REPRODUCTIVE CHARACTERISTICS OF THE MISSISSIPPI WHITE-TAILED DEER WITH NOTES ON HISTORY, WEIGHTS AND AGE-CLASS COMPOSITION

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
ROBERT E. NOBLE
1969

This is to certify that the

thesis entitled

REPRODUCTIVE CHARACTERISTICS OF THE MISSISSIPPI WHITE-TAILED DEER WITH NOTES ON HISTORY, WEIGHTS AND AGE-CLASS COMPOSITION

presented by

Robert E. Noble

has been accepted towards fulfillment of the requirements for

Ph.D. **degree in** _____

Wildlife Ecology

Geo A Petrides
Major professor

Date 1 May 1969

O-169

ABSTRACT

REPRODUCTIVE CHARACTERISTICS OF THE MISSISSIPPI WHITE-TAILED DEER WITH NOTES ON HISTORY, WEIGHTS AND AGE-CLASS COMPOSITION

By

Robert E. Noble

Over the three year period, February, 1960 through March, 1963, 354 female white-tailed deer were autopsied to determine their reproductive characteristics. Of these, 89 carried visible embryos.

As determined from back-dated embryos, the mean breeding date for 50 does from north Mississippi was December 23 (standard deviation 13 days). The average breeding date for 26 does in south Mississippi was January 15 (standard deviation 19 days). Correspondingly the average fawning date in north Mississippi was July 13 (standard deviation 13 days) while the mean fawning date in south Mississippi was August 5 (standard deviation 19 days).

The sample size of young does (1.5 years old) and old does (6.5 years and older) was small but there was no evidence that those collected had bred either earlier or later than other age-classes. Ovaries from 36 fawns collected from November through April were quiescent, showing

neither corpora lutea nor well-developed graafian follicles. No breeding was observed in fawns (six-month-age-class).

Based on examinations of 222 pairs of ovaries from deer collected November 11 through January 9 in the Mississippi River bottomlands of Bolivar and Washington Counties, adult does there experience their first seasonal estrus about December 1.

There was no significant difference between the average number of fetuses per gravid doe for deer from the highly-fertile batture forest (1.39) and for deer from the infertile longleaf pine belt (1.35). Collections from both areas were made on overstocked deer ranges indicating that excessive population density is more important than soil type in influencing reproductive rates in deer. The average number of fetuses per pregnant doe was 1.42, indicating that some areas had a higher reproductive rate than either of the overstocked ranges.

83 adult does were collected in late spring when breeding does are normally carrying visible fetuses. 76 were carrying young, a frequency of pregnancy of 91.6%. 78 pregnant does collected statewide were carrying 110 fetuses, and the ovaries of these deer contained 123 corpora lutea thus displaying an ovulation incidence of 1.58 and a reproduction efficiency of 89.4%.

Of 86 fetuses old enough to sex, 47 were males and 39 females (55:45). There was no significant difference between the F-R or C-R measurement between twins in 37 sets of twins, except in a case where one was dead. Neither of opposite-sex twins tended to dominate in length. Only the one case of prenatal mortality was observed in 89 visibly pregnant does.

The average age of 85 does 1.5 years and older was 4.58 years in a bottomland area that had been rigidly protected from hunting for 33 years prior to scientific collecting. The average age of 22 does 1.5 years and older was 4.59 years in the infertile longleaf pine belt where does had been protected for 18 years. The 15 extra years of protection at the delta location had added nothing to the average age of deer on that range. Evidently, the maximum average age of adult does in Mississippi herds is reached after the herd has been protected 10 years. Over 77% of 308 does collected in the state were less than 5.5 years old.

Despite about identical reproductive rates and average longevities for does from the two areas the does from the very fertile batture forest outweighed those from the infertile longleaf pine belt by an average of over 25 pounds per animal.

REPRODUCTIVE CHARACTERISTICS OF THE MISSISSIPPI WHITE-TAILED DEER WITH NOTES ON HISTORY, WEIGHTS AND AGE-CLASS COMPOSITION

By

Robert E. Noble

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Fisheries and Wildlife

1969

ACKNOWLEDGMENTS

This study was financed by the Mississippi Game and Fish Commission as an approved Pittman-Robertson, Federal Aid in Wildlife Restoration Project.

I wish to express my appreciation to my major professor, Dr. George A. Petrides, Department of Fisheries and Wildlife for reading and criticizing the manuscript and for his technical assistance and many helpful suggestions.

Dr. Peter I. Tack of the Fisheries and Wildlife Department, Dr. Rollin H. Baker, Director of the University Museum and Dr. William D. Collins of the Physiology Department edited the final manuscript.

I am grateful to Mississippi Game and Fish Commission employees, Mr. John H. Phares and Mr. William H. Turcotte, Federal Aid Coordinator and Chief of Game respectively, for making this study possible and coordinating the field work and for their patience, encouragement, suggestions and assistance in conducting the research.

My sincere thanks to the following employees of the Mississippi Game and Fish Commission without whose help this work would have been impossible: Biologists Sterling G. Clawson* and Louis W. Bays, Warden J. Lester Jones, and Area Manager John Shirley for assistance in collecting deer;

Biologists Ernest Parks and Pete Heard for invaluable assistance with lab work; Area Managers Quinton Breland,* Wilbur C. Carr, Edward H. Givens, Gerald Mize, Austin C. Shattles, John Starkey and Tate White for their genuine interest and complete cooperation while I worked on their respective game management areas.

The Wardens of the Mississippi Game and Fish Commission have been particularly helpful with field work. My thanks to Wardens Bill Strong, J. Vaughn, L.Q. Daniels, Norman Ammons, Matt E. Dakin, Wilton Brown, I.C. Farmer and Salvo A. Piazzo. Other personnel of the Commission to whom I am indebted are Fred Breland, Leaf River Game Management Area; Rabb Rodgers, Sardis Refuge; B.E. Gandy, Museum Director; and John J. Jackson,* Choctaw County Game Area.

I am most appreciative to the Board of Directors, Presidents, other officials and members of the Catfish Point, Delta Pine, Huntington Point, Merigold and Dixon Dossett Hunting Clubs of Bolivar County; the Ashbrook Island Hunting Club, Washington County; the Yucatan Island Hunting Club, Claiborne County; and the Coles Creek and Cypress Grove Hunting Clubs, Jefferson County, who not only granted me permission to collect deer from their lands but assisted materially in field work.

Messrs. R.J. Landers, Henry Hiter, John Greer, Jr. and L.L. Vance permitted me the use of their respective camps while I worked in Bolivar County. On Ashbrook Island

I stayed in the camp of Mr. P.B. Griffin. Mr. Richard Parker was kind enough to allow me the use of his hunting lodge near Yucatan Island.

Throughout the course of this study I have spent many enjoyable evenings in the home of Mr. and Mrs. G.O. McDaniel, Boyle, Mississippi.

Lastly, my sincere appreciation to my mother, Mrs. R.L. Noble and to my wife, Allene. They spent many hours assisting me with the analysis of data.

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*Deceased.

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INTRODUCTION

The white-tailed deer (Odocoileus virginianus) is the only big game animal in Mississippi present in sufficient numbers to justify hunting. In early times the black bear (Ursus americanus) was found over a large portion of the state, but today it is totally protected and there are probably less than 50 remaining in the state. Unlike the bear, the deer in recent years has benefited from man's effects upon its environment. As a consequence, there are perhaps more deer in Mississippi today than there were at the time of white man's first arrival.

a. Purpose of the Study

This study was conducted for the Mississippi Game and Fish Commission as Pittman-Robertson Federal Aid in Wildlife Restoration, Project Number W-48-R-8, Job No. 1, entitled, "A Study of Reproduction and Productivity in Mississippi Deer Herds." The purpose of the study were to:

1. Determine dates of mating and fawning.
2. Establish the date of first estrus.
3. Gather information on prenatal sex ratios, prenatal mortality, and fecundity.
4. Determine the extent of breeding by first year does.

5. Investigate the age distribution of female deer in herds where does have been rigidly protected for many years.

6. Compare the productivity of does on the highly fertile soils of the batture forest with those of the relatively infertile longleaf pine belt.

7. Investigate the popular opinion that "old" does do not breed.

b. Importance of the Study

Until this study, no organized research had been conducted on deer in Mississippi. All management was based on research findings in other states, largely states hundreds of miles from Mississippi (e.g., New York and Michigan) and representing different ecological conditions. In contrast to conditions in northern states, Mississippi deer do not congregate in winter and hunting is largely with the aid of dogs. Comparatively speaking, Mississippi winter weather is mild and especially so in the more southern regions of the state. Only a few other states have conditions similar to the batture forest, and very little research has been conducted on the deer herds inhabiting this heavily forested, highly fertile region adjacent to the Mississippi River.

c. History of Deer in Mississippi

The white-tailed deer and its ancestors have lived through drastic changes. Deer have been in North America about 20 million years. In primitive times the whitetail undoubtedly ranged over all of Mississippi. The state was

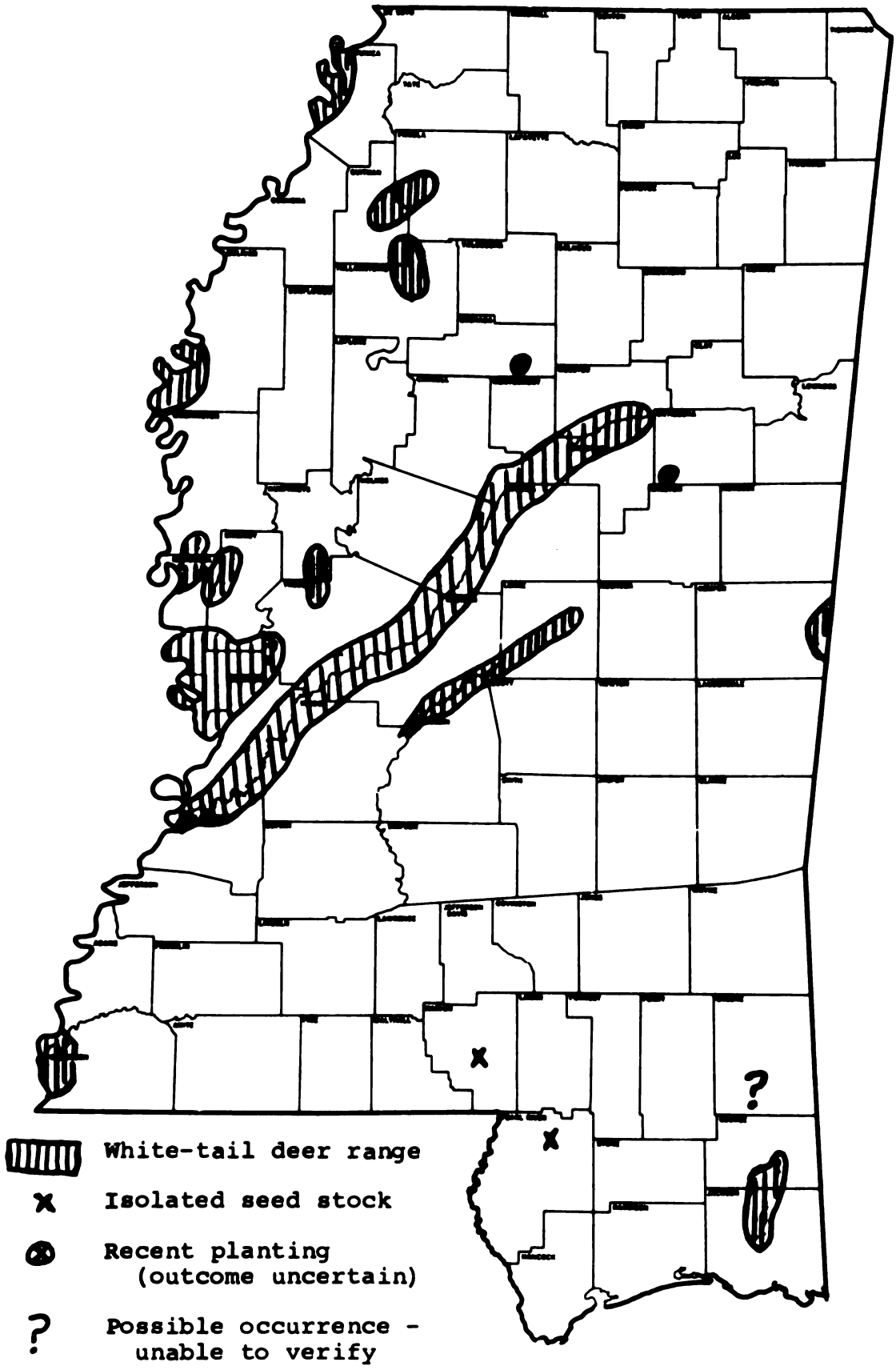
colonized by the French in 1699 (McLemore and McLemore, 1959) and probably these early settlers found no deer population such as we know today. As indicated by several septuagenarians who remembered hunting in the virgin longleaf pine (Pinus palustris)* belt of southern Mississippi, the virgin forests could not have supported high deer concentrations. They recalled the invariably open and clean conditions of the forest floor and their ability to see for long distances through the timber stand. Similar conditions existed in the virgin hardwood forest.

In 1905, Mississippi's first deer hunting season was set by the Legislature to extend from September 15 through March 1. In 1910, an act was passed imposing the state's first bag limit: five deer per year with fawns illegal. By 1915, the Legislature had retained the five deer limit but declared only males to be legal game. In 1928, the Legislature reduced the hunting season to November 15 through February 15 and the bag limit to three males.

Despite these early attempts at protection, deer had been exterminated over most of the state by 1925. A few small herds remained in inaccessible portions of the Mississippi River flood plain (loosely called the "Delta") and in the Pearl and Pascagoula River swamps (Figure 1). Fortunately for the deer, intensive logging and indiscriminate

*Botanical nomenclature after Brown (1945) except where otherwise noted.

Figure 1. Distribution of deer in Mississippi in 1929 (Leopold, 1929).


White-tail deer range
Isolated seed stock
Recent planting
(outcome uncertain)
Possible occurrence -
unable to verify

timber cutting occurred between 1900 and 1925, removing most of the virgin forest in Mississippi. During this time, due to unregulated hunting pressure, the deer population of the state reached an all-time low. Leopold (1929) estimated the entire deer population of the state in 1929 at no more than a few hundred animals and advised that

> . . . with the possible exception of very limited parts of the Delta, deer can nowhere be said to persist in numbers justifying hunting.

The "cut-out-and-get-out" policy of early logging operations was followed in many instances by wild fires that burned thousands of acres, removed the residual timber stand, and exposed the forest floor to sunlight. These conditions resulted in ideal second-growth timber favorable to deer.

The Mississippi Game and Fish Commission was organized June 16, 1932. Thereafter, deer were given at least partial protection. The Commission's first game survey in 1933 revealed that there might be a few hundred deer scattered over 34 of the 82 counties of the state (Handley, 1952). To supplement these, between 1933 and 1940 approximately 400 deer were purchased by the Mississippi Game and Fish Commission (Fleming, 1953), largely from North Carolina, Texas and Mexico (Handley, 1952). By 1940, Mississippi was operating 40 refuges totaling 241,138 acres, and the state claimed a deer population of 4,600 (Handley, undated). From 1943 through 1958, the Mississippi Game and Fish Commission

trapped 963 deer from these refuges and released them at favorable locations over the state (Anonymous, 1958).

