TIME OF OVULATION IN CATTLE

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE

James E. Brewster

1940

TIME OF OVULATION IN CATTLE

by

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A THESIS

Submitted to the Graduate School of Michigan State College of Agriculture and Applied Science in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

Department of Animal Husbandry

1940

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciate to Professor G. A. Brown, Head of the Animal Husbandry Department, for making this study possible and to Professor C. L. Cole for his invaluable guidance in conducting the study and preparing the manuscript. Appreciation is also due Dr. G. A. Branaman and Mr. Charles Walker for the help and advice they gave in handling the cattle.

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INTRODUCTION

There is a problem among livestock breeders relative to the time of estrus during which farm animals should be bred to secure the highest breeding efficiency. Non-producing females cause a serious loss to the stockman each year. The cost of their maintenance is as great as that of the regular producers but there is no return from the investment in them. A part of this breeding trouble can be attributed to abnormal females and part is due to a lack of information relative to normal physiological phenomena.

On the range a male often serves a female several times during one estrual period. Conception is likely to occur from any one of the services. Breeding several times during one estrus period is not economical when hand breeding is used and is even more expensive in the case of artificial insemination.

The question has been asked as to how the number of services necessary for conception can be reduced. That is, how can the breeding efficiency be improved? This has become especially important since artificial insemination of cattle has become popular. Questions have been raised regarding the rate of sperm travel, of the viability of sperm, and of the time of ovulation in an attempt to have the sperm available at the optimum time for union with the ovum.

This study was conducted with the purpose of determining as nearly as possible at what stage of the estrual cycle ovulation occurs. This knowledge should serve as a guide to breeders as to the optimum time for mating to produce the highest breeding efficiency. That is, the largest number of conceptions at the first service.

REVIEW OF LITERATURE

The work that has been done on the time of ovulation in cattle is quite variable and numbers are lacking in what work has been done. There are considerable data on ovulation in sheep, and more limited data on horses, swine, and small animals. Some work has also been done on the time of ovulation in primates.

A review of the literature pertaining to ovulation in the various mammals reveals that they vary in the length of estrus cycles and each ovulates at a different stage of the cycle. Ovulation occurs spontaneously in the higher mammals but it may be sped up or retarded by the injection of certain hormones. In some of the smaller animals copulation is necessary to cause ovulation.

Cattle

Hammond (14) observed that ovulation occurred spontaneously in the cow. This was confirmed by Ivanoff (17), Bouin and Ancel (6), and Kupfer (20). Hammond (14) concluded from the appearance of ovaries from several cows slaughtered that ovulation occurs between 24 and 48 hours after the onset of estrus. One cow had not ovulated when slaughtered 30 hours after the onset of estrus so ovulation is presumed to occur 40 hours after estrus begins. Hammond (15) in a later publication from his own work and that of Gerasimova (12) states that ovulation occurs an average of about 27 hours after the beginning or just after the end of estrus.

Nielsen (30) found that ovulation occurred before or at the beginning of proestrum.

Schmid (34) found that ovulation occurred at the end of estrus or about 18 to 24 hours after its beginning. Some of his work contradicts

this, however, as he found in some cases that ovulation had not occurred on the second day after estrus began.

Weber (36) killed two cows before estrus began and found that neither had ovulated. He killed a third cow on the second day of estrus and found a cyst and a recent corpus luteum although there was some doubt as to the age of the corpus luteum.

Krupski (19) examined the ovaries of 3 cows that were slaughtered at different intervals. The first one had not ovulated 36 hours after she came in estrus. The second one came in estrus in the morning and had ovulated when she was killed on the afternoon of the second day. The third cow had ovulated by the time she was slaughtered 3 days after coming in estrus.

Strodthoff (35) examined several cows per rectum and observed that ovulation normally occurred at the end of estrus but if estrus was long, ovulation occurred in the middle. He believes that the time of ovulation is related to the onset and not the length of the estrual period.

Beshlebnov (5) in determining the time from mating to ovulation did not confirm Hammond's statement that ovulation occurs about 40 hours after onset of estrus. In 5 cows examined 22 to 30 hours after service ovulation had occurred. In 4 others ripe follicles were found 21 to 26 hours after mating. Nine cows that were examined 34 to 49 hours after breeding had ovulated a considerable time before.

Andreev (3) states that ovulation occurs 30 to 40 hours after the onset of estrus.

Kirillov (18) divided his herd into two parts. One part he mated at the beginning of estrus, the other was mated after 18 to 24 hours. The majority of cases indicated that ovulation occurred after 18 to 24 hours because only 26% of these cows had to be rebred while 60% of those bred at the beginning of estrus returned.

Cole (8) states that ovulation occurs one day postestrum.

Miller, Swett, Hartman, and Lewis (24) recovered a fertilized egg from the uterus of a cow 48 hours after the appearance of estrus in the cow. The second cow that they slaughtered had not ovulated. An ovum was recovered from a third cow but it was not fertilized although she had been bred.

Murphy, McNutt, Zupp and Aitken (27) report examining a cow per rectum that ovulated between 40 and 64 hours after the beginning of estrus.

