COAT COLOR, PATTERN, HORN CONDITION AND BLOOD GROUPS IN CATTLE*

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by

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With a few exceptions, cattle breeds are kept uniform for superficial traits. Therefore, studies for linkage of blood groups with other genetic traits are thwarted. In studies of dwarf cattle, it has been necessary to cross breeds and obtain various segregants appropriate to such study. The present report is fragmentary. However, the authors prefer the viewpoint that the opportunity should not be neglected.

As reported briefly (Miller and Gregory, 1960), the sire family of one Angus-Hereford bull has exhibited genetic segregation for black versus red coat color, for whiteface versus self pattern, for polled versus horned, and for phenogroups in eight systems of blood groups. Forty-eight offspring of this bull now have been typed and classified for the above traits.

Materials and Methods

The blood typing procedure in cattle has been described often (cf Stormont and Cumley, 1943). Most of the reagents indicated by Stormont (1962) were used in these tests. However, a few (e.g.N, R', S') were too new to have been used on the earlier progeny.

The cattle used were bull 44, and F_1 Angus-Hereford, and the dams (Herefords, Angus, and Shorthorns and hybrids thereof) to which he was mated and their progeny. All these cattle were in the large dwarf herd under study by Gregory and others (cf Gregory, P. W. et al. 1964).

While minor qualifications (e.g. brockle face and scurs) may be involved in the expression of the non-blood group traits mentioned, it is generally believed that red color, self pattern, and horned condition are simple recessives to their alternatives mentioned (cf Shrode and Lush, 1947). They were so treated in the present material. For example, even though both parents were brockle face, a pure white face offspring was not assumed to be homozygous for it.

Small numbers allow a test only for very close linkage. Of the genes known to be transmitted to the offspring by the bull, if the gene for blood group F were closely linked to that for polled in bull 44 as $\frac{f^F \quad p^P}{f^V \quad p^+}$, one should find only two transmission classes of progeny.

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TABLE 1

SAMPLE OF DATA SHOWING SEGREGATION AND ASSORTMENT

OF BLOOD GROUPS, COAT COLOR, PATTERN, AND HORN CONDITION IN A SINGLE SIRE FAMILY

Animals	System			Marker loci		
	B	F-V	S	Color	Pattern	Horns
Sire 44 (F_1 Angus - Hereford)	O_1/O_xA'	F/V	H'/-	B/b	WF/+	P/+
Dam 63	$Y_1D'I'/-$	F/F	S/-	b/b	WF/WF	+/+
calf 250	$O_1/-$	F/F	-/-	B/b	*WF/+	+/+
Dam 163	Q/I'	F/F	-/-	B/b	+/+	P/
calf 339	O_xA'/I'	F/V	H'/-	b/b	+/+	*P/

B = black WF = white face P = polled
b = red + = normal or self pattern + = normal or horned

*Cannot detect sire's contribution

Then type F, polled and type V, horned of the four possible classes are expected while type F, horned and type V, polled should be absent. That is, diagonal corners of a 2x2 table would be deficient (likely completely void with small numbers involved) or have an excess, the deficient classes being the "cross over" combinations. If the genes for the traits are independent, the numbers in a 2x2 table should be relatively equal.

Often the sire's contribution could not be detected. For example, if both the sire and dam were genetically polled as well as the offspring (cf calf 339 in Table 1), it could not be determined which parent contributed the gene for polled. Only those combinations which represented a test cross or an appropriate segregation (as a horned offspring from a polled dam and sire) could be included in the data. The bias this introduces is serious but may be minimized, if one can assign offspring to any three of the four classes in the 2 x 2, or if oppositional classes representing "cross overs" are filled in the 2 x 2 combinations, and if one tests only for very close linkage.

Results

The full blood type of bull 44 is given in Fig. 1. Only his Z, A and M systems for which the bull is homozygous cannot be tested for linkage.

Fig. 1

Blood Group Systems of Bull 44

B	C	F-V	Z	S	A	L	J	M	N	R'-S'
O_1/O_xA'	C_1/C_2EW	F_1/V_1	-/-	H'/-	D/D	L/-	J/-	-/-	N/-	R'/S'

A sample of the kind of information available is presented in Table 1. The slash marks separate the genetic alternatives as is conventional in genetics.

Data in Table 2 are presented in 2 x 2 form. The traits whose controlling genes were known to be transmitted by the bull are listed across the top (and at the very bottom down the side) for the color, pattern and horn status, and down the side for the blood groups in 8 systems. The gene for type O_1 was transmitted 6 times along with a gene for black color and 9 times along with a gene for red color (i.e. non-black) by bull 44. The allele controlling O_xA' was transmitted four times with black and 11 times with that for red, etc.

Only the R'-S' system with horn condition and the N system with pattern lacked a "test" of close linkage in spite of the small numbers.

Discussion

The B, C, F-V and S systems have the highest numbers. The J system may have an additional bias since the weak J possessed by bull 44 may have been undetected in some progeny which were killed before maturity. However, three of the four combinations for each morphological trait were noted for the J system.

TABLE 2

KNOWN GENETIC CONTRIBUTIONS OF BULL 44 TO 48 PROGENY

System	Blood Group	Color		Pattern		Horn condition	
		black	red	white face	self	polled	horned
B	O_1	6	9	3	4	3	7
	O_xA'	4	11	2	5	5	5
C	C_1	4	10	4	2	2	6
	C_2EW	4	7	-	4	4	3
F-V	F_1	4	12	-	1	3	5
	V_1	6	5	3	4	2	6
S	H'	3	5	1	2	2	4
	-	6	9	3	6	4	7
L	L	1	1	1	-	1	1
	-	3	6	2	3	3	4
J	$\pm$J	-	3	-	1	1	-
	-	7	14	5	2	4	9
N	N	1	-	-	1	1	-
	-	2	1	1	-	2	2
R'-S'	R'	-	4	-	3	-	-
	S'	-	5	-	1	1	2
	white face	3	-				
	self	2	3				
	polled	4	3	1	2		
	horned	6	3	1	1		

No significant indications of linkage were present. The few apparent associations, e.g. red with no J and black with J, might well be due to the biases mentioned in the data.

The color, pattern and horn condition tested against each other also appear independent (cf bottom of Table 2).

Such a study could be greatly improved by being able to select many cows to which the bull could be testcrossed. For example, if this bull could have been mated to numerous red shorthorn cows selected for blood type, a much larger portion of the progeny would be classifiable as to the bull's contribution.

Summary

The sire family of one Angus-Hereford bull has exhibited genetic segregation for black versus red coat color, for white face versus self pattern, for polled versus horned, and for phenogroups in eight systems of blood groups. Segregation of the bull's phenogroups was at random or not significant with respect to the morphological characters, reasonably excluding close linkage with the B, C, F-V, S, L and J blood group systems.

References

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