From a low of a few hundred deer in 1933, the population increased to 4,600 by 1940. By 1943, the population had grown to an estimated 10,000, and during that year hunters bagged 450 bucks in the 26 open counties (Anonymous, 1958). In 1947, the deer herd was estimated at 20,000; 12,000 hunters killed 1,500 bucks during a short open season then. By 1948 the deer herd had increased to 25,000, and 20,000 hunters killed 1,750 bucks during a 15 day open season. Deer continued to expand so that by 1961 there was an estimated 120,000 deer in the state. During the 1961-1962 hunting seasons about 80,000 hunters harvested 11,015 deer. The 1964 estimate placed the deer population at approximately 180,000, and during the 1963-1964 seasons about 90,000 hunters bagged 18,143 deer. In 1966, the Mississippi deer herd was estimated at 240,000. During the 1966-1967 seasons 23,431 deer were legally taken in the state. 31,578 deer were legally killed and reported in 1967-1968.

The Mississippi Game and Fish Commission deserves considerable credit for its deer management program over the last 30 years, but the value of widespread indiscriminate logging should not be overlooked as a factor creating a favorable vegetative habitat. The Game and Fish Commission was established shortly after the removal of the virgin forest. The young second growth timber offered ideal deer

habitat. The protection and restocking program of the Mississippi Game and Fish Commission arrived on the scene at a favorable time.

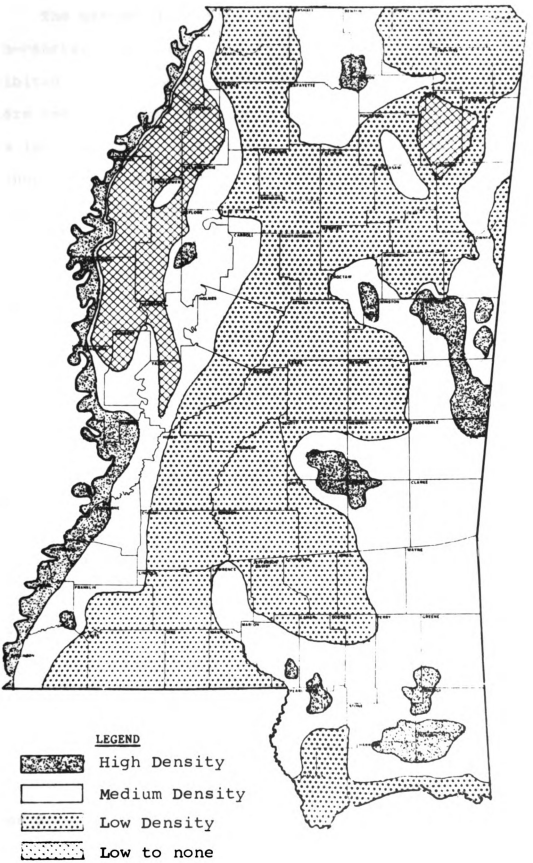
Present Range

Deer are now present in every county of Mississippi (Figure 2). During the 1966-1967 gun seasons, 79 of the 82 counties of the state were either completely, or partly open to deer hunting. Mississippi's deer population has increased markedly over the last 25 years, but many counties, due to inadequate management, still do not have the deer they are capable of supporting. Of the 1967-1968 kill, 17,517 (55.4%) were killed in 10 counties which represent less than 15 percent of the total land area of the state. The highest concentrations of deer occurred in the batture forest adjacent to the Mississippi River.

d. Regulations and Hunting Methods

Traditionally, the annual deer season in Mississippi opens on November 20 and extends through December 1. The season is then closed for 25 days and opens again on December 26, in most counties extending through January 9. Sportsmen in some counties, however, insist that their second season extend no longer than a week. Therefore, in Bolivar, Washington, and a few other north-delta counties the second season closes on January 3.

Figure 2. Distribution of deer in Mississippi in 1967.


LEGEND
High Density
Medium Density
Low Density
Low to none

The method of hunting varies over the state. In the north-central hill section, dogs and high-powered rifles are prohibited. In the north-delta (northwestern) section hunters use both dogs and high-powered rifles. In the south-delta (southwestern), rifles are largely prohibited because many hunters follow their hounds on horseback. In the long-leaf pine belt (southeastern and extreme south), shotguns are used more commonly than rifles. In some parts of this last area, deer are hunted with dogs. In other parts, dogs are prohibited.

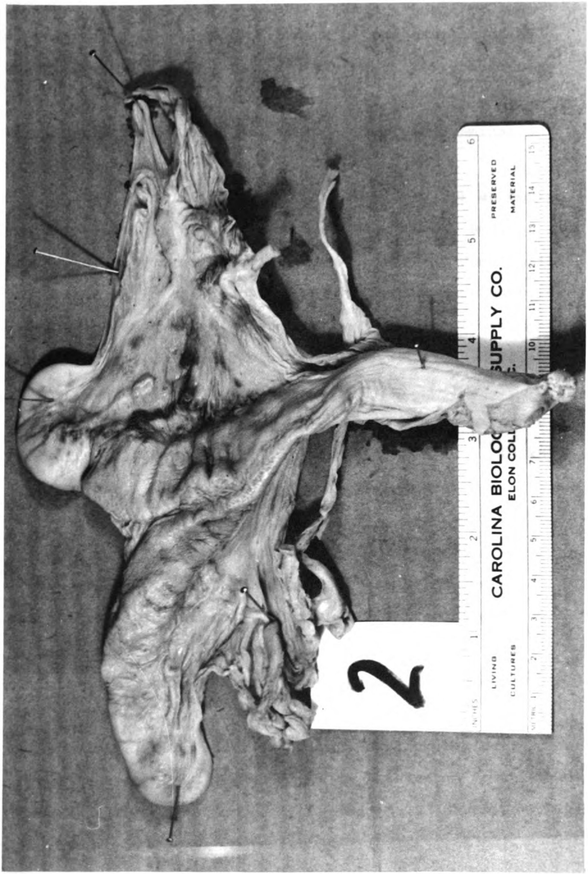
The bag limit from about 1935 until 1957 was one buck per hunter per year. In 1957, the bag was increased to two bucks, one per season segment. In most counties of Mississippi, however, the deer bag limit is traditionally ignored and, due to lack of cooperation from local people, wardens are helpless to enforce the law.

In most counties antlerless deer, nevertheless, are well protected. To kill a doe even by mistake forfeits one's membership in most hunting clubs. Although bucks are heavily harvested in some areas, deer herds remain mostly on the increase because of the many females present in the herds. Several areas have become seriously overpopulated.

e. Pregnancy and Fetal Development

In white-tailed deer the external appearance of the uterus does not change appreciably until after about 20 days

Figure 3. Reproductive tract of a 6.5 year non-gravid doe. The ovaries of this deer did not contain corpora lutea but old rupture sites are plainly visible on the right ovary. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


2
CAROLINA BIOLOG
SUPPLY CO.
ELON COLL
LIVING
CULTURES
PRESERVED
MATERIAL

of gestation, hence early evidence of pregnancy must be sought by examination of the ovaries (Cheatum and Morton, 1946). If the female has passed through "heat" (and, therefore, has possibly bred successfully), gross examination would reveal corpora lutea.

It is not known how long is required for an embryo to become visible to the naked eye. One of the smaller known-age embryos reported by Severinghaus and Cheatum (1956) measured 8 mm (crown-rump) at 28 days and another measured 16 mm at 37 days. Hudson and Bowman (1959) reported that a known-age mule deer embryo measured 6.6 mm at 28 days and another was 32.4 mm at 48 days.

Cheatum and Morton (1946) constructed a growth curve for white-tailed deer embryos and fetuses based on 15 known-age specimens. Hudson and Bowman (1959) constructed a growth curve for Rocky Mountain mule deer embryos using five known-age specimens. The two curves are almost identical.

The gestation period in deer seems to have been satisfactorily determined. Haugen (1959) reported the gestation period of 12 white-tailed does under experimental conditions in Alabama. The average obtained by Haugen was 193.8 days with a minimum of 187 days and a maximum of 198 days. Golley (1957a) observed five Columbian black-tailed deer (Odocoileus hemionus columbianus) in Washington State and found that the gestation period averaged 203 days and ranged from 199 to 207 days. Severinghaus (in litt., 1960),

Figure 4. Ovaries from a 2.5 year-old pregnant doe showing (sectioned) a well-formed corpus luteum. The right ovary is intact. The ruler is graduated in inches. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.

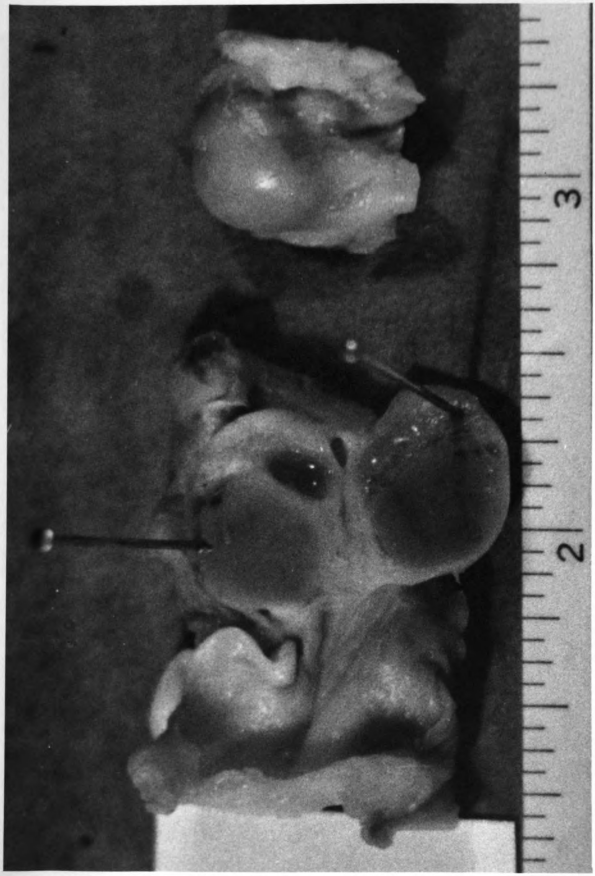
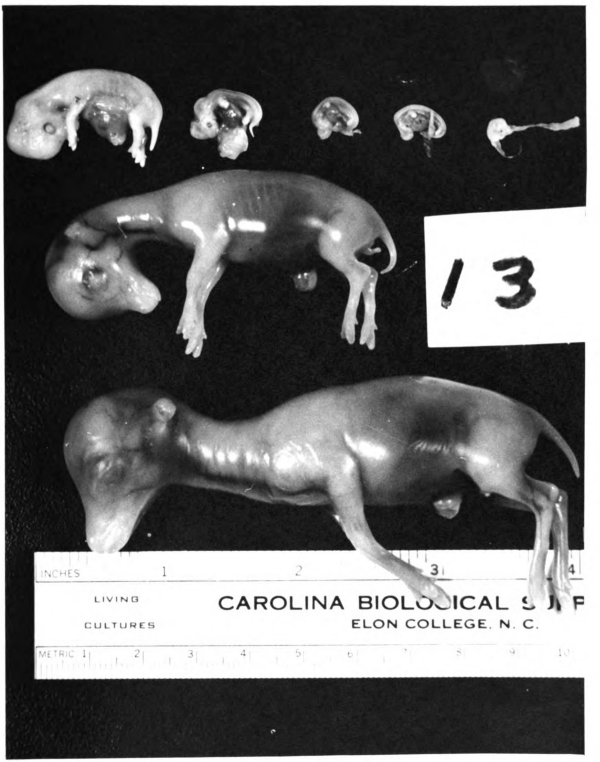

2
3

Figure 5. A series of seven white-tailed deer fetuses showing progressive stages of development. The estimated age of each fetus from small to large is 19, 28, 34, 38, 45, 60 and 68 days. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


13
INCHES
1
2
3
4
LIVING
CULTURES
CAROLINA BIOLOGICAL
ELON COLLEGE, N. C.
METRIC 1
2
3
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8
9
10

reviewed all literature available to him and reported 202 days to be the average gestation period for the whitetail.

RESEARCH METHODS AND MATERIALS

Collecting for the study extended over the three-year period February 1960 through March 1962 and involved 354 female specimens. Of 117 deer taken in spring (February, March and April) under special collecting permit, 24 were males which were mistakenly shot for females. Of the 117 deer collected under permit, 110 were taken by gun, 3 were killed by automobiles, 2 were killed by free-ranging dogs, and 2 were confiscated as illegal kills. 34 animals were shot nocturnally with the aid of headlights, and 76 were killed, mostly in late afternoon, on management area or refuge food plots.

Seven hunting clubs in Washington and Bolivar Counties agreed to hold limited antlerless-deer hunts on their lands in 1960 and 1961. These were the first antlerless-deer seasons in the state. The dates of these hunts were set so that no two clubs hunted on the same day. This allowed me an opportunity to be on most hunts and to collect a maximum of information. The dates were also fixed to provide a sample of 261 female reproductive tracts from the first week in November through the first week in January.

In summary, 93 females (76 pregnant adults, 7 non-gravid adults, and 10 nonpregnant fawns) were collected in spring, and 261 females were collected on antlerless hunts in Washington and Bolivar Counties in December, 1960 and January, November and December, 1961.

a. Field Procedure

Animals were weighed in the field on Chatillan displacement scales. No allowances were made for blood losses although these may have amounted to a pound or two in some cases.

Reproductive tracts were removed *in toto*, labelled, and placed in 10% formalin. Both lower mandibles were collected and labelled.

b. Laboratory Procedure

Reproductive tracts and jawbones were examined at the Copiah County Wildlife Management Area Laboratory, Barlow, Mississippi. Embryos and fetuses were carefully removed from the uterus and ages in days were estimated according to methods described by Cheatum and Morton (1946). Ovaries were examined grossly for corpora lutea (Cheatum, 1949; Golley, 1957b). Jawbones were cleaned and ages were assigned by the method described by Severinghaus (1949a).

Because of the difficulties in identification, no attempt was made to locate corpora albicantia. True corpora

lutea either of estrus or of pregnancy, however, are easily recognized. The possibility of error is small. (In the technique originally established by Cheatum (1949), corpora albicantia were identified on the basis of several assumptions. Golley (1957b), however, proved these assumptions to be largely incorrect and both Cheatum and Golley have pointed out that the procedure for gross examination of deer ovaries, which does not involve the more complicated histological techniques, is practical only when applied with a full knowledge of its limitations.)

Estimating Fetal Age

The ages of embryos and fetuses were estimated from total length. The crown-rump (C-R) measurement was taken on embryos and the forehead-rump (F-R) measurement on fetuses. C-R was measured from the mesencephalon to the posterior end of the specimen. The F-R measurement was taken from the points of the coronal and sagittal sutures of the skull to the tuberosity of the ischium. Embryos were measured with a Heliss caliper. Fetuses longer than 120 mm were measured with a ruler.

Immediately after removal from the uterus but before measuring and weighing, fetuses and embryos were partially dried on filter paper. Weights were taken on an Ohaus Cent-o-gram Moder 311 analytical balance.

The average length was recorded for multiple-birth embryos and fetuses, since for 17 sets of opposite-sex twins Hudson (1956) found no significant tendency for either sex to dominate in weight or F-R length.

In this paper, the term "fawn" refers to animals less than 10 months old. Most fawns collected were four to seven months of age. No specimens 10 through 13 months of age were taken. The term "adult" refers to an animal 14 months of age or older.

No monozygotic or true twins were observed. For convenience, "twin" is used throughout this paper to refer to two fetuses in the same reproductive tract. Each fetus seen was apparently the product of a separate ovum since two or more corpora lutea were found in the ovaries of every doe carrying two fetuses.

In deer the embryonic stage covers about the first 66 days of pregnancy. After the external organs are formed, at about 66 to 70 days, the embryo becomes a fetus. The fetal stage comprises the last 4.5 to 5 months of pregnancy.

c. The Study Areas

311 female deer were collected in the batture forest, 24 in the longleaf pine belt and 19 in the loblolly pine (Pinus taeda)--shortleaf pine (Pinus echinata)--upland hardwood type.

