Colour Patterns and Belted Galloway Registries

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The Belted Galloway can be considered to be a dual purpose breed—aesthetics and beef. It is the balance of these two attributes that attracts most of the breed's admirers. Minus either attribute the Belted Galloway would be of little interest to either cattlemen or hobbyists. It is thus very important that every Belted Galloway breeding program involve appropriate selection for both components, i.e. for both aesthetics and beef.

For the Belted Galloway the aesthetic component involves temperament, conformation, size, hair coat, and colour pattern. (Note: A distinction has been made here between 'colour' and 'colour pattern'.) Of these it is colour pattern that is the single most striking; and it is colour pattern that presents the most difficult and persistent challenge. Fortunately, in cattle, there is no evidence to indicate that any colour pattern is genetically linked to any beef characteristic. There is no genetic reason why the best beef animal in the world could not have a white belt around its midriff And, more importantly, there is no genetic reason why every animal with a white belt around its midriff cannot be a good beef animal.

The genetics for colour patterns and the genetics for beef characteristics are inherited totally independently of each other. However, selection for colour pattern and selection for beef characteristics can often be at odds with each other. Individual animals with the desired colour pattern do not necessarily have desirable beef characteristics and visa versa. This mutual selection interference is not unique to colour patterns and beef characteristics in Belted Galloways. The same problem occurs for all pairs of characteristics, for all species, under all circumstances, wild or domestic.

Selection for beef characteristics in the Belted Galloway should be no different from selection for beef characteristics in any other cattle breed. Information on, and help with, selection for beef characteristics is available from many sources. Further, the most desirable, beef characteristics in a particular environment for a particular management are not necessarily the most desirable beef characteristics under all circumstances. Thus there is good reason to leave selection for beef characteristics to the individual breeder.

Selection for colour pattern, on the other hand, should be a breed registry matter. The most desired colour pattern for the breed varies little from one breed registry to another. The genetics for both the desired colour pattern, and the mismarking that interferes with that colour pattern, are constant throughout the species. And, assistance with colour pattern selection is not readily available from any other source. Thus every Belted Galloway breed registry should offer its membership guidelines on colour pattern selection. Further, mistakes in colour pattern selection can propagate less desirable genetic combinations for colour pattern inheritance. The resulting decrease in the frequency of desirable genetic combinations can make it more difficult for

every Belted Galloway breeder to produce well marked animals. Thus every Belted Galloway registry should also have well defined colour pattern registration policies. Policies that are understood by everyone involved and enforced.

Here arises a major problem for Belted Galloway breed registries. The rules of eligibility and other registration practices of a Belted Galloway registry must be designed to be consistent with the inheritance of the relevant colour patterns for the breed. Consistent with the inheritance of both the desired colour pattern—the belt—and the undesired colour pattern complications—the mismarking. The genetics involved sets the absolute parameters. And, given that the objective is to consistently breed animals with a particular colour pattern, the breeders and their registry must function within those genetic parameters.

The rules of any registry will be consistent with the genetics involved only to the extent that the relevant inheritance, and the importance of that inheritance, is understood by the persons responsible for the rules. Most Belted Galloway breeders and breed registries, however, have failed to realize the limitations that the genetics of colour pattern inheritance place on consistently breeding well marked Belted Galloways. The problem is two fold. First, useful interpretation of the relevant information available on colour pattern inheritance requires a balance of genetics, animal husbandry, and purebred 'politics'. Such interdisciplinary interpretations have not been readily available. And second, many Belted Galloway breeders, and thus indirectly their breed registries, actively resist any attempt to revise established registry practices in line with relevant genetics. Nevertheless, it is imperative that all colour pattern registration policies of all Belted Galloway breed registries be consistent with both the genetics of colour pattern inheritance in cattle and the realities of purebred cattle production.

