

THE EXPERIMENTS OF T. H. RICHES CONCERNING THE PRODUCTION OF MONSTERS IN CATTLE

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IN the following account I have put together the main results obtained by my friend, the late T. H. Riches, in a series of experiments on cattle conducted by him during the past ten years. From a conversation with him shortly before his death last September, I gathered that he had been able to establish a definite point in connection with the genetics of certain forms of monstrous cattle, and this has been confirmed by an examination of his records. Further, some pencilled jottings among his papers are clear evidence that he viewed the case in the manner in which I have set it out below. The initiation, conduct and interpretation of the experiments are all his: my part has been that of the discriminating scribe. We may account it fortunate that so much progress had been made before his death, for such work could only have been undertaken by a man of keen scientific interest with the backing of ample private means.

It is well known that Dexter cattle mated together produce a proportion of monstrous "bull-dog" calves approaching to one-quarter of the total progeny¹, whence it has been concluded that we are here dealing with the incidence of a lethal factor which in the homozygous state brings about the production of the non-viable monster², and in the heterozygous state results in the short-legged animal of the Dexter type. The long-legged animals of the Kerry type also produced from the Dexter \times Dexter mating are the homozygous individuals from which the lethal factor is absent. To account for the varying proportions in which monsters appear in different herds of Dexters, Crew (1923) has suggested that there is a dominant low-grade achondroplastic factor which finds its expression in animals of the typical Dexter type, and that this becomes lethal only in conjunction with two other complementary factors. The hypothesis is admittedly speculative, and to establish it would require

¹ The largest series of figures from this mating with which I am acquainted is that given by Crew (1923), where 116 monsters are stated to have occurred in a total of 646 births. It seems to me not improbable that in such a case as this the numbers of the lethal monsters are for various reasons likely to be understated. Records of appreciable numbers bred under scientific control are not available.

² Portraits of some of these "bull-dog" calves are to be found in Crew's paper.

a large amount of critical breeding. For the purpose of subsequent discussion I shall take the view usually accepted, viz. that in the Dexter we are concerned with a single lethal factor.

Monstrous calves of a somewhat similar type are also thrown in certain herds of the Telemark breed of Norwegian cattle. The work of Mohr (1926) and of Wriedt (1930) has shown that we are here concerned with a definite lethal factor. The case differs in some respects from that of the Dexter. In the first place the heterozygous animal carrying the lethal does not differ visibly from the homozygous animal which lacks it; secondly, the lethal is not so potent. Unlike the Dexter monster, which is generally born prematurely, the Telemark monster calf normally goes the full term and is born alive. Death, however, generally supervenes within a few days owing to respiratory troubles. Although the achondroplastic condition is evident enough in the skull, limbs and general body formation it is not so marked as in the Dexter monster¹. Malfunctioning of the pituitary (hypophysis cerebri) has been suggested in both cases as the responsible causal agent—for the Dexter by Crew (1923) and for the Telemark by Mohr (1926). The experiments to be recorded here were designed to ascertain the genetical relation between the lethal factors in the two breeds—whether they are (1) identical, the difference in manifestation being due to some modifying factor, (2) whether they are members of a series of multiple allelomorphs, or (3) quite independent.

Through the kind collaboration of Prof. Mohr and Dr Wriedt a Telemark bull, "Thor", was imported in 1925 in order to mate with Dexter cows. Before leaving Norway he had been shown to carry the recessive lethal of the Telemark breed². Mated with eight Dexter cows he produced in the years 1926–31 twenty-four calves and one mummy (cf. Table I). Of these twenty-four calves five are recorded as of the long-legged type, eleven as typical Dexters, while eight were not recorded for this feature. Since Mr Riches generally made a point of recording animals of the Dexter type I am inclined to think that the eight animals unrecorded in respect of this character were probably of the long-legged type; in which case the mating would have produced approximately equal numbers of the Dexter and of the normal long-legged types. Of the Dexter cows used two, viz. Coolham Cecilia and Grinstead Tern,

¹ Illustrations will be found in the papers of Mohr (1926) and Wriedt (1927, 1930). From the account given by Caruichael (1933) it seems more likely that the monsters produced by certain South African cattle are of the Telemark rather than of the Dexter type.

