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Bovine Congenital Porphyrinuria (Pink Tooth) Inherited as a Recessive Character.

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THE first clinical cases of bovine congenital porphyrinuria were recorded by Fourie (1936). Towards the end of 1935 the Division of Veterinary Services acquired certain grade shorthorn animals from the herd in which the condition was found. These animals were brought to Onderstepoort with the object of studying (1) the hereditary nature of the condition, (2) the pathogenesis, and (3) the biochemical nature of the excreted porphyrins, etc. However, since the condition was recognised in this grade shorthorn herd, three further definite cases of pink tooth in bovines were found in the Union of South Africa as well as a fourth case in a shorthorn bull which is at the present time regarded as a very suspicious case of pink tooth. Confirmation of the diagnosis is being awaited pending the results of certain breeding experiments which were undertaken. These animals fall roughly into four groups, and as such they will be discussed from the hereditary point of view.

Group 1 comprises the Swaziland cases referred to by Fourie, 1936. Group 2 is the suspected shorthorn bull not yet reported in the literature but to which passing reference is made by Fourie and Roets (1934) (elsewhere this journal). Group 3 comprises the Cedara case reported by Fourie and Rimington (1938). Group 4 consists of two Friesland heifers (Ladysmith cases) in which the Government Veterinary Officer, Mr. Flight, made a clinical diagnosis of pink tooth. The diagnosis was confirmed when the urine and faeces were examined spectroscopically and revealed typical porphyrin bands.

GROUP 1.—THE SWAZILAND CASES.

The full history of these cases was given by Fourie (1936). The owner used three shorthorn bulls to improve his herd. When calves were produced as a result of the mating of the third bull to cows and heifers in the herd the first cases of congenital porphyrinuria appeared. The first cases were, therefore, not produced by mating father and daughter. When it was realized that the condition may possibly be transmitted hereditarily, great pains ware taken to find out if the third bull used by the owner was in any way related to

the previous bulls. The owner did not know of any such relationship, but later when careful enquiries were made it was definitely established that the sire of the third bull, and the second bull, were out of the same original herd. The third bull is the one which is at Onderstepoort and is referred to by Fourie (1936) as No. 7015. (See Figure 1.)

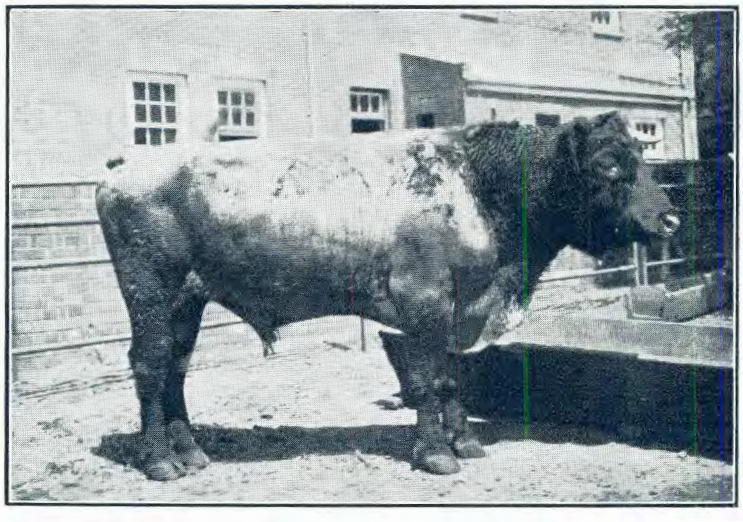


Fig. 1.—The porphyrin carrying bull 7015 (Dr.).

The sire which was used in the original herd is a bull named Royal Regent, E.H.B. No. 122649, and it is assumed that this bull, Royal Regent, is the sire of the second bull and that of the sire of the third bull (7015) referred to above. The pedigree of the bull, Royal Regent, is:—

Royal Regent

Rosebud 13th by Rosy Monk 93178	Royal Stamp
Gd. War Queen by Centaur 70118	
G.g.d. Roan Rosebud 3rd by	
Pride of Aberdeen 61484	
Roan Rosebud 2nd by	
Gravesend 46461.	

The bull 7015 has normal teeth, his urine does not contain porphyrins such as are present in his descendants, which are clinical cases of congenital porphyrinuria and there is no evidence whatsoever of photo-sensitization. It was, therefore, concluded that if the condition was being transmitted hereditarily, it must be transmitted as a recessive character. Breeding experiments were accordingly planned in order to prove this one way or the other.

Breeding Experiments with Cattle in order to prove that Bovine Congenital Porphyrinuria (Pink Tooth) is transmitted as a Recessive Hereditary Character.