Werner, Casida, and Rupel (37) after examining 15 heifers at half day intervals, concluded that ovulation occurred within the first day after cessation of estrus.

Nalbandov and Casida (29) from examinations at 15 estrual periods, determined that time of ovulation varied from $2\frac{1}{2}$ to $22\frac{3}{4}$ hours after the end of estrus. The average time of ovulation was $11\frac{3}{4}$ hours. Their observations indicate that estrus begins more often in the forenoon and that ovulation takes place more often in the forenoon. In 11 out of 17 cases ovulation occurred between 4 and 10:30 A.M.

Reese and Turner (32) in studies at the Missouri Experiment Station came to the conclusion that the right ovary is functionally more active than the left. This difference accounts for the greater number of pregnancies in the right uterine horn than in the left horn.

Hartmann (1) quotes Kupfer as stating that in 24 cows he found a larger number of corpora lutea of all ages in the right ovary while in 12 cows the larger number was in the left. He also quotes a statement from Atkeson's work (unpublished) at the Idaho Experiment Station that there was an 80% advantage for the right ovary. There were 166 ovulations from the right ovary and 92 were from the left.

Clark (7) in a study of 704 cases of single pregnancies concludes that both ovaries function with approximately equal frequency.

Horses

Satoh, Shigea and Hoshi Shuzoh (33) studied the estrus cycles of 12 mares for 1½ years. They observed that ovulation occurred without artificial stimulus on the sixth or seventh day of estrus. Estrus disappeared 1 to 5 days after ovulation. The average time from ovulation to the end of estrus was 1.6 days.

Mirskaia and Zaltzman (25) concluded that ovulation occurred 1 to 2 days but rarely 3 days before mating desire ceased in the mare.

Andrews and McKenzie (4) in a report on the sexual cycle of 45 draft mares and 35 light mares stated that ovulation occurred over a wide range of the estrual cycle. Ovulation occurred as early as 24 days prior to the cessation of estrus which varied from 1 to 37 days with a mean of 5.3 days, and as late as 5 days after the mare had passed out of estrus. Most of the ruptured follicles were palpated just before or just after the end of estrus. They observed that ovulation occurred in the left ovary in 60% of the cases in draft mares and 61.6% of the cases in light mares.

Sheep

Green and Winters (13) killed 20 Shropshire ewes at various intervals after the beginning of estrus and found that ovulation occurred late in the estrual period or near the time that the animal goes off estrus.

Quinlan and Mare (31) observed that ovulation in the ewe occurs 36 to 40 hours after the beginning of estrus and that the duration of estrus seems to depend on time of ovulation. Six hours after ovulation desire gradually passes off. The same ovary may ovulate 3 times successively, both ovaries may ovulate during one estrual period or a double ovulation from one ovary may occur.

Cole and Miller (9) found that ovulation occurs between the twenty-second and thirtieth hours of estrus.

Anderson (2) from 31 laparotomies came to the conclusion that there is a minimum period of 23 to 25 hours after the beginning of estrus before which ovulation does not occur and that ovulation, which occurs just before or just after the animal is off heat, is related to the beginning and not the end of estrus.

McKenzie and Terrill (23) concluded that ovulation occurs 12 to 41 hours after the onset of estrus but usually toward the end. Ovulation was induced in anestrus by the injection of pregnant mare serum in 5 of 11 cases. The time of ovulation was 36 to 72 hours after injection.

Hartmann (1) quoting Kupfer and Quinlan and Mare states that sheep favor the right ovary in ovulation. The same source quoting McKenzie and Terrill states that 230 ovulations occurred from the right ovary and 179 from the left ovary.

Swine

Corner and Amsbaugh (10) concluded that ovulation occurs spontaneously because ruptured follicles were found in sows that were killed on the third day of estrus showing that ovulation had taken place even in the absence of a boar.

Mumford, Hogan, and McKenzie (26) found that ovulation may occur as early as 24 hours after the onset of estrus.

Lewis (21) reported ovulation as occurring near the end of estrus.

Hartmann (1) quotes McKenzie and Terrill's report that the sow ovulates 30 to 40 hours after the beginning of estrus.

Small Animals

Hartmann (1) makes the statement that copulation is necessary in rabbits, and cats to cause ovulation and that the rabbit ovulates 10 hours post-coitum. He quotes Long and Evans' statement that ovulation in the rat occurs toward the end of estrus when the smear is in stage 2 - 3.

Hartmann (1), quoting Brambell and Parkes, states that ovulation occurs at the end of proestrum or the beginning of estrum in rats and mice.

Dukes (1) states that ovulation occurs in the cat 26 to 27 hours after coitus. He also gives the time of ovulation in the dog as the first or second day of estrus.

Myers, Young, and Dempsey (28) found that ovulation occurred in the guinea pig 10 to 12 hours after the beginning of estrus.

Primates

Hartmann (16) states that monkeys ovulate between day 8 and day 21 from the beginning of the menstruation regardless of the length of the cycle.

He quotes Knaus' results with testing the reactivity of estrus to pituitrin. Although his method lacks confirmation Knaus gives the eighth to the twenty-first day of the cycle as the limits of ovulation time in women.