A progressive Belted Galloway breed registry should thus actively pursue belting and belted mismarking colour patterns on three fronts:

A. Interpretation of relevant genetic information.
B. Research into the genetics of belting and belted mismarking.
C. Review of registry regulations.

A. Interpretation of relevant genetic information.

First the difference between 'colour' and 'colour pattern'. The colour of an animal is a result of the pigment, or lack of pigment, in its hair and skin. The colour pattern is the distribution of that pigment, or lack of pigment, on the body of the animal. The terms 'colour' and 'colour pattern' are often confused in reference to the 'Galloway-Belted Galloway-White Galloway' family. A black Galloway with a white udder, a black Belted Galloway, and a White Galloway with black points are all the same colour-black and white. Where the three differ is in their colour patterns. The Galloway has a solid colour pattern. The Belted Galloway has a belted colour pattern. And the White Galloway has a white park colour pattern.

There has been very little genetic research done specifically with belting and belted mismarking. There has, however, been a significant amount of work done with colour pattern inheritance in general, in cattle and in other mammals. This related genetic information can be used to help understand the probable mode of inheritance of belting and belted mismarking. For the present, part of the interpretation of the inheritance of colour pattern in the Belted Galloway must be based on this related colour pattern research. The resulting interpretations are not as conclusive as they could be if they were based on specific belting and belted mismarking studies. Whatever the information source, all interpretations must be subject to adjustment as more data becomes available.

The belted colour pattern is generally considered to be determined by a single, autosomal, dominant gene. In other words, belting is controlled by one gene, that gene is not sex-linked, and that gene is dominant to the 'wild' or 'original' type (i.e. solid coloured). However, the expression of belting in any given animal can be influenced by several factors. Belted colour pattern variation or mismarking can be divided into three main groups by cause:

- **a.) those without a specific genetic cause.**
- **b.) those caused by a lack of belting genetics.**
- **c.) those caused by the interference of other colour pattern genetics.**

The first—no specific genetic cause—is a random result of the action of the belting gene in the early stages of development of the fetus. This form of mismarking cannot be predicted and thus cannot be planned against or worked with. It is a possible cause of some imperfect belts. The second—the lack of belting genetics—causes only one form of mismarking, i.e. no belt. The third—the interference of other colour pattern genetics—causes most forms of mismarking. (Even a few 'no-belts' are caused by extraneous colour pattern genetics.) The genetics for extraneous colour patterns can be dominant or recessive, single or linked in groups, or any of the myriad of possibilities between either extreme. None, however, have been demonstrated to be sex-linked.

Most mismarking can be explained by the interference of extraneous colour pattern genetics. Given the history of the breed, it would be highly unlikely for there not to be some extraneous colour pattern genetics present in every Belted Galloway population. And, further, given the regulations of several Belted Galloway registries, it is highly likely that extraneous colour pattern genetics are very prevalent in some Belted Galloway populations. Two resulting assumptions should be noted:

- **a.) The relatively high incidence of mismarking in the Belted Galloway could be taken to indicate that belting is not controlled by not a single gene and/or that belting genetics is not strictly dominant. There is, however, good evidence to support the theory that belting is controlled by a single dominant gene. Further, mismarking can be explained by assuming a single dominant belting gene and interfering extraneous colour patterns. Thus, for the**

purposes of this report, belting will be assumed to be controlled by a single, autosomal, dominant gene.

b.) There is an element of randomness, possibly influenced by environmental factors, involved in some mismarking. Nevertheless, most mismarking can be explained by interfering extraneous colour patterns, many Belted Galloways are well marked, and there are some consistently well marked families of Belted Galloways. Thus, for the purposes of this report, most mismarking will be assumed to be inheritable.

(In general, the probable mode of inheritance of belting and belted mismarking will be assumed to be as presented in "Mismarking in Belted Galloways" by Hugh R. Crawford, Carmangay, Alberta, Canada, October 11, 1992, revised December 23, 1994. Copies are available from the Canadian Galloway Association.)

