EGG TRANSPORT IN BEEF CATTLE

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In most mammals the eggs reach the uterus 2.5 to 4 days after ovulation. This has been demonstrated in rats (Alden, 1942), rabbits (Greenwald, 1961), cattle (Schilling, 1959), sheep (Wintenberger-Torres, 1967) and horses (Hamilton and Day, 1945). The eggs do not seem to be transported at the same speed during their passage through the whole tube, but they stop in the isthmus or in the uterotubal junction and await some action of the tube which will transport them into the uterus. Reports as to the rate of transport through the ampulla vary considerably and depend on the techniques used in the various studies.

Little is known about the transport of eggs through the isthmus of the oviduct. Peristaltic and antiperistaltic contractions have been described, but the thickness of the muscular wall of the isthmus makes it difficult to observe the location and movement of eggs. Contractions were found to be responsible for the transport of rabbit ova through the oviduct, except for a critical point at the isthmic portion immediately anterior to the uterotubal junction where the movement of ova towards the uterus was arrested (Black and Asdell, 1958).

In general, egg transport through the oviduct is controlled by estrogens and progesterone. The administration of estrogens slows or even stops the passage of ova through the oviducts, whereas progesterone injection results in rapid passage (Greenwald, 1968). In cattle, in the presence of corpora lutea or after injections of progesterone the eggs travel down the oviduct at a greatly increased rate, but in some cases egg transport is slowed by the injection of estrogens (Rowson, 1951). It seems that the effect of estrogens on egg transport varies according to the dose.

The purpose of this investigation was to describe the patterns of egg transport in the oviduct at various intervals after ovulation in untreated and superovulated beef cattle.

Materials and Methods

Twenty-nine nulliparous Hereford heifers, about 2 years of age and weighing about 360 kg were used in this experiment. Heifers were checked twice daily with a vasectomized bull to determine onset of estrus, and then observed every 4 hr. to determine the end of estrus. Rectal palpation of the ovaries commenced at the end of estrus and was repeated at 4- to 6-hr. intervals until ovulation was detected. Animals were inseminated with frozen semen during the latter part of estrus. Multiple ovulation in 20 of these heifers was induced by injection of 1,500 to 3,000 IU of pregnant mare serum gonadotropin (PMSG—Equinex, Ayerst) on day 16 of the estrous cycle.

At various intervals after ovulation (8 to 90 hr.) the oviducts were recovered either by surgery or following slaughter. Flank laparotomy was performed in 25 heifers. The animals were taken off feed 24 hr. before surgery. Twenty minutes before starting the local anesthesia, each heifer was injected intramuscularly with 0.5 ml of propiopromazine hydrochloride (Tranvet, Abbott, 50/mg/ml) to facilitate handling the animal during anesthesia. Sympathetic nerve blocks in the paralumbar region were accomplished by injecting 4% procaine hydrochloride on the dorsal and ventral sides of the transverse processes of the first, third and fifth lumbar vertebra. The amount of procaine hydrochloride used varied from 100 to 160 ml depending on the individual situation. The incision was made between the last rib and the external angle of the ilium, from a point below the transverse process of the lumbar vertebra 17 to 20 cm in length. Bilateral ovariectomy and salpingectomy were performed using an ecraseur. The heifers slaughtered were stunned and bled. The reproductive organs were then removed and the tracts were flushed as soon as possible.

After measuring the length of the oviduct, it was divided into eight equal segments. The segment close to the fimbriae was designated.
as segment 1. Each segment was flushed from both ends using a 26-gauge needle attached to a 5 ml syringe containing physiological saline. The uterus was also flushed when the eggs were not recovered from the oviduct.

Results and Discussion

The mean duration of estrus was 10±5 hr. and the majority of the heifers ovulated 16±2 hr. after cessation of estrus. The length of the oviducts ranged from 18 to 31 cm with a mean of 25±1.7 centimeters.

Figure 1 shows the distribution of 124 eggs recovered from the oviduct and uterus. By 30 hr. after ovulation, most eggs were located in segments 4 to 6. From 40 to 70 hr. after ovulation the eggs progressed at a much slower rate through segments 4 to 6. Very few eggs were recovered from segments 7 and 8 throughout the intervals studied. In animals with multiple corpora lutea the eggs reached the uterus by 72 hours. In untreated animals the eggs were in segment 6 by 72 hours. Only one-celled eggs were recovered from segment 1. All eggs recovered from the uterus had more than 8 cells.

