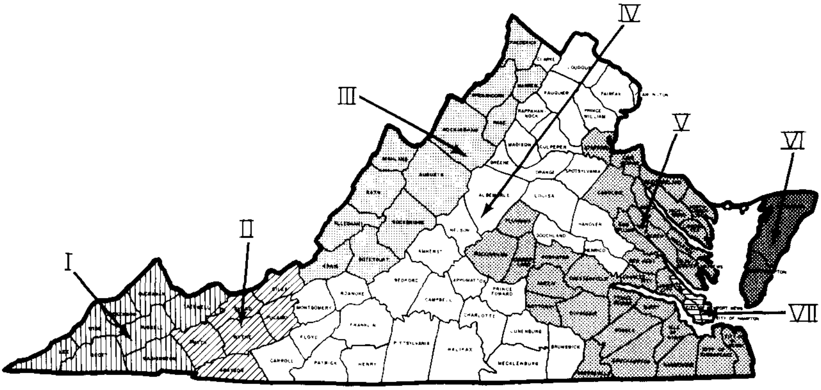

Figure 2. Preliminary deer management regions of Virginia based on calculated G-value.

OVARIAN FOLLICULAR AND RELATED CHARACTERISTICS OF WHITE-TAILED DEER AS INFLUENCED BY SEASON AND AGE IN THE SOUTHEAST[1]

by

R. L. Kirkpatrick
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blackburg, Virginia 24061

ABSTRACT

Ovaries, anterior pituitary glands and pineal glands of 206 white-tailed deer collected from 6 areas of the Southeast over a 3 year period during the four seasons of the year were examined. Ovaries were sliced and all follicular and luteal structures $\geq$ 1 mm were measured and counted. Significant seasonal effects were found on ovarian weight, average diameter of the 2 largest follicles, and anterior pituitary weights. Follicular development was greatest in the summer and fall seasons although large follicles were present on ovaries during all seasons. Ovarian weights were greatest during the winter and anterior pituitary weights were greatest in summer. Ovarian and anterior pituitary weights increased significantly with age but the size and number of follicles did not. Little relationship was found between follicular measurements and ovulation or fetal rates when data were examined for each of the areas.

Several workers have reported on the use of ovarian luteal structures (corpora lutea, corpora albicantia, corpora rubra) to evaluate reproductive performance of female deer. Among these are Cheatum (1949), Golley (1957), Trauger and Haugen (1965) and Mansell (1971). Mansell (1971), citing work by Gibson (1957), discussed the validity of and the sources of error in the use of luteal structures in assessing reproductive performance. While undoubtedly one of the best methods currently available for determining past and potential productivity of deer herds, the use of luteal structures has several shortcomings and is not always feasible or desirable. Many states have doe seasons which coincide with or precede the period of breeding and ovulation. In does killed prior to ovulation, data can be obtained only on the prior reproductive

[1]This Study was supported in part by The Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens, through Contract No. 14-16-0008-777 from The Fish and Wildlife Service, U. S. Dept. of Interior.

season by use of pigmented scars (corpora rubra), and no information can be obtained on the current reproductive season.

The ovaries contain other structures, however, which have been largely overlooked by wildlife biologists and which may provide more information on the reproductive potential of deer. These are the ovarian follicles which contain the ova prior to ovulation (or degeneration) and which are present on the ovaries of most species almost continuously. Howland et al. (1966) have shown a positive relationship between follicular development and subsequent numbers of corpora lutea and young produced in domestic sheep. Their work along with that of Bellows et al. (1963) further indicated that ovarian follicles may be useful indices to the nutritional condition of the female. In several controlled studies on the phenomenon of "flushing" of sheep (i.e. placing animals on a high nutritional plane for 1-3 mo. prior to breeding in order to increase ovulation rate and number of lambs produced) these workers found significant increases in development of ovarian follicles in ewes on higher planes of nutrition at all stages of the estrous cycle. Kirpatrick and Kibbe (1971) found similar relationships between nutrition and follicular development in cottontail rabbits (*Sylvilagus* floridanus).

Very little is known concerning the development of ovarian follicles in white-tailed deer. Teer et al. (1965) described ovaries of sexually inactive does as having follicles about 1 mm in diameter and those of sexually active does as having follicles 4 to 7 mm in diameter. Brokx (1972) reported considerable follicular development in Venezuelan does year round and found little difference between pregnant and nonpregnant does. He believed that "Follicular development in northern (temperate zone) does begins in the autumn; apparently it is restricted much of the balance of the year." However, he further stated "There is a lack of pertinent information." The present study was conducted to determine the effects of season and age on follicular development and related characteristics of deer in the Southeast and to explore the use of follicular measurements as an index of reproductive potential.