B. Research into the genetics of belting and belted mismarking

Useful research into the inheritance of belting and belted mismarking could be undertaken by any Belted Galloway breed registry regardless of size or budget. First, the research can be cumulative and thus involve the effort of more than one Belted Galloway registry. And second, the research itself can be inexpensive. The process of good scientific research can be viewed as involving three steps—planning, collection of data, and interpretation of results. (A conscientious scientist would add a fourth step—verification.) Planning the research and interpreting the results would require the assistance of qualified persons knowledgeable in the relevant genetics. However, that help would probably be available at little cost by taking advantage of two aspects of the scientific community. First, many scientists are, either directly or indirectly, public servants in capacities that do considerable extension work. And second, graduate students at most academic institutions are eager to find projects that are challenging, useful, and inexpensive. Gathering the data necessary for a scientific interpretation of the genetics involved in the inheritance of belting and belted mismarking could be as simple as appropriately initiating a second program currently needed by Belted Galloway breeders. To consistently produce a high percentage of well marked animals Belted Galloway breeders need a reliable form of colour pattern monitoring. With consultation and planning, that colour pattern monitoring could simultaneously collect the data for colour pattern research. Every application for registration and resulting herd book entry could be designed to record the information necessary for both colour pattern monitoring and colour pattern research.

Thus on going breed registry coordinated research into the inheritance of belting and belted mismarking colour patterns should involve at least three steps:

a.) Initial consultation to define the colour pattern problems involved and to identify the data necessary to interpret the inheritance involved in those problems.

b.) Collection of the necessary data by the breed registry through a colour pattern monitoring program.

c.) Periodic consultation to interpret the colour pattern data collected and to identify the mostly likely mode of inheritance of the relevant colour patterns from that data. (A few specific test matings may be necessary to verify a particular conclusion.)

C. Review of registry regulations

The regulations of all Belted Galloway registries should be subject to periodic review to ensure their continued consistency with the most likely mode of inheritance of the colour patterns involved in belting and belted mismarking. Any changes, and the reasons for those changes, should be fully explained to all Belted Galloway breeders effected.

As explained above, for the purposes of this report, it has been assumed that:

a.) belting is controlled by a single, autosomal, dominant gene.
b.) belted mismarking is, for the most part, caused by interfering extraneous colour patterns.

Thus:

a.) Given that belting itself is dominant any animal with only one belting gene (i.e. heterozygous) can be belted. Yet only animals with two belted genes (i.e. homozygous) will 'breed true' and produce only belted calves. Homozygous animals cannot be identified by pedigree, visual inspection, or laboratory test. Only a breeding test involving appropriate matings can reliably differentiate between homozygous and heterozygous belted animals.

b.) Given that the genetics controlling extraneous interfering colour patterns can be recessive a Belted Galloway can carry unexpressed mismarking genetics. This is further complicated by the fact that some of the extraneous colour patterns may involve more than one gene at more than one loci (i.e. genes from more than one location in the chromosomes). These colour patterns are only expressed when the right combination of different genes are present . Thus even well marked individual Belted Galloways can carry 'hidden' mismarking that can 'reappear' in later generations. It should be noted that single, dominant, interfering colour patterns (e.g.. white face) do not present a problem. When such genes are present they are expressed and thus readily selected out.

These two factors—the dominance of belting and the recessiveness and interaction of some mismarking—set limitations on the types of registration practices appropriate for the Belted Galloway breed. Based on the above assumptions regarding the most probable mode of inheritance of belting and belted mismarking. Belted Galloway breed registries should consider the following four aspects of Belted Galloway regulation:

1.) Monitor and track colour pattern

The disappearance and reoccurrence of mismarking in the Belted Galloway often noted by frustrated breeders is probably a result of recessiveness and linkage in extraneous colour pattern genetics. To the extent that those extraneous colour patterns are inheritable, mismarking can be controlled by appropriate breeding. However, the mode of inheritance of those extraneous colour patterns and their distribution through the Belted Galloway population are unknown. Without that knowledge it is impossible to consistently plan and complete an appropriate breeding program. The occurrence of many perfectly marked individual Belted Galloways, and the occurrence of some consistently well marked Belted Galloway families, tends to indicate that most forms of mismarking are inherited and inherited independently of belting. However, that inheritance is intricate enough that mismarking will probably not be successfully controlled by the current intuitive mating practices. Further, until the inheritance and distribution of mismarking are better understood, even professional advice on appropriate matings will be of little help.

