# The Genetics of the Hereford Pattern

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# THE GENETICS OF THE HEREFORD PATTERN[1]

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It is a well-known fact that red calves occasionally are produced in the Aberdeen-Angus breed and red-and-white calves in the Holstein-Friesian. In the Hereford breed, on the other hand, every calf is white-faced. No attempt hitherto has been made to explain this last mentioned phenomenon. By making use of genes recently proposed by the senior author (1933) and by taking into consideration what is known concerning the mode of formation of the Hereford breed, a fairly satisfactory explanation can be made.

In order to make this explanation intelligible it will be necessary to discuss briefly the genes directly, and, to a slight extent also those indirectly, concerned. The pertinent historical facts will then be mentioned and the genetic deductions therefrom will be presented.

Evidence obtained recently proves fairly conclusively that the whole Hereford pattern, by which is meant the pigmented as well as the white part of the coat, is due to one gene, $S^H$, which is allelomorphic to self *(S)* and to recessive white spotting *(s)*. Based on a few cases, it has been assumed that $(S^H)$ is incompletely dominant to *S*. Information furnished the authors by Professor Rufus F. Cox, of the Kansas State College, gives added weight to this assumption. He states that between the years 1909 and 1914 many ranchmen in western Texas, and particularly the owners of the Stanley ranch in Wheeler county, mated Angus bulls $(S^S)$ to Hereford cows, most of which were high grades. Hundreds of crossbreds $(S^HS)$ were produced, and invariably they showed less white than the Hereford dams. A large majority, if not all, had legs that were entirely pigmented; in many only a small portion of the belly was white, and in approximately all the pigment extended well forward on the head. Unpublished data obtained by the authors show that $S^H$, on the other hand, is completely dominant to *s*.

Other genes, previously described in detail by the senior author (1933), which will be taken into consideration in the present discussion are black-spotting *(Bs)*, found usually in Jerseys and

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Ayrshires, and brindling *(Br)*, which acts on *(Bs)* to produce the brindle character.

Since *($S^H$)* is incompletely dominant to *S*, but completely dominant to *s*, the simplest and the surest method for producing a homozygous strain of "white-faces" *($S^HS^H$)* from a mixed population would be to mate white-faces, whether homozygous or heterozygous, to selfs, preferably homozygous *(SS)*, and retaining for further breeding those white-faces that had a very small amount of white *($S^HS$)*. The latter when inbred should produce on the average one-fourth good, homozygous, white-faces *($S^HS^H$)*, one-half white-faces with too little white *($S^HS$)*, and one-fourth selfs *(SS)*. The continual discarding of recessive white-spotted *(ss)* animals, if any should occur, would also help matters.

Strange as it may seem, the above method was practically the one followed by the founders of the Hereford breed, altho they had no conception genetically of what they were doing. The historical material given here is taken from Wallace (1907). It seems to be generally agreed that the original cattle of Herefordshire were self reds *(S)* with black extremities *(Bs)*. These animals were closely related to the ancestors of other present-day self breeds such as the Devon, Welsh and Sussex. The white-face character supposedly was introduced from three different sources, (1) Flanders (where the Groningen breed, also white-faced, is in existence at the present time), (2) Yorkshire, and (3) by mutation in the "herd of an ancestor of P. Tully". It is evident that little, if any, recessive white spotting *(s)* was present in the foundation stock of the Hereford breed, and for that reason it became a simple matter to produce true breeding white-faces.

When the Hereford Herd Book appeared in 1845 four different color types were in existence, and were eligible for registry. These were described as "mottled face, dark grey, light grey, and white faced." The mottled-faced probably corresponded to what are now called "brockle-faced" and were due to a dominant gene, *Pl*, which causes not only the large pigmented spots on the face, but also extra pigment on the legs. This gene could easily be eliminated by selection because of the fact that it is a dominant. We have not as yet been able to ascertain what was

meant by dark grey and light grey[2]. If animals with these colors were "blue gray" (black roans, *BBNn*) there also should have been whites with black points *(BBNN)* and blacks *(BBnn)*.

In the early history of the breed there were a few brindles *(Bs, Br)*. Later, the brindle character and black hairs *(Bs)* were considered undesirable and selection was practiced to rid the breed of them. At the present day, however, animals are still produced that have what appear to be black hairs. These hairs are usually found in the tail. Mr. E. N. Wentworth (communication to authors) is of the opinion that at least many of these "black" hairs are actually red hairs with the pigment granules very closely packed. There is, nevertheless, the possibility that the animals having black hairs do carry Bs, but that the amount of the black has been greatly decreased by selection. The brindling gene, *(Br)*, may be found in the breed at the present time, but, since it does not express itself except in the presence of *Bs*, one does not become aware of its presence except by a cross with a breed carrying *Bs*. If some Herefords actually carry *Bs* the amount of black is so small that it undoubtedly would be extremely difficult to determine whether such animals also carry *Br* since there probably would not be enough black present for it to form into the characteristic stripes of the brindle character. Another difficulty is that the brindling gene does not seem to affect the black hairs of the tail.

It should not be assumed from the foregoing account that the authors believe they have completely solved the problem of the inheritance of the Hereford pattern. More crucial evidence is necessary before it can be stated with complete certainty that the postulated gene for the Hereford pattern $S^H$, is allelomorphic to self *(S)* and to recessive white-spotting *(s)*. After this question has been settled there still will remain considerable work to be done with the modifiers of the Hereford pattern.

Miss Pitt (1920) has made but a beginning in the study of the Hereford pattern modifiers. In order to obtain more data on the subject the authors are keeping photographic records of all pure-bred Hereford calves born at the Kansas Agricultural Experiment Station, and also of calves produced by nurse cows (chiefly grade Holsteins) mated to Hereford bulls. In addition, data that bear on the question are being collected from various herds in

2 After the paper had been presented we were informed by Mr. E. N. Wentworth that so-called, unregistered, "greys" still are to be found in Herefordshire, and resemble in appearance the grayish animals occasionally seen in purebred Jerseys. Such individuals undoubtedly would tend to breed fairly true.

the state of Kansas and adjoining states. The Hereford pattern modifiers, so far as they are known, have been described and labeled (Ibsen, 1933), but there is every reason for believing that with a fuller knowledge many changes will have to be made in our present concepts.

LITERATURE CITED

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## EIGHT YEARS OF COOPERATIVE MEAT INVESTIGATIONS

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It was in 1924 that the first steps were taken toward organization of the cooperative project, "A Study of the Factors Which Influence the Quality and Palatability of Meat." In 1925 the research activities were actually begun. Approximately 25 state experiment stations and the United States Department of Agriculture have engaged in the work each year during the 8 years which have ensued. The participating stations have spread from the Canadian line to the Gulf of Mexico and almost from coast to coast.

"Cooperative Meat Investigations" replaced the original title of the project in 1930, on unanimous agreement of the cooperating institutions. The work was and is, in fact, more a field of investigation than merely a major project. It is now widely regarded as a permanent addition to the general field of animal husbandry research.

It has been apparent from the beginning that this field of investigation divides itself into two major parts. One includes the various factors which affect the quality of meat, their relative importance and control. The other deals with the basically important subject of methods—the development of methods which will be adequate to measure differences in the several characteristics of meat, regardless of how large or small they may be. This phase of meat investigations proceeds quietly and the developments receive little publicity. However, progress in it is greatly necessary to success in the work. As investigators we should always be ready to give full credit to a fellow worker who supplies us with improved technique.