Location of Specimen Collections in the Batture Forest

The collection sites in Bolivar, Washington, Claiborne, and Jefferson Counties (Figure 8) typified the batture forest, the heavily forested region between the main levee of the Mississippi River (or in Claiborne and Jefferson Counties the natural bluffs) and the river itself. The area is subject to annual inundation from flood waters of the Mississippi River. It contains very fertile alluvial deposits, 35 feet deep in places (James, 1951). The Mississippi River batture extends from Cairo, Illinois, to the Gulf of Mexico and contains about two million acres (McKnight, 1950). There are about 259,700 acres in the batture forest of Mississisippi (Krinard, in litt., 1962).

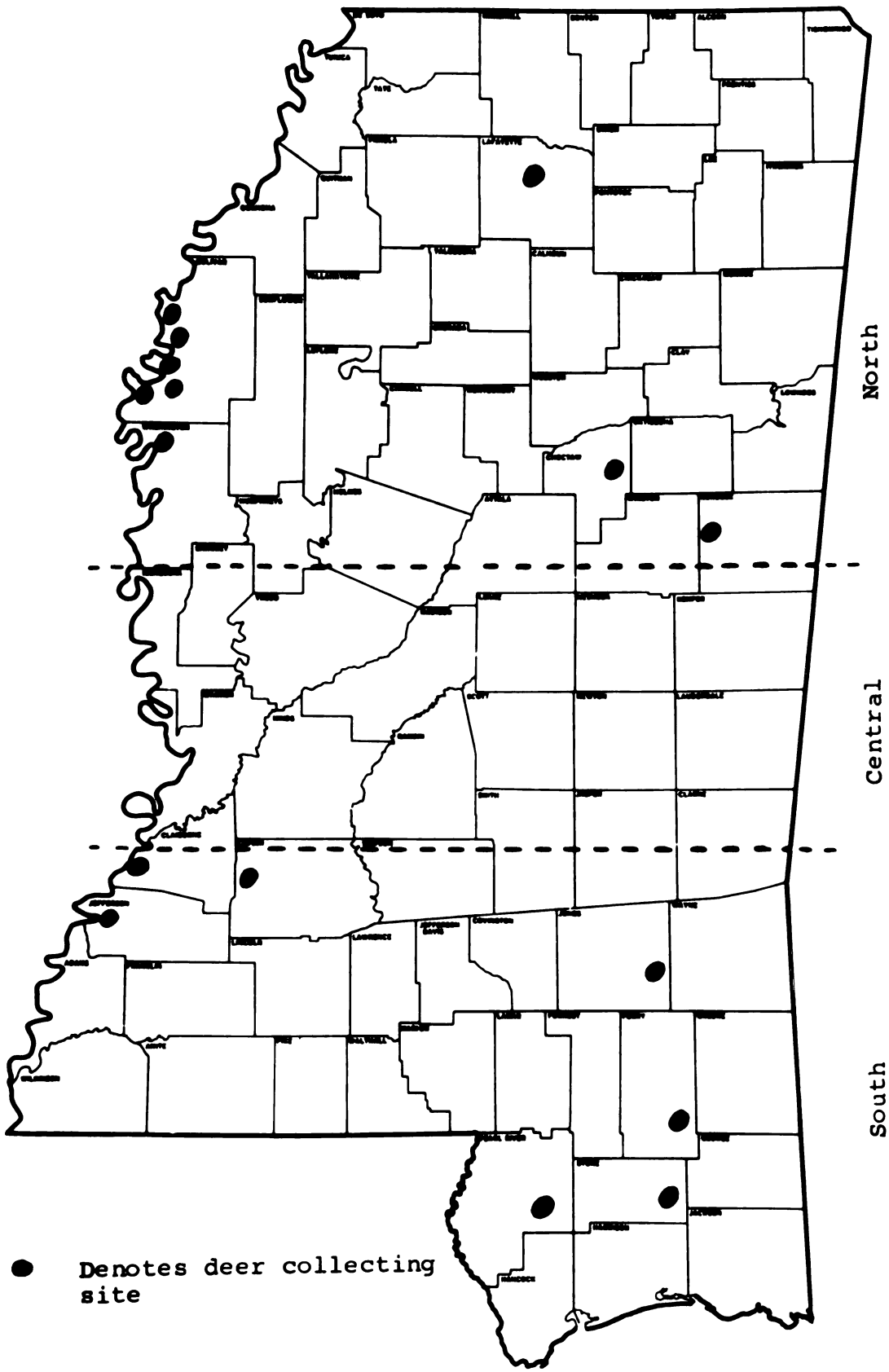
The batture forest (Putnam, et al., 1960) overstory is characterized by sweetgum (Liquidambar styraciflua), cottonwood (Populus deltoides), sycamore (Platanus occidentalis), pecan (Carya illinoensis), persimmon (Diospyros virginiana), hackberry (Celtis laevigata), black willow (Salix nigra), boxelder (Acer negundo), American elm (Ulnus americana), and several species of oaks (Quercus spp.). Understory plants include giant cane (Arundinaria gigantea), Johnson grass (Sorgum halepense), cocklebur (Xanthium pennsylvanicum), stinging nettle (Tragia urticifolia) pokeweed (Phytolacca americana), dewberries (Rubus spp.), grapes Vitis spp.), greenbriers (Smilax spp.), poison ivy (Rhus

Figure 6. The author assisted by Biologist L. P. Heard (standing) measuring a deer embryo at the Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte.

Figure 7. A white-tailed deer embryo about 38 days after conception. The ruler is graduated in millimeters. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


38 days
UNITED STATES OF AMERICA
ONE CENT
1 2 3 4 5 6

Figure 8. Deer collecting sites and approximate geographical boundaries of North and South Mississippi.


North
Central
South
Denotes deer collecting site

radicans), buttonbush (Cephalanthus occidentalis), possumhaw (Ilex decidua), and swamp privet (Forestiera acuminata).

Some areas of the batture forest support one deer per six acres (Noble, 1961a).

Longleaf Pine Belt

The longleaf pine belt is characterized by almost pure stands of longleaf pine. Thousands of acres of these pine stands are maintained in most instances by controlled burning and deadening of other tree species. These are accepted forestry practices used by state, private and federal foresters in the region.

Deer collections in the longleaf pine belt were made in Jones, Stone, Perry, and Pearl River Counties.

Lesser vegetation in the understory of the pine stands include flowering dogwood (Cornus florida), tree-huckleberry (Vaccinium arboreum), gallberry (Ilex glabra), St. Andrew's cross (Ascyrum hypericoides), and winged sumac (Rhus copallium).

The flood plains of small streams in this area support sweetbay (Magnolia virginiana), titi (Cyrilla racemiflora), silverbell (Halesia diptera), bigleaf snowball (Styrax grandifolia), blue beech (Carpinus caroliniana), several species of oaks, beech (Fagus grandifolia), and magnolia (Magnolia grandiflora).

The soils of the longleaf pine belt are largely sandy and infertile. The maximum deer carrying capacity usually does not exceed one deer per 23 to 30 acres.

Miscellaneous Collecting Sites

The shortleaf-loblolly pine and the upland hardwood type were not heavily sampled in this study. They have been described by Westveld (1949).

12 female specimens were collected in the loblolly-shortleaf forests of Copiah, Choctaw, and Noxubee Counties, and 7 were taken from the upland hardwood forest of Lafayette County.

Range Conditions on the Collecting Areas

Deer taken in Bolivar, Washington, Claiborne, Stone, and Perry Counties represent animals from overpopulated ranges. Lafayette, Jefferson, Pearl River, and Jones Counties are considered to be moderately and properly stocked. Copiah, Noxubee, and Choctaw Counties are understocked deer ranges.

311 of the female specimens were taken from overpopulated ranges, 24 females were collected from properly stocked areas, and 9 does were taken from understocked districts. This investigation, therefore, is largely a study of breeding and productivity on overpopulated deer ranges in Mississippi.

BREEDING SEASON FOR MISSISSIPPI DOES

Sandusky (1960) summed up what was known about deer breeding dates in Mississippi when he wrote in his Sunday news column, "Outdoor Mississippi":

> Even arbitrary dates are lacking for the height of breeding and fawn drop, although it is known that our deer breed some time between November 1 and January 15 and that fawns are dropped some time between May 1 and October 1.

a. Definition of Breeding Season

Cheatum and Morton (1946) defined the rutting season as the period when the buck is fertile. The male whitetail, however, is sexually active over a longer period of time than the female (Trippensee, 1948). A similar situation is found in other mammals (Layne, 1958; Vaughn, 1962).

The breeding season is defined here as the period during which conception regularly occurs. This definition delimits the period regardless of sexual differences in either physiology or behavior. The conception dates for Mississippi deer studied here were determined by subtracting the age of each fetus found in the reproductive tracts of 89 pregnant does from the date of specimen collection.

b. Regions for Which Breeding Dates Were Determined

Gravid deer were collected in five areas of Mississippi (Figure 9); seven were taken from the north-central portion of the state (Lafayette County), 49 were collected along the Mississippi River in the northwestern portion (Bolivar County), seven were taken from eastcentral Mississippi (Choctaw and Noxubee Counties), six were collected in southwestern Mississippi (Jefferson, Claiborne, and Copiah Counties), and 20 were taken from the extreme southern portions of the state (Jones, Perry, Pearl River, and Stone Counties).

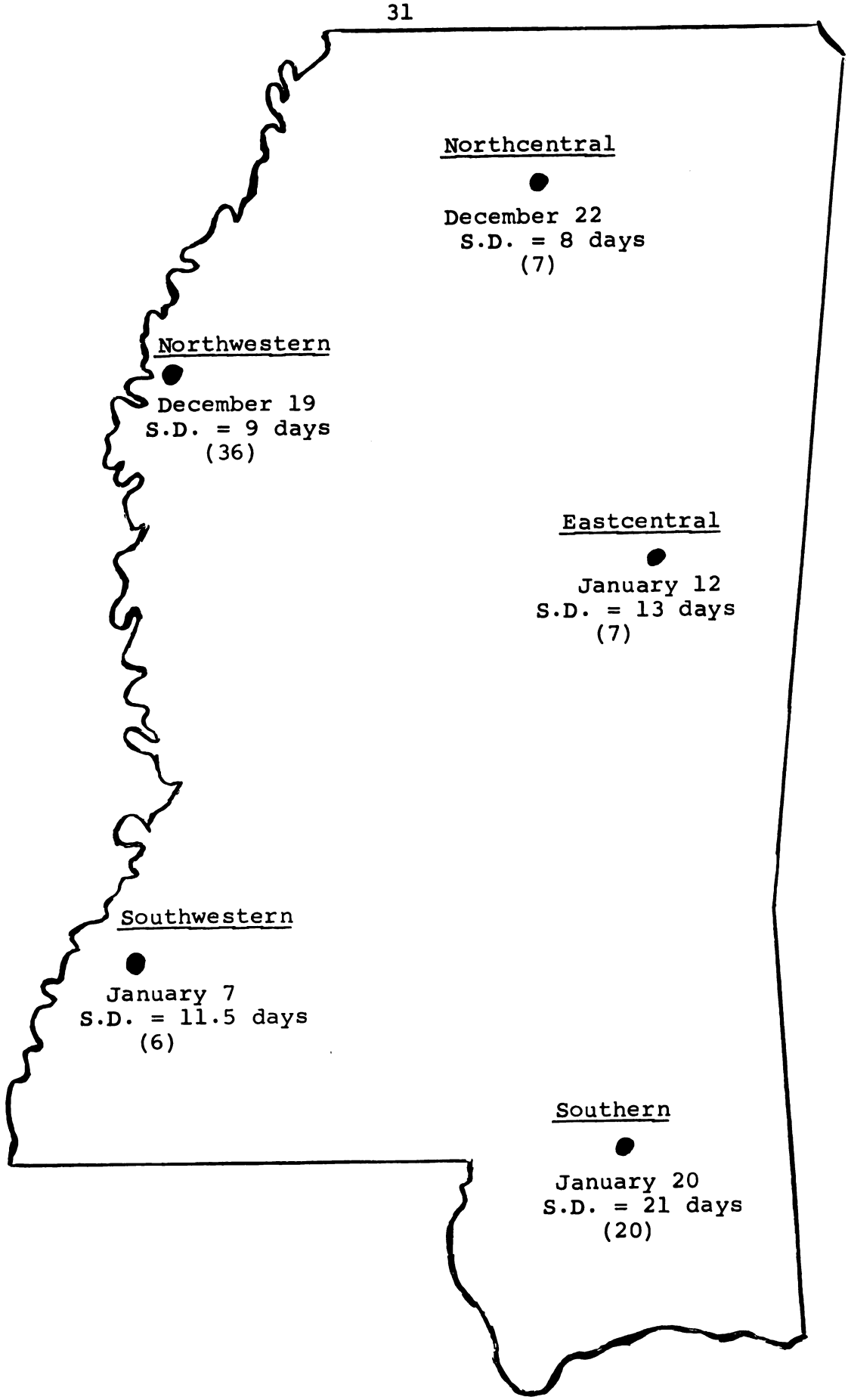
Breeding dates are given (Figure 9) for each of five state areas. Because of the relatively small number of specimens from some areas, however, detailed discussion is restricted to 63 gravid deer from north Mississippi and 26 from south Mississippi.

Apparently, dates of breeding within the state are determined to some extent by latitude, presumably through adaptation to local environments. There is a noticeable difference in breeding dates between north and south Mississippi (see beyond).

Northcentral Area

The mean breeding date for seven pregnant does was December 22 with a standard deviation of eight days. The

Figure 9. Mean deer breeding dates for five areas in Mississippi. Number in parentheses is the number of gravid does in the sample.


Northcentral
December 22
S.D. = 8 days
(7)
Northwestern
December 19
S.D. = 9 days
(36)
Eastcentral
January 12
S.D. = 13 days
(7)
Southwestern
January 7
S.D. = 11.5 days
(6)
Southern
January 20
S.D. = 21 days
(20)

earliest breeding date was December 12 and the latest January 5, but only one animal had bred in January. All were collected in the upland hardwood forest of Lafayette County.

Northwestern Area

Deer from the northwestern portion of the state were collected in the batture forest of Bolivar County. The average breeding date for 36 gravid does there was December 19 with a standard deviation of 9 days. The earliest breeding date was December 5 and the latest January 18. 33 (91%) of these does had bred during December. There was no appreciable difference between breeding dates in northcentral Mississippi and northwestern Mississippi.

Eastcentral Area

The main breeding date for seven gravid does in eastcentral Mississippi was January 12 with a standard deviation of 13 days. The earliest date was December 28 and the latest February 3. Only one had bred in December.

The does from this area had conceived about three weeks later than does from northcentral and northwestern Mississippi. Yet only about 95 miles separates the eastcentral collection sites from the collection sites in the northcentral and northwestern areas. The eastcentral sample was small, however, and the validity of these differences must await verification. The northcentral, northwestern, and

eastcentral areas have been combined to represent breeding dates in north Mississippi.

Southwestern Area

The six pregnant does collected in the southwestern area had bred between December 22 and January 22. The mean breeding date was January 7; the standard deviation being 11.5 days.

Southern Area

Deer from extreme southern Mississippi were collected in the longleaf pine belt. The average breeding date for 20 pregnant deer was January 20 with a standard deviation of 21 days. Breeding dates extended over the period December 13 to February 24. Breeding dates from the southwestern and southern areas were combined to represent breeding dates in south Mississippi.

c. Breeding Dates in North Mississippi

Deer mate several weeks earlier in northern Mississippi than they do in the southern part of the state.

The average breeding date was determined for 50 pregnant does collected in north Mississippi in late spring when breeding does normally carry visible fetuses. The computed date was December 23, with a standard deviation of 13 days. Successful mating extended over a 61-day period, from December 5 through February 3. 40 (80.0%) of the sample had

bred during December; nine (18.0%) in January, and only one (2.0%) in February. In north Mississippi, the height of breeding occurred during the two-week period of December 5 through December 18, when 44.0% of the sample had bred (Table 1).