Mismarking will only be controlled through appropriate planned matings. Those matings can only be planned when both the inheritance of mismarking and the genetic history of the mated individuals is understood. The first step in acquiring that knowledge is to appropriately categorize, identify, and track the various forms of mismarking. Appropriate accurate colour pattern tracking will:.

a.) supply the raw data necessary for a professional interpretation of the inheritance of mismarking.

b.) supply the history on each animal necessary for breeders to productively use that interpretation.

However, not all forms of tracking will fulfill this dual roll. To do so the categories of mismarking identified and tracked must be consistent with the genetics of colour pattern inheritance in the bovine.

Thus the mismark categories used in the tracking process should be decided in consultation with qualified personnel. Care should be taken not to split the physical expression (i.e. phenotype) of any one genetic cause into more than one category (e.g.. white on the lower legs divided into above and below the level of the dew claws). Splitting would cause unnecessary record keeping and could result in unreasonable expectations . (e.g.. There is probably no genetics that can keep white below the level of the dew claws.) Care should also be taken not to group together forms of mismarking that could have different genetic causes (e.g. narrow belt and spots in the belt). Grouping would significantly reduce the value of the information collected without reducing the amount of record keeping. It should be noted that:

a.) some forms of mismarking should be culled and thus will not warrant tracking (e.g. white face and no belt).

b.) any one animal can have more than one form of mismarking.

The categories developed must then be described simply and accurately so as to be understood and used by all breeders.

The single most effective way to ever control mismarking would be with such a 'genetically friendly' colour pattern tracking program. This approach could control mismarking even faster than the more drastic measure of refusing registry to all mismarked animals. The 'cull' approach has three major drawbacks:

a.) to cull all mismarks does not identify the carriers of recessive extraneous colour pattern genetics (i.e. the parents of mismarked animals) for the benefit of other Belted Galloway breeders.

b.) to cull all mismarks removes mismarked animals but does not remove the carriers of recessive mismarking and thus does not reduce the incidence of mismarking genetics.

c.) to cull all mismarks does not add to the data base of mismark inheritance essential to understand and control mismarking.

The initial design of a 'genetically friendly' colour pattern tracking program and the periodic review of accumulated data would take extra time and effort. However, the day-to-day administration of the program would add little to the time and expense of operating the registry. A 'genetically friendly' colour pattern tracking program, periodic review of the accumulated data by qualified personnel, and dissemination of any conclusions to breeders could significantly reduce the incidence of mismarking in Belted Galloways.

2. Restrict the introduction and spread of extraneous colour pattern genetics

All non-Belted Galloways used to produce animals entered in a Belted Galloway registry must be as devoid of other colour pattern genetics as possible. Every animal used that has other colour pattern genetics potentially adds more extraneous colour pattern (i.e. mismarking) genetics to the Belted Galloway population. A solid coloured animal devoid of all other colour pattern genetics could be said to be homozygous solid coloured. However, it should be noted that to be homozygous solid coloured is not to have two genes for a solid colour pattern. There are no solid colour pattern genes. Rather the solid colour pattern is what results when there is no other colour pattern. Thus to be homozygous solid coloured is to not have any of the genes for any of the other colour patterns.

