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Ovarian Analysis for Data on Corpora Lutea Changes in White-tailed Deer[1]

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Abstract. The reproductive capacity of the white-tailed deer (*Odocoileus virginianus*) in Iowa was determined for the peiod 1957 to 1961. Ovarian structures were checked in 425 pairs of ovaries. Physical characteristics of corpora lutea and corpora albicantia were checked. Breeding by fawns was indicated by the presence of an average of 1.09 corpora lutea per doe in their first winter of life, and by 0.87 corpora albicantia between the ages of 1 and 2 years. This indicates a loss or lack of detection of 25 per cent of the corpora albicantia. As is to be expected, no corpora albicantia were found in fawn does. Adult whitetails had an average of 2.27 corpora lutea per deer, while the mean number of corpora albicantia was 2.21. This indicates a decrease of 3 per cent in counts from corpora lutea to their scar tissue remnants, the corpora albicantia, in deer 2½ years and older. Discussion of technique is included.

INTRODUCTION

In 1957, the Iowa Cooperative Wildlife Research Unit initiated a study to determine the productivity of the white-tailed deer (*Odocoileus virginianus*) in Iowa. Such information is a valuable tool for wildlife biologists and managers in deer herd management. Reproductive data may reflect the physical condition of the deer herd, indicate deer range conditions, and provide clues for setting deer hunting seasons in keeping with levels of production.

This investigation utilized the technique of ovarian analysis for corpus luteum of pregnancy as outlined by Cheatum (1949). Reproductive data for two successive seasons can be studied through this analysis, and the breeding habits of the deer population can be evaluated.

METHODS OF INVESTIGATION

Reproductive tracts from doe deer were collected from animals shot during hunting seasons and those accidentally killed on highways. During the 5 years (1957-61) of this study hunting seasons occurred in mid-December.

Hunters were asked to remove and preserve the tracts of does

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as per printed instructions mailed along with each hunter's license. Instructions called for saving the uterus, ovaries, and one cheek-tooth section of the lower jaw, including information on the location and date of the kill, and name of the hunter. The collected materials were placed in plastic bages, frozen and forwarded to Iowa State University by State Conservation personnel. Many tracts were collected at two deer checking stations operated by Commission personnel during each hunting season.

Tracts and jawbone sections of deer killed by vehicles on highways were salvaged by conservation officers and biologists, and forwarded to the University. At the Research Unit, the tracts were preserved in a 10 percent solution of formalin. Information on pregnancy, number and measurements of embryos (fetuses) and dates of breeding were recorded. The scope of this paper will be confined to information on relative changes in physical appearance of the corpus luteum and the technique of ovarian analysis in assessing deer reproduction in Iowa.

Each ovary examined was sliced in the plane of its greatest dimension with a sharp razor blade, and the surfaces of the thinly-cut sections(about 0.5 mm) were examined for hollow follicles, corpora lutea, and corpora albicantia. Measurements were taken of the corpora lutea, corpora albicantia and the larger follicles. External surfaces of the ovaries were examined for the presence of apparent sites of rupture ("rupture bumps").

The data were recorded on special card forms.

The Corpus Luteum

The nature of the corpus luteum is briefly outlined to illustrate the role of this structure in mammalian reproduction. Detailed discussions of the corpus luteum may be found in Parks (1956) and Asdell (1946).

The Graafian follicle contains the ovum or egg. At ovulation the follicle ruptures, freeing the ovum which proceeds down the Fallopian tube. The ruptured follicle, after discharging the egg, undergoes a series of changes resulting in formation of the corpus luteum. The corpus luteum in turn secretes hormones throughout pregnancy. Secretions inhibit further ovulation, prepare the uterus for implantation, and stimulate the mammary glands (Brambell, 1930).

