This is the fourth in a series of articles designed to acquaint Angus breeders with genetic defects, problems which occur in every breed of every species.

SYNDACTYLY

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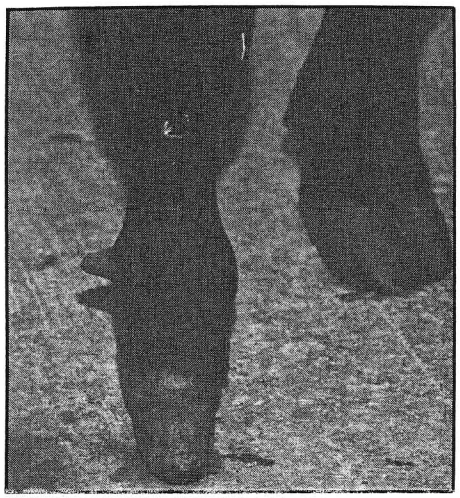


Figure 1. A typical case of mulefoot. Photo courtesy Kansas State University Pathology Dept.

Syndactyly is commonly known as mulefoot because most affected animals have fused or uncloven hooves that resemble mules' feet *(see Figure 1).* The genetic form of mulefoot originated as the result of a mutation, and it's passed along by a simple recessive gene.

Mulefoot is one of the most common genetic defects of U.S. cattle. It's most frequently seen in Holsteins, but the recessive gene is present in Angus and several other breeds. The defect also has been found in many cattle breeds abroad in addition to lambs, pigs, dogs and cats. And a similar form of syndactyly occurs in humans.

Mulefoot was added to the American Angus Assn.'s list of Class I defects in 1976. Since then, Angus breeders conscientiously have monitored and progeny tested for the defect, and it's well under control in today's Angus population.

Although it's a simple autosomal recessive trait, mulefoot has some irregularities.

First, the expression of mulefoot varies. One, two, three or all four feet may be affected, and this follows a distinct pattern. The right front foot is always first and most severely affected. If two feet are affected, it will be the two front feet. The right hind foot is next, and the left hind foot is last and least likely to be fused.

Other Irregularities

But hooves aren't the only thing different about these cattle. The genetic form always involves horizontal fusion of the bones of the feet *(see Figure 2).* This is one way to differentiate between an inherited and noninherited problem.

Bone fusion results in stiff and insecure joints. It follows the same pattern as hoof fusion—that is, if X-rays of the two front feet are compared, the bones of the right one usually are more fused than those of the left, etc.

The second irregularity is incomplete penetrance—some affected animals appear normal. The hooves show no external signs of fusion; however, X-rays reveal bone fusion. This is rare, and these animals are called escapers.

Four groups of hoof fusion severity have been distinquished *(see Figure 3):* (a) Hooves show no external signs of fusion. (b) Hooves are partially fused at their axial-coronary border. (c) Hooves are fused but have a groove from the toe bed to the tip of the hooves and show signs of dual embryonic origin. (d) Hooves are completely fused and show no signs of originating as normal hooves.

Not all calves from one bull are likely to have the same number of feet affected or to the same degree of severity.

More Serious Problems

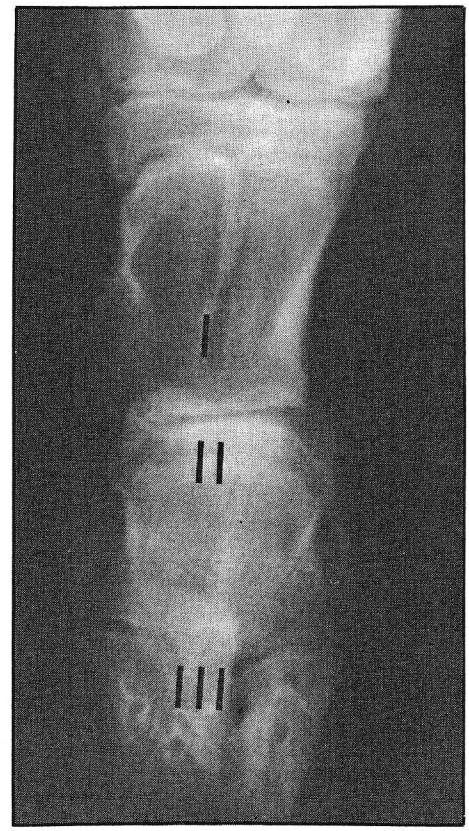
Fusion or non-division of the hooves occurs during early gestation and, in most cases, the physical signs of syndactyly are easily recognized at birth. But while uncloven hooves are the most obvious physical signs of syndactyly, they're not the most serious problem.