MATERIALS AND METHODS

A total of 206 doe deer was collected during the four seasons of the year over a 3 year period from six areas of the Southeastern United States. These deer were collected by the Southeastern Cooperative Wildlife Disease Study by shooting at night with a high powered rifle. Five deer were taken from each area during each season without regard to age or sex but only the females were used in the present study.

In all years the spring collections were made between mid-April and late May, the summer collections between mid-July and late August, the fall collections between mid-October and late November, and the winter collections between mid-January and late February. During the first year of the study (1967-68), collections were made from one of the following areas each week for 6 successive weeks during each season in the following order: (1) A. P. Hill Military Reservation, Virginia, (2) Forks Game Management Area, South Carolina, (3) Chocolocco Game Management Area, Alabama, (4) Daniel Boone Game Management Area, North Carolina, (5) Eglin Air Force Base, Florida, and (6) Fort Stewart Military Reservation, Georgia. During the last 2 years of the study (1968-69, and 1969-70), deer were again collected seasonally but the order of sampling of the respective areas was random. Daniel Boone Game Management Area and Eglin Air Force Base were not sampled during the third year (1969-70). Deer were aged by tooth wear and replacement as described by Taber (1971). Age classes as described in this paper are as follows: one year olds = deer estimated to be 0.5 yr. to 1.25 yr., 2 year olds = 1.5 yr. to 2.25 yr., etc. Number and estimated age of fetuses present was also recorded.

Ovaries, anterior pituitaries and pineal glands were removed at necropsy and stored in 10 percent formalin. These organs were later cleaned of extraneous tissue and weighed. Ovaries were sliced into 1 mm thick sections using a razor blade or scapel as described by Cheatum (1949). They were then examined for tertiary follicles, corpora lutea and pigmented scars. All tertiary follicles 1 mm or greater in diameter were measur^d using vernier calipers and counted. Follicular data were then expressed as average diameter of the 2 largest follicles per pair of ovaries, total follicles 1 mm per pair and sum of all follicle diameters per pair. Seasonal and age differences were assessed by analysis of variance using a least squares regression procedure of the Statistical Analysis System of Barr and Goodnight (1971).

RESULTS AND DISCUSSION

Seasonal changes in ovarian, anterior pituitary and pineal weights and the various follicular measurements are shown in Table 1. Significant (P .05) seasonal changes were found in ovarian and pituitary weights and in the average diameter of the two largest follicles. No significant seasonal differences were found in total number of follicles or the sum of follicular diameters. Ovarian weights were smallest in the summer and greatest in the winter, probably reflecting an increase in mass due to the presence of one or more corpora lutea at that time. All three measures of follicular development were numerically greatest in the summer and fall seasons. Follicular growth and development were expected to be greatest just prior to breeding. However, considerable follicular development was also present during winter and spring even though most females were pregnant during the winter and spring collections. These results are in agreement with those of Morrison (1960) in cow elk *(Cervus canadensis)* and of Brokx (1972) in deer in that no great differences were found in follicular development between gravid and nongravid females.

Table 1. Seasonal means of ovarian, pituitary and pineal weights and follicular measurements for deer collected from 6 areas of the Southeast.

Season	No. does	Paired ovarian wt.* (mg)	Avg. dia. 2 largest follicles*	Total no. follicles (1mm)	Sum of follicle dia. (mm)	Anterior pituitary wt.* (mg)a	Pineal wt. (mg)
Spring	56	955	3.2	11.3	17.6	261(39)a	52(53)
Summer	49	827	3.5	17.5	26.6	309(39)	71(45)
Fall	47	975	4.1	16.5	27.0	226(32)	50(43)
Winter	54	1027	3.0	14.8	21.2	201(33)	49(50)

aNos. in parentheses indicate sample size where less than shown.

*Seasonal differences $P < .05$.

Table 2. Age means of ovarian, pituitary and pineal weights and follicular measurements for deer collected from 6 areas of the Southeast.

