy with too much color are highest if both parents have a lot of color, are lower if only one parent has a lot of color, and are lowest if neither parent has a lot of color. Given this situation the reaction of most people would be to say that if you want to minimize the risk of exceeding allowable 50% body coloration you should always breed dogs with minimal body coloration to one another. However, there are two potential problems with this approach. Suppose you take this to the extreme and breed two dogs with all white bodies (no body spots at all) to one another. You now increase the probability of producing puppies that have mismarked heads with too much white or with white that touches the ears and/or the eyes. Such mismarkngs are disqualifications in both the UKC and AKC breed standards. Another problem that has been observed by at least some breeders is that dogs with more body coloration also often have darker and richer color intensity. Therefore, in striving for minimal body coloration the breed could lose some of the richness of color in those body spots that are present and on the head. To prevent either of these problems from occurring, it may be desirable to, at least periodically, if not consistently, breed a dog with more body color (25-40%) to one with minimal color (0-20%). This should hopefully maintain the color intensity while resulting in only a small risk of producing offspring with too much color.

All of this suggests that while you can tip the scale in favor of the desired outcome you cannot guarantee that outcome with any degree of certainty. The basic premise of the “genetic gamble” is that you “breed the best to the best and hope for the best”.