Hartmann himself believes that ovulation occurs during the middle of the menstrual cycle in women although different length cycles may cause a variation in the exact days of the cycle that ovulation may occur.

EXPERIMENTAL MATERIAL

This study was conducted from June 1939 to April 1940. The animals used were females of all ages from the dairy and beef cattle herds at Michigan State College. Ovarian palpations were made at 73 estrual periods on 47 cows.

PROCEDURE

Each cow in estrus was confined in the barn and tried with a steer at two hour intervals until she refused to stand for the steer to mount. An effort was made to detect the duration of estrus by vaginal examinations. However, there was not a distinct enough change in the condition of the vagina to draw definite conclusions as to the stage of estrus.

Beginning a few hours after a cow went off estrus, or if estrus was unusually long, before she was off estrus, examinations were made of the ovaries at two hour intervals until she had ovulated.

The time for going off estrus and for ovulation was computed by taking an average between the last two observations in each case. The examinations were made by palpating the ovaries through the rectum. Both ovaries were examined each time.

Nine of the cows examined were slaughtered to verify the observations made by ovarian palpation.

In several cases it was impossible to determine either the exact end of estrus or the time of ovulation within two hour limits. In these cases the history was included and the length of time from the end of estrus to the last examination was given, but the hours were not used in computing averages. They were used only to substantiate more definite information.

OBJECTIVES

The object of this study was to determine the time of ovulation during the estrual cycle in cattle and its relation to the end of estrus.

In addition to this, information was sought as to the difference in time of ovulation between the types and breeds of cattle, as to the influence of age upon the time of ovulation, as to which ovary functioned more often, and at what time of day ovulation was most likely to occur. No attempt was made to determine the length of estrus.

CASE HISTORIES

Dairy

Brown Swiss Cow No. 235 *

Age 4 years

1. In heat 10/24/39

   Off heat 12:00 P.M.

   Ovulated left ovary 10:00 P.M. 10/25/39

   22 hours

2. In heat 11/14/39 **

   Off heat 11:00 A.M.

   Ovulated left ovary by 5:00 A.M. 11/15/39

   18 hours

Guernsey Cow No. 44 * **

Age 6 years

   In heat 6/6/39

   Off heat 5:00 P.M.

   Ovulated right ovary 1:00 P.M. 6/7/39

   20 hours

Ayrshire Cow No. 160 * ***

Age 4 years

   In heat 1/11/40

   Off heat 8:00 A.M. 1/12/40

   Ovulated right ovary 5:00 P.M. 1/12/40

   9 hours

Jersey Cow No. 101 * ***

Age 8 years

In heat 2/5/40

Off heat 8:00 P.M.

Ovulated right ovary 1:00 P.M. 2/6/40

17 hours

Jersey Cow No. 118 * ***

Age 6 years

In heat 1/11/40

Off heat 6:00 P.M.

Ovulated left ovary 5:00 A.M. 1/12/40

11 hours

Ovulated right ovary 10:00 A. M. 1/12/40

16 hours

Twin ovulation

Angus

Angus Cow No. 520 *

Age 10 years

1. In heat and bred 7/31/39 **

Off heat 8:00 P.M.

Ovulated left ovary twelve noon

16 hours

2. In heat and bred 10/25/39 **

   Off heat 6:00 A.M.

   Ovaries not normal. No follicles at any time.

3. In heat and bred 1/24/40 ***

   Ovulated left ovary 9:20 P.M. 1/24/40 While still in heat.

   0 hours

4. In heat 2/12/40 ***

   Ovulated left ovary at 8:45 A.M., while still in heat.

   0 hours

5. In heat 3/26/40 **

   No follicle, when examined.

   Slaughtered and found that there was a small cyst deeply imbedded in the right ovary; entirely surrounded by a luteal tissue.

Angus Cow No. 144

Age 12 years

1. In heat and bred 11/16/39 ***

   Off heat 6:00 P.M.

   Ovulated left ovary 8:00 P.M. 11/17/39

   26 hours

2. In heat and bred 11/27/39 ***

Off heat 12:00 P.M. 11/28/39

Ovulated right ovary 11:00 A.M. 11/29/39

11 hours

3. In heat and bred 1/22/40 ***

Off heat 7:00 P.M.

Ovulated left ovary at 10:00 A.M. 1/23/40

15 hours

4. In heat 2/12/40

Off heat 5:00 P.M.

Ovulated left ovary 9:00 A.M. 2/13/40

16 hours

5. In heat 2/24/40

Off heat 12:00 P.M.

Ovulated left ovary at 3:00 P.M. 2/25/40

15 hours

Angus Cow No. 28

Age 11 years

1. In heat 1/9/40 **

Off heat 3:00 P.M. 1/9/40

Had ovulated right ovary 11:00 A. M. 1/10/40

20 hours

2. In heat and bred 2/22/40

Off heat 10:00 P.M.

Ovulated left ovary at 11:00 A.M. 2/23/40

13 hours

Angus Cow No. 354

Age 6 years

1. In heat 2/24/40 **

Off heat 5:00 P.M.