Over 69.0% of the does in the region had bred between the two hunting seasons (December 1 - 25), and 16.0% had bred after the second hunting season (after January 3). Only seven (14.0%) bred during the second hunting season (December 26 - January 3). Hale (1959) reported that disturbance by hunters in Wisconsin during the rut had little effect on the success of the breeding season. Nevertheless, he pointed out that in an area of heavy hunting pressure and low deer numbers, a season timed to hit the peak of the breeding could be a method of intensifying population control. The main effect of such management, however, would probably be a later fawn crop since does disturbed by hunters during their regular breeding period would experience another estrus about 28 days later.

Deer in most of north Mississippi, and especially in the batture forest, are hunted with dogs. This may be the reason that so little successful breeding occurred there during the hunting season.

Seven (14.0%) of the 50 pregnant does collected in the late springs of 1960 and 1962 had bred between December 5 and December 11. Between January 3 and January 9, 1961,

Table 1. Estimated breeding periods* for 76 gravid deer collected in Mississippi--1960, 1961, 1962.

Breeding Period	North Mississippi Does		South Mississippi Does	
	Number	Percent	Number	Percent
December 5 - December 18	22	44.0	2	7.7
December 19 - January 1	18	36.0	7	28.6
January 2 - January 15	7	14.0	6	23.1
January 16 - January 29	2	4.0	3	11.6
January 30 - February 12	1	2.0	6	23.1
February 13 - February 24	0	0.0	2	7.7
Total	50	100.0	26	100.0

North Mississippi Mean Breeding Date	North Mississippi Standard Deviation (Days)	North Mississippi Range	South Mississippi Mean Breeding Date	South Mississippi Standard Deviation (Days)	South Mississippi Range
December 23	13	December 5 - February 3	January 15	19	December 13 - February 24 (74 days)

*Date of mating estimated from back-dated embryos.

73 adult does were collected from this region. Only 13 (17.8%) carried visible fetuses, and eight of these (11% of the 73 collected) had bred between December 5 and December 11. These data indicate little if any difference between breeding dates for the three years concerned. Probably 11% to 14% of the breeding adult does in Bolivar County and perhaps throughout north Mississippi regularly conceive between December 5 and December 11.

d. Breeding Dates in South Mississippi

The mean breeding date for 26 gravid does from this region was January 15 with a standard deviation of 19 days. Breeding dates (Table 1) extended over a 74-day period from December 13 through February 24. Seven (26.9%) had bred in December, 12 (46.2%) had bred in January and seven (26.9%) had bred in February. The height of breeding occurred during the 28-day period between December 19 and January 15, when half of the animals bred.

Three (11.5%) does bred between the hunting season; 10 (38.5%) mated during the second season (December 26 - January 9), and 13 (50.0%) became pregnant after the second hunting season. Since many deer bred during the second gun season, the hunting season evidently may not influence breeding in south Mississippi.

Hunters were not permitted to use dogs on the areas where these deer were collected.

e. Comparison of North and South Mississippi Breeding Dates

In north Mississippi, the height of successful breeding occurred about three weeks earlier than in the south (Table 1). Breeding in the north commenced eight days and ended 21 days sooner than breeding in the south. The difference in breeding dates is correlated with latitude and climate. The airline distance between extreme northern and southern collection sites was about 250 miles, while the closest collection sites were 87 miles apart.

Proximity to the Gulf of Mexico is largely responsible for south Mississippi's relatively mild climate. A marked difference in climate exists between the extreme collection sites of Lafayette County in the north and Stone County in the south. The December mean temperature in Lafayette and Stone Counties over a 29-year period (1931-1960) was 46.9°F. and 54.3°F. respectively. Lafayette and Stone Counties over the 29-year period of 1921-1950 averaged 224 and 272 frost-free days a year, respectively. Other climatological data for the two regions (Table 2) show similar differences.

f. Regional Differences in Breeding Dates Within Other States

Reports of regional differences in breeding dates within a state are not uncommon. According to Sweet and Wright (undated), the peak of breeding activity among adult does in southern New Jersey is approximately 12 days later

Table 2. Climatological data for Mississippi deer collecting sites.*

Collection Sites	Mean Dec. Temp. in °F (1931-1960)	Mean No. Temp. in °F (1959)	Mean No. Frost Free Days (1921-1960)	Mean Date of First Killing Frost (1921-1950)	Mean Annual Temp. in °F (1931-1960)	Average Annual Rainfall in Inches (1931-1960)
North Mississippi						
Lafayetts (Extreme Northern)	45.6	46.4	224	Nov. 7	63.1	53.21
Choctaw (Extreme Southern)	47.1	45.8	231	Nov. 10	63.9	53.94
South Mississippi						
Jefferson (Northern)	49.2	46.8	223	Nov. 3	64.9	56.12
Stone (Extreme Southern)	54.3	53.0	272	Dec. 2	67.9	61.81

*Climatological data provided by the U. S. Department of Commerce, Weather Bureau, New Orleans, Louisiana.

than among adult does in the northern part of the state. Calhoun (in litt., 1962) reported that does in northern Illinois breed earlier than those in southern Illinois.

Bischoff (1957) reviewed breeding dates for 427 pregnant mule deer (Odocoileus hemionus) from 12 herds representing five California subspecies. There, too, the more northern herds tended to have earlier breeding seasons. Cheatum and Morton (1946) reported that does in southern New York State breed a week later than in northern New York. For Missouri, Murphy (in litt., 1962) says that, "the rut apparently begins first in southeastern Missouri and progresses in a northwest direction across the state . . . In northern Missouri 17.9% of the females are in breeding condition before November 10; in central Missouri 31.7% are in breeding condition and in southern Missouri 44.4% are in breeding condition before that date."

Lang (1957) reported a difference in breeding dates for mule deer in southern New Mexico and those in northern New Mexico. The southern deer breed a month later than those in the northern part of the state.

Loveless (1959) pointed out a marked divergence in breeding dates between Everglades and Key whitetail deer of Florida. The ranges of these two herds are about 100 miles apart and climate conditions are reasonably comparable. Yet the peak of breeding occurs approximately five months apart as Loveless says,

> Superficially it would appear that these two herds, which are closely related geographically and apparently once occupied a continuous range, would breed and drop their fawns about the same time of year. Information shows, nevertheless, that the reproductive cycle in Key deer is more similar to that reported for deer in northwest Florida by Tyson (1954) approximately 500 miles away. It seems fairly evident that range conditions, and undoubtedly a complex of other influences, are significantly related to reproductive cycles, and these cycles are not necessarily determined by length of day, temperature, or other climatic factors and are in part a function of adaptation to environment effects.

The genus Odocoileus generally breeds earlier in the northern regions than in the southern regions of the United States (Table 3).

Figure 10. Deer breeding dates by regions, Mississippi, 1960-1962.

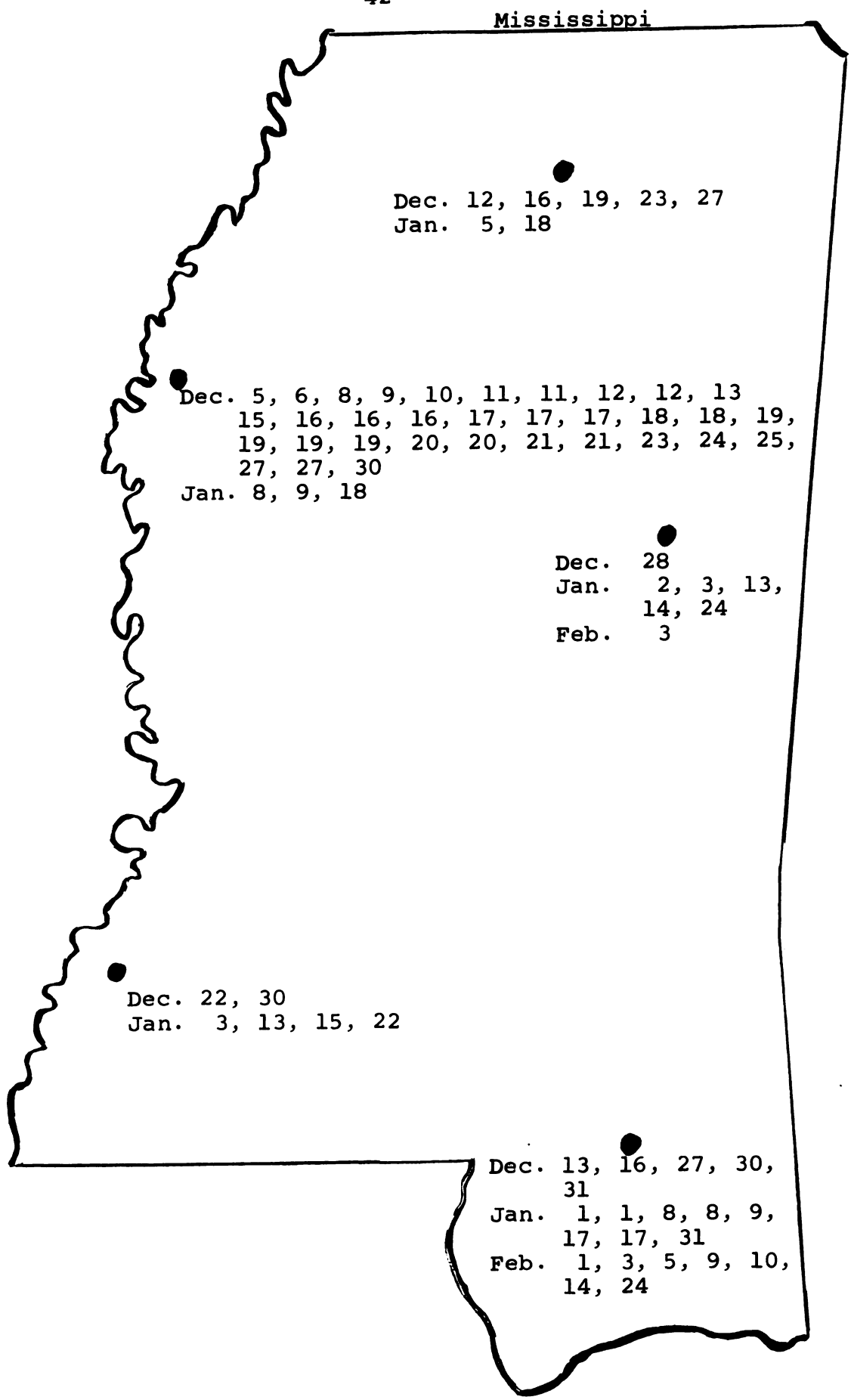

Mississippi
Dec. 12, 16, 19, 23, 27
Jan. 5, 18
Dec. 5, 6, 8, 9, 10, 11, 11, 12, 12, 13
15, 16, 16, 16, 17, 17, 17, 18, 18, 19,
19, 19, 19, 20, 20, 21, 21, 23, 24, 25,
27, 27, 30
Jan. 8, 9, 18
Dec. 28
Jan. 2, 3, 13,
14, 24
Feb. 3
Dec. 22, 30
Jan. 3, 13, 15, 22
Dec. 13, 16, 27, 30,
31
Jan. 1, 1, 8, 8, 9,
17, 17, 31
Feb. 1, 3, 5, 9, 10,
14, 24

Table 3. Reported breeding dates for the genus Odocoileus in 28 states.

State or Providence	Geographical Location	Species	Range of Breeding Dates	Height of Breeding or mean Breeding Date	References
Alabama	Eastcentral	Whitetail	Dec. 26-Feb. 21	Jan. 1-8	Haugen (1959)
Arizona	Central	Mule	Dec. 1-Feb. 20	Jan. 1	Swank (1958)
California	Lake County	Blacktail	Oct.-Nov.	Oct. 15-Nov. 15	Taber (1953
	Northwestern	Blacktail		Early Nov.	Taber & Dasmann (1958)
	Central Coastal	Blacktail	Sept.		Longhurst, et al. (1952)
	Sierra	Blacktail	Late Nov.		Longhurst, et al. (1952)
	Southwestern Deserts	Blacktail	Jan.		Longhurst, et al. (1952)
	Tuolumne County	Blacktail	Nov.-Jan.	Mid Nov.	Leopold, et al. (1951)
	Interstate Herd	Mule	Nov. 15-Jan. 3	Nov. 15-Dec. 6	Chattin (1948)
Florida	Osceola Game Area	Whitetail		Oct. 8	Eichhorn (1962)
	Citrus Game Area	Whitetail		Nov. 26	Eichhorn (1962)
	Everglades	Whitetail	Yearlong	Sept.	Loveless (1959)
Illinois	Northern	Whitetail	Oct.-Dec.		Calhoun (in litt., 1962)
	Southern	Whitetail	Nov.-March		Calhoun (in litt., 1962)
Indiana	Statewide	Whitetail	Oct.-Dec.	Nov.	Hamilton (in litt., 1962)
Iowa	Statewide	Whitetail	Nov.-Dec.	Nov.	Haugen (in litt., 1962)
Louisiana	Tensas Parish	Whitetail	Dec.-Jan.	Dec.	Brunette (1957)
	Statewide	Whitetail	Oct. 30-Nov. 6		Brown (1957)

Table 3 Continued

State or Providence	Geographical Location	Species	Range of Breeding Dates	Height of Breeding or mean Breeding Date	References
Maine	Statewide	Whitetail	Oct. 20-Dec. 28		Banasiak (1961)
	Statewide	Whitetail	Oct. 20-Dec. 28	Nov. 10-23	Banasiak (in litt., 1962)
Massachusetts	Statewide	Whitetail		Nov. 10-25	Shaw & McLaughlin (1951)
Michigan	Upper Penin.	Whitetail		Nov. 7-Dec. 13	Verne (1961)
	Upper Penin.	Whitetail	Nov. 1-Dec. 31	Nov. 7-Dec. 12	Verne (in litt., 1962)
	Statewide	Whitetail		Nov.	Jankins & Bartlett (1959)
Minnesota	Statewide	Whitetail	Oct.-Feb.	Nov.	Erickson, et al. (1961)
Mississippi	Northern	Whitetail	Dec. 1-Feb. 3	Dec. 19	Noble (this study)
	Southern	Whitetail	Dec. 13-Feb. 24	Jan. 15	Noble (this study)
Missouri	Statewide	Whitetail	Oct.-Jan.	Late Oct.-early Nov.	Robb (1959)
	Statewide	Whitetail		Nov. 15	Murphy (in litt., 1962)
Montana	Nat. Bison Range	Mule	Nov. 5-Dec. 26	Nov. 20	Hudson (1956)
Nebraska	Statewide	Whitetail	Nov. 10-Dec. 15	Nov. 20-Dec. 1	Bailey (in litt., 1962)
New Hampshire	Statewide	Whitetail	Oct.-Jan.	Mid Nov.	Laramie (in litt., 1962)
New Jersey	Northern	Whitetail	Oct. 20-Jan. 4	Nov. 3-23	Mangold (1958)
	Northern	Whitetail	Oct. 25-Dec. 10	Nov. 2-17	Sweet & Wright (undated)
	Southern	Whitetail	Oct. 21-Dec. 28	Nov. 15-30	Sweet & Wright (undated)

Table 3 Continued

State or Providence	Geographical Location	Species	Range of Breeding Dates	Height of Breeding or mean Breeding Date	References
New Mexico	Statewide	Mule	Dec. 20-Mar. 23	Jan. 13	Harrington (1961)
	Southwestern	Whitetail	Jan.-Feb.		Lang (1957)
	Northern	Mule and Whitetail	Dec.-Jan.		Lang (1957)
New York	Northern	Whitetail		Nov. 10-16	Cheatum and Morton (1946)
	Southern	Whitetail		Nov. 17-23	Cheatum and Morton (1946)
North Dakota	Statewide	Whitetail and Mule	Oct. 20-Nov. 20		McKenzie (in litt., 1962)
Oregon	Western	Blacktail	Oct.-Dec.		Mace (1962)
	Eastern	Mule	Oct.-Dec.		Mace (1962)
	Statewide	Whitetail	Oct.-Nov.		Mace (1962)
South Dakota	Statewide	Whitetail	Nov.-Dec.	Nov. 20-Dec. 10	Priewert (in litt., 1962)
Tennessee	Catoose Game Area	Whitetail	Oct.-Dec.		Lewis (1961)
Texas	Edwards Plateau	Whitetail		Oct. 24-Nov. 20	Teer (1959)
Washington	Statewide	Blacktail	Oct. 22-Jan. 11	Nov. 10-25	Brown (1961)
West Virginia	Statewide	Whitetail	Oct. 17-Jan. 29	Nov. 14-27	Degarmo and Gill (1958)
	Statewide	Whitetail	Oct. 20-Mar. 8	Nov. 10-23	Chadwick (1961)
	Statewide	Whitetail	Nov. 3-Jan. 8	Nov. 10-Dec. 7	Chadwick (1958)
Wisconsin	Statewide	Whitetail	Oct. 5-Feb. 7	Nov. 17	Hale (1959)

THE DATE OF SEASONAL ESTRUS IN BOLIVAR COUNTY DEER

The presence of a corpus luteum in an ovary indicates that the doe has ovulated and possibly has bred successfully. If ovary collections are initiated early enough and continued over a sufficient period of time, it is a simple matter to establish the date of estrus.