The homozygous aspect here is crucial. The extraneous colour patterns that will cause the most trouble, and thus should be avoided, are recessive and/or linked in groups and therefore can be present but not expressed. Homozygous solid coloured animals could be identified by breeding tests from the commercial cattle population. However, such testing would be impractical given that it would be necessary to test for all colour patterns. The only practical source of animals with a high degree of probability to be

homozygous solid coloured is the pedigreed animals of solid coloured breeds. Given that the Belted Galloway is polled, and that polled is dominant to (and thus can cover up) horns, there should also be a second restriction. All non-Belted Galloways used to produce animals entered in a Belted Galloway registry should be pedigreed animals from polled, solid coloured breeds.

Until the genetics of mismarking is more fully understood, it would be advisable to take two precautions even within polled, solid coloured breeds:

a.) avoid non-Belted Galloways with white on their underline regardless of breed or pedigree.

b.) be extra cautious of dun coloured non-Belted Galloways. Light coloured patches can be white spots and it is very difficult to identify white on a homozygous dun animal.

Besides restricting all non-Belted Galloway influence to pedigreed animals of polled, solid coloured breeds. Belted Galloway registries should discourage the use of non-belted animals with belted ancestry regardless of pedigree. Animals with belted parentage but with no belts fall into one of two categories:

a.) Most non-belted animals with belted parentage did not inherit any genetics for belting from either parent. Thus, if only one parent was belted, that parent was heterozygous belted. And, if both the sire and the dam were belted, both the sire and the dam were heterozygous belted. These non-belted animals are themselves homozygous non-belted.

b.) A few non-belted animals with belted parentage inherited the genetics for belting (probably only one gene and are thus heterozygous) but also inherited enough modifying genetics to 'shutoff or 'cover-up' the belt. Although these animals do not have an obvious belt, they are actually extremely imperfectly belted.

Only a breeding test involving matings to homozygous solid coloured animals can differentiate between these two types of non-belted animals.

The first type of non-belted animal—those with no belting genetics-should only be used in a Belted Galloway breeding program as base animals to produce half bloods in an upbreeding program. (Note: This is the first type. Only a breeding test can differentiate between the first and second types.) The belted progeny of these 'first-type' non-belted animals mated Belted Galloway will, like all half bloods, be heterozygous belted. Half of the progeny of these first cross animals, when mated to homozygous belted animals, will also be heterozygous. As will one-quarter of the grandchildren, one-eighth of the great-grandchildren, etc. All inheritance is paniculate: a gene is never diluted out. Through time (i.e. successive matings) a gene becomes more diffused through the population, and thus more difficult to find, but the gene does not disappear. In fact without negative selection pressure (in this case an active test for, and elimination of, heterozygosity), the frequency of occurrence of a gene in the population remains constant. To use 'first-type' non-belted animals

other than to produce half-bloods is to start the diffusion of non-belting in the Belted Galloway population at a point farther into an upbreeding process than the first cross.

The second type of non-belted animal—those with extreme modification—should never be used in a Belted Galloway breeding program. The modifiers that shutoff belts, put spots in belts, and/or take bites out of belts are, to the Belted Galloway, genetic defects. Any animal with enough modification to completely shutoff or cover-up a belt should be treated like any other seriously genetically defective animal. They should be culled.

In review:

a.) There are two types of non-belted animals with belted parentage.
b.) The first type of non-belted animal has limited use.
c.) The second type of non-belted animal should not be used.
d.) The two types of non-belted animals can only be differentiated by breeding tests involving matings to homozygous solid coloured animals.

Therefore, every Belted Galloway registry should discourage the use of non-belted animals with belted parentage.

3. Identify and reward homozygosity

In any domestic population with an important dominant trait an attempt should be made to identify those individuals homozygous (and thus 'true breeding') for that trait. In the case of the belted colour pattern of the Belted Galloway there are two possible approaches: a.) identify individual homozygous animals through breeding tests. b) assume that the foundation animals had a high degree of homozygosity and identify direct descendants of those animals. These two approaches are not exclusive and could be combined in some way.