Ovulated left ovary before 3:00 P.M. 2/25/40

22 hours

2. In heat and bred 3/22/40

Off heat 8:00 P.M.

Ovulated right ovary at 10:00 A.M. 3/23/40

14 hours

Angus Cow Chain No. 6

Age 8 years

In heat and bred 7/11/39

Off heat 7:00 P.M.

Ovulated left ovary at 11:00 A.M. 7/12/39

16 hours

Angus Cow No. 394 **

Age 5 years

In heat and bred 7/15/39

Off heat 8:00 P.M.

Follicle on left ovary at 9:30 A.M. 7/16/39. Definite time of ovulation not determined.

11 hours plus

Angus Cow No. 509 **

Age 2 years

In heat and bred 7/23/39

Off heat 4:00 P.M.

Had ovulated right ovary by 9:00 A.M. 7/24/39

17 hours

Angus Cow No. 485

Age 3 years

In heat and bred 9/1/39

Off heat 11:00 P.M.

Ovulated right ovary at 3:00 P.M. 9/2/39

16 hours

Angus Cow No. 2

Age 6 years

In heat and bred 10/30/39

Off heat 6:00 P.M.

Ovulated right ovary at 3:00 P.M. 10/3/39

21 hours

Angus Cow No. 469

Age 4 years

In heat and bred 11/21/39

Off heat 12:00 P.M.

Ovulated right ovary 2:00 P.M. 11/22/39

14 hours

Angus Cow No. 466

Age 4 years

In heat and bred 11/27/39

Off heat 11:00 P.M.

Ovulated right ovary 5:00 P.M. 11/28/39

18 hours

Angus Cow No. 234 **

Age 8 years

In heat 2/8/40

Off heat 11:00 A.M.

Ovulated left ovary by 9:00 A.M. 2/9/40

22 hours

Angus Heifer No. 525

Age 1 year

In heat 1/11/40

Off heat 9:00 P.M.

Ovulated from right ovary at 11:00 A.M. 1/12/40

14 hours

Shorthorns

Shorthorn Heifer No. 721

Age 2 years

1. In heat and bred 7/23/39 **

   Off heat 4:00 P.M.

   Ovulated right ovary at 9:00 A.M. 7/24/39

   17 hours

2. In heat and bred 9/1/39 **

   Off heat 6:00 P.M.

   Ovulated right ovary 11:00 A.M. 9/2/39

   17 hours

3. In heat 2/16/40

   Off heat 9:00 P.M.

   Ovulated left ovary 9:00 A.M. 2/17/40

   12 hours

Shorthorn Heifer No. 720

Age 2 years

1. In heat 7/11/39

   Off heat 12:00 P.M.

   Ovulated left ovary 4:00 P.M. 7/12/39

   16 hours

2. In heat 7/31/39

Off heat 11:00 P.M.

Ovulated right ovary 4:00 P.M. 8/1/39

17 hours

3. In heat and bred 3/23/40

Off heat 2:00 A. M. 3/24/40

Ovulated left ovary at 1:00 P.M. 3/24/40

11 hours

Shorthorn Heifer No. 722

Age 2 years

1. In heat 11/19/39 **

Off heat 2:00 A.M. 11/20/39

Unable to palpate a follicle when examined and no evidence of ovulation having occurred.

2. In heat 1/25/40 ***

Off heat 7:00 A.M. 1/26/40

Ovulated left ovary 11:00 A.M.

4 hours

3. In heat and bred artificially 3/4/40

Off heat 12:00 P.M.

Ovulated right ovary at 9:00 A.M. 3/5/40

9 hours

Shorthorn Cow No. 729

Age 6 years

1. In heat 7/15/39 **

   Off heat 3:00 P.M.

   Ovulated left ovary 9:00 A.M. 7/16/39

   18 hours minus

2. In heat and bred 3/4/40

   Off heat 12:00 P.M.

   Ovulated right ovary at 10:00 A.M. 3/5/40

   10 hours

Shorthorn Heifer No. 717

Age 2 years

   In heat and bred 3/28/40

   Off heat 8:00 P.M.

   Ovulated right ovary at 8:00 A.M. 3/29/40

   12 hours

Milking Shorthorn Cow No. 41874 **

Age 8 years

   In heat 8/12/39 and bred

   Off heat 12:00 A.M.

   Ovulated left ovary by 6:00 A.M. 8/13/39

   18 hours minus

Shorthorn Cow No. 378 **

Age 5 years

In heat and bred 7/11/39

Off heat 3:00 P.M.

Ovulated left ovary 8:00 A.M. 7/12/39

17 hours minus

Shorthorn Cow No. 729 **

Age 6 years

In heat and bred 7/15/39

Off heat 8:00 P.M.

Follicle on right ovary 9:30 A.M. 7/16/39

Time of ovulation not determined.

11 hours plus.

Shorthorn Cow No. 409 **

Age 4 years

In heat 7/23/39

Off heat 5:00 P.M.