² Confirmation of this was obtained in the course of the experiments; for he produced a Telemark monster when put to one of his daughters, viz. Cunning (cf. Table II).

TABLE I.

Records of pure Dexter cows with various bulls

Coolham Cecilia	D. Black					
	× Telemark	♀	L. 1926	Black	Critic	
	"	♀	D. 1927	Black	Carina	
Grinstead Tern	"	♂	—	1928	Black	
	D. Black					
	× Telemark	♀	L. 1926	Black	Crosspatch	
	"	♀	L. 1927	Chocolate		
	"	♀	D. 1928	Dark brown	Sturdy	
	"	♀	—	1929	Black	
Alvechurch Beatrice	"	♂	D. 1930	Black		
	× Sturdy	♂	—	1931	chocolate	
	"	♂	D. 1933	Chocolate		
	"	♂	D. 1933	Black		
	"	♂	D. 1934	Black		
Alvechurch Blossom	D. Black					
	× Telemark	♀	—	1926	Red	
	"	♀	D. 1927	Red	Enigma	
	"	♀	L. 1928	Light fawn		
	"	♀	—	1929	Chocolate	Elegance
	"	♀	L. 1930	Chocolate		
	× Dreadnought	♀	D. 1931	Black		
"	♀	L. 1933	Black	Dauntless		
"	♀	D. 1934	Black			
La Mancha Dote	D. Black					
	× Telemark	♀	D. 1925	Black	Midget	
	"	♀	L. 1927	Black	Contrary	
	"	♀	—	1928	Black	
	"	♀	—	1929	Black	
	"	♀	—	1930	Black	
	"	♀	D. 1931	Black	Curiosity	
	"	♀	L. 1932	Black		
	"	♀	L. 1933	Black		
× Telemark	♀	—	1926	Black		
Sunshine of Hookstile	D. Black					
	× Telemark	♀	D. 1926	Black	Crafty	
	× Dreadnought	<i>D. monster</i>				
	"					
Midget	D. Black					
	× Critic	♀	D. 1927	Black	Illegality	
	× Telemark	♀	D. 1929	Black	Coy	
	"	♀	D. 1930	Black	Tiny	
	"	♀	D. 1931	Black	Catastrophe	
	× Dreadnought	♂	L. 1932	Black		
× Sturdy	<i>D. monster</i>	1935	Black			
Curiosity	D. Black					
	× Sturdy	♀	L. 1935	Black		
Quernmore Alice	D.					
	× Telemark	♀	—	1929	Black	
"	♀	D. 1930	Red	Expectancy		

Note. D denotes Dexter and L normal long-legged type.

TABLE II

Records of F_1 cows, etc.

Crafty (F_1)	D. Black					
	× Telemark	♀	—	1929	Black	Craven
	”	♀	D.	1930	Black	
	”	♂	—	1931	Red	
	× Sturdy		<i>D. monster</i>	1932		
”	♂	—	1933	Red		
”	”		Mummy	1935		
Crosspatch (F_1)	L. Black					
	× Telemark	♀	—	1929	Black	Orthodoxy
”	♀	L.	1930	Red		
Constancy (F_1)	D. Red					
	× Telemark	♂	—	1929	Red	Success
	”	♀	D.	1930	Red	
	”	♂	—	1931	Red	
	× Sturdy	♂	D.	1932	Black	
”	♀	D.	1933	Red		
”	♀	D.	1934	Black		
Carina (F_1)	D. Black					
	× Telemark	♀	L. (?)	1929	Red	
	”	♂	D. (?)	1930	Black	
× Sturdy		<i>D. monster</i>	1931			
”	”		<i>D. monster</i>	1934		
Enigma (F_1)	D. Red					
	× Telemark	♂	—	1930		Charity
	× Dreadnought	♀	D.	1932	Black	
	× Sturdy	♂	—	1933	Black	
	”	♀	L. (?)	1935	Red	
Cunning (F_1)	L. Brown					
	× Telemark		<i>T. monster</i>	1931	Brown	
	× Dreadnought	♂	L.	1932	Black	
Coy (F_1)	D. Black					
	× Sturdy		<i>T. monster</i>	1932		
	× Dreadnought		<i>D. monster</i>	1933		
	”	♂	L.	1934	Black	
	× Sturdy	♀	L.	1935	Black	
Illegality	D. Black					
	× Sturdy	♀	L.	1930	Chocolate black	Doubtful
	× Dreadnought	♂	—	1932	Black	
”	♀	—	1933			
Charity	D. Black					
	× Sturdy	♂	L.	1935	Red	