Age (year)	No. does	Paired ovarian wt.* (mg)	Avg. dia. 2 largest follicles (mm)	Total no. follicles 1mm	Sum of follicle dia. (mm)	Anterior pituitary wt.** (mg)	Pineal wt. (mg)
1	52	532	3.4	14.4	22.2	164(38)a	46(47)
2	34	837	3.5	13.3	21.0	221(27)	48(33)
3	45	1015	3.8	14.8	24.4	276(29)	57(44)
4	33	1228	3.1	15.5	21.1	297(27)	71(29)
5	18	1277	3.5	16.2	24.2	365(13)	58(17)
6	9	1326	3.2	19.6	28.8	347(5)	57(9)
7	5	1294	3.9	12.4	21.4	279(2)	60(2)
8	5	1092	3.0	19.2	26.8	—(0)	57(5)
9	5	1200	3.8	12.6	20.6	416(2)	72(5)

aNos. in parentheses indicate sample size where less than shown.
**Age differences $P < .01$.
*Age differences $P < .05$.

Table 3. Means of follicular measurements and luteal and fetal counts for deer[a] collected from 6 areas of the Southeast.

	No. does	Avg. dia. 2 largest follicles (mm)	Total no. follicles 1mm	Sum of follicle dia. (mm)	Fetuses per pregnant doe[b]	Corpora lutea per doe ovulating[b]	Pigmented scars per doe[c]
A. P. Hill MR	39	3.4	16.5	24.2	1.89(9)[d]	1.89(9)	2.5 (4)
Forks GMA	45	3.9	10.3	19.0	1.80(10)	2.00(11)	1.17(6)
Chocolocco GMA	34	3.1	19.9	29.1	1.86(7)	1.67(9)	1.25(4)
Daniel Boone GMA	24	3.2	18.5	25.6	1.00(4)	1.17(6)	1.83(6)
Eglin AFB	23	3.6	16.2	24.4	1.57(7)	1.67(9)	1.0 (2)
Ft. Stewart MR	41	3.3	11.4	18.2	1.60(5)	1.50(10)	1.17(6)

[a]Luteal and fetal counts for does 3 years old and older only.

[b]During winter and spring seasons only.

[c]During summer and fall seasons only.

[d]Numbers in parentheses show sample size where different from that indicated.

Anterior pituitary weight was greatest in spring- and summer- killed females. It has been shown that the anterior pituitary increases in size in the human female during gestation (Guyton 1971). The seasonal changes in pituitary weight in these deer probably are due largely to the fact that most females were pregnant in the spring and lactating in the summer. Similar seasonal changes have been reported in white-tailed deer by Hoffman and Robinson (1966).

No significant seasonal changes were found in pineal weights. The pineal has been implicated in mechanisms controlling seasonal breeding in several rodent species (Van Tienhoven 1968). However, little evidence has been found in this or other studies for a role of the pineal in seasonal breeding of ungulates (Roche et al. 1970).

Table 2 shows the various characteristics as affected by age. Ovarian and anterior pituitary weights increased significantly (P .05) with age but the three measures of follicular development did not. This is in contrast to the findings of Morrison (1960) who reported an increase in the number of large follicles from the one to 2 year old age class and then a levelling off or a decrease in cow elk. Since none of the measures of follicular development showed an increase, the observed increase in ovary weight with age was probably due to an increase in stromal and/or connective tissue. The increase in nonsecretory tissue also since there is little evidence for an increase in the secretory capacity beyond the first or second year of age in ungulates. No age differences were found in weight of the pineal gland.

A cursory comparison of the follicular data with fetal counts and corpora lutea and corpora rubra counts from each of the six areas was made by examining the area means for these data shown in Table 3.

It can be seen that the follicular measurements do not parallel closely any of the three commonly accepted measurements of fecundity. Thus, these data do not indicate that follicular measurements show promise as indicators of potential productivity. However, sample sizes for individual areas were quite small in the present study, and more work in comparing numbers and sizes of follicles to fetal and corpora lutea counts in areas of known habitat quality and with documented differences in fecundity seem warranted.

LITERATURE CITED

Barr, A. J., and J. H. Goodnight. 1971. Statistical Analysis System. North Carolina State University, Raleigh. 58 pp.

Bellows, R. A., A. L. Pope. R. K. Meyer, A. B. Chapman and L. E. Casida. 1963. Physiological mechanisms in nutritionally induced differences in ovarian activity of mature ewes. J. Anim. Sci. 22(1):93-100.

Brokx, P. A. 1972. Ovarian composition and aspects of the reproductive physiology of Venezuelan white-tailed deer *(Odocoileus virginianus gymnotis).* J. Mammal. 53(4):760-773.

Cheatum, E. L. 1949. The use of corpora lutea for determining ovulation incidence and variations in the fertility of white-tailed deer. Cornell Vet. 39:282-291.