Ovulated left ovary 2:00 P.M. 7/24/39

21 hours minus

Shorthorn Cow No. 477

Age 4 years

In heat and bred 8/20/39

Off heat 2:00 A.M. 8/21/39

Ovulated left ovary 9:00 P.M. 8/21/39

19 hours

Milking Shorthorn No. 2283300 ***

Age 8 years

In heat and bred 11/16/39

Off heat 3:00 A.M.

Ovulated right ovary 8:00 P.M. 11/17/39

17 hours

Shorthorn Cow No. 351 *** *

Age 9 years

In heat 1/22/40

Off heat 7:00 P.M.

Ovulated left ovary at 9:00 A.M. 1/23/40

14 hours

Shorthorn Cow No. 482

Age 6 years

In heat 2/20/40

Off heat 12:00 P.M.

Ovulated left ovary 11:00 A.M. 2/21/40

8 hours

Shorthorn Cow No. 345

Age 11 years

In heat and bred 3/11/40

Off heat 4:00 A.M. 3/12/40

Ovulated right ovary 8:00 P.M. 3/12/40

16 hours

Herefords

Hereford Heifer No. 654

Age 2 years

1. In heat 2/23/40

Off heat 8:00 P.M.

Ovulated right ovary 2:00 P.M. 2/24/40

18 hours

2. In heat 3/15/40

Off heat 8:00 P.M.

Ovulated left ovary 8:00 A.M. 2/16/40

12 hours

Hereford Cow No. 620

Age 7 years

1. In heat 1/25/40 ***

Off heat 1:00 A.M. 1/26/40

Ovulated left ovary 1:00 P.M. 1/26/40

12 hours

2. In heat 3/4/40

Off heat 8:00 P.M.

Ovulated right ovary 9:00 A.M. 3/5/40

13 hours

Hereford Heifer No. 622

Age I year

1. In heat 1/24/40 ***

Off heat 4:00 P.M.

Ovulated right ovary 10:00 P.M. 1/24/40

6 hours

2. In heat 2/11/40 *

Off heat 11:00 P.M.

Ovulated left ovary 6:00 A.M. 2/12/40

7 hours

Hereford Cow No. 303

Age 8 years

1. In heat 2/5/40 ***

Off heat 9:00 P.M.

Ovulated right ovary 1:00 P.M. 2/6/40

16 hours

2. In heat 2/24/40

Off heat 12:00 P.M.

Ovulated right ovary 3:00 P.M. 2/25/40

15 hours

Hereford Cow 617

Age 4 years

1. In heat 1/23/40

Off heat 6:00 P.M.

Ovulated left ovary at 9:00 A.M. 1/24/40

15 hours

2. In heat 2/23/40

Off heat 10:00 P.M.

Ovulated left ovary 2:00 P.M. 2/24/40

16 hours

Hereford Cow 606

Age 3 years

1. In heat 11/9/39

Off heat 12:00 P.M.

Ovulated left ovary 2:00 P.M. 11/10/39

14 hours

2. In heat and bred 11/28/39

Off heat 3:00 A.M. 11/29/39

Ovulated right ovary 3:00 P.M. 11/29/39

12 hours

Hereford Cow No. 475

Age 4 years

1. In heat 10/27/39

Off heat 12:00 P.M.

Ovulated left ovary 1:00 P.M. 10/28/39

13 hours

2. In heat 11/12/39

Off heat 8:00 P.M.

Ovulated left ovary 2:00 P.M. 11/13/39

18 hours

Hereford Cow No. 10 **

Age 9 years

In heat 7/24/39

Off heat 12:00 P.M.

Ovulated right ovary by 5:00 P.M. 7/25/39

17 hours

Hereford Cow No. 626

Age 5 years

In heat and bred 11/12/39

Off heat 10:00 P.M.

Ovulated left ovary 4:00 P.M. 11/13/39

18 hours

Hereford Heifer No. 615

Age 1 year

In heat 11/21/39

Off heat 11:00 A.M. 11/22/39

Ovulated right ovary 5:00 P.M. 11/22/39

6 hours

Hereford Heifer No. 623 *

Age 1 year

In heat 11/22/39

Off heat 5:00 A.M. 11/23/39

Ovulated right ovary 7:00 P.M. 11/23/39

14 hours

Hereford Cow No. 326

Age 9 years

In heat and bred 11/28/39

Off heat 6:00 P.M.

Ovulated right ovary 3:00 P.M. 11/29/39

21 hours

Hereford Cow No. 652

Age 4 years

In heat and bred 3/15/40

Off heat 10:00 P.M.

Ovulated right ovary 9:00 A.M. 3/16/40

11 hours

Hereford Cow No. 368

Age 6 years

In heat and bred 3/21/40

Off heat 12:00 P.M.

Ovulated right ovary 1:00 P.M. 3/22/40

13 hours

Hereford Cow No. 613 **

Age 9 years

In heat and bred 3/27/40

Off heat 12:00 A.M. 3/28/40

Ovulated right ovary 9:00 A.M. 3/29/40

20 hours minus

* Slaughtered

** Hours not used in computations

*** Follicle erupted while palpating ovary.

RESULTS AND DISCUSSION

Seventy-three examinations were made on 47 cows. Seventy ovulations were recorded and in 3 cases ovulation did not occur. Fifty-three of the 70 ovulations are included in computing averages. The remaining 17 were not checked within the two-hour interval.

