Dwarfism in Beef Cattle

Walter H. Smith and Lewis A. Holland

During recent years there have been several scientific and numerous breeders' reports on dwarfism in the Angus, Hereford, and Shorthorn breeds of beef cattle. These have described what appear to be several different kinds of dwarfism, only two of which are apparently associated with recognizable types of cattle. Many of the scientific publications have discussed the mode of inheritance as well as the description of the kind of dwarfism considered. The general problem is complex and research pertaining to most phases of it is as yet in the preliminary stages; however, there are some important facts known at this time which should be understood by breeders who are attempting remedial measures to suppress incidence of dwarfism in breeding herds.

The Kansas Experiment Station has not conducted a formal research project on dwarfism. The authors have observed several kinds of dwarfs in the three major British beef breeds and have presented this discussion of the most troublesome kind in Hereford cattle. Some of the information contained herein includes discussions of preliminary experimental findings reported by research workers. These are indicated as such and are not intended to be considered conclusive at this time. A more detailed discussion of several types of dwarfism in Hereford, Angus, and Shorthorn cattle is being prepared by the authors and will be provided by the Animal Husbandry Department upon request after it is completed, which should be by June 1, 1954.

Reports by breeders indicate that dwarfs have been produced occasionally in some herds of conventional[1] Herefords for many years. The first technical report on the description and mode of inheritance of this type of dwarfism was made by a group of research workers of the South Dakota Experiment Station in 1950.

1. Description

Dwarf calves produced by conventional Herefords are generally born alive and survive during the suckling period and variable periods of time following weaning, although some breeders believe that still-births and early calfhood death losses are more prevalent in dwarf than normal calves. Most cattlemen who have observed dwarf calves can recognize dwarfs at the time of birth because dwarf calves possess a blocky appearance, shorter than normal cannon bones, bulging foreheads, and protruding lower jaws. Dwarf calves have been mistaken for outstanding prospects in many instances. Some are born with contracted flexor tendons of the forelegs and are unable to stand naturally and most show evidence of incoordination as indicated by a somewhat staggering gait. The condition is variable, some being more extreme than others, and as yet no one has discovered a criterion for the positive identification of dwarfs at the time of birth.[2] The dwarf condition becomes more pronounced at three to four months of age because these calves fail to grow normally and most develop distended paunches as a result of chronic bloat. Nearly all dwarfs that have been permitted to live have died prior to two years of age, presumably because of bloat. Because of its usual causation of death at an early age, dwarfism is often referred to as a sub-lethal character. Its primary detrimental effect is that of lowering reproductive efficiency. Survivability in dwarfs is variable and some have lived long enough to reproduce under experimental conditions.

Post mortem examinations have revealed no gross abnormalities although many reports describe dwarfs as hydrocephalic because the lateral ventricles of the brain possess more than a normal amount of fluid.

1. Conventional Herefords are those which are not of the distinct "compress" type.
2. X-rays of lumbar (loin) vertebrae are being used by some research workers.

2. Physiological Cause of Dwarfism

Research workers have made several attempts to determine the physiological cause of growth failure in dwarfs. Some breeders have believed that nutritional deficiencies may be responsible although none of the experimental findings to date substantiate this assumption. The Oklahoma research workers found that the blood mineral content of cows suckling dwarf calves was the same as cows suckling normal calves. Dwarfism occurs in herds where normal calves are produced and there have been several reports of fraternal twins in which one calf was a dwarf and the other normal. Other evidence indicates a hereditary basis, so there is considerable proof that dwarfism is not caused by a nutritional deficiency.

Research workers generally agree that dwarfism is due to an endocrine malfunction that is conditioned by heredity. Most studies of this aspect of dwarfism have entailed assays of dwarf pituitaries for thyrotrophic and growth hormones. These investigations were made to determine whether or not it would be possible to identify dwarf producing cattle by means of hormone assays and to explore the usefulness of hormonal therapy for inducing a growth response in dwarf calves. Endocrine assays have been made at the California, Oklahoma, and Purdue Experiment Stations. To date no gross abnormalities of the endocrine glands have been found to be consistently associated with the dwarf condition and hormonal therapy has not resulted in a skeletal or muscular growth response in the dwarf. Work is being continued on these studies at some stations; however, no endocrinological techniques useful for detection of dwarf producing cattle or correction of the dwarf condition have been devised to date.

