Inheritance of Color Pattern and Shade of Hair Color in Hereford Cattle

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The red and white color pattern of Hereford cattle has long been one of the breed's distinguishing trade-marks. The breed originated in England some two hundred years ago from cattle of mixed colors and breeding. By selection for a given type and color pattern, a beef animal with red body, white face and under-parts, white feet, white at the end of the tail, and white feather along the top of the neck to the rear of the shoulders, has been developed. Certain deviations from the above color pattern do, however, still occur among the progeny of registered parents, and some discrimination against individuals with these departures is usually made by breeders in the selection of breeding stock.

The two deviations which are most severely criticized by American breeders include "red-necks" and "line-backs." Red-necks are those cattle whose white feathering along the top of the neck is missing or greatly reduced while line-backs are those which have white hair along the topline behind the shoulders. The degree of these deviations varies quantitatively and the amount of emphasis placed upon these color deviations varies with individual breeders. Other deviations such as "red-eye", "smutty-nose" and "black-tail" do occur and breeders usually practice some selection against these also. It was reported in 1957 (See Okla. Agri. Exp. Sta. Misc. Pub. MP-48, p. 28) that the amount of eyelid pigmentation was highly heritable in Hereford cattle and that cattle with pigmented eyelids had fewer cases of eyelid cancer than cattle with non-pigmented lids. No lid lesions were observed to develop on completely pigmented lids, but the pigmentation of the eyelid did not prevent the development of lesions on the eyeball or on the nictitating membrane.

As a result of the above observation, a study was conducted to determine the relationship between eyelid pigmentation and color pattern of Hereford cattle with particular reference to the deviations of line-back and red-neck. It was also designed to study the inheritance of these two traits and to determine the nature of the inheritance of shade of hair color which may vary from light yellow to dark red. Considerable variation in breeder preferences for shade of hair color exists in different parts of the United States.

Nature of the Data and Methods of Analyses

The data were obtained from 312 Hereford cows and 434 calves sired by 38 different bulls during 1956 and 1957 at the Ft. Reno Livestock Experiment station. An additional 83 female progeny of the above parents dropped during 1954 and 1955 were used in parts of the

study. Each animal was scored visually for topline pattern by evaluating the amount of white on the neck, shoulders, and back. The system of classification contained nine classes with numerical values being assigned to each animal according to the following key:

Numerical Score	Description of Topline Pattern
1	Red-neck (no white present on topline)
2	White flecks, or small white spots, on neck
3	White patches on neck but not enough to be desirable
4	Sufficient white on neck to be desirable but sparing
5	Perfectly marked individual
6	More white than necessary but not a line-back
7	Small white spots on back or loin
8	Large white spots on back or loin
9	Line-back (white extending along entire topline)

The first three classes (1, 2, 3) would be discriminated against by breeders who discriminate against red-necks and the last three classes (7, 8, 9) would be discredited by those who discriminate against line-backs. The three remaining classes (4, 5, 6) could be considered to be desirably marked.

Each animal was scored for shade of hair color by comparing its hair coat to a color standard containing seven different hair samples which varied from light yellow to very dark red. The light yellow animals were scored as 1 while the darker colored animals received the larger scores with a score of 7 being assigned to the darkest red animals.

The values for eyelid pigmentation were obtained from color photographs and were expressed as a percentage of the eyelid length which was pigmented. It varied from zero for animals devoid of eyelid pigment to 100 for those having completely pigmented eyelids.

Heritability estimates were calculated for topline pattern and for shade of hair color by four different methods: (1) the intra-sire regression of offspring's score on dam's score; (2) the paternal half-sib, intra-class correlation using a nested classification which removed the average effects of year, age of dam, and line or experimental treatment; (3) the paternal half-sib, intra-class correlation without adjustment for the above sources of variation; and (4) the regression of offspring's score on mid-parent's score (the average score of the sire and dam).

The correlations between topline pattern and eyelid pigmentation, shade of hair color and eyelid pigmentation, and topline pattern and shade of hair color were calculated within groups and pooled.

Results and Discussion

It was found that the scores for both the topline color pattern and shade of hair color were controlled to a marked extent by hereditary factors as shown in Table 1. The heritability estimates for these traits ranged from 35 to 67 percent. The estimates based upon the intra-sire regression of offspring on dam were somewhat higher than those

Table 1.—Heritability estimates for topline pattern and shade of hair scores

Methods of Analysis	Extent of Data	Heritability Estimates	
		Color Pattern	Shade of Color
(1) Intra-sire regression of offspring on dam (b x 2)	517 dam-daughter pairs	.67	.59
(2) Paternal half-sib, intra-class correlation (nested) (r x 4)	43 degrees freedom for sires	.35	.36
(3) Paternal half-sib, intra-class correlation (un-nested) (r x 4)	37 degrees freedom for sires	.42	.56
(4) Regression of offspring score on mid-parent score (b x 1)	419 parent-offspring pairs	.54	.49

b = regression coefficient
r = correlation coefficient

obtained from the paternal half-sib, intra-class correlations. The estimates obtained by regression of offspring score on mid-parent scores were intermediate to those obtained by the other methods and they may be somewhat more reliable. These heritability estimates indicate that one could expect to increase or decrease the amount of white along the topline of Herefords rather rapidly by selecting for more or less white. They also indicate the possibility of changing the shade of hair color by selecting for lighter or darker shades of color.