Certain animals which were acquired from Swaziland in December, 1935, formed the nucleus of the animals which were used in the breeding experiments. The animals so obtained are: the bull (No. 7015), two clinically normal cows, being mothers of affected animals; three clinically normal heifers (7019, 7021 and 7022) daughters of the bull and four affected animals (3 steers, 7016, 7017, and 7018 and one heifer, No. 7023—sons and a daughter of the bull, 7015. (Fig. 2.) The breeding experiments were actually carried out in two parts.

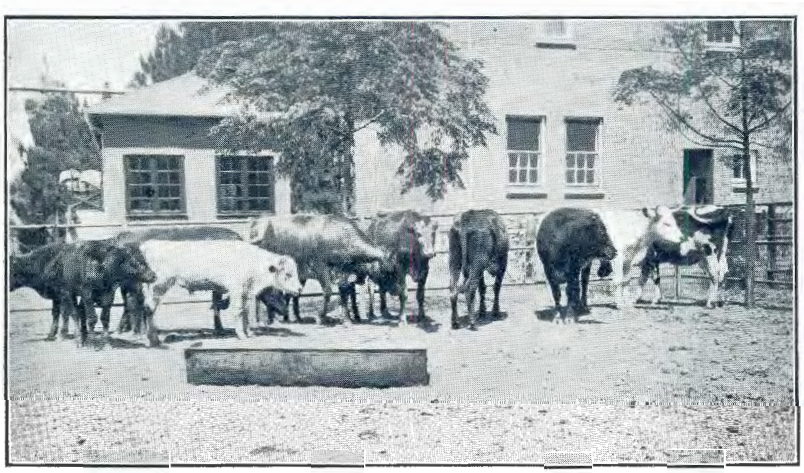


Fig. 2.—Females of the porphyrin herd with calves born at Onderstepoort.

In Part 1 the bull 7015 was mated to ten unrelated clinically normal heifers. If the bull is a carrier of the recessive character he will transmit this character to a portion of his progeny. The intention is to mate the bull subsequently to his daughters born out of these unrelated females, in an attempt to produce actual cases of pink tooth. Unfortunately most of the calves produced are males, and the two females are not yet mature, consequently it will take some years before the complete results of this experiment will become available. In the meantime the bull is becoming an old man and I may in the end be forced to complete this part of the breeding experiments with another bull.

However, up to the present eight normal calves were produced by these ten heifers and one calf was aborted as a result of *Trichomonas foetus infection*. All these eight calves are clinically normal and are therefore free from pink tooth. This is regarded as strong albeit not conclusive evidence that the character is not dominant. (Fig. 3.)

Fig. 3.—Unrelated females mated to bull 7015 with calves.

In the second part the bull was mated to all the females acquired from Swaziland. The results obtained are:—

1. *The one old cow* (7024) calved a few days after she arrived here. She herself unfortunately died from acute metritis. The calf, a heifer (7029), is clinically normal and it is practically certain that her sire is the bull 7015 as this was the only bull the owner used at the time. This heifer subsequently was served by her own father and produced a clinically normal male calf (7572). (The Pink Tooth female 7023 is probably a calf of cow 7024—this is according to the owner.)

2. *The other old cow* (7020) has contagious abortion and although served by bull 7015, never produced a calf at Onderstepoort. (The Pink Tooth Ox 7016 is her calf born in Swaziland.)

3. *Cow* 7019. She arrived here as a heifer and her first calf (7025) was actually born in the truck on her way to Onderstepoort. She herself is therefore almost certainly a daughter of bull 7015. One cannot however accept this as an absolute fact, as under practical conditions of farming, it is always possible that a neighbour's bull may sometimes serve a cow, especially on an unfenced farm as is the case with the farm concerned in Swaziland.

Her first calf is a heifer (7025). She is clinically normal. Subsequently she has been repeatedly served by bull 7015, has however never produced a calf and is apparently sterile..

Her second calf is a male (7388), is clinically normal and died when it was about six months old from sand colic. On post mortem examination no evidence of porphyria was present.

Her third calf is also a male (7678), is now six months old and is clinically normal.

But outward proportions are but uncertain indications of the value of the carcase as regards proportion of fat to muscle, as evidenced in carcase competitions, where an ideal outward appearance sometimes yields very disappointing results when seen in cross-section. Feeding has become an art in itself and by packing on sufficient fat a carcase is often moulded into the ideal shape, which only on cutting displays the lack of muscular development and the superabundance of fat. No criterion in judging has yet been found whereby the proportions of fat and muscle in a cross-section of the loin can be determined from external appearance. It is only when the carcase is cut through that we can make a study of the proportions of muscle and fat in it.