Egg transport through the ampulla in the bovine oviduct was extremely rapid. By 8 to 10 hr. after ovulation, some eggs had already passed through the ampulla and were found in segments 5 and 6 of the oviduct. It seems that egg transport in the first two segments is affected primarily by the action of cilia, but further progress is governed by muscular contraction and results in a hesitant advance of the ovum one segment at a time. Similar results have been reported in the rabbit (Harper, 1961a, b). After rapidly descending into segment 5 or 6, the eggs remain between the ampulla and isthmus for some 72 hr. after ovulation. This prolonged arrest of egg transport at the ampullary-isthmic junction is similar to that observed in other species (Schilling, 1959; Oxenreider and Day, 1965; Wintenberger-Torres, 1967). Black and Davis (1962) indicated that there is a resistance to the flow of cow oviduct fluid

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Figure 1. (Top) Rate of egg transport in relation to time of ovulation. Number of eggs recovered from different segments in untreated and PMS-treated cattle. (Bottom) Rate of cleavage in relation to location of oviductal segments. A.I.J.—hypothetical ampullary-isthmic junction. Fifty-three eggs were recovered from Segment 6; and five eggs were recovered from Segment 7.
into the uterus which retards the entry of the egg. No or slight resistance has been found 72 hr. or longer after ovulation. These investigators also indicated from in vitro insufflation of the oviduct, that the block was caused by contraction of the isthmic circular musculature rather than by changes in the uterotubal junction. This hypothesis may serve to explain the rapid transport through the isthmus found in this experiment since the resistance in the isthmus had declined 72 hr. after ovulation. It would appear that the ampullary-isthmic junction or the isthmic portion of the oviduct functions as a valve preventing the egg from entering the uterus too early for subsequent survival.

No structural basis for an “isthmic block” has been demonstrated, even though various histological methods have been tried (Greenwald, 1961). A. A. El-Banna and E. S. E. Hafez (unpublished data) measured, planimetrically, the area of the lumen of sections from various segments of the bovine oviduct after projections at known magnification, using a projection microscope. They found that the lumen of segments 5 and 6 had the smallest surface area at all reproductive stages. However, at 72 and 168 hr. after ovulation, the lumen in these two segments was twice as large as that of the same segments during estrus. Also, the changes from the characteristic ampullary structure to the isthmic structure occurs at these two segments. The ampullary-isthmic junction (AIJ) is probably located somewhere between segments 5 and 6 or between segments 6 and 7 of the oviduct. The change in width of the oviductal lumen at the AIJ might be responsible for the characteristic pattern of egg transport.

The eggs entered the uterus of the cow at the 8 to 16-cell stage in the present study, although most of the initial cleavage occurred in the ampulla. Egg transport was enhanced in animals with PMSG-induced multiple corpora lutea. This is in agreement with the finding of Rowson (1951). It has been reported that in the pig eggs are transported through the oviducts more rapidly than in other domestic mammals. In some pigs the eggs are only in the 4-cell stage when recovered from the uterus (Oxenreider and Day, 1965). The rapid transport of ova in the pig may be due to the large number of corpora lutea (Pomeroy, 1955) and subsequent high progesterone level. However, the literature on the endocrine basis for egg transport through the mammalian oviduct contains many contradictory and confusing observations at present, and more investigations will be required to resolve the problem.

Summary

Twenty-nine nulliparous Hereford heifers were used to study egg transport. Multiple ovulation in 20 of these heifers was induced by injection of 1,500 to 3,000 IU of PMSG. The oviducts, recovered either by surgery or after slaughter, were measured and divided into eight equal segments. The segment close to the limbrae was designated as segment 1. Each segment was flushed from both ends with physiological saline. By 30 hr. after ovulation, most of the eggs were located in segments 4 to 6. From 40 to 70 hr. after ovulation the eggs progressed at a much slower rate through segments 4 to 6. In animals with multiple corpora lutea the eggs reached the uterus by 72 hours. In untreated animals the eggs were in segment 6 by 72 hours. Only one-celled eggs were recovered from segment 1. All eggs recovered from the uterus had more than eight cells.

Literature Cited