PENNSTATE College of Agricultural Sciences

From the Department of Dairy and Animal Science

This regular column from Penn State's Department of Dairy and Animal Science features the research findings, student opportunities, and resports on other important topics generated in the Department. The back issues of the column are archived on *Lancaster Farming's* Internet *www.lancasterfarming.com* home page. Look for them.

Prospects For Improving Fertility Of Bull Semen

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Efficient reproduction is critically important to the financial success of the dairy cattle industry. More than 70% of the dairy cows in the United States are bred by artificial insemination using semen from genetically superior sires. On the average, about 50% of these matings result in birth of calves Given these results, there is considerable interest in improving pregnancy rates to shorten the average calving interval for a dairy herd, thereby increasing profits

Researchers at Penn State University's College of Agricultural Sciences are studying how the fertility of sperm from bulls is influenced by proteins that are present in the male and female reproductive tracts The dairy bulls used for artificial insemination are unique because extensive data have been gathered to document their individual fertility Fertility assessment is based on use of their semen to inseminate thousands of females, a feat made possible only through the use of artificial insemination and good record keeping. Because the fertility of individual bulls is known, comparisons between the protein composition of the seminal fluid in which sperm are suspended are possible for semen from higher and lower fertility bulls Comparisons are made between bulls by preparing protein maps of seminal fluid using a technique known as two-dimensional polyacrylamide gel electrophoresis. The technique provides information about the protein size and pH associated with the more than 50 proteins in the map

Penn State researchers discovered that two proteins are present in greater concentrations in seminal fluid of higher fertility bulls than in lower fertility bulls. Additionally, lower fertility bulls tended to have greater concentrations of two different proteins. These studies are painstaking in nature, because the fertility proteins represent much less than 1% of all of the proteins present in seminal fluid.

What are the fertility proteins in seminal fluid? The process of identifying the fertility proteins involves determining the sequence of amino acids, or protein building blocks, which are unique to each protein The process is tedious because of the small amount of protein in an individual spot of a map However, working with colleagues at the National Institutes of Health, and the Osaka Bioscience Institute, Japan, the two high fertility proteins were identified as osteopontin and prostaglandin-D-synthase. The identity of the two low fertility proteins in seminal fluid remains unknown.

Osteopontin was originally discovered in bone matrix but also has been found in many other tissues of the body, where osteopontin facilitates attachment and signaling among cells. Prostaglandin D synthase is present in high concentrations in human cerebral spinal fluid where it appears to be involved in sleep induction. Prostaglandin D synthase may function in prostaglandin metabolism and or in transport of retinoids such as vitamin A, which is essential for normal sperm production.

The major challenge now confronting Penn State scientists is to understand how the high fertility proteins actually improve male fertility. In order to study the effect of the proteins on sperm, bioassays are being used to determine whether treatment of sperm with these proteins improves the rate of fertilization and embryo development in vitro. If a beneficial effect were shown in the laboratory, field trials would follow. The field trials would be used to confirm that cows inseminated with sperm treated with high fertility proteins have improved pregnancy rates. Unfortunately, conducting the studies outlined above requires more of the high fertility proteins than can be realistically purified from seminal fluid. Producing recombinant forms of the proteins in the laboratory using molecular biology techniques is solving this problem.

This story began by recognizing that dairy bulls used for artificial insemination are unique experimental animals with documented fertility. These circumstances have made it possible to establish, using a variety of analytical tools, that proteins associated with fertility do exist in bull semen. As new information becomes available on how these proteins may function to enhance fertility, practical applications are likely to emerge. This information should be useful in developing diagnostic tests for screening bulls of unknown fertility, and boosting the fertility of lower fertility bulls by the addition of the high fertility proteins to semen extenders used for artificial insemination. These developments are likely to improve pregnancy rates for a dairy herd and, in turn, farm profitability.

Another current area of research has potential impact on reproductive performance of livestock species. A laboratory assay method, known as a sperm-binding assay, is being further developed to compare the fertility of an individual male with other males. This assay is based on the ability of sperm of a variety of species to bind to a membrane derived from chicken eggs. The objective of the current studies is to develop a method that can be used to identify young prospective herd sires that have the highest fertility. Although this research began only recently, results to date are encouraging. This line of research will not make it possible to improve the fertility of an individual male. Instead, by providing a means to identify the most fertile males and making it possible to rank males according to their fertility, it should lead to more-informed sire selection, higher herd fertility and greater profits for dairy and livestock producers.