The first antlerless-deer seasons in Mississippi were held on the Catfish Point and Merigold Hunting Clubs in Bolivar County December 15 - 22, 1960, and January 3 - 9, 1961, respectively. These hunts yielded 136 adult females.

Preliminary examination of the ovaries from these deer indicated, on the basis of corpus luteum counts, that many had gone through heat. In addition, 13 of the January sample contained visible fetuses. It was decided that an earlier fall collection was necessary. Therefore, the 1961 antlerless season for Catfish Point was set for November 11 - 15, inclusive. In addition, the Ashbrook Hunting Club in adjacent Washington County agreed to conduct an antlerless hunt on November 20 - 21, 1961. On these two hunts I collected information from 76 females, 67 adults and nine juveniles. A fourth antlerless hunt, at the Huntington

Point Club, enabled 31 adult females and five fawn females to be collected December 2 - 7, 1961, inclusive.

In total, 234 adult female reproductive tracts were collected on antlerless-deer hunts in Bolivar and adjacent Washington County covering the period November 11 through January 9 in the years 1960, 1961, and 1962. Of these, 12 were unusable because they were partially destroyed by gunshot (6), improperly preserved (2), or with one or both ovaries missing due to improper removal of the reproductive tract (4).

A further 36 pregnant does were killed by me in the county during February, March, and April of 1960 and 1962. Their estimated breeding dates extended over the 45-day period December 5 through January 18. The average breeding date was December 19 with a standard deviation of nine days.

On the January 3 - 9, 1961, antlerless hunt, I collected the reproductive tracts from 73 adult does. Thirteen (13) (17.1%) of these animals were visibly pregnant but the calculated breeding dates were not used in calculating the mean because they represented only the earliest breeding dates for that year. These 13 early breeders had bred between December 1 and December 11.

No corpora lutea were found in 60 pairs of adult ovaries collected between November 11 and November 22 (Table 4). Many of these ovaries exhibited maturing graffian follicles, however, indicating that ovulations would have

Table 4. The number of adult does, collected on antlerless hunts, by date and the number showing corpora lutea; Bolivar and Washington Counties, Mississippi, 1960-1962.

Date of Collection	Number of Adult Does Collected	Number With Corpora Lutea
November 11	27	0
November 12	10	0
November 14	1	0
November 21	22	0
December 2	6	2
December 3	7	0
December 5	3	1
December 6	6	1
December 7	6	0
December 15	13	8
December 16	2	2
December 17	9	1
December 18	12	7
December 21	13	6
December 22	11	7
January 3	21	11
January 4	12	9
January 5	6	4
January 6	13	6
January 7	5	4
January 8	14	12
January 9	3	2

occurred within a few weeks. The deer collected on November 21 were taken at the Ashbrook Hunting Club in adjacent Washington County but the collecting sites in Washington and Bolivar Counties are separated by only a few miles. All other deer were taken in Bolivar County.

On December 2, 1961, two of the six adult does taken contained corpora lutea. In one of the two specimens the corpora lutea were not completely luteinized. Ovulation in that animal evidently had occurred only one or two days before, probably on December 1.

The earliest estrus date in Bolivar County was evidently December 1. The earliest established breeding date for 49 pregnant deer from the county also proved to be December 1.

Between December 5 and 16, 1961, thirty adult does were collected. The ovaries of 12 of these animals (40.0%) contained corpora lutea. Fourteen (38.3%) of the 1960 and 1962 spring collection of pregnant does had bred between December 5 - 16. These figures are almost identical and further indicate that deer breeding dates did not vary during the three breeding seasons concerned in this study.

Eleven adult does were collected on December 22, 1961, and the ovaries of seven (63.9%) contained corpora lutea. 27 (75.0%) of 36 spring collected does had bred before December 22.

During January 8 - 9, 1961, 17 adult does were collected, and 14 (82.3%) either contained fetuses or corpora lutea. In the gravid sample, 97.2% were estimated to have mated before January 10.

Minor discrepancies above can be explained as follows: An attempt was made during the spring collecting period in Bolivar County to kill only does with fawns following them. This obviously gave a sample derived from the breeding population but was the best method to prevent the killing of antlerless males which were then common. The spring collections in Bolivar County therefore were not random samples of the female segment of the herd, but presumably were a random sample of deer from the breeding population. The samples from antlerless hunts undoubtedly included non-breeders since there is no reason to think that hunters were selective of breeding does.

In summary, it appears that the earliest estrus in Bolivar County and possibly throughout north Mississippi occurs about December 1. About 14% of adult does experience their first estrus of the year during the period December 2 through December 7 and 82% of the adult does in the county show corpora lutea or fetuses by January 9. Perhaps 15% of adult does do not breed in a given year since samples from the breeding population taken during the gestation period indicate that 97.2% of animals which breed are mated by January 10.

The deer ranges from which these does were collected in Bolivar and adjacent Washington County were seriously overpopulated as evidenced by winter browse studies (Noble, 1960).

No fall and winter deer collections were made in south Mississippi but from established breeding dates (above) the first estrus in the southern region must occur about December 15.

BREEDING BY FAWNS

In New York, according to Morton and Cheatum (1946), "the incidence of breeding among doe fawns, which at the time of conception were six months old, indicates that a high percentage of such deer are capable of breeding successfully."

a. Mississippi Fawns

37 female fawns aged four to nine months, were collected during this study. Nine were taken in November, 13 in December, four in January, four in February, six in March and one in April. None carried featuses and all ovaries appeared quiescent (Figure 11). Neither corpora lutea nor well-developed graffian follicles were found. The evidence is that few, if any, Mississippi does experience estrus before they are at least one year old.

b. Incidence of Fawn Breeding in Other States

Teer (1959) examined 13 fawns from the Edwards Plateau in Texas but found only one of these animals with a corpus luteum. Graffian follicles were well developed in several of the fawns, none of which was older than six

months, but ova had not ruptured from the ovaries. Thomas (1962) collected 24 fawns from the same area and reported that two contained corpora lutea. He pointed out that fawns may breed later in the season than adults. Lueth (in litt., 1962) reported one incidence of fawn breeding in Alabama. Brunette (1957) found no pregnant fawns in Louisiana.

Mangold (1958) found 14 of 55 New Jersey fawns to be pregnant. According to Sweet and Wright (undated), about 40% of the fawns in New Jersey breed during the first rutting season after their birth.

Robb (1959) found that 37% of his Missouri sample of 4-7 month-old fawns had mated and attributes this to above-average nutrition. Erickson et al. (1961) estimated that 20% of Minnesota fawns breed annually.

Severinghaus and Cheatum (1950) examined 346 New York fawns six to eight months old and found 75 to be pregnant. Chadwick (1958) found six of 23 West Virginia fawns to be pregnant.

Taber (1953) examined four blacktail fawns (Odocoileus hemionus) in California and found no evidence of breeding. Bischoff (1958) studied 20 California mule deer fawns and found no evidence of ovulation. Lassen et al. (1952) reported that ovaries of California mule deer fawns showed no indication of follicular maturity.

Apparently, whitetail fawns in New Mexico do not breed (Lang, 1957). Harrington (1961) reported no incidence

of fawn breeding in New Mexico mule deer. However, Snyder (1959) collected 100 mule deer fawns in New Mexico and found one to be pregnant. Brown (1960) later collected 19 fawns from Snyder's study area and reported that the ovaries of four contained corpora lutea.

Verme (1961) reported that only about 5% of the fawns in the Upper Peninsula of Michigan breed and credits this low percentage to the severe winters of northern Michigan.

Figure 11. Immature reproductive tract from a six-month-old female fawn collected March 14, 1962, in Bolivar County, Mississippi. This animal was typical of all female fawns collected in this study. The smooth, white, relatively flat, quiescent ovaries are visible. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


1
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MISSISSIPPI FAWNING DATES

Fawning dates were estimated from breeding dates by adding the gestation period. 202 days was the gestation period used in this study. Severinghaus (in litt., 1960) reviewed the available literature and concluded that 202 days was the average gestation period for whitetail deer.

I spent large portions of the summers of 1960 and 1961 on various game management and private areas throughout Mississippi. Personal observations of fawning dates in the field agreed closely with those estimated from fetal age.

a. Fawning Dates in North Mississippi

The average of 50 fawning dates for north Mississippi was July 13, with a standard deviation of 13 days. Fawning dates extended over the 61-day period from June 25 through August 24. The height of fawning occurred between June 25 and July 22, when 80% of the pregnant does would have fawned.

In 1960, the earliest fawn on Catfish Point (Bolivar County) was observed by Mr. Raymon Nokes, caretaker, on June 23. By the second week in July, spotted fawns were common and by the last week in August a majority of the adult does had spotted fawns following. In 1961, Mr. Nokes reported Catfish Point's first spotted fawn on June 20. During June

27-30, 1961, I camped there and covered the area extensively on horseback. I observed 102 antlerless deer during the three days and two of these were new-born fawns. From my notes of June 29, 1961, "I observed a deer at base of large pecan tree near river about 9:30 AM. Approached within 25 yards before deer flushed. It ran a short distance and stood watching base of tree. Investigated and found small male fawn unable to stand. Picked him up. After a minute's struggle, he quieted and seemed content with my scrutiny of his tooth development--incisors erupted--probably born last night." The next morning (18 hours later), both doe and fawn were gone.

b. Fawning Dates in South Mississippi

The mean fawning date for 26 gravid deer from south Mississippi was August 5, with a standard deviation of 19 days. Computed fawning dates extended over a 74-day period from July 3 through September 14. Thirteen (50%) would have given birth in July, 11 (42.3%) in August, and two (7.7%) in September. The height of the fawn drop in south Mississippi occurred between July 19 and August 15 when about 60% of the pregnant does from this region would have fawned.

Based on the average date of conception, the mean fawning date must have occurred about three weeks later (August 5) in south Mississippi than in the northern part of

the state. Fawning in the north starts eight days earlier and ends 21 days earlier than in the south.

c. Comparison of Mississippi Fawning Dates with Those in Other States

Most mule deer in central Arizona drop their fawns during the last week of July and the first week of August (Swank, 1958) as do whitetails in south Mississippi. In Tuolumne County, California (Leopold, et al., 1951), the peak of fawning occurs at about the same time as in north Mississippi, mid-July. Harrington (1961) reported August 6 as the mean fawning date for mule deer in New Mexico. This is only one day later than the mean fawning date for south Mississippi whitetails. Longhurst and Douglas (1953) reported that the majority of the blacktail fawns in the north coastal portion of California are born the first two weeks of May. In Washington State, blacktail fawns appear mostly between June 5 and June 10 (Brown, 1961).

In New Hampshire the height of the fawn drop occurs in mid-June (Laramie, in litt., 1962). Eichhorn (1962) gave May 8 as the mean fawning date for 16 gravid does taken from the Osceola Game Area in Florida and June 28 as the average fawning date for does on the Citrus Game Area of Florida. In Wisconsin whitetails, the average fawn drop date is June 5 (Hale, 1959) which is a month earlier than the average fawning date in north Mississippi. The mean fawning date in Missouri is June 15 (Murphy, in litt., 1962). In northern

Illinois peak fawning occurs about June 10 while in southern Illinois the peak is not reached until June 30 (Calhoun, in litt., 1962).

Reports of unusually early and late fawns are not uncommon in the literature. Erickson et al. (1961), reported a doe in Minnesota that would have given birth in September or October. Chadwick (1958) reported a fawn in West Virginia that must have been born about February 3, and September 10 or 11 (Gordenier, 1948) and September 25 (Verne, 1962) are reported as birth dates for the Upper Peninsula of Michigan.

Late breeding often is associated with the onset of sexual maturity in precocious fawns six to eight months of age (Cheatum and Morton, 1942).

Table 5. Estimated fawning period (from back-dated embryos) for 76 gravid does collected in Mississippi, 1960, 1961, 1962.

FAWNING PERIOD	DOES FAWNING DURING PERIOD NORTH MISSISSIPPI		DOES FAWNING DURING PERIOD SOUTH MISSISSIPPI	
	NUMBER	PERCENT	NUMBER	PERCENT
June 25 - July 8	22	44.0	2	7.7
July 9 - July 22	18	36.0	7	26.8
July 22 - August 5	7	14.0	6	23.1
August 6 - August 19	2	4.0	3	11.6
August 20 - September 2	1	2.0	6	23.1
September 3 - September 14	0	0.0	2	7.7
Totals	50	100.0	26	100.0

NORTH MISSISSIPPI			SOUTH MISSISSIPPI		
MEAN FAWNING DATE	STANDARD DEVIATION (DAYS)	RANGE	MEAN FAWNING DATE	STANDARD DEVIATION (DAYS)	RANGE
July 13	13	June 25 - August 24 (61 days)	August 5	19	July 3 - September 14 (74 days)

Figure 12. Reproductive tract of a 1.5-year-old doe containing a single fetus as it appears *in situ*. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


5
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MINIMUM AND MAXIMUM BREEDING AGES OF MISSISSIPPI DOES

Most Mississippi hunters are of the opinion that old does do not breed. Any deer manager in his association with hunters will hear the inevitable cliches, "dry doe," "barren doe," "single doe," "maiden doe," and "blue doe." These terms are used collectively in reference to female deer which, supposedly, do not produce offspring. To a hunter, any doe may be "old."

Severinghaus and Cheatum (1956) stated that 10-year-old individuals are of little consequence in most whitetail populations. Jenkins and Bartlett (1959) stated:

> As far as we know, there is no such thing as a "barren doe" because of age.

Sweet and Wright (undated) wrote:

> It was found during the course of this study that age did not affect the breeding ability of the does in New Jersey. It appears that they breed just as long as they live and that the older animals have just as many offspring as the younger animals.

The two oldest animals taken in this study were estimated to be between 9.5 and 10.5 years of age. One was carrying twins and the other would have given birth to a single male. Of the two 8.5-year-old animals, one was carrying twins and had two fawns following and the other was carrying

a single fetus. The five 7.5-year-old animals collected in spring were all pregnant and carried an average of 1.50 fetuses each, which was better than the 1.42 average for all pregnant does examined. Six 6.5-year animals were accompanied by young and also were carrying an average of 1.33 fetuses each.

Of the 83 adult does collected in late spring, only seven were apparently unbred. The ages of those animals in years were: 1.5, 1.5, 2.5, 3.5, 5.5, 6.5, and 9.5.