If an ovum becomes fertilized, all corpora lutea enlarge slightly and persist to the end of pregnancy (Graves, 1931). This is known as the corpus luteum of pregnancy. If fertilization fails to occur, the current corpus luteum begins regressing before the onset of the new esterous cycle which results in a second "heat" and ovulation with a new corpus luteum forming. This cycle varies with a given species. In deer the period between successive heat cycles is about 28 days (Cheatum, 1949). After parturition the corpus luteum of pregnancy degenerates and becomes the corpus albicans of pregnancy. Essentially, this is merely a pigmented scar of the corpus luteum of pregnancy.

When first formed, the corpus luteum appears as a greyish structure in the ovary. The corpus luteum varies in color from bright yellow to pale cream. Corpus albicans range from brick red to faint tan in color. The corpus luteum indicates the present season's rate of ovulation, and the corpus albicans is usually indicative of the previous year's ova production.

The relative diameter of the corpus luteum in Iowa deer was 6 to 9 mm., but with considerable variation. Extreme dimensions from about 3 and 13 mm. were encountered. Cheatum (1949) used size to segregate the larger corpus luteum of pregnancy from the smaller unfertilized luteinizing bodies, which sometimes occur in the ovary and resemble true corpora lutea. The unfertilized structures should not be included in the ovulation count.

Measurements of the corpora albicantia exhibited similar variations ranging from about 0.1 to 5 mm. in diameter. The average size was approximately 2 mm. Variations in this structure apparently were related to date of kill, as the larger corpora albicantia occurred in ovaries of does killed shortly after parturition. Pressures of new developing follicles within the ovary caused the corpora albicantia to appear as compressed smaller pigmented bodies. Cheatum (1949) states that scars of the luteinizing follicles not associated with pregnancy exhibited no evidence of pigmentation. Golley (1957) working with Columbian black-tailed deer (*Odocoileus hemionus columbianus*) found evidence that occasionally these bodies form pigmented structures similar to the corpora albicantia.

Cheatum's (1949) technique involved gross observation of the corpus luteum, which yielded data on "ovulation incidence." In order to estimate the average number of young produced per doe during the breeding season he calculated a "frequency of fertilization." This factor is ascertained by determining the average number of embryos (fetuses) present per doe, and then dividing this by the average number of corpora lutea found in the deer. This frequency of fertilization, a figure of less than one, is then multiplied by the ovulation incidence to provide the calculated figure for the average number of fawns expected per doe the following summer. In this paper only data on relative numbers of corpora lutea and corpora albicantia will be presented, with a report on the ovulation incidence.

Results of Investigation

Ovaries (pairs) of 425 does were examined for copora lutea and corpora albicantia (Table 1). Sufficient data were available for age classes through 4½ years. Deer 5½ years and older were grouped together because of the small numbers representing this group.

Table. 1 Yearly distribution of deer ovaries collected for study

Year	Pairs of ovaries
1957	34
1958	146
1959	137
1960	108
Total	425

Ovaries were included in this study if data on age, date of kill, and both ovaries were available. If age or date of kill was not known, these deer were classed as unknown age.

Breeding by Fawns

In the fawn group (young-of-the-year), 140 deer were studied for the presence of corpora lutea. Of this number 117 had undergone esterus by the time of the hunting season. These data indicate that 83.6 precent of the fawn population (4 to 7 months old) were sexually mature at that time. This figure, however, does not represent the number of fawn does that became pregnant. That information has not yet been analyzed fully, but from preliminary analysis it seems reasonable to assume that most fawn does in Iowa come into heat their first fall. (A sample of 44 killed after January 1 indicated three-fourths were pregnant). On New York's best range, Cheatum and Morton (1942) found that of 64 fawn does, 25 were pregnant and had reached sexual maturity as indicated by the appearance of the corpus luteum. This figure represents 40.3 percent of the fawn population. Under ideal conditions, between 30 and 40 per cent of Michigan's fawn does conceive in the year of their birth (Jenkins and Bartlett, 1959). On their poor deer range, however, only about 6 percent breed. Fawn pregnancies in Wisconsin's deer seldom occur (Dahlberg and Guettinger, 1956). Illige (1951) working with Texas whitetails found no evidence of breeding by female fawns. Ovarian analysis by a Missouri biologist (Robb, 1959) indicated sexual maturity in 37 percent of their fawn population when using pregnancy as a criterion.