were known to have produced monsters before they came into the possession of Mr Riches, while one other, Sunshine of Hookstile, produced a monster when put to a Dexter bull in the course of the work. No monster made its appearance in the course of the matings between the Dexter cows and "Thor", and this fact alone tells strongly against the identity of the lethal factors in the two cases. For if this were so, and if the difference in expression were due to a modifying factor in one or other of them, we should have expected six monstrous calves of a grade intermediate between the two types of monster. Yet not one made its appearance in this relatively long series. Moreover, the hypothesis of multiple allelomorphs is equally ruled out. For here again we should have expected the appearance of half a dozen monsters. There remains therefore the highly probable assumption that these two lethals are quite independent, and that each breed carries the normal factor corresponding to the lethal of the other. Thus if **D** represent the normal factor of the Dexter and **d** the lethal, and if **T** represent the normal factor of the Telemark and **t** the lethal, the cross we have been discussing is of the nature **DdTt** × **DDTt**. Since every animal from such a mating must contain both **D** and **T**, expectation is normals only, though of course the **Dd** animals would be of the Dexter type. But such F_1 animals may be genetically of four kinds, viz.:

$$\left. \begin{array}{l} \mathbf{DDTt} \\ \mathbf{DDTt} \end{array} \right\} \text{Long-legged type.} \qquad \qquad \qquad \left. \begin{array}{l} \mathbf{DdTt} \\ \mathbf{DdTt} \end{array} \right\} \text{Dexter type.}$$

In other words half of the F_1 animals of the Dexter type should also carry the **t** lethal, and we may now consider the breeding results obtained from them.

As shown in Table II, five F_1 cows of the Dexter type were mated with "Sturdy", also an F_1 animal of the Dexter type. The resulting progeny may be tabulated as follows:

Dexter type	...	...	...	5
Long-legged type	...	...	...	2
Dexter monster...	...	...	...	3
Telemark monster	...	...	...	1

With two of the F_1 cows, viz. "Carina" and "Crafty", "Sturdy" produced Dexter monsters, and with one of them, "Coy", he produced also a Telemark monster. These results are remarkably close to expectation on the assumption that "Sturdy" is genetically **DdTt**, and that the five F_1 cows may be either **DdTt** or **DdTt**. As set out in the conventional scheme below, the expectation from the **DdTt** × **DdTt** type of mating is six Dexters, three normals, three Dexter monsters, three

Telemark monsters, and one Dexter-Telemark monster in every sixteen animals.

DT DT Norm.	DT Dt Norm.	DT dT Dext.	DT dt Dext.
Dt DT Norm.	Dt Dt T.M.	Dt dT Dext.	Dt dt T.M.
dT DT Dext.	dT Dt Dext.	dT dT D.M.	dT dt D.M.
dt DT Dext.	dt Dt T.M.	dt dT D.M.	dt dt D.T.M.

D.M. = Dexter monster.
T.M. = Telemark monster.
D.T.M. = Dexter-Telemark monster.

Again, expectation from the **DdTt** × **DdTt** cross, as shown below, is Dexters, normals, and Dexter monsters in the ratio 2 : 1 : 1. On the normal assumption that half of the F_1 cows are of the constitution

DT DT Norm.	DT Dt Norm.	DT dT Dext.	DT dt Dext.
dT DT Dext.	dT Dt Dext.	dT dT D.M.	dT dt D.M.

DdTt and half are **DdTt**, the expectation from "Sturdy" mated with his Dexter sisters is

					Actual Nos.
Dexters	...	...	...	6 + 8 = 14	5
Normals	...	...	...	3 + 4 = 7	2
Dexter monsters	...	...	...	3 + 4 = 7	3
Telemark monsters	...	...	...	3 = 3	1
Dexter-Telemark monsters	...	...	...	1 = 1	0

The actual numbers obtained, though small, are clearly in close accord with expectation. What a Dexter-Telemark monster (**ddtt**) would look like we cannot say. It might resemble an ordinary Dexter monster, or it might present a distinctive appearance. The obvious method of deciding the point would be to breed a considerable number of monsters from the **DdTt** × **DdTt** type of mating. The available material is, however, far too scanty to undertake this with any reasonable prospect of success.