Although the heritabilities of the scores for both the amount of white on the topline and the shade of hair color are rather high, these do not necessarily indicate the degree of success one may expect to attain by selecting for a given desired color pattern or shade when the goal is an intermediate amount of white or shade of color. They do indicate that one could reduce the amount of white toward zero (red-neck) or increase the amount of white toward 100 percent (lineback), but since these extremes are discriminated against by breeders and an intermediate amount of white at a specific location is desired, it is interesting to look at the results one could expect to obtain with varying degrees of selection for the desired color pattern. Table 2 shows the distribution of the offspring's color pattern corresponding to that of their parents. Of the 419 offspring in this study for which the scores of both sires and dams were known, 294 (70 percent) were considered to be desirably (scores 4, 5, and 6) marked with 59 (14 percent) having too little white (scores 1, 2, and 3) and 66 (16 percent) having misplaced white (scores 7, 8, and 9) and falling in the line-back classification. Among the 252 offspring from desirably marked parents (scores 4, 5, and 6) 188 (75 percent) were desirably marked with equal numbers of the remaining offspring being classified with too little or too much

Table 2.—Distribution of offspring color pattern according to color pattern of parents

Class of Parents	Offspring Class				% Each Class		
	Total	R	D	L	R	D	L
Total	419	59	294	66	14.1	70.2	15.7
DxD	252	32	188	32	12.7	74.6	12.7
5x5	142	18	108	16	12.7	76.1	11.2
RxR	8	7	1	0	87.5	12.5	0
RxD	74	16	52	6	21.6	70.3	8.1
DxL	69	2	44	23	2.9	64.8	33.3
RxL	14	2	8	4	14.3	57.1	28.6
LxL	2	0	1	1	0	50.0	50.0

D includes scores 4, 5 and 6 (cattle classified desirable)
5 is the score assigned to cattle marked most desirably
R includes scores 1, 2, and 3 (cattle classified "red-neck")
L includes scores 7, 8, and 9 (cattle classified "line-back")

white. If one further restricts the color pattern of the parents to those perfectly marked (score of 5) only 142 offspring were available and of these only 108 (76 percent) were desirably marked (scores 4, 5, and 6) with the remainder being equally divided among the red-neck and line-back groups.

These data suggest rather strongly that the amount of white preferred by breeders is due to some sort of intermediate genetic situation which may never become completely fixed by selection of breeding stock based upon their own appearance. The data in this study, however, did not include enough matings of the extreme types to determine the exact number of gene pairs involved or the specific mode of gene action concerned with either the amount of white on the topline or the shade of hair color. The fact that breeders differ in their preferences for the shade of hair color, some preferring the yellow and others the darker red shades, means that the genetic situation which apparently exists with regard to the intermediate is not likely to be such a handicap to those who prefer the extremes. The major handicap to the effective selection for shade of hair color involves errors in classification due to certain environmental factors which influence shade of hair color such as age, season, and age of dam.

It was stated earlier that one of the purposes of this study was to determine whether or not the selection for eyelid pigmentation would disrupt the Hereford color pattern with regard to the amount of white on the topline or the shade of hair color. The correlation between the amount of eyelid pigmentation and topline pattern scores was .06 for 585 individuals and was not significant. This indicated that there was little if any relationship between the two items and that one could expect to increase eyelid pigmentation without adversely affecting topline color pattern. There was a small but significant correlation of .12 between the amount of eyelid pigmentation and shade of hair color score. This indicated a tendency for the darker animals to have eyelids with slightly more pigment, but the correlation is so small that one

could increase eyelid pigmentation without any appreciable effect upon the shade of hair color. The correlation between the scores for topline pattern and shade of hair color for 974 animals was —.07 and barely significant, meaning that there was a tendency for the animals with the most white along the topline to have the darkest shade of red color. Again the correlation is so small that one can assume that the two traits are independent for all practical purposes.

Summary

A study of the inheritance of topline color pattern and shade of hair color was made from scores obtained from 517 offspring and their 312 dams and 38 sires at the Ft. Reno station during 1956 and 1957. The results indicated that the amount of white along the topline of Herefords and the shade of hair color were sufficiently heritable (.35 to .67 for amount of white on topline and .36 to .59 for shade of hair color using different methods of analyses) that one could expect to make changes in either trait by selection for either more or less white on topline or for lighter or darker hair coat. A study of the data, however, indicates that the preferred amount of white on the topline of Herefords is the result of an intermediate genetic situation and that it is not likely that selection of breeding stock for this trait will fix the color pattern for this preferred intermediate. Additional data need to be obtained to determine more precisely the nature of the genetic situation with regard to the number of gene pairs involved and the specific mode of gene action concerned with the expression of this trait. The correlations between the two traits above and the amount of eyelid pigmentation were so small that one could assume the three items to be independent. One could, if he wished, increase the amount of eyelid pigmentation without disrupting the color pattern or changing the shade of hair color in his herd.

Fattening Trial with Western Feeder Lambs in Dry Lot

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The number of lambs fattened in Oklahoma varies from about 25,000 to 75,000, depending on feed availability and price outlook. Most of these lambs are fattened by grazing on wheat pasture, however, some are fed in dry lot. This project was initiated in the fall of 1952 at the Ft. Reno Station to study various methods of fattening feeder lambs, making maximum use of home-grown feeds.