Although without evident fetuses, the ovaries of the 9.5-year-old animal contained corpora lutea when collected on March 8. The 3.5-year-old and one of the 1.5-year-old animals showed corpora lutea on February 25. The other four animals, three of which were collected on March 14, did not display corpora lutea.

There is little, if any, fawn breeding in Mississippi. The minimum breeding age for deer is approximately 1.5 years and the animals drop their first fawns when about two years old. Six of eight does in the 1.5-year-old class collected in late spring were gravid. All carried a single fetus (Figure 12). There is no maximum breeding age. It appears that whitetail does in Mississippi breed and produce offspring as long as they live.

a. Age of Doe as Related to Date of Breeding

So far as could be determined, no age class tended to breed earlier or later in the year than any other age class. December 1 was the earliest breeding date recorded for north Mississippi. One 3.5-year-old animal and one 4.5-year-old animal was estimated to have bred on that date.

The earliest breeding date in south Mississippi was December 13. A 2.5-year-old animal was estimated to have bred on that date.

The latest breeding date for south Mississippi (February 24) occurred with a 4.5-year-old animal. The latest breeding date in north Mississippi (February 3) was for a 2.5-year-old animal.

The youngest breeding class, the 1.5-year-old animals, bred during the height of the rut in both regions. The sample of old does (6.5 years plus) was limited in size, but the 15 collected had bred neither noticeably earlier nor later than any other age class.

BIRTH RATES IN MISSISSIPPI DOES

Fawn production in a herd is best measured by determining the exact number of fawns born to a given number of does. This is a difficult procedure except in semi-wild or tame herds. For that reason the deer manager must rely upon fetal counts which incurs the danger of error induced by prenatal mortality. If pregnant deer are collected throughout the gestation period, however, sufficient information on prenatal mortality should be available to enable final calculations to be corrected for fawns lost prior to birth.

a. Factors Influencing Birth Rates in Deer

Perhaps the three factors that influence birth rates more than others are (1) age of the doe, (2) conditions of the winter range, and (3) population density. Eberhardt (1960) has shown that reproductive rates of white-tailed deer in Michigan vary inversely with population densities.

A number of observers have reported that does on good range produce more fawns than females in poor habitats (Banasiak, 1961; French et al., 1955; Morton and Cheatum, 1946; Verme, 1962).

Many animal species have been shown to reproduce more successfully when at a low rather than high density. Higher percentages of adult females also engage in reproduction under uncrowded conditions. This phenomenon has been demonstrated with moles under laboratory conditions, by Clarke (1955) and for muskrats (Ondatra zibethicus) in natural conditions by Errington (1954). Patric (1962) observed the same phenomenon in the red-backed mouse (Clethrionomys sp.).

Age has an effect on birth rates, for fawns, if they breed, nearly always give birth to a single fawn (Banasiak, 1961). The 1.5-year-old age class, if breeding for the first time, usually also produces only one fawn (McDowell, 1962). Higher birth rates are found in the older age classes (Severinghaus and Cheatum, 1956) as has been described above for Mississippi deer.

b. Average Number of Fetuses Per Doe

The average number of fetuses per doe is a good indication of fawn production. If the average number of fetuses per doe and population densities are known, annual herd increment can be estimated. Though McConnell and Dalke (1955) have shown that there is considerable variability from year to year in fawn production in Idaho mule deer, continuous studies are impossible. The deer manager must rely upon carefully planned studies and apply these findings with discretion from year to year.

Statewide Sample

126 fetuses were taken from 89 adult does collected throughout Mississippi. The average number per doe was 1.42. This is low as compared to other states (Table 6). In compiled studies from 22 states and one Canadian province (Table 6), 2,250 gravid animals were examined and 3,701 fetuses identified. This is an average of 1.64 fetuses per pregnant doe when whitetail, mule and blacktail deer are combined. The average is 1.65 fetuses per pregnant doe for whitetails alone.

Most Mississippi does, however, were from overpopulated ranges. Higher fawn averages may be expected on less crowded ranges of the state.

Fawn Production on Mississippi River Bottomlands as Compared with the Longleaf Pine Belt

Collections on Mississippi River Bottomlands (batture forest of Bolivar County) and from the longleaf pine belt were both made largely on overpopulated ranges. The Bolivar County collection, however, represents deer from a highly fertile, alluvial soil while data for the longleaf pine belt represent animals on a sandy, infertile soil type.

41 pregnant does from Bolivar County were carrying 57 fetuses, an average of 1.39 fetuses per doe. 20 pregnant does from the longleaf belt contained 27 fetuses, an average of 1.35 fetuses per gravid female. This is a superiority of

Table 6. Average number of fetuses per gravid doe as reported from various states and provinces.

State or Province	Species	No. of Gravid Does in Sample	No. of Fetuses in Sample	Average No. of Fetuses per Gravid Doe	Reference
Alabama	Whitetail	15	24	1.60	Lueth (1961)
Florida	Whitetail	16	20	1.26	Eichhorn (1962)
Florida	Whitetail	19	22	1.16	Harlow & Fickett (1961)
Louisiana	Whitetail	5	7	1.40	Brown (1957)
Maine	Whitetail	65	117	1.80	Banasiak (1961)
Maine	Whitetail	143	244	1.71	Banasiak (in litt., 1962)
Massachusetts	Whitetail	11	20	1.82	McDonough (1958)
Mississippi	Whitetail	89	126	1.42	Noble (this study)
Nebraska	Whitetail	11	21	1.90	Bailey (in litt., 1962)
New Hampshire	Whitetail			1.70	Laramie (in litt., 1962)
New Jersey	Whitetail	223	414	1.86	Sweet & Wright (undated)
New York	Whitetail	112	174	1.55	Severinghaus & Cheatum (1956)
North Dakota	Whitetail			1.70	McKenzie (in litt., 1962)
Pennsylvania	Whitetail			1.74	Lang (in litt., 1962)
South Dakota	Whitetail	10	17	1.70	Priewert (in litt., 1962)
Tennessee	Whitetail	4	7	1.75	Lewis (1961)
Texas	Whitetail	163	281	1.72	Teer (1959)
Texas	Whitetail	220	341	1.55	Teer (1960)
Texas	Whitetail	115	154	1.34	Thomas (1962)
West Virginia	Whitetail	83	141	1.70	Chadwick (1958)
Wisconsin	Whitetail	588	1000	1.70	Hale (1959)
Ontario	Whitetail	49	86	1.76	Clarke (in litt., 1962)

Table 6. Continued

State or Province	Species	No. of Gravid Does in Sample	No. of Fetuses in Sample	Average No. of Fetuses per Gravid Doe	Reference
Arizona	Mule	16	24	1.50	Swank (1958)
California	Mule	26	46	1.77	Hiehle (in litt., 1962)
California	Mule	48	84	1.75	Chattin (1948)
Montana	Mule	64	104	1.62	Sears (1955)
Montana	Mule	50	85	1.70	Hudson (1956)
New Mexico	Mule	28	40	1.43	Harrington (1961)
North Dakota	Mule			2.42	McKenzie (in litt., 1962)
Washington	Blacktail	77	102	1.32	Brown (1961)
TOTALS	All species	2250	3701	1.64	
	Whitetail	1941	3216	1.65	
	Mule	309	485	1.57	

only 0.04 fawns per pregnant doe for the fertile batture forest over the infertile longleaf belt. Although on the basis of general observations, the population density of deer was much lower on the longleaf area, here again is evidence that regardless of absolute density, density with respect to carrying capacity is more important in determining reproductive success.

Twins are supposed to be more common in deer on higher quality range (Cowan, 1956). 16 of 41 gravid does from Bolivar County and 7 of 20 from the longleaf belt were carrying twins. From chi-square tests, there was no reason to believe that there was a difference in the proportion of twins between Bolivar County and the longleaf belt at the 1% level of confidence (calculated chi-square = 0.00051).

Birth Rates as Related to Range Condition

A number of investigators have pointed out that an overbrowsed deer range results in a lowered rate of reproduction (Park and Day, 1942; O'Roke and Hamerstrom, 1948; Cheatum and Severinghaus, 1950).

Of the pregnant deer taken for this study, nine were from good range, 11 were from fair range and 69 were from poor range.

Good range refers to an area where food is plentiful throughout the year and where the deer population is well below the range carrying capacity. On fair range the deer herd

is approaching overpopulation and some competition for food exists in early spring. Poor range is overbrowsed, native foods are scarce in late winter and early spring and deer numbers exceed the range carrying capacity.

Pregnant does from good range in Mississippi were carrying an average of 1.56 fetuses each, and the does on poor range averaged 1.36 fetuses each. These data support the evidence that does on overstocked range produce less fawns than does on properly-stocked to understocked range.

c. Frequency of Pregnancy

The frequency of pregnancy is the percentage of does that become pregnant during a given breeding season. Albegglen and Roppel (1959) prefer "pregnancy rate," Sweet and Wright (undated) use "incidence of pregnancy," and Brown (1957) proposed the term "frequency of fertilization." The need for a standard code of nomenclature in the wildlife profession has been discussed by Hill and Kimball (1948).

Statewide

83 adult does were collected in late spring (when breeding does normally have visible fetuses) and 76 (91.6%) were carrying young. This is probably higher than the average pregnancy rate for Mississippi deer since some attempt was made to collect only females from the breeding population.

In general (Table 7), the frequency of pregnancy throughout the country in the genus Odocoileus averages 92% to 93%. Some small samples revealed a frequency of pregnancy of 100%.

Mississippi River Bottomlands

39 adult does were collected on the Mississippi River bottomlands (of Bolivar County) in late spring and 36 were pregnant (92.4%). The three non-pregnant does taken on March 14, 1962, had no corpora lutea present. Evidently only a few animals would have been unproductive in the 1962 fawning season.

Longleaf Pine Belt

20 (95.2%) of 21 adult does taken in the longleaf region in late spring were pregnant. The one nongravid animal was a 9.5-year-old doe killed March 9, 1962, on the Leaf River Game Management Area in Perry County. The right ovary contained a well-developed corpus luteum. Whether this meant a late breeding date, a recurrent estrus, or early prenatal mortality was uncertain.

Upland Hardwood Forest

All seven adult does collected in the upland hardwood forest (Lafayette County) were heavy with young.

Table 7. Frequency of pregnancy in deer as reported from various states.

State	Species	Number of Adult Does Examined	Frequency of Pregnancy	Reference
Illinois	Whitetail	*	100.0	Calhoun (in litt., 1962)
Louisiana	Whitetail	7	71.4	Brown (1957)
Michigan	Whitetail	*	90.0	Verme (in litt., 1962)
Mississippi	Whitetail	83	91.6	Noble (this study)
Nebraska	Whitetail	11	100.0	Bailey (in litt., 1962)
New Jersey	Whitetail	164	98.2	Sweet & Wright (undated)
New Jersey	Whitetail	138	96.4	Mangold (1958)
North Dakota	Whitetail and Mule	*	75.0	McKenzie (in litt., 1962)
Pennsylvania	Whitetail	*	90.2	Lang (in litt., 1962)
Arizona	Mule	855	82.3	Swank (1958)
California	Mule	28	92.9	Hiehle (in litt., 1962)
California	Mule	48	100.0	Chattin (1947)
Colorado	Mule	143	72.8	Tolman (1950)
Montana	Mule	70	91.4	Sears (1955)
Montana	Mule	60	83.0	Hudson (1956)
New Mexico	Mule	301	80.7	Snyder (1959)
New Mexico	Mule	40	100.0	Brown (1960)
New Mexico	Mule	38	74.0	Harrington (1961)
Washington	Blacktail	88	87.5	Brown (1961)
TOTALS	Whitetails	403	91.5	
	Mule	1671	87.5	

*Not stated.

d. Ovulation Incidence

The number of corpora lutea in the ovaries of pregnant deer is indicative of the number of eggs ovulated during the preceding estrus period. Where two eggs were ovulated, two corpora lutea would form even though only one egg developed into a fetus. When fertilization occurs, all follicles from which ova were expelled become luteinized.

The ovulation incidence is defined as the ratio of the total number of corpora lutea in the ovaries to the total number of pregnant reproductive tracts. It is the average number of eggs ovulated per doe during the estrus period in which conception occurred:

$$\text{Ovulation Incidence} = \frac{\text{Number of Corpora Lutea in Ovaries of Gravid Tracts}}{\text{Number of Gravid Tracts}}$$

Pimlott (1959) used the term "ovulation rate" and Sears (1955) preferred "corpora luteal incidence" in referring to "ovulation incidence."

Factors Influencing the Ovulation Incidence

Nutrition and age affect the ovulation incidence (Cheatum and Severinghaus, 1950). On inadequate diets, does produce fewer ova (Longhurst, et al., 1952). Sears (1955) found the lowest ovulation incidence among mule deer of the

one and two-year age classes. A diet low in protein and phosphorus causes a low ovulation rate in sheep (Taber and Dasmann, 1958).

Ovulation Incidence in Mississippi Deer

Corpus luteum counts were possible in 78 pregnant does collected throughout the state. The does averaged 1.58 corpora lutea each. 35 (44.9%) had ovulated only one ovum while 41 (52.6%) had produced two eggs. In two does, three corpora lutea were recorded. No single ovary contained more than two corpora lutea.

20 deer from the longleaf pine belt had an ovulation incidence of 1.50; 41 batture forest deer (Bolivar County) averaged 1.46 ova per doe. There was no significant difference between these averages, yet the two areas show a marked difference in soil fertility and deer carrying capacity. The batture forest supported one deer per six acres while the longleaf belt carried one deer per 30 acres. The deer from both areas, however, were taken on overbrowsed ranges.

17 additional does were collected on understocked ranges (7 from the upland hardwood forest of Lafayette County and 10 from the shortleaf-loblolly pine forests of Choctaw, Noxubee and Copiah Counties), and they had an ovulation incidence of 1.94. These data demonstrate that regardless of soil fertility, ovulation incidence falls when overpopulations occur.

Although several workers have reported a lower figure for mule deer (Table 8), the statewide ovulation incidence (1.58) for Mississippi deer is the lowest average reported for whitetails. It is believed, as in some other states (see Table 8), that this is due to generally overpopulated deer ranges.

e. Reporductive Efficiency

Reproductive efficiency (the "fertilization rate" of Taber, 1953; and the "parturition frequency" of Provost, 1960) may be expressed by the proportion or percentage of ovulated eggs which become embryos. If a doe is carrying a single fetus and her ovaries contain two corpora lutea, she is reproducing fawns at 50% of her ovulation potential.

Where it can be assumed that reproductive efficiency is constant for a given population, corpus luteum counts can provide information to estimate rates of population increase from year to year.

Several studies have shown that does produce slightly more ova than fetuses during the estrus period in which conception occurs (Taber, 1953; Cheatum and Morton, 1946; Bischoff, 1958). Eggs that do not become fetuses may be resorbed or be lost due to failure of sperm to reach the egg, failure of the fertilized egg to implant, or to a combination of these factors.

Table 8. Ovulation incidence in the genus Ococoileus as reported by various authorities.

State or Province	Species	Sample Size	Ovulation Incidence	Reference
Alabama	Whitetail	15	1.87	Lueth (1961)
Louisiana	Whitetail	5	1.80	Brown (1957)
Maine	Whitetail		1.64-1.84*	Banasiak (1961)
Massachusetts	Whitetail		2.00-2.10*	McDonough (1958)
Mississippi	Whitetail	78	1.58	Noble (this study)
North Dakota	Whitetail		1.50-2.26*	McKenzie (in litt., 1962)
New Jersey	Whitetail	187	1.66-2.00	Sweet and Wright (undated)
New York	Whitetail		1.11-1.97	Cheatum and Severinghaus (1950)
South Dakota	Whitetail	10	2.00	Priewert (in litt., 1962)
West Virginia	Whitetail	41	1.68	Chadwick (1958)
West Virginia	Whitetail	947	1.27-1.90*	Gill (1956)
California	Mule		1.40	Lessen et al. (1952)
Montana	Mule	63	1.79	Sears (1955)
North Dakota	Mule		0.33-3.23*	McKenzie (in litt., 1962)
New Mexico	Mule	101	1.21	Snyder (1959)
New Mexico	Mule	33	1.73	Harrington (1951)
New Mexico	Mule	40	2.05	Brown (1960)
Washington	Mule	49	1.41	Brown (1961)

*Depending on age and/or range conditions.