Carcase competitions at shows allow the public taste to be conveyed into figures. Butcher judges representing the public demand, award prizes to carcases in order of merit. The measurements of such prize-winning carcases, taking the measurements directly, in relation to one another, and in relation to weight, may be interpreted as the public demand. The fat measurements are absolute, that is they stand at an almost fixed figure, irrespective of muscle, bone and weight changes. More than a certain thickness of fat is wasteful and is left on the plate or has to be pared off the joint before it is sold. A slice of meat from a joint with a heavy fat layer is repelling to most people in the London area; too little fat gives it an unfinished, unattractive appearance and influences cooking detrimentally by allowing juices to escape from the lean meat, with a consequent drying and loss of succulence of the joint. Thus is fat an absolute measurement.

Muscle on the other hand is elastic and the more there is within certain weight-controlled limits which will be discussed later, the more do the public like it. Bone which represents direct waste is an all-round loss, and the cry is for a very light-boned carcase. Bone weight may be to a certain extent camouflaged by a shortening and thickening of the bone as has been done in the case of the Southdown breed (Hammond 1932). Although there may be no actual loss in weight of a particular bone, the shortening and thickening brings with it a shortening and thickening of the muscle covering. This produces, as in the case of a leg of mutton, a more attractive joint, allowing of a deeper slice of mutton and a larger area from which such slices can be cut (see figure, p. 428). Waste from the extremity of the joint is reduced, that is there is less shank. In addition to shortening the bone it is also possible to refine it to some extent as has been done with the Aberdeen Angus beef cattle; but too much lightening tends to bring with it a reduction of the thickness of the muscle covering, a factor which has been realized and is being guarded against by suitable breeding. A thickening of the bone in shortening it, with no weight reduction, is preferable to reducing the weight of bone in a carcase by making the bones thinner. Actually then it is rather the long bone, than the somewhat heavy bone that is objected to, particularly in mutton. In beef a bone both light and short is very desirable, but refinement to the extent of destroying the bulge of meat must be guarded against, for the appearance of the uncut carcase goes a long way towards determining its sales value on the wholesale meat markets. The ideal proportions of a mutton carcase weighing about 55 lb. are given on page 398.

absolutely certain who the sire of this calf is. The eldest of the calves born out of unrelated females and sired by bull 7015 is a bull calf No. 7446, born on the 22.9.37. This bull calf was kept in the same camp as cow 7022 and at the time this cow was served (beginning of September, 1938), to produce the porphyrin calf 7941, the bull calf 7446 was just about 1 year old. There is therefore just a

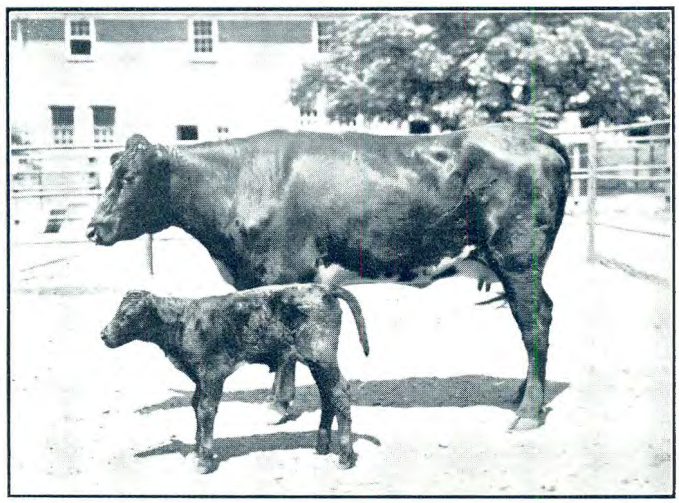


Fig. 4. Cow 7021, a carrier (Dr.) with a porphyrin affected calf 7357 (rr.) both mother and daughter sired by bull 7015.

