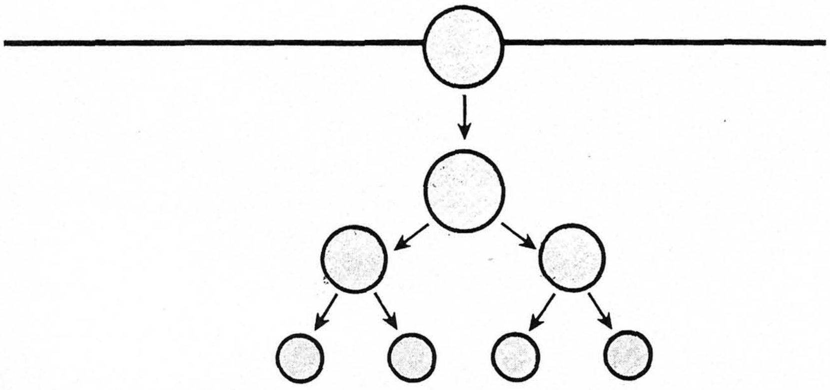


GENETIC DEFECTS

Part II of this series on genetic defects and Association policy details double muscling and progeny testing procedures. Part I, included in our September issue, gave a general overview and took a closer look at syndactyly, osteopetrosis, hydrocephalus and heterochromia irides. This information, compiled by Marilyn Barr Pieper with the help of Dr. Horst Leipold, is presented in an effort to help breeders better understand and control genetic defects.

DOUBLE MUSCLING

"The philosophy among many breeders seemed to be that, if a moderate amount of muscling is good, then more muscling is better. The era of the great muscle hunt began and with it an upsurge in the incidence of double muscling in all breeds of cattle of European origin." (From the Texas Agricultural Experiment Station Bulletin B-1325, Double Muscling in Cattle.)

That was in the early 1960s when demand for leaner beef led to the "meat-type" steer concept, and trim cattle with thick bulging muscles were pictured as ideal slaughter animals. This in turn created great demand for heavily muscled bulls.

Double muscling existed long before the 1960s, though. It probably originated in cattle native to western Europe and was seen as early as 1804 in cattle developed in England. The first U.S. case was recorded in 1934, and it has been encountered in every beef breed of European origin.

Double muscling is genetically controlled, inherited by a single pair of recessive genes. But carrier animals are usually different in conformation than normal animals, indicating that the recessive gene is incompletely recessive to its partner gene for normal muscling.

Rare in Angus

Double muscling is not lethal and occurs very rarely in Angus cattle, but is included on the Association's list of Class I defects because most affected cattle have reproductive problems that severely limit their usefulness in registered or commercial herds.

The defect's correct name is muscular fiber hyperplasia, and the term double muscled actually is misleading. Affected animals do not have twice as many muscles as normal animals. Instead, each muscle has about twice as many fibers, and the animal appears to have what the French call "explosive" muscles.

Double muscling involves several characteristics that together lower the overall fitness of an animal. Affected animals usually can be identified by appearance; however, no one individual is likely to express all traits.

Muscle development is accented more in males than females (except as young calves), because males normally are heavier, and the defective gene tends to magnify the sex difference in muscling.

These cattle become physically mature sooner and usually are smaller at maturity.

Expression varies

The degree of expression of double muscling varies considerably, indicating that other genes interact to cause some animals to show the traits more strongly than others. Also, signs of the defect will be less evident after sexual maturity and calving.

Environment also plays a role in degree of expression. Superior environment and high level of feed cause muscular enlargement to be more pronounced.

The appearance of carrier animals also varies considerably. In general, carriers express the same traits as double-muscled cattle but to a lesser degree. In most cases, carriers look distinctly different than normal or double-muscled animals; but some may be almost as extreme as pure double-muscled animals, while others may look almost normal.

Double-muscled cattle boast some advantages over normal cattle. They grow faster and are more feed efficient up to one year of age. In general, they have a higher dressing percentage, higher yield of edible meat, less fat and bone, and their meat may be higher in protein than that of normal cattle. In fact, people in some European countries prefer meat from these cattle, and it is usually tender and palatable.