The breeding tests required to identify homozygous individuals are not difficult. A test producing ten or more calves, all belted, from matings with homozygous solid coloured cattle gives a 99.9% verification that the tested animal is homozygous belted. Those ten calves need not all be born in the same year. Nor must they be produced from ten different matings. All matings must, however, involve one solid coloured parent. And, all matings must produce only belted calves. Ten calves from a test sire is obviously not difficult, and, with embryo transfer, ten calves from a test dam is not impossible. With an open herd book any belted calves produced in a test could be recordable as half-bloods.

The second approach—to assume a high degree of homozygosity in the foundation animals—is easier but far less reliable. First three definitions;

a.) Foundation Belted Galloways would be the original animals admitted to the original herd book. Some of the ancestry of those foundation animals could have been unknown. None of the ancestors of those foundation animals would have had Belted Galloway registration numbers.

b.) Fullblood Belted Galloways are animals with every line of ascent in their pedigrees traceable only to foundation animals.

c.) Purebred Belted Galloways are animals with upbred backgrounds that have, in theory, attained a predetermined percentage of Belted Galloway ancestry.

It is tempting to assume that the foundation animals were 'true' Belted Galloways and thus their fullblood descendants are 'true-breeding' (i.e. homozygous). However, most Belted Galloway registries have not been keeping track of their fullbloods. Most breed societies of other breeds with open registries actually maintain two herd books. One closed for fullbloods. And one open with an an upbreeding appendix for purebreds. Most Belted Galloway registries, on the other hand, have only one herd book and register fullbloods and purebreds together under a continuous numbering system with no distinguishing notations. Thus Belted Galloway fullbloods can only be identified through a thorough pedigree search. A search that must go to foundation animals, not just the United Kingdom herd book, because the herd book in the United Kingdom is one that has mixed fullbloods and purebreds.

The original Belted Galloway herd book was started in 1921 and remained open to inspected animals for several years. Note:

a.) There was no attempt to chose only homozygous belted animals as foundation Belted Galloways.

b.) Each individual foundation Belted Galloway could have been heterozygous. (Those entered in the original herd book with one Galloway parent definitely were.)

c.) There has never been an attempt to identify and remove heterozygous fullbloods. d.) There are far too few generations in a small population between the original foundation animals and the present fullbloods to have identified all heterozygosity by casual observation.

Thus, although the probability of homozygosity in fullbloods may be somewhat higher than in purebreds, there is no assurance of homozygosity in any given individual fullblood.

It would be advantageous to identify homozygosity for the belting gene. In this case, heterozygosity and homozygosity cannot be differentiated by visual inspection or laboratory test. And, although pedigree information can be helpful, pedigree study it is not conclusive. Only breeding tests are reliable. To be identified as homozygous would be highly desirable and a homozygosity identification program would probably be well received. (Heterozygosity, on the other hand, is undesirable and it is thus very doubtful if a heterozygosity identification program would ever receive the cooperation needed to be usefull.) There could be no short cuts, however. A homozygous identification program would have to involve simple, planned, breeding tests and appropriate recognition.

4. Revise counterproductive and restrictive policies

a.) Sexist and directional upbreeding

Most Belted Galloway registries have provisions for an appendix upbreeding program. Unfortunately, most appendix programs have the standard 'purebred-males-only' and 'increase-Belted Galloway-percentage-each-generation' approaches. Both restrictions—sexism and directionality—are unnecessary and counterproductive. Sexist, directional upbreeding programs were designed for maximum return to established breeders. Sexist, directional upbreeding programs were not designed for maximum breed improvement. Sexist, directional upbreeding programs are designed to provide markets for purebred bulls, increase the numbers in the breed, and keep the breed constant. Sexist, directional up breeding programs do not necessarily facilitate breed improvement.