A few matings were also made between "Sturdy" and normal Dexters. Expectation here is Dexters, normals, and Dexter monsters

in the ratio 2 : 1 : 1. Of the five animals so bred, as may be gathered from Table I, one was a Dexter, two were normals, one was a Dexter monster, while one was unrecorded (*i.e.* either a Dexter or a normal). The results are clearly in accordance with expectation.

From this series of experiments the fact of the independence of the two lethal factors emerges clearly, and this may eventually have an important bearing upon the aetiology of the achondroplastic condition in other living forms, including man.

Colour. The colours of the animals bred were for the greater part recorded, but the records add little to our previous knowledge. All of the pure Dexters were stated to have been blacks¹. Their progeny from the red Telemark bull ("Thor") were as set out below:

	Black	Brown	Fawn	Red
Coolham Cecilia	3	—	—	—
Grinstead Tern	2	3	—	—
Alvechurch Beatrice	—	2	1	2
Alvechurch Blossom	1	—	—	—
La Mancha Dote	2	—	1	1
Sunshine of Hookstile	1	—	—	—
Midget	3	—	—	—
Quernmore Alice	1	—	—	1

Three of these cows evidently carried recessive red. Black or brown F_1 cows mated back with their red sire give four black, one brown and five red. These data are in accordance with the well-known fact that red is recessive to black, as also are the few cases from "Sturdy" mated with his sisters, either black or red (cf. Table II). Brown must be regarded as belonging to the black class as opposed to red, but the data are too scanty to attempt to establish any relation between the two. Fawn is a colour sometimes met with in the pure Dexter. Only two examples appeared in the experiments, and one of these, "Cunning", was recorded as a brown when adult.

Pattern. Telemark cattle are of the "colour-sided" type, showing a white dorsal stripe, white belly, and usually some white on the head². Wriedt (1925) has brought forward evidence that this type of white

¹ For most of these there is no record of colour in the notes, and since most of them are now dead I have had to rely upon the memory of the cow-man. I have no doubt, however, that they were either clean blacks or else of a dark black brown. The distinction between these was not always made. Thus *Elegance* (cf. Table I) was recorded in one place as a dark chocolate and in another as black. The only record for another calf is "black, actually dark brown". I do not regard the records as sufficiently critical for any discussion of the relation between brown and black. Here I may mention the case of "Enigma", a red F_1 cow stated to have had a black patch on the left loin. It seems of sufficient interest to place on record in view of similar cases mentioned by Horlacher (1928).

² Figures of Telemark cattle are given by Wriedt (1927, p. 64 and 1930, pp. 88-9).

pattern behaves as an incomplete dominant to self-colour, and is dependent upon a single genetical factor. From such records as I have been able to extract from the notes the results of the Telemark-Dexter cross support this view. The sixteen F_1 animals recorded for pattern all exhibited white markings of the Telemark type, though the amount of white showed some variation. Some are described as very like the sire in this respect, while in others the amount of white was reduced. The greatest reduction was in the bull "Sturdy" where the dorsal stripe was reduced to a linear patch at the base of the tail though there was a fair amount of white ventrally. Nine animals from F_1 cows crossed back to "Thor" all showed the Telemark pattern, the amount of white being generally as much as or not much less than in the sire. Of six F_2 animals from "Sturdy" four are recorded as with much white, one with some white, while in one case no white is recorded, though it is not specifically stated to be absent. Of three animals from F_1 cows crossed back to the Dexter no white is recorded in two cases, while in the third there was some white on the udder only.

SUMMARY

Monstrous calves due to the operation of a lethal factor have long been known to appear as the result of mating Dexter cattle together. A similar type of monster, though rather less marked, has been met with in Norwegian Telemark cattle. Its appearance is also due to the operation of a lethal factor. The experiments recorded show that these two lethals are genetically independent.

A few observations on the inheritance of colour and of the white pattern of Telemark cattle tend to confirm the results of earlier observers.

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