3. Inheritance of Dwarfism in Conventional Herefords

Research workers at the South Dakota, Iowa, California, and Arizona Experiment Stations have reported that dwarfism in conventional Herefords is transmitted as a single recessive gene. The character is not associated with sex because it occurs in both bulls and heifers with equal frequency. Observations by other research workers substantiate the assumption that dwarfism is transmitted in this manner. Cattle are of three kinds in regard to this type of dwarfism: normal non-carriers, normal carriers, and dwarfs. The inheritance is best explained by using the symbols **d** to represent the dwarf hereditary factor or gene, and **D** to represent the gene for normal growth. Since an animal must receive a unit of inheritance from each of its parents, it possesses two genes. Non-carriers are **DD**, carriers **Dd**, and dwarfs are **dd**. The **Dd** individuals are normal and cannot be distinguished from **DD** animals on the basis of their appearance because the **D** gene is dominant or "overshadows" **d** when the two are present in the same individual. Dwarfs must be **dd**, which means that each parent has to contribute a **d** gene to that type of individual; therefore, both parents of the dwarf are carriers of the **d** gene and are equally responsible for a dwarf calf.

Six mating types are possible for a pair of genes such as **D** and **d**. These may be summarized as follows:

	Mating types or parents	Offspring	
		Genetic composition*	Appearance*
1.	DD x DD	All DD	All normal
2.	DD x Dd	½ DD and ½ Dd	All normal
3.	Dd x Dd	¼ DD; ½ Dd; ¼ dd	¼ dwarfs
4.	DD x dd	All Dd	All normal
5.	Dd x dd	½ Dd and ½ dd	½ dwarfs
6.	dd x dd	All dd	All dwarfs

* All ratios represent average expected values.

Only the first three mating types normally occur under natural breeding conditions because the last three involve dwarfs and are not likely to occur in non-experimental herds.

Some breeders have questioned this explanation of the inheritance of

dwarfism on the basis of observations in herds in which more than 25 percent of the calves produced in a single calf crop were dwarfs and others have believed that some carrier bulls tend to sire more dwarf calves than others. These exceptions have undoubtedly been due to chance deviations which are likely to occur in genetic ratios involving small numbers of offspring and variations in the proportions of carrier and non-carrier cows to which carrier bulls have been mated.

Practically all reports on dwarfism in conventional Herefords indicate that the frequency of occurrence of dwarf calves has increased during recent years. The gene which causes dwarfism is perpetuated in the breed by carrier animals and because both parents of a dwarf must be carriers, the percentage of carrier animals must have increased in breeding herds.

Breeders believe that inbreeding and linebreeding might have caused this increase in the percentage of carrier animals. These and other breeding plans do not create new genes but have a definite influence on the distribution of those present in a population. Many breeders have attributed the increase in the percentage of carriers as having been due to chance on the basis of the assumption that some of the outstanding sires in the breed were carriers by chance and that due to the fact that their close relatives, primarily sons, were used extensively in the breed, the dwarf gene was spread and its frequency increased in the breed. There is no doubt that some of the outstanding sires in the breed were carriers which has been instrumental in causing some increase in the frequency of the dwarfism gene; however, population geneticists generally assume that to have increased the frequency of this gene to its present level, breeders must have unknowingly practiced some preference for carrier animals in the selection of breeding stock.

There is no conclusive evidence to prove this assumption but if it is true, it means that breeders must be selecting carriers on the basis of their desirability in regard to one or more physical characteristics emphasized in type standards. Some breeders believe that nearly all outstanding individuals are carriers and others have not recognized any association between these two factors. There are many reports by breeders which indicate that animals of so-called "old-fashioned" type as well as "modern" type produce dwarf calves. This aspect of the dwarfism problem in conventional Herefords has received consideration by research workers but as yet no one has devised a method by which carrier and non-carrier animals can be differentiated on the basis of visual appearance. Additional information is required before conclusions can be made and breeders should not discriminate against a particular type on the basis of the assumption that it is definitely associated with preference for carrier animals in breeding selections. Body measurements of normal calves produced from known carrier matings are included as part of the study of dwarfism being conducted at the Iowa Experiment Station and decisive facts will be established as the result of this and other research work.