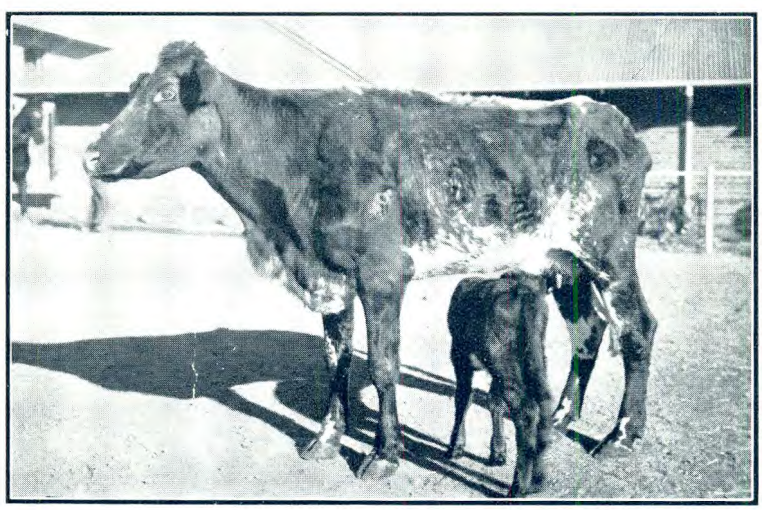


Fig. 4a.—Cow 7022, a carrier (Dr.) with a porphyrin affected calf (7941).

possibility that this bull calf may be the sire of the porphyrin calf 7941. If this is the case, the bull calf 7446 must be a carrier (Dr.) inheriting the porphyrin gene from his sire 7015. It is, however, more likely that the sire is the porphyrin suspect bull 7597 to be referred to later. This bull owing to the marked lesions he develops when exposed to the sun was only allowed to run with these cows during the night, whilst he was stabled during the day. If it is his calf final proof will have been furnished that he is a porphyrin bull, showing marked photosensitization, without well marked discolourisation of the teeth.

After having given birth to two clinically normal calves sired by the carrier bull 7015, it was thought that the cow 7022 may be a completely normal animal (DD), but after the birth of her third calf, she is now definitely classified as a carrier (Dr.).

6. *Cow* 7023.—When she arrived at Onderstepoort she was a young heifer, being the only female showing clinical symptoms of porphyria. She was repeatedly served by the bull 7015, her father, and it was at first thought that she may be sterile. She however eventually held to a service during the late summer (last week in March, 1937), and actually calved on the 30th December, 1937.

The animal 7023 does not show well marked evidence of photosensitization. She is a roan. Therefore she possibly has a good deal of pigment in her skin, this may explain the absence of lesions of photosensitization, together with the fact that the amount of porphyrin excreted by her is considerably less than that excreted by the two worst cases I have, viz. 7017 and 7018.. It is, therefore, possible that although this animal does not show lesions of photosensitization, her photosensitive state, even though this may be of a mild degree, may nevertheless result in a certain amount of interference with normal conception, especially during the time of intense sunshine of midsummer. During the late summer or autumn this is not so severe, and this may have been the reason why she held to a service during that time.

Her 1st and only calf so far was born on the 30th December, 1937. She could not calve normally. I had to deliver the calf. It was a dorso-sacral presentation with lateral deviation of the head. When this was corrected the calf was delivered without difficulty. The tongue was, however, very markedly swoollen and protruding from the mouth and the calf did not breathe. Artificial respiration was practised and eventually breathing commenced. The calf could not stand, it was slung in a bag, with four holes for the legs and fed by bottle. It drank readily, but its head and its neck was never normally straight. It could bear weight on the hind legs, but not on the forelegs. In spite of nursing this calf very carefully, it died after ten days. Its inability to stand was put down to an injury of the neck during birth. The teeth of the calf were not markedly discoloured, but on post mortem examination all the bones were found to be of a uniform pink discolouration. This calf, therefore, is the third case of porphyria produced under experimentally controlled conditions.

Evidence of the Recessive Nature of the Inherited Character.

If the character were dominant one would expect clinical evidence of the condition in one of the parents or in a proportion of the first generation progeny of one parent, when mated to an unrelated animal. There is no evidence that this has occurred. When the bull 7015 was mated to ten unrelated heifers the condition was absent in the 8 calves which were born out of these females. It is true that the first cases of the condition appeared in the first generation when the bull was used on the Swaziland farm. If the females to which the bull was mated are unrelated to the bull, one could not exclude the possibility that the character may be partially dominant, but I have not the slightest hesitation in accepting the owner's word that the second bull* he used was out of the same herd as the third bull 7015. From this it is assumed that the bull was being mated to related females.

The evidence which favours the conclusion that the character is recessive is:

(1) The bull transmitting the condition is himself clinically normal.

(2) Under practical farming conditions a proportion of cases appeared when the bull, himself clinically normal, was mated to clinically normal females, which were, however, related to him through a previous common ancestry.

(3) Under experimentally controlled conditions three cases of the condition were produced (1) by mating the bull to his own daughter, she herself being clinically normal, (2) by mating him to another daughter showing clinical evidence of pink tooth, and (3) by mating a daughter (7022) of the bull 7015, to either one of his sons (7446) or to another porphyrin bull 7597.