Dressing percentage

Average dressing percentage (hot carcass weight divided by live weight) is higher for affected cattle because bone and nearly all dress-off items weigh less. That includes hide, digestive tract, kidney fat, brain, stomach, lungs, blood, etc.

Cutability obviously is increased because of increased muscle mass and the severe reduction of fat. Some double-muscled carcasses have almost no intramuscular fat (marbling), outside covering or internal fat. (With prolonged feeding of high-concentrate rations, they will put on fat. But they cannot handle certain fatty acids in roughages and need high-concentrate rations or milk for optimum gain.)

There is also an increase in total nitrogen percentage, associated with the decreased amount of marbling, that indicates an increase in protein.

However, the meat merits a lower quality grade, has much less energy, and the scanty fat covering (especially over the round) allows the meat to dry out readily, reducing its keeping quality for shipping and storing.

Carriers tend to be intermediate in carcass traits, corresponding closely to the ideal "meat-type" animal in muscle development and fat deposition. But at present there is not an economical way to produce carriers for slaughter animals.

Plagued by problems

But carcass cutability advantages are offset by a list of reproductive problems.

Double-muscled females are slow to reach sexual maturity. In the Texas A&M research herd, average age at first breeding of these cows was about 22 months. One extremely double-muscled cow did not conceive until 30 months of age, and some never conceived.

Sterility due to infantile reproductive tracts is common in extremely double-muscled females. In those animals, the uterine horns and vagina are shorter than normal, and the uterus is larger. The vulva is small and located higher up on the rump at an acute angle from the ground, and natural breeding may be difficult.

Death of calves and/or cows due to dystocia (calving trouble) is frequent. Of 25 calves born to double-muscled cows at Texas A&M, nine were taken by Caesarean, 10 were given a hard pull with a calf puller, two were assisted with hand pull, and four were born without assistance. Ten calves were born dead because of trauma associated with birth.

Main factors

Two main factors cause this high incidence of dystocia. First is shape of the calf. The massive hips and shoulders of most double-muscled calves make it difficult to pass through the birth canal. Second, the birth canal of an affected cow is small. And those two factors combined lead to high death loss.

Reduced udder size and lower milk production are common in double-muscled cows. A 1965 study showed that average milk production of double-muscled cows during the first three months of lactation was only about half that of normal cows. At the end of the third month, milk production was less than half of what their calves would have eaten if more milk had been available, while normal and carrier cows still were producing very near the amount their calves would consume. It is not uncommon for double-muscled cows to be essentially dry 90 days into lactation.

Observations of affected bulls are that testes are thin and light in weight, but the bulls usually are fertile. Research indicates that size of testes is correlated to age that a bull's daughters reach puberty, which seems to hold true in this case.

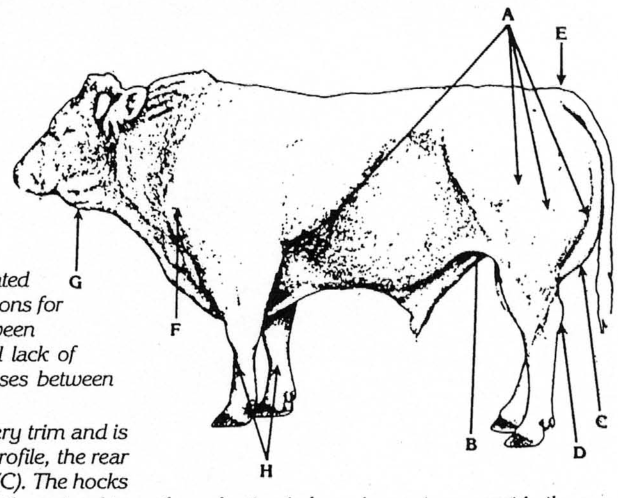
Carrier bulls have normal size testicles, and carrier cows resemble normal cows in reproductive traits and milk production.

Calves face problems

Double-muscled calves face several problems, too. They often appear strong and vigorous at birth but soon become weak and unable to stand and nurse. They tend to have high blood acidity levels, and a buffer can help lower the acidity and increase viability.