The belted colour pattern is not sex-linked and there is no genetic justification for a sexist registration policy. A percentage animal with a Belted Galloway dam is as much a percentage animal as one with a Belted Galloway sire. In fact, given that all genetic material is not confined to the nucleus, every animal is actually more closely related to its dam than to its sire. The sire supplies one-half of the nuclear genetic material for its offspring. The dam supplies the other half of the nuclear genetic material and all of the cytoplasmic genetic material. The importance of this maternal cytoplasmic inheritance is not known but it is possible that it could effect some aspects of embryology. The belt is probably formed fairly early in embryo development and could conceivably be influenced by maternal inheritance. Also, the best, and most reasonably priced, outside beef production genetics available from polled, solid coloured breeds will probably be available through bulls and/or A.I. Thus, in addition to being totally unnecessary, a sexist restriction can be counterproductive.

There is also no reason why each successive generation in the appendix must produce a higher percentage of Belted Galloway. The Appendix could simply record the exact percentage of Belted Galloway from any given mating. The breeder could then use outside males and/or females, percentage males and/or females, and/or purebred males and/or females in whatever combination or order best suits their breeding program. This freedom could become essential in any future anti-mismarking programs. 'Purebred' could be defined as any animal over a designated percentage of Belted Galloway. The registry's computer could then be programmed to calculate the exact percentage of Belted Galloway and not round any percentage upwards. The result would be simple to administer, fair to all breeders, and effective as an aid to both reduction of mismarking and improvement of beef production.

b.) White below the dew claws

The only form of mismarking currently monitored by at least two Belted Galloway registries is white below the dew claws of herd book females. There

are two genetic complications with singling out white on the lower legs and/or feet of herd book females for preferential treatment:

i.) None of the genetics for white in the Belted Galloway is sex-linked. Females with white on the lower legs and/or feet have the same colour pattern genetics as similarly mismarked males. Thus, animals with identical genetics and identical abilities to 'pass-on' mismarking are treated differently.

ii) There is no documentation that any genetics restricts the extra white to below the level of the dew claws. There is good reason to believe that the same genetics that puts white below the level of the dew claws also regularly puts white higher on the leg and periodically puts white elsewhere on the body. Thus, genetics that can probably periodically put fairly large patches of white on the body is maintained.

The 'dew claw' rule also presents potential problems from an administrative point of view. The dew claws are on the back of the lower legs. Dew claws do not encircle the legs. White on the legs below the level of the dew claws but on the front of the legs is not technically below the dew claws. It would be more accurate to state 'below the level of the dew claws' or 'below the fetlock joint'. Also the dew claws are not points but are rather several centimeters deep. Is "below' meant to be below the top, middle, or bottom of the dew claws? Is the rule meant to include animals with both colour and white below the level of the dew claws? (Some animals have white 'anklets' rather than 'socks'.) Does the rule apply only to hair and skin, or are white hooves permissible? And the inevitable question: What about the animals with two white hairs above the level of the dew claws?

The expression of white on the lower legs and/or feet is random. The genetics involved does not restrict the white to below any anatomical point. A subjective word like 'small', 'slight', or 'moderate' to indicate the amount of white better describes the physical expression (i.e. phenotype) of the genetics involved than an anatomical point. (With a subjective description each breeder would be obliged to decide for themselves where 'small', 'slight', or 'moderate' stops. The market place would probably rapidly apply any necessary correction to the breeders' interpretation.) Thus, although one form of mismarking is being tracked, the data being collected is of questionable value in the understanding of the inheritance of white feet and, thus, in the control of mismarking. And, to the extent that monitoring white below the level of the dew claw implies that any extra white on any progeny will be restricted to below the level of the dew claw, the registries involved are misleading their breeders.

The Belted Galloway's striking colour pattern—the belt—is both a strong attraction and a persistent problem. The odds can be improved! Consistent production of well marked animals can be increased with a knowledge of colour pattern inheritance and with appropriate breed registry regulations. Good luck.

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