It is hoped in due course to produce final conclusive proof that the character is a recessive one by mating an affected bull to affected females, when all the progeny must be affected cases. But it will probably take a good many years before this can be done. It will have been observed that no attempt has been made to discuss the percentage incidence of pink tooth in these breeding experiments. Clearly these experiments have not yet reached a stage which would justify a discussion of the percentage incidence. This is of importance in determining whether the character is a simple recessive or otherwise. It is somewhat doubtful, if one would be justified on economic grounds, to maintain sufficient animals, merely to prove this point.

If the character is a simple recessive, the transmission occurs as follows:—D represents the normal gene in so far as the abnormal character is concerned and r represents the abnormal gene. A

* This bull, long since dead, was not a registered animal and therefore no pedigree is available.

completely normal animal in so far as bovine congenital porphyrinuria is concerned will have a genetic constitution of DD, a carrier animal Dr and the affected animal rr. Mating now the carrier bull 7015 (Dr) to a completely normal animal (DD), the possibilities are DD, DD, Dr, Dr. Thus 50 per cent. of the cases will be completely normal and 50 per cent. will be carriers. In mating a carrier animal (Dr) to another carrier animal the possibilities are: DD, Dr, Dr, and rr. Thus 25 per cent. of the progeny will be completely normal, 50 per cent. will be carriers and 25 per cent. will be affected cases.

In mating a normal animal to an affected animal, all the progeny must be carriers (Dr) and when mating affected cases all the progeny must be affected cases (rr).

Up to the time this Swaziland herd was found nothing was known concerning the hereditary nature of congenital porphyrinuria in animals. In referring to congenital porphyrinuria and other anomalies in man Garrod (1923) states that "if the lack of a special enzyme be in each instance the underlying factor, it is to be expected that they should behave as Mendelian recessive characters.

Cockayne (1933) believes one form of congenital porphyrinuria in man to be a recessive disorder due to a single gene, with an unexplained partial limitation to the male sex and another form to be dominant.

The question now arises as to whether this character must be regarded as an inherited lethal character. In accordance with the definition of lethal characters given by Hull (1934) that "all hereditary conditions causing premature death must be classified as lethal regardless of the age at which they are effective", it seems to me that the recessive inherited character of bovine congenital porphyrinuria must also be regarded as lethal.

It is true that most of the symptoms which develop in bovines are due to photosensitization, when the animals are kept under natural conditions, as a result of which they become exposed to the sun. However, one does meet with cases which do not seem to thrive even though they are protected against the harmful rays of the sun. I have at the moment two oxen (7017 and 7018) under experimental observation. Animal 7017 excretes somewhat more porphyrins than animal 7018. When both are protected against the sun by stabling, animal 7018 puts on weight and looks a magnificent animal; 7017, on the other hand, is not in good condition. It would seem, therefore, that in the case of ox 7017, the presence of the porphyrins may have a general harmful effect. It is, of course, not possible to say that this animal is otherwise completely normal. The animal has however, been tested and found to be negative for tuberculosis and there is no clinical evidence of any other abnormality. Both these animals have at the moment rather puzzling red counts when they were examined haematologically during February, 1938. 7018 had 7·0 million red cells per c.mm., and 7017 had 5·6 millions per c.mm. In August, 1938, 7018 had a count of 5·6 million and 7017 of 5·0 million. In December, 1938, 7018 had 4·4 million and 7017 3·7 million cells per c.mm.

The animals are admittedly being kept under rather abnormal conditions. They do not get any exercise at all and green food is not regularly available. If this may be a factor which is at present influencing the blood picture is not definitely known.

Fourie (1936) pointed out that the cases of congenital bovine porphyrinuria occurs in the male in 77 per cent. of cases. In man also the great majority of cases are males. It would seem as if there may be a partial sex limitation in this condition, but it is certainly not sex linked in the ordinary way, as in South Africa five cases in heifers are known.

Group 2.—Shorthorn Bull 7597.

This bull was briefly referred to by Fourie and Roets (1939). This is an animal showing marked lesions of photosensitization. When the skin lesions were first seen, their cause was not known to the farmer and no attempt was made to protect the animal against the sun. The lesions were therefore of an acute nature. There is marked reddening and in places more or less raw surfaces are exposed. The lesions are very extensive occurring on the skin of the back and extending over large areas of the thorax on each side. (See Fig. 5.)

Fig. 5.—The suspected bull 7597 shewing lesions of photosensitization.