Though sexually mature to the extent that they are able to reproduce, fawns have not attained the highest reproductive efficiency (Taylor, 1956). Therefore, reproductive data representing fawn ovulation must be considered separately from information on reproduction by older deer.

Ovarian analysis of 140 whitetail does from 1957-60 showed an average of 1.09 corpora lutea per doe (Table 2). Size of these corpora lutea varied somewhat. Many corpora lutea present in fawn specimen occupied almost the entire ovary which in fawns are considerably smaller than in adult does. Many corpora lutea in fawn ovaries had hollow centers when collected in the hunting season. Since the hollow center condition is present shortly after ovulation, this is perhaps indicative of a later ovulation date in fawns than in older deer. Cheatum and Morton (1946) found that breeding dates of fawns were somewhat later than those for older deer. Robb (1959) stated that in Missouri the younger does were generally the last to breed.

Table 2. Corpora lutea counts for deer shot in mid-December

Age	1957* No. deer	1957* No. c.l.	1958 No. deer	1958 No. c.l.	1959 No. deer	1959 No. c.l.	1960 No. deer	1960 No. c.l.	Total No. deer	Total No. c.l.	Mean corpora lutea per doe
Fawn	6	4	59	63	48	55	27	30	140	152	1.09
1½	4	8	20	43	30	65	12	26	66	142	2.15
2½	3	10	17	39	8	15	10	21	38	85	2.23
3½	1	3	9	19	8	18	11	25	29	65	2.24
4½	0	0	4	13	2	3	3	8	9	24	2.67
5½ & up	3	6	3	7	1	2	2	4	9	19	2.11
Total 1½ and up of all deer									181	411	2.27

* Figures might be low because of early hunting season. The 1957 season was December 7 and 8, other years were around December 15.

In evaluating the true relationship between corpora lutea found immediately after ovulation and corpora lutea of pregnancy, comparisions of the corpora lutea (Table 2) and corpora albicantia counts (Table 3) must be made. In Iowa deer the average corpora albicantia per doe 1½ years old was 0.87. (Corpora albicantia of 1½-year old deer reflect previous breeding as fawns.) The difference of 1.09 (current ovulation) and 0.87 (previous breeding) suggests a loss or error in detection of 0.22 corpora lutea per doe, about 25 percent.

There are several possible explanations for this difference. Perhaps not all the developing corpora lutea peristed as corpora

Table 3. Corpora albicantia counts of all deer examined

Age	1957 No. deer	1957 No. c.a.	1958 No. deer	1958 No. c.a.	1959 No. deer	1959 No. c.a.	1960 No. deer	1960 No. c.a.	Total No. deer	Total No. c.a.	Mean corpora albicantia per doe
1½	7	2	28	23	45	47	28	22	108	94	.87
2½	5	10	21	45	10	26	15	32	51	113	2.21
3½	1	3	13	29	9	14	14	29	37	75	2.03
4½	0	0	5	12	4	8	3	10	12	30	2.50
5½ & up	3	6	4	9	1	2	2	8	10	25	2.50
Total 2½ and up combined									110	243	2.21

structures may also have resulted in part from sample size (140 lutea of pregnancy or corpora albicantia. This could easily happen since the hunting season coincided with the later ovulation dates of fawn does. Disparity in correlation of ovarian fawns versus 108 does 1½ years old), ovarian changes or oversights in the examinations.

No pigmented structures resembling corpora albicantia were found in the ovaries of 140 fawn does less than one year old.

Adult Doe Comparisons

Adult Iowa whitetail does had an average of 2.27 corpora lutea per doe. This figure is based on a sample of 181 pairs of ovaries from deer 1½ years and older. These data are broken down into age classes for individual comparisons in Table 2. All adult does in this study had experienced esterus and indicated ovulation by presence of one or more corpora lutea in mid-December.