4. Identification of Carriers

The control of dwarfism depends upon the identification and disposal of carrier animals in breeding herds. The authors believe that the only technique that possesses proved reliability to identify carrier animals is the breeding test. Breeding tests are costly because test herds must be maintained and these also necessitate delays in breeding programs.

Carriers are identified when a cow produces or a bull sires a dwarf calf. The dwarf gene is perpetuated and transmitted in the breed by normal carriers, and since dwarf females will usually not reproduce, it is necessary to use known carrier cows for the establishment of test herds. Each cow must have produced at least one dwarf calf to be considered a known carrier.

Breeding tests are designed to determine whether or not prospective herd sires are carriers of the dwarf gene. A bull is a carrier if he sires a dwarf calf when mated to carrier cows. Since approximately one-

fourth of the calves from carrier matings are dwarfs, a carrier bull may be mated to carrier cows to produce a few calves which by chance are all normal. In other instances a carrier bull may sire a dwarf as the result of a first service to a carrier cow. Because chance may cause pronounced deviations from expected genetic ratios, with only a few calves in breeding tests, it is necessary to use a test which is adequate to permit reliable decisions. The following table shows the percentage of carrier bulls which would be expected not to sire dwarf calves when mated to carrier cows for various numbers of progeny in test matings.

Number of calves from known carrier cows	Percent of carrier bulls which would sire no dwarfs
1	75
2	56
4	32
8	10
10	6
12	3
14	2
16	1

It is evident that the reliability of a breeding test increases with the number of calves produced. Prospective herd sires must sire 15 or more calves, all of which are normal, from carrier cows before they may be classified as non-carriers with a high degree of confidence. On the average there is about one chance in 100 of misclassifying a carrier for a non-carrier on the basis of 16 progeny, all of which are normal, from carrier cows.

Still-births and questionable pedigrees of calves produced by test herds may result in wrong decisions. Hand breeding is necessary for the avoidance of pedigree errors under most conditions. Approximately 20 carrier cows are required to test a questionable bull in a single year because not all cows used are likely to produce calves in that length of time. Normal calves from a test herd should not be used as replacements in regular breeding herds even though their sires are apparently non-carriers because approximately one-half of these will be carriers because of their dams which may transmit the dwarf gene to them.

Many breeders are not aware of the limitations of a method of controlling dwarfism which is useful for the determination of only whether or not sires are carriers or non-carriers of the dwarf gene. In herds in which only non-carrier bulls are used the dwarf gene may yet be possessed by many females although these may not have produced dwarf calves. Carrier females transmit the dwarf gene to their offspring sired by a non-carrier as well as to those by a carrier bull. Dwarf calves are not produced by the use of a non-carrier bull but a breeder may be assured that some carrier calves will be produced in a herd if part of the cows are known carriers or possibly if some of the close relatives of the cow herd are known carriers.

The continued use of non-carrier bulls is an effective method of controlling dwarfism because it eliminates the occurrence of dwarfs and reduces the percentage of carriers in the females produced each generation. The average generation interval is approximately five years in beef cattle, so many years would be required to reduce the frequency of the dwarf gene to a level which is negligible for all practical purposes in breeding considerations. Even under these circumstances, the technique for the identification of non-carrier bulls would need to be continued because of the possibility of selection preference for carriers over non-carriers.

During the last five years several experimental studies have been initiated to detect possible measureable differences between carrier and non-carrier bulls. The research on endocrine functions and blood composition has been previously mentioned. Other studies have in-

cluded head shape which is obtained by means of the profilometer,[3] length and diameter of the cannon bone, bone structure using X-ray, and cellular antigens of blood. Some of the preliminary studies have shown promise, but none of the techniques devised from these investigations for differentiating between carrier and non-carrier cattle has been adequately tested at present to justify recommendation to breeders.