The teeth of the animal are, however, not discoloured, or if there is discolouration of the teeth this is so slight that one cannot recognise it definitely when examining the teeth in the ordinary way with the naked eye. Well marked discolouration of the urine is also absent. The porphyrin excretion in the faeces is on a low level, as compared with the affected cases in Group 1, but definitely higher than in other bovines which are clinically normal. [Total daily

porphyrin in cases in Group 1: 7016, ·3 gm.; 7017, 1·6 gm.; 7018, ·8 gm.; bull 7597, 11·298 mgm; clinically normal bovines vary from 3 mgm. to 8·9 mgm., but the animal which has 8·9 mgm. is related to porphyrin animals (see Group 1, No. 7022)]. Uroporphyrin could not be found in the urine and at this stage it is not clear if the absence of the uroporphyrin may explain the absence of discolouration of the teeth and the urine.

When I heard that a certain farmer had this animal showing skin lesions and when I heard that this was a shorthorn bull, it was natural to look for a common ancestry between this animal and the Swaziland shorthorn bull, No. 7015. Knowing that bull 7015 was bred in a herd in which the imported bull Royal Regent was used as a sire, I wrote to the owner of bull 7597 and amongst others I asked him if this bull had any Royal Regent blood in him. He replied that the sire of the bull is Fairview Royal Regent IV. This seemed very satisfactory as it was inferred that "Royal Regent" in the name Fairview Royal Regent IV, must be evidence of some relationship between this bull and the imported bull, Royal Regent. In consulting the herd book in order to confirm this it was immediately seen that the bull, Fairview Royal Regent IV, was sired by another imported bull, Pitsford Abbot 232606. Consequently there is no South African relationship between him and the bull Royal Regent. It was therefore necessary to make a painstaking search for any common ancestry by consulting the shorthorn herd books. The results of this examination are:—

Ancestry of Fairview Royal Regent IV (8367)

Pitsford Abbot 232606
Rickford Raider 175474
Collynie Royal Regent 148043
Masterstroke 126820
Max of Clunie 112487
Douglas Commodore 105256
Jim Sidey 99230 (1907)
Avondale 94085 (1905)

Ballechin Roan Rose by
Victor Chief 82532
g.d. Scottish Rosebud by
Scottish Archer 59893
ggd. Red Rosebud 1st by *Gravesend* 46461
Red Rosebud by Borough Member 33186,
Rosebud by Novelist 34929,
Rosebud 1st (1879) by Diphthong 17681 (1860).

The first common ancestor between the bulls Royal Regent and Fairview Royal Regent IV therefore is the bull Gravesend 46461. If we, however, work backwards from Rosebud 1st we find:

Rosebud 1st is the dam of Rosebud by Sir Christopher.

Rosebud is the dam of Roan Rosebud by Borough Member.

Roan Rosebud is the dam of Roan Rosebud 2nd by Gravesend 46461.

Roan Rosebud 2nd is the dam of Roan Rosebud 3rd by Pride of Aberdeen 61484.

This establishes a further common ancestry between the two bulls. This will be clearly seen if reference is made to the pedigree of the bull Royal Regent already recorded earlier on.

The bull Royal Regent is four generations removed from the bull Gravesend and the bull Fairview Royal Regent is some 12 generations removed from the bull Gravesend and 14 generations from the cow Rosebud the 1st.

It is very interesting to be able to establish this common ancestry and it is of course possible that the recessive porphyrin gene may have been successfully transmitted through all those generations. It is, however, no proof that any of these ancestors were affected cases (rr) or even carriers (Dr) of the porphyrin gene. In a breed like the shorthorn or any pure breed of cattle, it is obvious that one must eventually arrive at a common ancestor for any two animals if one goes back far enough. All that one can say is that this common ancestry may afford a possible clue of the manner in which the porphyrin gene has been transmitted. In this connection one should also bear in mind that there is no definite evidence that the bull Royal Regent 122649 is a carrier (Dr.) of the porphyrin gene. He is implicated by inference, as the porphyrin carrier bull 7015 and the bull which was previously used in the Swaziland herd were out of the same original herd in which the bull Royal Regent was used as a sire.

If the bull Royal Regent and the bull Fairview Royal Regent IV actually did inherit the recessive gene from a remote common ancestor one is here faced with a most extraordinary coincidence in that this rare anomaly was introduced into South Africa along two separate but related blood lines and that in the case of the Royal Regent blood line clinical cases appeared as a result of accidental close breeding. The dam of bull 7597 is not a registered cow and up to the present I have not been able to find out where she may have obtained the recessive character.

" Royal Regent " in the name Fairview Royal Regent IV was used because of the relationship of the bull to its ancestor Collynie Royal Regent—but " Royal Regent " in Collynie Royal Regent, I am told is pure coincidence and was not deliberately used to indicate a relationship between the bulls Royal Regent and Collynie Royal Regent.

