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BASIC RESEARCH IN REPRODUCTIVE PHYSIOLOGY WILL HELP IMPROVE FERTILITY OF BROILER BREEDER MALES

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For many years, the semen quality of male chickens and turkeys was evaluated on the basis of the number of sperm cells in a certain volume of semen, the motility or movement of the cells, the number of malformed cells, or the metabolic activity of the cells. Although these measurements informed researchers and breeding companies about the quality of the semen outside the body of individual males, or groups of males, they did not give much information about the semen where the action is, that is, at the point of fertilization of the egg.

When the female is inseminated, either naturally or artificially, the sperm cells are first stored in sperm storage tubules that are located at the uterus-vagina junction of the oviduct. The sperm cells are released from these sperm storage tubules at various times for a week or more after insemination. Fertilization takes place in the uppermost section of the oviduct, called the infundibulum, immediately after the yolk, or ovum, is shed from the ovary, and before any albumen is secreted to surround it. So, in order to fertilize the egg, the sperm cells must travel the length of the oviduct and attach themselves to the membrane surrounding the yolk (called the perivitelline membrane). Keep in mind that the yolk, or ovum, is a single large cell with a nucleus (located in the germinal disc) and a huge amount of fat and protein to nourish the developing embryo during incubation.

Research by Wishart (1987), who used fluorescent dyes to identify the sperm cells, showed that a certain number of sperm cells must attach to the yolk membrane to assure fertilization. The average number has been placed at 2.0 to 2.5 cells on the first day of insemination according to Wishart (1989), and will reach 1,000 cells or more by the second day after insemination according to Alexander and her coworkers at Penn State (1993). Further work by Bromwell and associates (1992) at the University of Georgia suggests that not only is binding of the sperm cells to the membrane necessary but penetration of the membrane must also occur. These researchers developed a method to count the number of penetration holes produced by the sperm cells in the area covering the germinal disc.

This basic research is helping researchers and poultry breeders solve two important questions about reproduction in domestic fowl.

• 1. Effects of frozen storage of semen. Although artificial insemination of *fresh* semen has been highly successful in domestic chickens and turkeys, in contrast to mammalian semen, the use of *frozen* then *thawed* semen of birds has been notably unsuccessful. Penn State scientists have found that the number of previously frozen sperm cells that attach to the yolk membrane is severely reduced in frozen compared to fresh semen, even though the cells appeared normal by such criteria as concentration and motility. They hypothesize that the reason for the poor fertility of frozen semen is that many of the sperm cells fail to enter the sperm storage tubules or have reduced ability to leave the tubules and transverse the length of the oviduct to attach to the yolk membrane.

• 2. Effect of high environmental temperature. The second important question that is being investigated is how elevated temperature during the summer months reduces fertility in broiler breeder flocks. It has been estimated (Keirs, 1982) that fertility declines by an average of 15 percent in July, August and September, resulting in a potential reduction of 279 million broiler chicks nationwide. McDaniel and his associates at the University of Georgia (1995) showed that although semen volume, sperm concentrations and the percentage of dead sperm were unaffected by environmental temperatures, the number of sperm cells that are able to penetrate the yolk membrane is reduced in males exposed to 85-90 degree F for periods as short as 12 hours. It is not unusual for afternoon temperatures to reach such levels in the summer in broiler producing areas.

Thus, research into the basic mechanisms of reproduction may lead to improvements in fertility and increased broiler chick yield. For more about this subject, see the following publications:

Alexander, A., J. Graham, R. H. Hammerstedt, and G. F. Barbato, 1993. Effects of genotype and cryopreservation of avian semen on fertility and number of perivitelline spermatozoa. Brit. Poult. Sci. 34:737.

Bromwell, R. K., H. L. Marks, and B. Howarth, Jr., 1992. Quantitative determination of spermatozoa penetration of the perivitelline membrane of the hen's ovum as assessed in oviposited eggs. Poult. Sci. 72(Suppl 1):140.

Keirs, B., 1982. Summer heat, loss of fertility in hatching eggs. Poultry Digest 41:352.

McDaniel, C. D., P. K. Bromwell, J. A. Wilson, and B. Howarth, Jr., 1995. Fertility of male and female broiler breeders following exposure to elevated ambient temperatures. Poult. Sci. 74:1029.

Wishart, G. J., 1987. Regulation of the length of the fertile period in the domestic fowl by numbers of oviductal spermatozoa, as reflected by those trapped in laid eggs. J. Reprod. Fertil. 80:493.

Wishart, G. J., 1989. Physiological changes in fowl spermatozoa during in vitro storage. Brit. Poult. Sci. 30:443.

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