Bone measurement and X-ray studies are still in progress at the Iowa Experiment Station and the blood antigen studies are being continued at the Ohio Station. All techniques are necessarily being checked with breeding tests which require much time and large experimental breeding herds.

Some herds and blood lines are claimed to be free from the dwarf gene. If this is true breeders can avoid dwarfism by using bulls from "carrier-free" families. Caution must be advised in the selection of sires on this basis because the dwarf gene may be present in these families or lines but at such a low frequency that no dwarf calves have as yet been produced. Pedigree errors may cause the dwarf gene to be introduced into families which were free or at least considered to be free from the dwarf gene.

Pedigree penalties may lead to complete discrimination against certain families although many individuals in carrier lines are non-carriers. If selection against dwarfism is carried to the extreme on a pedigree basis, breeders may lower the performance of beef herds in other traits associated with efficient production in beef cattle.

The disposal of animals closely related to dwarfs facilitates the disposal of carrier individuals from breeding herds. Even though there are many limitations to pedigree studies, the studies should be used to "screen" breeding herd replacements, particularly prospective sires to be placed on breeding tests. In many instances pedigree studies have been the only method of controlling dwarfism that has been available for adoption by breeders.

5. Summary

One type of dwarfism in Hereford cattle has been considered in this discussion and the primary aspects of the general problem that have been subjected to experimental study have been reviewed. Breeders should be aware of the following conclusions, which appear justifiable at this time.

1. Dwarfism in conventional Herefords is transmitted as a single, autosomal recessive gene.
2. The increase in the frequency of occurrence of dwarf calves suggests that carriers are being preferred over non-carriers in breeding selections although the reason has not been determined.
3. At present the only reliable technique for the identification of non-carrier sires is the progeny test.
4. Pedigree studies may be useful for controlling dwarfism.
5. It is not advisable to place all selection preference on freedom from dwarfism and to disregard many other traits which are also important in efficient beef cattle production.

3. The profilometer is an instrument developed by the California research workers to obtain the median profile contour of cattle heads.

Sheep

Feedlot Fattening Experiments with Lambs, 1953-54

T. Donald Bell and A. B. Erhart*

The tests this year compared whole milo with steam-rolled milo, and ground milo when fed with a standard roughage ration of ground sorghum fodder (little grain), plus a protein supplement and supplemental salt and limestone. The roughage comparisons included: (1) all sorghum fodder, (2) sorghum fodder and alfalfa hay, (3) sorghum silage and alfalfa hay, (4) sorghum silage and sorghum fodder, and (5) beet top silage and alfalfa hay. One lot of lambs received the standard ration of fodder, milo grain, and protein in pellets containing all three ingredients.

The value of antibiotics was checked in one lot and the value of stilbestrol implants and progesterone-stilbestrol implants was checked in two other lots.

Lambs

The lambs for this year's tests were secured from New Mexico and included a large proportion of white-face fine wool lambs and a smaller number of black-face crossbred lambs, with a larger number of ewe lambs than usual. They entered the feeding tests weighing approximately 67 pounds.

Feed Prices

Milo grain	$ 2.10 per cwt.
Grinding	.10 per cwt.
Steam rolling	.15 per cwt.
Cottonseed meal	80.00 per ton
Alfalfa hay	30.00 per ton
Ground sorghum fodder	11.00 per ton
Beet top silage	8.00 per ton
Sorghum silage	8.00 per ton
Pellets—60% dehydrated sorghum fodder, 35.3% milo grain, 4.7% cottonseed meal	41.50 per ton

Table 19.—Feedlot Tests.

First Feeding Period—November 10, 1953, to February 23, 1954.

Lot number	1	2	3	4
Number of lambs per lot	48	48	48	48
Ration fed	Beet top silage, milo, alfalfa hay, protein, salt, limestone	Stilbestrol implants, Axtell fodder, milo, protein, salt, limestone	Sorghum silage, milo, alfalfa hay, protein, salt, limestone	Milo (steam rolled), Axtell fodder, protein, salt, limestone
Number of days on feed	105	105	105	105
Initial wt. per lamb	67.2	66.8	68.5	65.8

* Appreciation is expressed to the Cudahy Packing Company of Wichita for providing the carcass data from these experimental lambs.