The New Genetics And the Angus Breeder

by Anthony Robertson

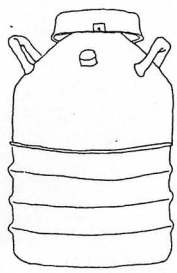
Embryo transplant, like artificial insemination, is here to stay, while gene splicing and cloning are just around the corner. Will they be economically important and if so, what should we know about them?

It took nearly 300 years from the discovery of the sperm and the egg to the first successful embryo transplant in man but less than 30 from the discovery of the structure of DNA to the first attempts to cure a human genetic defect by gene splicing. What does this tremendous acceleration in progress mean to the Angus breeder? First, a few facts.

DNA is a large molecule. It carries genetic information rather as though it was a tape of computer instructions. Each cell in every cow contains several feet of DNA tightly wound up in 30 chromosome pairs. Each gene is a piece of DNA—that is, part of a chromosome. Mutations occur when the structure of a gene is altered, changing its coded message, but this happens very rarely. Most mutations are harmful. For example, sickle-cell anemia in humans is caused by a mutation in the gene for hemoglobin, the red blood pigment that carries oxygen. A blood cell with two mutant genes can make only sickle-cell hemoglobin. This defective hemoglobin forms long rods that break the red blood cell open when oxygen is low.

Dwarfism

Dwarfism is caused by another mutation; in this case, the genetic instructions have changed so growth hormone is not made properly. An animal with two mutant genes is dwarfed, but a carrier (with only one mutant gene in each cell) grows because it can make normal growth hormone. In this situation, as in sickle-cell anemia, the mutant gene is called recessive and is dominated by the original wild-type gene. Its full effects can be seen only in animals with no wild-type genes.



We are now faced with the task of deciding how important new techniques will be for the cattle business. Embryo transplanting, like artificial insemination, is here to stay; gene splicing and cloning are just round the corner. Will they be economically important and, if so, what should we know about them? The answers to these questions depend on so many ifs and buts that it is vital not to get carried away with too much early enthusiasm. Nonetheless we cannot and should not want to avoid progress.

The case for embryo transplants is the easiest to discuss, if only because it is analogous to artificial insemination, whose economic importance and value for breed improvement should by now be obvious to all. In both techniques we are not changing the DNA but trying to increase the proportion of favorable genetic combinations. We are using them to make the production and selection of good cattle faster.

Gene Pool

Here it is important to keep in mind the pool of genes in the whole population of Angus cattle. Some of the numbers are quite surprising. Except for identical twins or for animals produced by artificial cloning, no two animals of the same breed have exactly the same genes. In each population there is a lot of variability. This is why we can select so effectively for different traits (such as fast growth) that are affected by many genes in combination. It is like shuffling a pack of cards to deal different hands: The cards remain the same, but some combinations are better than others.

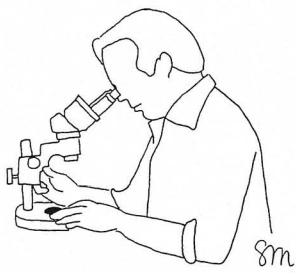
When we find a good combination, artificial insemination and embryo transplanting can help spread it quickly. Even without modern technology, this is what progressive breeders have tried to do when mating superior bulls to superior cows. Even before artificial insemination could be used by Angus breeders, this intense search for good combinations had led to a situation in which most animals in the breed were much more closely related than they would have been if allowed to breed by chance, without any selection. For example, between 1850 and 1900, the effective size of the American Angus population in each generation was 91 animals, with 23 bulls.

All this means is that a few bulls from superior herds always will dominate to such an extent that the whole breed appears to be closely related: The good ones spread their genes! This effect of selection is increased by any technique that increases the domination of particular bloodlines. Artificial insemination does this and so will embryo transplanting if the practice becomes widespread. Superior herds will get better and breed improvement will be faster so long as we avoid the adverse effects of too much inbreeding.

Of Permanent Importance

Therefore, I think embryo transplanting will be of permanent economic importance so that eventually very valuable females will be almost as common as top bulls. About 17,000 successful transplants were made in U.S. cattle in 1979, more undoubtedly in 1980. Faster selection of superior females will result, and this is especially important to the purebred industry. Once embryos can be selected on the basis of sex, which will not take long, improvement will be even quicker: The top 10% of cows could then easily supply all our replacement heifers! This tendency, already remarkable for bulls, can only accelerate as on-the-farm cheap transplant technology is improved.

What of gene splicing and cloning? Here, I think, the benefits are less certain. In gene splicing, new DNA is put into a cell to replace a defective gene or to give a new capacity to the animal. For example, cells that produce red blood cells carrying sickle-



cell hemoglobin can be removed from a human and grown in the laboratory. Normal DNA can be inserted and the cells put back to produce normal blood. This is a very expensive and uncertain procedure, though technically possible. In cattle, it is obviously easier to breed out defective genes. As we know, there are very few that matter.

Cloning

Cloning is the production of individuals whose genes are identical. This has now been done in mice. Its greatest significance is for research, since it allows us to produce pure strains of animals for testing drugs and for genetic experiments. Again, this does not seem too important for the Angus breeder, who really wants to preserve variability in his herd.

Out of all these techniques, I personally feel that progeny testing of cows by embryo transplant offers the most immediate rewards. We can see its value for bulls. Perhaps it won't be too long before there are reference dams as well as reference sires.

Anthony Robertson, a native of Berkshire, England, and a newcomer to the Angus business, is president of Biological Research Corp. and Beef Cattle Breeders, Inc., Lexington, Ga. He holds a degree in natural sciences-physiology from Cambridge University in England and from 1975-1980 was research associate professor, Dept. of Biophysics and Theoretical Biology, The University of Chicago. Robertson is writing a book about beef cattle breeding for farmers and investors and a textbook on embryology.