Gibson, D. 1957. The ovary as an indicator of reproductive history in the white-tailed deer *Odcoileus virginianus borealis.* Miller. M.A. Thesis. Univ. of Toronto. 61 pp.

Golley, F. B. 1957. An apprasial of ovarian analysis in determining reproductive performance of black-tailed deer. J. Wildl. Manage. 21(1):62-65.

Guyton, A. C. 1971. Textbook of medical physiology. Fourth ed. W. B. Saunders Company. Philadelphia. 1032 pp.

Hoffman, R. A., and P. F. Robinson. 1966. Changes in some endocrine glands of white-tailed deer as affected by season, sex and age. J. Mammal. 47(2):266-280.

Howland, B. E., R. L. Kirkpatrick, A. L. Pope and L. E. Casida. 1966. Pituitary and ovarian functions in ewes fed on two nutritional levels. J. Anim. Sci. 25(3):716-721.

Kirkpatrick, R. L. and D. P. Kibbe. 1971. Nutritive restriction and reproductive characteristics of captive cottontail rabbits. J. Wildl. Manage. 35(2):332-338.
Mansell, W. D. 1971. Acessory corpora lutea in ovaries of white-tailed deer. J. Wildl. Manage. 35(2):369-374.
Morrison, J. A. 1960. Ovarian characteristics in elk of known breeding history. J. Wildl. Manage. 24(3):297-307.
Roche, J. F., D. L. Fster, F. J. Karsch and P. J. Dziuk. 1970. Effect of castration and infusion of melatonin on levels of luteinizing hormone in sera and pituitaries of ewes. Endocrinology. 87(6): 1205-1210.
Taber, R. D. 1971. Criteria of sex and age.*In* ". H. Giles (Editor) Wildlife management techniques pp 325-402. The Wildlife Society, Washington, D. C. 633 pp.
Teer, J. G., J. W. Thomas and E. A. Walker. 1965. Ecology and management of White-tailed deer in the Llano basin of Texas. Wildlife Monogr. 15:1-62.
Trauger, D. L. and A. O. Haugen. 1965. Corpora lutea variations of white-tailed deer. J. Wildl. Manage. 29(3):487-492.
van Tienhoven, A. 1968. Reproductive physiology of vertebrates. W. B. Saunders Company. Philadelphia. 498 pp.

POPULATIONS AND REPRODUCTIVE EFFORT AMONG BOBWHITES IN WESTERN TENNESSEE

by
Ralph W. Dimmick
Department of Forestry
The University of Tennessee, Knoxville

ABSTRACT

Relationships between pre-breeding (March) and post-breeding (December) populations, and certain characteristics of reproductive effort are described for a population of bobwhites (*Colinus virginianus*) in western Tennessee. Numbers of quail on the 2100-acre study area ranged from 681 to 1269 in March, and from 1007 to 1587 in December during the period December, 1966 to March, 1974. A total of 1571 nests were studied to determine such items as hatching rate of nests with eggs (23.0%) and clutch size (x=11.9 eggs). Of all variables examined, total number of nests found on the nesting area showed the strongest positive correlation with post-breeding population size (r=0.81) and summer gain (r=0.72). The predictive value of "total nests" for post-breeding populations was high (R^2=0.65). Environmental events which influence the physiological condition and numbers in the breeding population are believed to be most important in determining summer gains and post-breeding (December) population density.

INTRODUCTION

The nesting ecology of bobwhites has been investigated in several portions of the species' broad range. An early but extensive investigation by Stoddard (1932) presented a thorough description of several facets of bobwhite nesting ecology in the coastal plain of Georgia and Florida. Errington (1933) described the nesting of bobwhites in Wisconsin, near the northern extremity of its range in the mid-western region of North America. Since those early studies, other investigators in Illinois (Klimstra and Scott 1957), Texas (Parmalee 1955; Lehman 1946), Georgia (Simpson 1972) and Tennessee (Dimmick 1968, 1971) have expanded our knowledge of such aspects as regional preferences for nesting habitat, predominant causes of nest destruction, chronology of nesting and clutch size. Perhaps a major contribution which these studies have made to our understanding of quail population dynamics is the composite picture they present of a species having a high biotic potential, capable of producing large broods, and of withstanding heavy nest losses through its strong re-nesting potential and lengthy breeding season. It is, however, these same features which so confuse our efforts to relate nesting "success" or "failure" to annual productivity.

Most efforts to "predict" productivity (autumn populations) have centered on either various weather parameters which influence nesting success (notably Edwards 1972