But the most serious problem is a large thick tongue that may be partially or completely attached to the bottom of the mouth. In normal newborns, the tongue forms a cup so the teat can be grasped to nurse. But when the tongue is enlarged, this is not possible. While the calf has a strong hunger impulse, he soon becomes tired and weak. The tongue usually regresses in about three months.

Double-Muscled Bull



The most obvious departure from normality of the double-muscled animal is enlargement of the skeletal muscles. Although all muscles are enlarged, the increase in muscle mass is most apparent in the muscles of the rear quarters. In the figure at right, the muscles are delineated by deep creases (A). One of the reasons for the apparent sharp separation between different muscles is the almost total lack of external fat to smooth out the creases between different muscles.

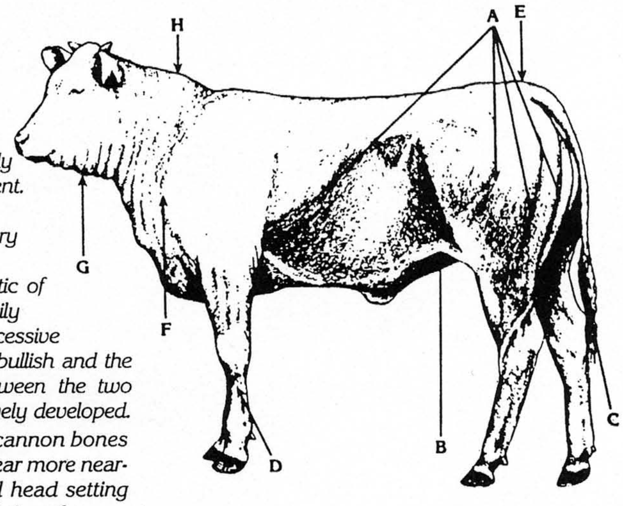
The double-muscled animal is very trim and is often "cut-up" in the flanks (B). In profile, the rear quarters describe the arc of a circle (C). The hocks are often very straight (D), causing the animal to stand on its toes. This is called the post-legged condition, although the opposite or sickled-hocked condition is sometimes seen. The tail head (E) is attached farther forward than in non-double-muscled animals.

The shoulders are prominent because of increased muscle mass (F). Double-muscled animals often have "open" shoulders because muscles medial to the shoulder blades tend to push the shoulders away from the body.

Double-muscled animals are light-boned, and the reduction in bone is most apparent in the cannon bones (H). The muscle which occupies the space between the two halves of the lower jaw tends to sag prominently below the jaw bone (G). The head of the double-muscled bull is often plain and "cow-like" and may lack the overall masculinity of non-double-muscled bulls.

Double-muscled animals (both males and females) within a given breed are usually smaller at maturity than their contemporaries even though they may grow more rapidly than normal during the first 12 months of life.

Double-Muscled Heifer



The overall image projected by this heifer is one of coarseness of head and neck, trimness of body and excessive muscular development. Sparse external fat is indicated by distinct muscular creases and a very "tight" trim body.

Masculinity, which is characteristic of the double-muscled female, is readily apparent in this heifer. There is excessive neck development (H), the head is bullish and the muscles occupying the space between the two halves of the lower jaw are excessively developed.

Fine bone is evident in the front cannon bones (D), but the rear cannon bones appear more nearly normal in development. The tail head setting (E) is placed much farther forward than for normal cattle.

In general, the double-muscled female exhibits many of the same characteristics exhibited by the male. However, muscular development is accented more in males than in females. This results because males are normally heavier than females, and the presence of the double-muscled gene tends to magnify sex differences in muscling.

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Affected calves also appear more sensitive to stress and disease, and they have a higher death rate. Most double-muscled calves are obvious at birth (large hips and shoulders, large muscles delineated by creases, forward tail head attachment, etc.). Occasionally a calf will be genetically double muscled but will appear normal; however, the defect usually becomes obvious within a month after birth. ■

PROGENY TESTING

Valuable genetic material should not be thrown away. Breeding powerful seed stock that can improve and perpetuate a breed takes years of hard work and careful selection, because most of the traits we select for—fertility, growth, milk production, etc.—are controlled by many genes. They are much harder and more costly to change than genetic defects caused by a single pair of genes. We cannot afford to discard a lot of good genes because of one bad gene.