Statewide Reproductive Efficiency

78 pregnant does from throughout the state carried 110 fetuses and 123 corpora lutea yielding a reproductive efficiency of 89.4%, 41 Bolivar County (batture forest) gravid does carried 57 fetuses and showed a reproductive efficiency of 95.0%, while 20 pregnant does from the longleaf pine belt carried 27 fetuses with a reproductive efficiency of 87.1%.

Ovulation incidence and frequency of fertilization is slightly greater in the longleaf belt than in the batture forest but reproductive efficiency and the average number of fawns per doe is higher in the batture forest. It is not known whether these matters are related to the higher fertility of the Bolivar County soils.

Reproductive efficiency rates in other states range from 94% in California mule deer (Taber, 1953) to 78% for a small sample of Louisiana whitetails (Brown, 1957). In part, the moderate reproductive efficiency in Mississippi deer may balance the low ovulation incidence.

f. Number of Fawns Following Gravid Does and Number of Fetuses *in utero*

Many of the pregnant does killed in the spring were ambushed at food plots. Some were observed for over an hour before they provided a favorable shot. For 28 pregnant does from the batture forest and 16 pregnant does from the longleaf pine belt it was possible thus to determine the number of fawns following a particular doe.

No does later determined to be 1.5 years old had fawns following. The 2.5-year-old age class was expected to have only one fawn following since they had probably bred for the first time as 1.5-year-olds. A 1.5-year-old deer breeding for the first time usually produces only one fawn (McDowell, 1962). Eleven of 12 2.5-year-old gravid does collected in the batture forest had only one fawn following. One such female, however, was followed by two fawns.

Three of four 2.5-year-old does from the longleaf pine belt were carrying a single fetus and one carried twins. However, only one of these animals had a fawn following. The other three does either did not breed as 1.5-year-olds, or had lost their fawns. These does could have had fawns, however, that were not observed.

The 28 gravid does from the batture forest carried 44 fetuses and were seen to be followed by 36 fawns. The averages of 1.29 fawns per doe and 1.57 fetuses per doe indicate about an 18% postnatal mortality. However, after correcting for the 2.5-year-old animals which, regardless of the number of fetuses in utero, were expected to have only one fawn following, the postnatal mortality is 8.4% (excluding any prenatal mortality and assuming that the productivity of these does remains constant from year to year).

The 16 does from the longleaf belt were followed by 15 fawns. The does carried 21 fetuses, an average of 1.31 fetuses per doe and 0.94 fawns per doe. After correcting

for the 2.5-year-old class these data indicate a 17.6% postnatal mortality (under the same assumptions mentioned above). Apparently postnatal fawn survival is higher in the batture forest than in the longleaf pine belt.

g. Age of Doe as Related to Number of Fetuses

All of the six does in the 1.5-year-old age class were pregnant; each carried a single fetus (Table 9). Twins were more common in the 2.5-year-old does than any other age class; 60.7% of the 2.5-year-old animals carried twins. Doubtless, in part because of their high rate of twinning, 2.5-year-old animals carried an average of 1.61 fetuses each, the highest in any age class. Does older than 4.5 years carried an average of 1.34 fetuses each. Fawn production was higher in the 2.5 and 3.5-year-old animals than in any other age classes (Table 9).

No triplets _in utero_ were observed. In seven years of field work in Mississippi, I observed only seven instances of three fawns following a doe. On May 8, 1962, Area Manager Tate White informed me of a large doe killed by an automobile in Oktibbeha County which, it developed, carried three female fetuses.

Chadwick (1958) reported that only one of 35 West Virginia deer had triplets. Benasiak (1961) found that 5% of Maine whitetails carry triplets. Teer (1959) reported two of 163 pregnant does carrying triplets. Later Teer

Table 9. Age of doe as related to number and sex of fetuses. Data from 89 gravid deer collected in Mississippi, 1960-1962.

Age	Number of Does in Age Class	Percentage* of Does in Age Class Carrying Twins	Sex of Fetuses					Sex Unknown**		Proportion of Females	Average Number of Fetuses Per Doe
			Twins			Singles					
			Males	Females	Opposite	Males	Females	Twins	Singles		
1.5	6					2	2		2	.50	1.00
2.5	28	60.7	3	4	6	1	6	4	4	.61	1.61
3.5	21	42.9		4	3	4	1	2	7	.63	1.43
4.5	18	27.8	1	1	2	3	3	1	7	.50	1.28
5.5	1						1			1.00	1.00
6.5	6	33.3	1			2		1	2	0.00	1.33
7.5	5	40.0		2		1			2	.80	1.40
8.5	2	50.0	1			1				0.00	1.50
9.5	2	50.0			1	1				.33	1.50
Totals	89	42.0	6	11	12	15	13	8	24	.55	

*Only twins or single young were observed in utero.

**Too small to sex.

(1960) found one of 220 Texas whitetails carrying triplets. Thomas (1962) examined 115 pregnant whitetails in Texas and detected no incidence of triplets. Swank (1958) found no triplets in 16 Arizona mule deer. Hudson (1959) reported that 3% of the 50 gravid mule deer he autopsied contained triplets.

h. Functioning of the Right and Left Ovary

Reece and Turner (1938) reported that bovine ovulation occurs 60.2% of the time from the right ovary. Salisbury and Van Demark (1961:84) speculated that the right ovary functions more frequently than the left in cows because of the anatomical location of the rumen and its close proximity to the left ovary. These authors theorized that the gas-filled rumen may slow the function of the left ovary by exerting sufficient pressure to lower the blood flow to the left ovary.

No one seems to have tested this in deer. In my sample 64 does had ovulated (82 ova) only from the right ovary, 59 does had ovulated (73 ova) only from the left ovary, and 28 does had ovulated from both ovaries (30 ova from the right and 29 from the left). Collectively, therefore, 151 does had ovulated 112 ova from the right ovary and 102 from the left. The chi-square test indicated no significant difference at the 1% level between the number of

eggs ovulated by the two ovaries (calculated chi-square = 0.4672). According to this sample, ovulation in Mississippi white-tailed deer occurs as often in one ovary as it does in the other.

Figure 13. A single white-tailed deer embryo. The right ovary contained a well-developed corpus luteum. The left ovary did not produce an ovum. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.

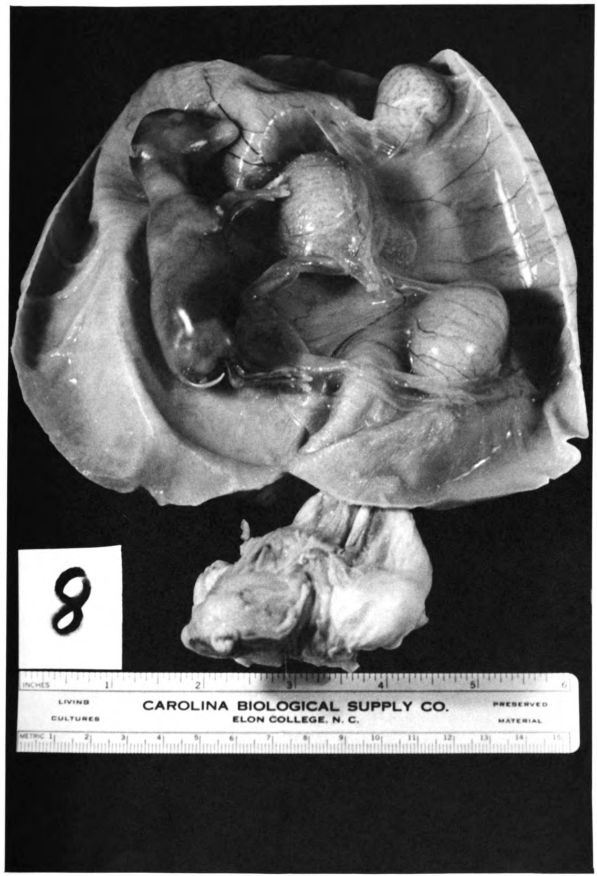
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Figure 14. A white-tailed deer embryo about 28 days old. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


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FETAL SEX RATIO

Of 126 fetuses collected during this study 86 were old enough that external sexual organs were clearly visible. Of these 39 were males and 47 females, a sex ratio of 45:55. The chi-square test, after correcting for continuity, indicated that there was no significant difference between the proportion of males and females at the 1% level from what would be expected by genetic theory (calculated chi-square = 0.57; tabled chi-square, one degree of freedom at 99% level - 6.63).

a. Uterine Sex Ratio in North Mississippi Compared with South Mississippi

The sex ratio of 15 fetuses from South Mississippi was 60:40 while 71 from North Mississippi had a ratio of 42:58. Chi-square tests, after correcting for continuity, indicated that neither of these ratios were significantly different from the expected 50:50 at the 1% level (Calculated chi-square for the southern sample = 0.27; for the northern sample = 1.41).

b. Sex Ratio in Twins and Singles

Of 29 sets of sexable twins from throughout the state, six were twin males, 11 were twin females, and 12 were

Figure 15. Twin fetuses *in utero* about 88 days after conception. The external genital organs are plainly visible. The fetus on the left is a female. The one on the right is a male. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.

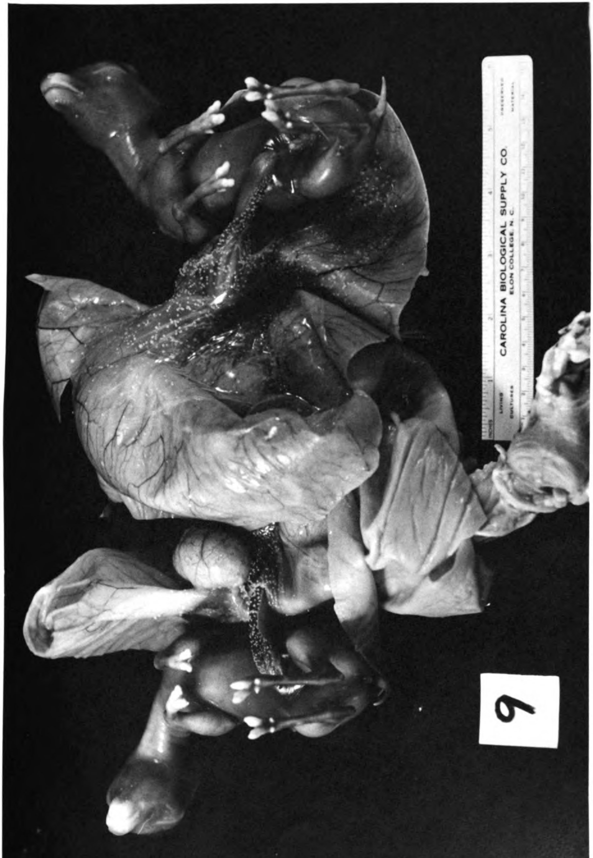
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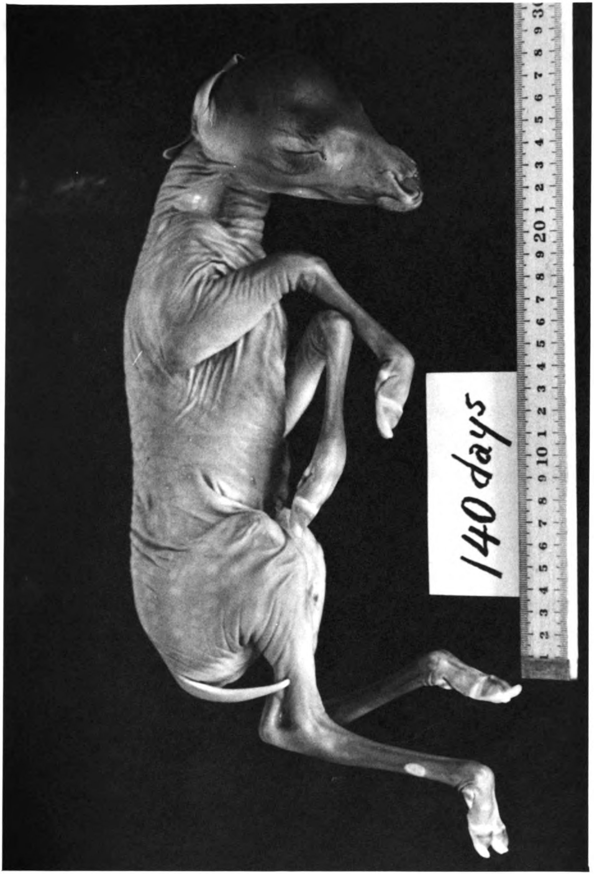
Figure 16. A white-tailed deer fetus about 140 days old. The black spot on the head is the potential site of the right antler, but these spots are found on both male and female fetuses. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


140 days

twins of opposite sex. A calculated chi-square, after correcting for continuity, of 0.047 indicated that there was no significant difference between the proportion of male and female twins at the 1% level from what would be expected by genetic theory.

The same statistical test was used to test if there was a significant difference between the proportions of male, female and opposite sex twins. A calculated chi-square of 2.14 indicated that the observed proportion of male, female, and opposite sex twins do not differ significantly at the 1% level from what would be expected from genetic theory.

52 of the 89 gravid does collected in this study were carrying a single fetus and 28 of these were developed well enough to determine sex. The 54:46 ratio was not significantly different at the 1% level from the 50:50 expected by genetic theory.

c. Fetal Sex Ratio as Influenced by Range Conditions

Gerstell (1936) reported that female fawns exceeded males by about a two-to-one ratio on areas of heavily overbrowsed deer ranges in Pennsylvania.

In this study 6 pregnant does from good range carried 6 male and 4 female fetuses: 8 does from fair range carried 4 males and 9 females and 43 does from poor range carried 29 males and 34 females. None of these sex ratios differed significantly from a 50:50 sex ratio.

d. Uterine Sex Ratios Reported in Other States

The uterine sex ratio in deer is frequently in favor of males (Table 10). Severinghaus and Cheatum (1956) reported a sex ratio of 54:46 for 4,096 whitetail fetuses collected in 11 states. McDowell (1962) reported a ratio of 52:48 for 2,759 whitetail fetuses from eight of the northeastern states. McDowell's data indicate a statistically significant difference between the percentage of male fetuses carried by precocial fawns and the percentage carried by all other age classes combined.

Table 10. Uterine sex ratios in deer as reported for various states and provinces.