Groups 3 and 4. The Cedara Case and the Ladysmith Cases.

The Cedara case was described by Fourie and Rimington (1938). Flight (1938) described the occurrence of the condition in two heifers (Ladysmith cases). I am indebted to him for a personal communication concerning their history. A clinically normal registered Friesland Bull Kamnatie Charles was used as a sire in the Ladysmith area for a number of years. He sometimes served his own daughters. The two affected heifers are his granddaughters, out of his own daughters. Both the dams are clinically normal. Those of his other descendants which were available for examination were found to be clinically normal. A full sister of one of the affected heifers is also clinically normal. These cases constitute further evidence of the recessive nature of the character. (See Fig. 6.)

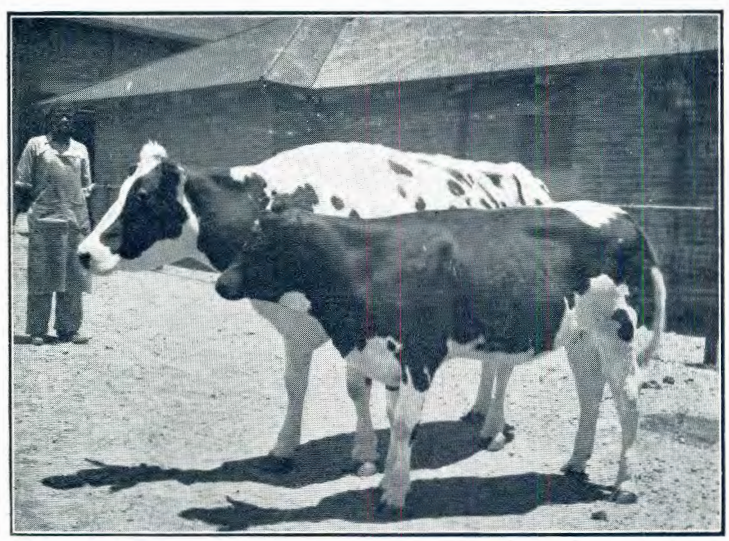


Fig. 6.—The Cedara case (rr.) with well grown calf (Dr.).

It would be surprising if one cannot establish a common ancestry, by a careful study of the ancestors of the Cedara case and that of the Ladysmith cases as both these are Frieslands. This indeed is the case, and here also, as in the case of the two shorthorn groups, the common ancestry may possibly indicate how the recessive character has been transmitted, but one cannot accept it as proof that that is the case. The common ancestor is the bull Albert 1306^{H}. He is five generations removed from the Cedara case (rr) and four generations from the carrier bull Kamnatie Charles (Dr) both on the sire and the dam side of the dam (De Goede Laaste) of the bull Kamnatie Charles.

Alberta in the name of the bull Alberta Roland does not necessarily indicate Albert 1306^{H} blood. Alberta is merely a prefix used by a particular breeder. This common ancestor may or may not contain the recessive porphyrin carrying gene. Should one get

other cases in which the Albert blood shows up so prominently one would have reasonable grounds for suspecting it as the carrier of this abnormal factor.

The ancestry of the Cedara case is:—

Cedara Ria 4th No. 177—Cedara case—

Cedara Ria 2nd No. 113 — Cedara Joe

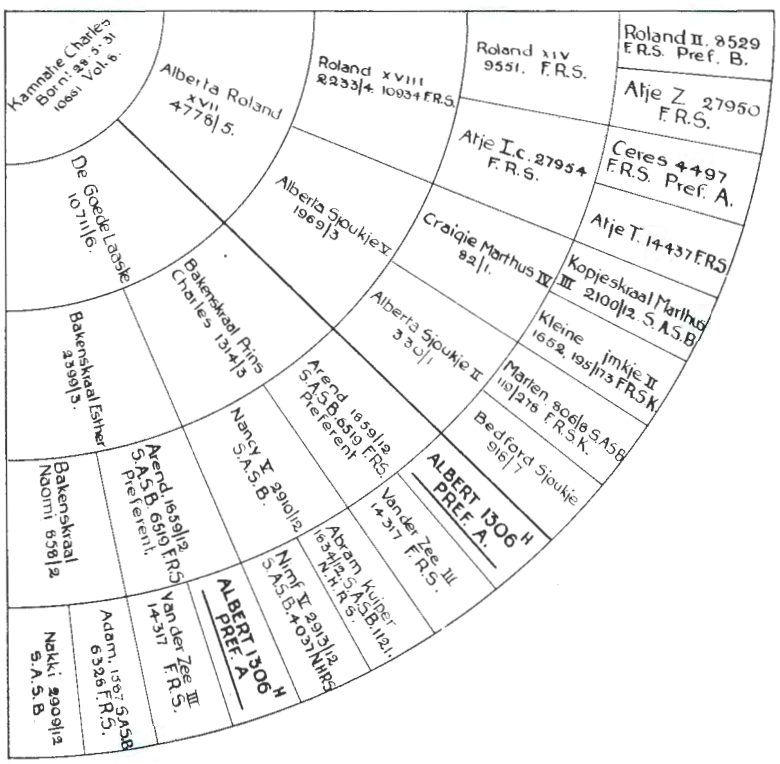
Cedara Jetzke 2nd — Nelsrust Commodore 2nd 1707