"Fused hooves are just a trivial expression of a dramatic biochemical abnormality," says Dr. Horst Leipold, pathologist at Kansas State University, Manhattan. Further research is needed to determine just what biochemical changes the recessive gene causes, however.

Mulefoot renders animals economically useless. They can't cope with stress, especially heat. They can't stand temperatures of 80° or higher and often die of heat stroke. In addition, they frequently develop signs of hyperthermia, including elevated temperature, fast heart rate and rapid breathing. They're unthrifty and frequently die soon after birth. And whether an animal has one or four feet affected doesn't seem to affect its ability to adapt to stress.

Mulefoot cattle that are given special care and live to sexual maturity are capable

Figure 2. Radiograph of a mulefoot. Note abnormal development of toe bones and abnormal fusion. Photo courtesy Kansas State University Pathology Dept.



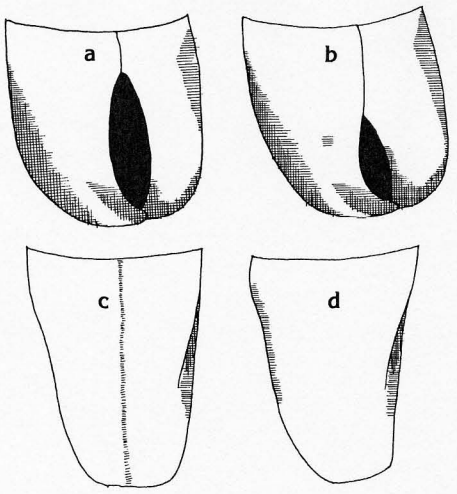


Figure 3.

of reproduction, and affected cattle have been mated in the Kansas State University research herd. In the general population, though, mulefoot animals seldom live long enough to reproduce, which helps control spread of the defect. The recessive gene isn't likely to be passed along by affected animals but is handed from generation to generation by carrier animals.

May Not Be Syndactyly

Breeders shouldn't be too hasty in dubbing a calf syndactylous or in calling a sire a carrier. A fused or single hoof on the end of a leg doesn't necessarily mean mulefoot—conditions exist that look like syndactyly but aren't. For example, a condition has been obeserved where fused hooves are correlated with facial defects; the face isn't formed right and the legs aren't formed right. And there are forms of syndactyly that may not be inherited.

As with all calves suspected of having a genetic defect, mulefoot suspects should be examined by a veterinarian or diagnostician, and the exam should include X-rays of the feet.

If veterinary inspection confirms inherited syndactyly, parentage verification should be obtained by blood typing. Any sire or dam that has produced an affected animal should be listed as a carrier.

Researchers at Kansas State University have studied mulefoot for some 20 years, and a small herd of affected and carrier animals is maintained there. One area of current research involves the pattern of syndactyly in beef cattle vs. dairy cattle. Although it's more frequent in some dairy breeds, studies indicate that it's more severe in beef cattle. Dairy animals usually have one foot affected, sometimes two or three, but rarely four. On the other hand, beef animals more often have all four feet affected.

Modern Progeny Tests

Another area of successful research involves methods to speed up and cut costs of progeny testing for syndactyly. Since it's an hereditary defect present at birth, test matings can be used to identify carrier animals.

But rather than mating a bull to 35 different daughters of confirmed carriers sires and waiting until calves are born to determine the outcome, new procedures include embryo transfer and early fetal removal. This cuts number of cattle needed, time and cost, and makes it more feasible to test bulls before they're widely used or females before they're used for embryo transfer.

To test a bull, the new methods require only seven fetuses to be recovered from seven affected (homozygous recessive) cows or one superovulated affected cow. To test a female, she's bred to an affected bull, and seven fetuses must be recovered. In both cases, the fetuses can be transferred into four recipients, they're removed by cesarean section after 60 days of gestation and readily can be identified as normal or affected. This proves the animal to be clean or to be a carrier with 99.6% accuracy.

Syndactylous embryos have been recovered and identified as early as 31 days of gestation, but 60 days leaves less margin for error or doubt in identification of normal and affected embryos. The American Angus Assn. requires a minimum of 60 days gestation.

To date, two Angus bulls have been progeny tested free of the mulefoot gene, and six bulls have tested free of all genetic defects. One female, tested by the new methods, has been proven free.