On the other side, confirmed carriers of genetic defects should not be used in registered herds—no matter how strong they are in other traits. A carrier's offspring stand a 50 percent chance of carrying the defective gene, so they should not be used unless they are proven clean. And grandsons or granddaughters should not be used extensively unless they are proven clean, because they run a 25 percent chance of being carriers.

That is where progeny testing comes in. A carrier's superior traits can be passed on to benefit future generations, without spreading the defect, by using outstanding sons or daughters that have been progeny tested and declared clean. Rather than throwing out whole lines of cattle because of one undesirable gene, superior animals in that line can be tested. Cattle that successfully complete a test should be accepted by the industry as clean, and not be discriminated against, even if they are closely related to an affected or carrier animal.

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Progeny testing involves breeding the bull or female in question to animals which carry, or stand a higher than average chance of carrying, a defective gene. This increases the chance of abnormal genes pairing up in the offspring. If even one defective calf is born, we can be 100 percent sure that the tested animal is a carrier.

If no abnormal calves are born in tests following Association guidelines, we can be 99 percent sure that the animal is not a carrier. Breeders should note, however, that an animal never can be labeled clean with 100 percent assurance. There is always a chance of nondetection no matter how many normal calves are born. But with 99 percent accuracy under Association policies, that chance is very slim.

Association guidelines offer four ways to check a bull for the marble bone, mule foot, double muscling or dwarfism genes: Mate to abnormal females (marble bone cases usually do not live to sexual maturity, however); mate to known carriers; mate to daughters of a carrier bull; and mate to the bull's own daughters. The first three methods test only for a single defect; mating to a bull's own daughters checks for all recessives.

A female can be tested by breeding to an affected bull or to a known carrier and using embryo transfer.

Numbers vary

When mating to abnormal animals, seven live calves (with no defects) are required to prove, with 99 percent accuracy, that the animal is not a carrier. Mating to known carriers requires 16 live offspring. Mating to daughters of a carrier or daughters of the bull on test requires 35 different daughters. Trials do not have to be completed in one year so long as the required number of matings are made.

Since mule foot can be detected early in gestation, both bulls and females can be tested using super ovulation, embryo transfer and fetal removal after a minimum 60 days pregnancy, which saves time, money and number of cattle needed. The same number of fetuses are required as the number of live calves listed in the preceding paragraph.

When is a progeny test justified? The process is expensive and time-consuming, but using tests to spot carriers is cheaper than trying to control a defect after it has spread through a herd or a breed. Such a test generally is warranted for superior animals that are related to a carrier.

Several factors should be considered when deciding whether to test. Will the breeder's program be built around one bull so that his genes will form the foundation of the herd? Will a large quantity of semen be sold, distributing a bull's genes throughout the industry? Will buyers pay premiums for the offspring because the bull has been tested? Will a female be used extensively enough to warrant the test?

Justification for test

A yes answer to any of these questions may indicate sound justification to run a progeny test.

A sire-daughter test is a more powerful tool than a test for one specific defect. These matings check for all undesirable recessives, and bulls that successfully complete a test on 35 different daughters are declared genetic defect free. Sire-daughter tests can fill a specific and important industry need by providing a bank of solid clean genetic material, but they should be kept in proper perspective. Genetic defect-free bulls should be used as another tool in overall breeding and merchandising plans.

However, this is the most expensive progeny test. It also produces a lot of inbred calves. And it takes three to four years to complete, delaying the use of good young sires. If a bull is tested as a yearling, he would be at least four years old when his first daughters' calves are born. Breeders should not hold back from using a young bull unless there is reason to suspect that he may be a carrier.

Because of time and money involved, sire-daughter tests probably will be limited to a few bulls expected to be used widely in the industry through sons, also to bulls with outstanding genetic merit that are suspect because of an affected or carrier relative.

Test for single defect

Tests for a single defect are quicker and more economical than sire-daughter matings. The Association's test policies were especially designed to allow a breeder to prove an animal free of a single undesirable gene when that problem has cropped up in related animals.