In several instances the follicle erupted during the process of palpation. The question was raised as to whether the follicle erupted prematurely due to handling. As a result of this, an effort was made to break some of the follicles, but it was very difficult to rupture them until about the time that most of the cows ovulated normally. The conclusion was drawn from this that, although ovulation may have occurred sooner than it would have normally, the difference was so slight that it would fall within the two-hour interval.

Ovulation was found, in all cases except 3, to occur within the first day after the end of estrus. One cow, Angus number 520, ovulated on 2 occasions before she went off estrus. Another cow, Angus number 144, ovulated 26 hours after the end of estrus. The average time of ovulation from the end of estrus for the 53 ovulations was 13.57 ± 0.68 hours. Of these ovulations 88.68 percent occurred between 6 and 19 hours and two-thirds fell between 8 and 16 hours after the end of estrus. The two cows that were extremes in their ovulation time were bred several times during the winter without conceiving. If their records were taken out, all ovulations would fall between 4 and 22 hours after estrus.

Records were not kept of the length of estrus in the cow as it was impractical to determine the exact time the cow came in estrus. A great deal of variation was noted in the length of the estrual periods,

however. Some cows only stayed in estrus about 12 hours while others still had mating desire as long as 36 hours after they were first noticed in estrus.

A great amount of work has been done on the length of estrus indicating considerable variation between different individuals. Hammond (14) has given 17 hours as an average time that cows stay in heat. In computing the length of time from the beginning of estrus until ovulation to compare with other work where ovulation was relative to beginning of estrus, 17 hours should be added to the results obtained here.

Of the ovulations reported, 5 were dairy cows, 13 were Shorthorns, 15 were Angus, and 20 were Herefords.

The mean time of ovulation for dairy cows was 15 ± 2.6 hours; Shorthorn, 12.69 ± 1.15 hours; Angus, 13.93 ± 1.68 hours; and Hereford, 13.5 ± .87 hours. These averages are so close that they probably do not indicate any variation between breeds or types. The greatest difference was 2.31 hours between dairy and Shorthorn cows. In each case the numbers were small.

There seems to be no set rule as to which ovary will ovulate after a certain estrual period. In this study successive ovulations occurred from the same ovary in some instances and in others successive ovulations occurred from alternate ovaries. Of the 70 ovulations recorded, 35 were from the left ovary and 35 were from the right ovary. Of the 53 ovulations reported there were 26 from the left ovary and 27 from the right ovary. The average time of ovulation from the left ovary was 13.19 ± 1.14 hours while from the right ovary the average was 13.93 ± 0.75 hours.

One cow, Jersey number 118, had a twin ovulation. She ovulated from the left ovary 11 hours after the end of estrus and from the right

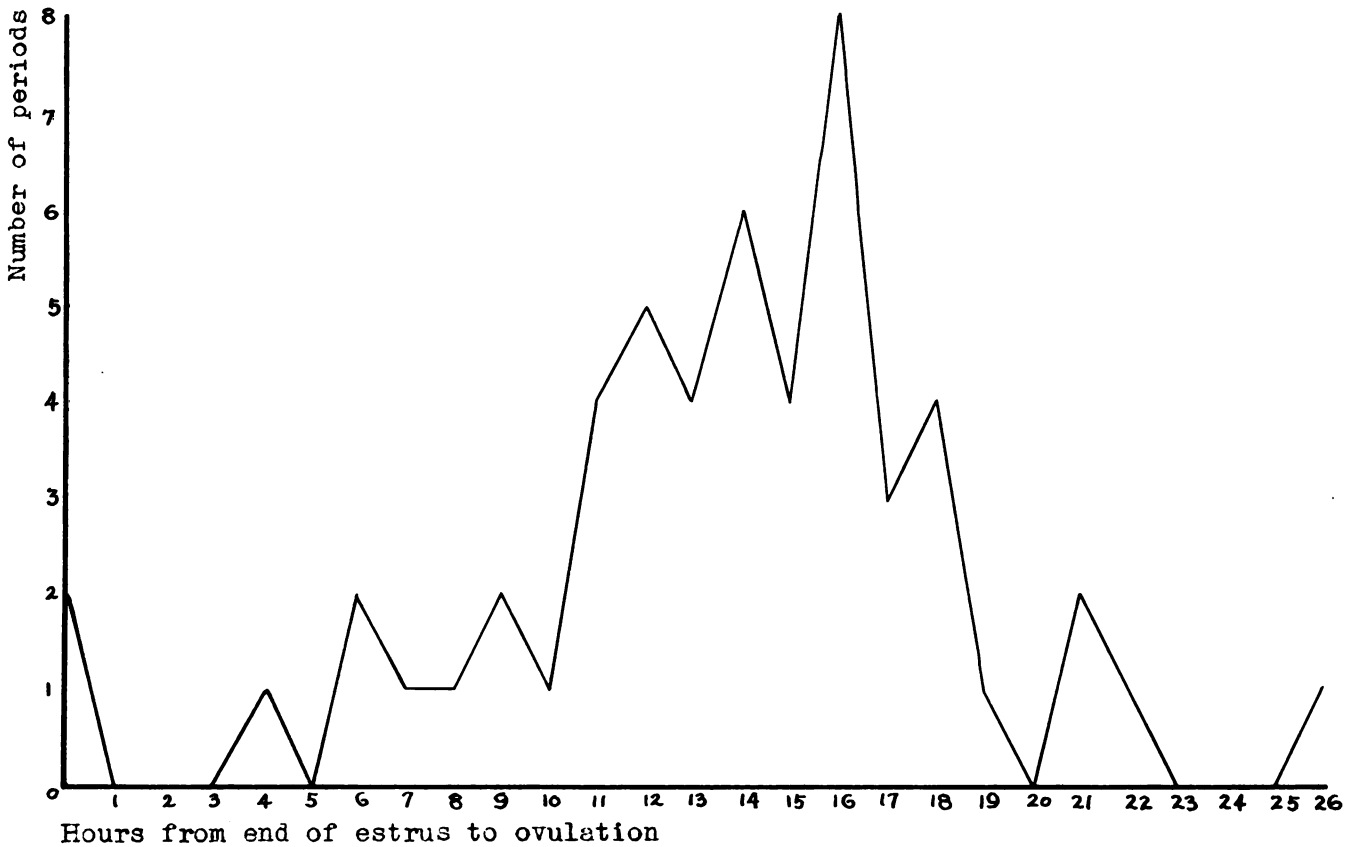
ovary 16 hours after the end of estrus. The two ovulations were checked on slaughter.