Ogden Hall *Alberta* — Nelsrust Beatty 2nd

Akke III 1902 119/266 F.R.S.K. — Albert II 1247

Akke II — Albert 1306H

The extended pedigree of the bull Kamnatie Charles, kindly supplied by the Secretary of the Friesland Breeders Association, Bloemfontein, is:—



At the present time there is this extraordinary fact, that bovine congenital porphyrinuria has been found in four different groups of cattle in South Africa. (For the moment I am assuming that bull 7597 is a genuine case of the condition. In the absence of reliable standards of quantitative porphyrin excretion in a sufficient number of normal animals, the final proof must be furnished by breeding experiments, already commenced, unless, of course, this bull should prove to be sterile, an eventuality which is not unlikely.) Two of the groups are shorthorns, in which it has been possible to establish a common ancestry, albeit a remote one. The other two groups are Frieslands and here a common ancestry appears within the first five generations. Although this is the case, a conclusion at this stage that the common ancestor is the carrier of the porphyrin gene in the groups of shorthorns and Frieslands concerned is premature.

It is, however, very remarkable that so many of these cases should be found in South Africa and not in the parent stock in Great Britain and Holland. My own opinion is that there are certain to be cases in those countries, but they remain unrecognised. By saying this I do not mean to convey that veterinarians in South Africa are better or more accurate observers than their colleagues in Great Britain and Holland, but the reason almost certainly is to be found in the difference of climate in South Africa and that of Holland and Great Britain. In South Africa the intense sunshine throughout the year is responsible for marked lesions which develop because of the photosensitization in the porphyrin animal, and also for the fact that such animals do not thrive. Such abnormalities force the owner to seek professional advice, whereas in Europe, the lack of intense sunshine will not produce lesions and disturbances to the extent they are seen in South Africa and the cases may, therefore, never be brought to the notice of veterinarians in those countries.

Summary and Conclusions.

1. In mating a bull (7015), being a carrier of the porphyrin gene (Dr) to ten unrelated heifers, 8 calves were produced. These are all clinically normal. This is regarded as evidence that the inherited character is not dominant.

2. In mating bull 7015 (Dr) to his own daughters the results are (*a*) 7019 had 3 normal calves. 7019 is therefore probably a DD.

(*b*) 7021 had 2 calves. The first calf suffered from congenital porphyrinuria. The second calf is normal. She is therefore a carrier (Dr).

(*c*) 7022 had 3 calves, two are normal, the 3rd is a case of pinktooth. She is therefore undoubtedly a carrier (Dr).

(*d*) 7023 is an affected heifer (rr). She had one calf, also an affected case.

(*c*) 7024 is not a daughter, but related to bull 7015 through her own sire. She had one affected calf, 7023, and one normal calf 7029. This normal calf was mated to her own father (bull 7015) and a normal calf was produced. 7024 is therefore a carrier (Dr) and her calf 7029 may be either completely normal (DD) or a carrier (Dr).

These results indicate that bovine congenital porphyrinuria is inherited as a recessive character.

3. The recessive character was probably introduced into the Swaziland herd by bull No. 2 used by the owner. This bull was apparently never used on this own daughters and as the character is not dominant, no cases were seen in that herd during the time of his reign. The 3rd bull, No. 7015 was bred out of the same herd as bull No. 2. They were therefore related and probably inherited the recessive character from the same sire, the bull Royal Regent. Bull 7015, was therefore mated to related females and within a relatively short time, 13 cases of the condition were observed in that herd, whilst the bull 7015 was being used as a sire.

(4) When the Friesland bull Kamnatie Charles was inbred to his own daughters two cases of the condition were observed. This bull is therefore a carrier (Dr). He is related to a grade Friesland cow, suffering from the condition (rr) (Cedara Case).

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