Corpora albicantia data were obtained from 110 adult does in the 2½-year and older age classes (Table 3). A mean of 2.21 Corpora albicantia per doe was obtained. Comparision of the 2.27 corpora lutea figure with the 2.21 corpora albicantia calculation indicates a loss of only 0.06 corpora albicantia per doe. This represents a 3 percent loss (fewer corpora albicantia than corpora lutea). This difference is indeed small. An error of 3 percent might reflect only a difference in sample sizes for various age groups. In Iowa we are in a better position to combine data on ovulation rates for various age classes, because range conditions, which apparently have a profound effect on reproductive capacity, are more uniformly favorable than in some other states. Deer range and reproduction interrelationships studied by Cheatum and Severinghaus (1950) illustrate the reciprocal nature of this association.

Initially it was suspected that lack of exact theoretical correlation between corpora lutea and corpor albicantia counts might be due to the investigator overlooking inconspicuous corpora albicentia in analysis. This deduction becomes obvious after one had had experience examining large numbers of deer ovaries. The often inconspicuous corpora albicantia in Iowa's adult does varied from dark brown, round bodies to faint tan crescent-shaped structures. This variability in shape and size relative to the season when the deer was killed, and the wide range in degree of pigmentation made corpora albicantia determinations difficult in some ovaries. Other ovarian structures, such as blood clots, developing follicles, or small luteinizing bodies resembling corpora albicantia, added to possible confusion. However, when the thin slices of the ovary were placed between the investigator and a bright light source, the tough, more heavily pigmented corpus albicans cast a definite "shadow." This technique was used to aid in detecting corpora albicantia in ovaries of 155 deer collected during the 1960 season. No other structure was observed to cast a similar shadow.

Study of ovaries of adult does collected in May suggest that corpora albicantia counts are undependable for deer killed after the month of April. Only 2 of 7 pairs of ovaries collected as late as May contained corpora albicantia. Cheatum (1949) states that an accurate determination of corpora albicantia numbers cannot be relied upon beyond 8 months. Therefore, where parturition occurs in June, corpora albicantia counts made after the following February are not reliable for indicating breeding the previous year.

Corpora lutea comparisons within individual age classes with corpora albicantia data may result in a certain degree of disparity due to smallness of the sample size. Variation seems sufficiently great to warrant an increase in sample size.

Discussion of Analysis

Cheatum (1949) and Golley (1957) recognized several areas of analysis where factors of error could occur. The analysis of Iowa's ovary data also indicates possibilities for error. Sources of error resulting from failure of ova to become fertilized, obliteration of corpora albicantia due to pressures of developing follicles, sample size, oversight in analysis, and combination of data from different age groups have been discussed where they seem to apply.

There are records of Iowa deer carrying twin embryos, yet showing only a single corpus luteum. Evidently this indicates identical twin phenomenon. The incidence of identical twinning is not known, but the fact that it does occur should be considered when ovulation incidence and fertilization frequency are considered.

An opposite effect on the calculated fawn potential results when only one embryo is present in the uterus, but two corpora lutea occur. The corpus luteum of pregnancy could not always be segregated from luteinizing bodies in terms of size as Cheatum (1949) proposed. Microscopic study of the luteinizing cells of the corpus luteum enables one to differentiate these structures, but this study involved only gross macroscopic observations.

More data are needed from deer killed between January and April, when they are carrying visible embryos. Cheatum (1949) describes this period as the most productive, yielding data on embryo counts, information on breeding failures including abnormal pregnancies, and data on the incidence of ovulation. Does available from the months of November and December yielded much information on the rate of ovulation during the breeding season, and breeding success for the previous year. Does collected during this period, however, leave the breeding success for the current season somewhat obscure.

Iowa deer enjoy a fertile range, and their early maturity, incidence of ovulation, and breeding success reflect this condition. In most every state where deer have been studied intensively, regional differences have been discovered (Morton and Cheatum, 1946; Gill, 1956; and Robb, 1959). The incidence of ovulation and the possibility of regional differences in the productivity of deer in Iowa merit closer analysis when such data become available.

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