The greatest difference found was in the time of ovulation between cows that had calved and heifers that had not calved. There were 16 ovulations recorded among yearling and two-year-old heifers. They ovulated an average of 11.44± 0.99 hours after the end of estrus. Among 37 cows from 3 to 12 years of age ovulation occurred 14.48 ± .84 hours after estrus. A difference of 3.04 hours was found between the time required for cows and heifers.

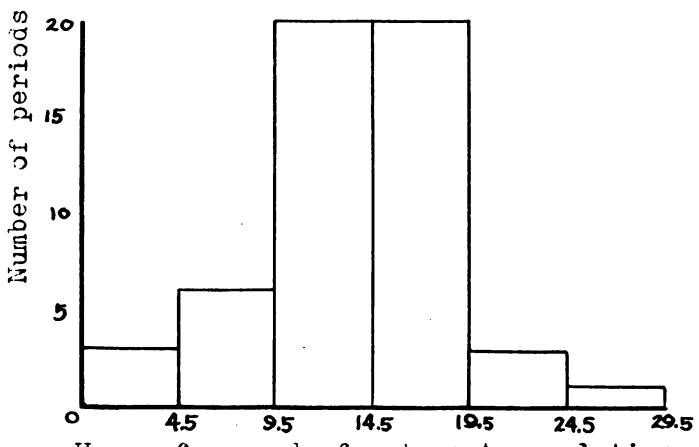
This difference was found to be significant by the use of Fisher's test of significance between means of small samples. Difference was found to be 2.12 while only 2.08 was required to show a significant difference.

It was found that the time of day had no bearing on the rupture of the follicle. Of the 53 ovulations reported, 22 were between 12:00 o'clock P.M. and 12:00 o'clock A.M. while 31 were between 12:00 o'clock A.M. and 12:00 o'clock P.M. Ovulation occurred at almost every hour of the day.

Nine cows were slaughtered a few hours after the end of estrus. Ovarian palpations were made to determine the state of the ovaries. In each case the condition of the ovaries was exactly as predicted.

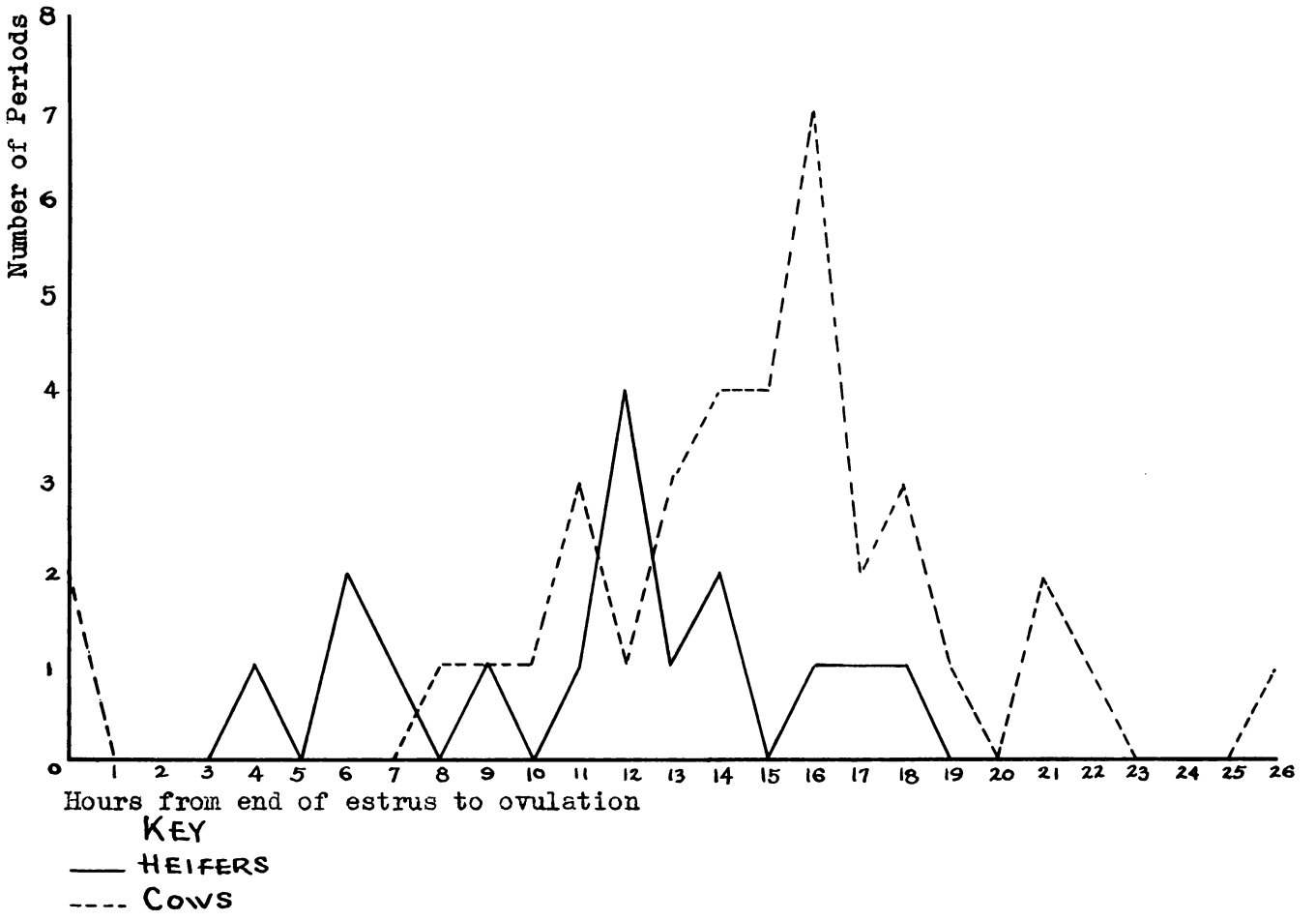


GRAPH
Showing Hours from the End of Estrus
to Ovulation for 53 Periods



HISTOGRAM
Showing Time of Ovulation in Cattle
after the End of Estrus

GRAPH
Showing Difference in time of Ovulation
Between Cows and Heifers



SUMMARY

Observations were made at 73 estrual periods of 47 cows of beef and dairy breeds. The time from the end of estrus to ovulation was determined by rectal palpations of the ovaries. From the data of 53 estrual periods, an average time of ovulation after the end of estrus was computed and the following conclusions were made:

1. Cows ovulated within the first day after the end of estrus. The average time from end of estrus to ovulation for 53 ovulations was 13.57± 0.68 hours. The greatest number of the ovulations were between 8 and 16 hours after the cessation of estrus.

2. If 17 hours is used as an average for the duration of estrus, the average time would be 30 to 31 hours from the beginning of estrus to ovulation.

3. The season of the year apparently has very little effect on the length of time from the end of estrus to the time of ovulation.

4. There was no apparent difference between the different breeds of beef cows and dairy cows as to length of time from the end of estrus to ovulation.

5. The 2 ovaries functioned equally. Of 70 ovulations 35 were from the left and 35 from the right ovary. There seems to be no set rule as to which will ovulate as one may produce the follicle 2 or 3 estrual periods in succession.

6. Heifers required less time to ovulate than cows that had calved. The average time for 16 heifers from the end of estrus to ovulation was 11.44± .99 hours and the time for 37 cows was 14.48± .84 hours. The average difference in time was 3.04 hours.

7. There was no correlation between ovulation and the time of day. There were 31 ovulations between 12:00 o'clock P.M. and 12:00 o'clock A.M. while 22 were between 12:00 o'clock A.M. and 12:00 o'clock P.M. Ovulations occurred at almost every hour of the day.

CONCLUSION

Ovulation normally occurs within the first day after the end of estrus. In this study the average time from the end of estrus to ovulation for 53 estrus periods was 13.57 hours. Andreev (2) and Beshlebnov (5) found that 24 hours after insemination the number of motile sperm was greatly reduced.

May (22) found that it took sperm an average of 7 hours after insemination to reach the infundibulum. Therefore, it is recommended that cows be bred toward the end of the estrual period or if artificial insemination is practiced that they be bred not later than 10 hours after the end of estrus in order to have a greater number of motile sperm available for the ovum when it reaches the oviduct. It is entirely possible that if a cow is bred during the fore part of estrus and ovulation does not occur for 15 or 20 hours after the end of estrus that the sperm will be dead after 30 or 40 hours and conception will not take place. If there is any doubt as to the duration of estrus, it is recommended that the cow be bred a second time several hours after she was first bred to increase the chance of fertilization.

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