State or Province	Geographical Location	Species	Number of Fetuses in Sample	Sex Ratio Male:Female	Reference
Alabama	Eastcentral	Whitetail	20	60:40	Haugen (1959)
Florida	Flatwoods	Whitetail	22	59:41	Harlow and Fickett (1961)
	Citrus Game Area	Whitetail	10	60:40	Eichhorn (1962)
	Osceola Game Area	Whitetail	19	74:26	Eichhorn (1962)
Illinois	Statewide	Whitetail		52:48	Calhoun (in litt., 1962)
Maine	Statewide	Whitetail	95	55:45	Banasiak (in litt., 1962)
Michigan	Upper Peninsula	Whitetail	406	55:45	Verme (in litt., 1962)
	North Lower Peninsula	Whitetail	713	56:44	Verme (in litt., 1962)
	South Lower Peninsula	Whitetail	101	41:59	Verme (in litt., 1962)
Mississippi	Statewide	Whitetail	86	45:55	Noble (this study)
Nebraska	Statewide	Whitetail	261	48:52	Mangold (1958)
Pennsylvania	Statewide	Whitetail		54:46	Lang (in litt., 1962)
Tennessee	Catoosa Game Area	Whitetail	4	75:25	Lewis (1961)
West Virginia	Statewide	Whitetail	142	40:60	Chadwick (1958)
Wisconsin	Statewide	Whitetail	1016	55:45	Hale (1959)
Ontario	Statewide	Whitetail	34	32:68	Clark (in litt., 1962)
California	Lassen County	Mule	40	35:65	Hiehle (in litt., 1962)
	Doyle Herd	Mule	106	52:48	Lasses, et al. (1952)
		Mule	64	54:46	Chattin (1948)
Montana	Nat. Bison Range	Mule	96	50:50	Hudson (1959)
	Nat. Bison Range	Mule	97	53:47	Sears (1955)
New Mexico	Statewide	Mule	35	54:46	Harrington (1961)
Washington		Blacktail	11	64:36	Golly (1957)
	Western	Blacktail	113	61:39	Brown (1961)

PRENATAL MORTALITY

One case of prenatal mortality was observed in 89 does carrying visible embryos. In a 7.5-year-old doe, killed March 5, 1962, in the refuge of the Leaf River Wildlife Management Area, one fetus was dead and the second appeared normal. It was apparently alive and helthy up until the time of the doe's death (Figure 17). The right ovary contained two well-formed corpora lutea.

The dead fetus was in the left horn of the uterus. The surrounding embryonic fulids were cloudy. It did not appear that the fetus was being resorbed. The fetus was 21.40 mm long and evidently died about 39 days after conception. The normal fetus was 82.10 mm long. Since its age was about 65 days, the dead fetus must have been dead about 26 days. The normal fetus weighed 82.10 gr.; the dead fetus 0.53 gr.

The doe was in fair condition. She had no body fat, but the bone marrow was of a firm consistency. Her live weight of 79 pounds was better than average for the region (longleaf pine belt). A blood sample collected from the animal hemolyzed and was unfit for serological study.

The majority of visibly gravid does was collected the first four months of pregnancy. If high mortality occurs in the three months prior to parturition, it would not have been evident.

The ovaries of a 9.5-year-old doe collected March 14, 1962, contained corpora lutea but none were visible even though a fetus becomes visible about 20 days after conception. It is unlikely that this doe bred as late as February 22, since most bucks in the area dropped their antlers by February 15. These corpora lutea probably represent early prenatal mortality or a recurrent estrus. I can find no reference to the persistence of corpora lutea in deer following prenatal death.

Prenatal mortality is uncommon in deer. Sears (1955) found no evidence of abortion or resorption in 64 pregnant mule deer. Thomas (1962) found no signs of abnormal pregnancies in 88 Texas whitetails. Teer (1960) found only one case of prenatal death in 220 pregnant Texas whitetails. Bischoff (1958) found 19% of 64 pregnant California mule deer examined carrying abnormal fetuses.

Teer (1959) described a dead fetus in a uterus containing a normal fetus in the opposite horn. Bischoff (1958) reported three cases of does carrying twins in each of which one of the twins was dead and the other apparently normal.

a. Length Comparison Between Twin Fetuses

There was no appreciable difference between the F-R or C-R measurements between twins in 37 sets of twin fetuses except in one case where one of the twins was dead and the other continued to develop normally. The greatest length difference between individuals of any set of normal twins was 12.0 mm. The average difference in length between all twins was 3.70 mm. Neither set of opposite sex twins tended to dominate in length. There was less discrepancy in length between twins of early embryonic development. The average difference between eight sets of twins under 50 days of age (less than 60 mm) was 0.82 mm. 29 sets of twins over 50 days of age differed on the average by 4.50 mm. Twins over 300 mm long did not show any greater difference in length between the two fetuses than did twins under 300 mm (Table 11).

Table 11. Length* comparison between fetuses in 36 sets of twin deer collected in Mississippi, 1960-1962.

Twin Males			Twin Females			Twins of Opposite Sex			Twins of Unknown Sex		
Length of Fetuses		Length Difference	Length of Fetuses		Length Difference	Length of Fetuses		Length Difference	Length of Fetuses		Length Difference
288.0	285.0	3.0	231.0	225.0	6.0	338.0	330.0	8.0	59.0	56.0	3.0
257.0	246.5	10.5	218.0	216.5	1.5	315.0	306.0	9.0	53.0	52.0	1.0
215.0	209.5	5.5	217.0	216.5	0.5	297.0	294.0	3.0	30.0	31.0	1.0
193.5	193.5	0.0	206.0	205.5	0.5	215.0	221.0	6.0	18.0	17.0	1.0
174.0	171.0	3.0	204.0	199.5	4.5	192.0	188.5	3.5	16.0	16.0	0.0
94.0	90.0	4.0	176.0	164.0	12.0	177.0	180.0	3.0	11.2	11.5	0.3
			158.0	160.0	2.0	167.0	176.0	9.0	8.0	8.3	0.3
			155.0	152.0	3.0	163.0	158.0	5.0	6.0	6.0	0.0
			90.0	90.0	0.0	135.0	134.0	1.0			
			86.2	76.9	9.3	120.0	130.0	10.0			
			66.6	65.5	0.1	88.0	85.0	3.0			
						73.0	68.5	4.5			
Averages		4.33			3.67			5.4			

*In mm; either forehead-rump, or crown-rump measurement.

Figure 17. These two fetuses were taken from a 7.5-year-old doe killed March 5, 1963. The top fetus was apparently alive and healthy up until the time of the doe's death. The second fetus probably died when about 39 days old and had been dead *in utero* about 26 days. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.


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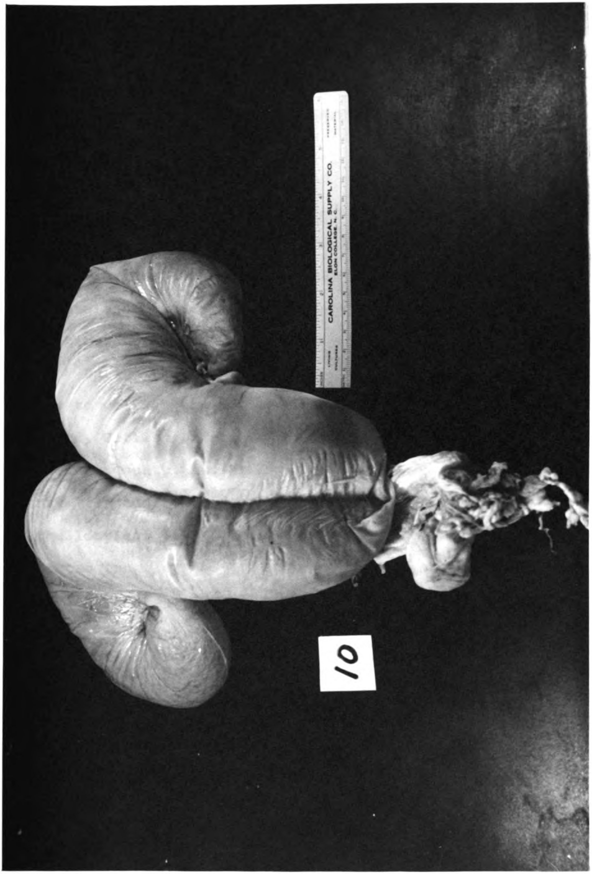
Figure 18. Pregnant reproductive tract of a 2.5-year-old doe (containing twins) about 78 days after conception. The ruler is 150 mm long. Copiah Wildlife Management Area Laboratory, Barlow, Mississippi, May 3, 1963. Photograph by W. H. Turcotte and the author.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AGES OF DOES FROM PROTECTED HERDS

Very little is known about the longevity of Mississippi deer, and practically nothing has been recorded regarding the age class distribution of females in herds where antlerless deer have been protected for many years. Such data are particularly important to compare with hunted populations so as to appraise the effects of cropping.

During the course of this study I had a rare opportunity to collect antlerless deer on the private lands of Merigold, Catfish Point, and Huntington Point hunting clubs in Bolivar County, and at Ashbrook Island in Washington County. In addition, specimens were taken on state refuges in the longleaf pine belt. On all these areas does had been protected for many years.

a. Collections on Club Lands

Collections at private clubs were made in the batture forest, the heavily forested bottomland areas situated between the main levee and the channel of the Mississippi River. At its maximum width in Bolivar County, the batture forest does not exceed 10 miles and averages four to five miles wide. East of the levee there is little deer habitat because the land has been cleared for agriculture. The

batture deer, therefore, are ecologically confined on the east by open fields and on the west by the Mississippi River. The property of each club is further isolated ecologically by various barriers to the north and south. These consist largely of "ox-bow" lakes or meanders left by the Mississippi River in changing its channel over the years. These lakes are three-fourths to one mile wide. The deer on each club's land, therefore, represent distinct and more or less isolated herds.

The average age of adult female deer collected from club lands where antlerless deer have been protected for a long time was less than 4.6 years (Table 12). The data do not truly represent the average age of adult female deer because attempts were made to shoot only does with fawns following. The 1.5-year-old age class is not fully represented since these does would not have had fawns following.

Merigold Hunting Club

The Merigold Club lands consist of 16,500 acres in northwestern Bolivar County. The club was chartered in 1921. Deer were purchased from private sources and released on the lands in 1928, but hunting was not permitted until 1942. A full-time caretaker has always been employed and spends his time patrolling the area, planting food plots, working roads, etc. Poaching is at a minimum because of rigid protection and the geographic "lay" of the land. Guest privileges are

Table 12. Average ages of adult female deer (1.5 years old and older) collected from five Mississippi herds, 1960-1962.

	Merigold	Catfish	Huntington	Ashbrook	Longleaf Belt
Years Protected	33	9	7	10	18
Sample Size	85	113	41	25	22
Average Age (Years)	4.58	3.86	3.21	2.94	4.59
Standard Deviation	1.99	2.12	1.38	2.27	2.45
Average Age of Does 2.5 Years and Older	4.90	4.31	3.44	3.00	4.74
Standard Deviation	1.81	2.02	1.37	2.21	2.35

limited. There, prior to scientific collecting, antlerless deer had been totally protected for 33 years.

85 adult does were removed from the area, nine in the spring of 1960, 73 in January, 1961, and three in March, 1962. Because of the relatively small number of deer taken in 1960 and 1962, the data for all three years have been combined in analyzing the age class distribution (Table 14).

The November 1961, Merigold deer herd was estimated at 1800. The number of bucks killed anually has never exceeded 100. Usually it is less. Most of the Merigold members are trophy hunters. It is not uncommon for a hunter to pass up 10 legal bucks in a day's hunt.

Catfish Point Hunting Club

The Catfish Point Club controls 10,000 acres two miles south of Merigold. The Mississippi Game and Fish Commission operated the area as a refuge in the 1940's. The Commission lost its lease in 1951, and the landowners, Chicago Mill and Lumber Company, U.S. Gypsum Company, and Delta Pine and Land Company, turned the hunting rights over to a group of Bolivar and Washington County sportsmen. The Club was incorporated in 1952 and in November and December, 1952, the first year the area was hunted by the Catfish Club, 250 legal bucks were killed. Since that time the average kill has been about 145 legal bucks.

A full-time caretaker is employed. The poaching kill is negligible. Since it is known that some deer were poached on the area when it was a state refuge, total protection for antlerless deer is dated from 1951.

The November, 1961 deer population was estimated at 1,396 (Noble, 1961b).

Specimen collections were: spring, 1960, 14; November, 1960, 54; November, 1961, 42; and spring, 1962, three. All data were combined (Table 12).

Huntington Point Hunting Club

Huntington Point Club lands consist of 18,000 acres south and adjacent to Catfish Point. A full-time caretaker is employed. Antlerless deer have been totally protected since 1953. The November, 1961, deer population was estimated at 1600. 41 adult does were taken from the area, nine in the spring of 1960 and 32 in November, 1962. Both sets of data were combined to calculate average age.

Ashbrook Island Hunting Club

The Ashbrook deer herd is isolated on a 5000-acre island surrounded by the main channel and an old channel of the Mississippi River. The September, 1961, deer population was estimated at 800.

A full-time caretaker is employed and lives on the island. Because of inaccessibility except by airplane or

river-worthy boat, the illegal kill is negligible. Antlerless deer have been protected since 1952. 25 adult does were collected there on November 21, 1962.

b. Collections in the Longleaf Pine Belt

22 adult does were collected from longleaf pine forests. These were taken from the refuges of the Leaf River, Red Creek, Wolf River, and Chickasawhay Wildlife Management Areas. The number of years each refuge had been protected varies from 10 to 20, averaging 18. The Mississippi Game and Fish Commission employs fulltime personnel for protection and management work. The only deer removed from these refuges are a few trapped each winter for restocking purposes.

c. Comparison of Individual Herds

Apparently the life expectancy of a doe in the wild does not exceed five years (Tables 12 and 13). Antlerless deer on Merigold have been protected for 33 years and yet the average age of 85 adult does from this herd was only 4.58 years. If the 1.5-year-olds had been truly represented, the average age would be less. Since on Huntington Point, where complete protection has been in force for only seven years, the average of adult does was 3.21 years, it seems that the 26 additional years of protection on Merigold has added only 1.37 years to the life expectancy of adult does.

The average age of 22 adult does from the longleaf belt was 4.59 years, and the animals have been protected about 18 years. There is only 0.01 years difference in the average age of the longleaf does and Merigold does so the 15 additional years of total protection at Merigold has had little effect on average longevity.

The data indicate that a maximum average age for adult does was achieved after 10 to 15 years of total protection. Probably, the maximum average life was reached after 10 years of total protection since few deer, because of severe tooth wear, live beyond this age in the wild (Table 13).

Range conditions may influence average age but I do not have sufficient data from understocked ranges for comparative purposes.

d. Average Age in Statewide Sample

308 ages were determined from all adult female deer collected. With the exception of two confiscated illegal kills, all were collected from private club lands or state refuges where antlerless deer have received a minimum of seven years total protection. Actually, except on a few club lands in Bolivar and Washington Counties in 1960 and 1961, antlerless deer have been protected by state law since 1905. However, one, two, or at most three game wardens to a county cannot provide total protection such as a relatively

small state refuge or an exclusive private club might provide for their lands. Therefore, by total protection, I refer to a situation where few, if any, animals die except by natural causes.

If age is normally distributed and the data (Table 13) represent a random sample of adult female deer, the probability of collecting an adult doe 5.5 years old, or older, in Mississippi is about 0.227. Actually, it is much less since the 1.5-year-old animals are not truly represented in the sample.

Over 77% of the statewide sample was less than 5.5 years old. The average age was 3.92 years with a standard deviation of 1.43 years (Table 14).

Table 13. Age-class distribution of 308 adult female deer collected in Mississippi, 1960-1962.

Age (Years)	Number in Age-Class	Percent in Age-Class	Accumulative Percent
1.5*	36*	11.4*	11.4
2.5	97	31.6	43.0
3.5	54	17.6	60.6
4.5	51	16.6	77.2
5.5	20	6.5	83.7
6.5	17	5.5	89.2
7.5	16	5.2	94.4
8.5	10	3.3	97.7
9.5 and older	7	2.3	100.0

Average age = 3.92 years

Standard deviation = 1.43 years

*Since in many instances an attempt was made to shoot only does with fawns following, this age-class is not truly represented in the sample.

Table 14. Age classes of adult female deer from various herds in Mississippi.

AGE (YEARS)	MERIGOLD		CATFISH		HUNTINGTON		ASHBROOK		LONGLEAF BELT	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
1.5	8	9.4	18	15.9	5	12.2	1	4.0	1	4.5
2.5	10	11.8	36	31.9	20	48.8	14	56.0	6	27.4
3.5	17	20.0	16	14.2	5	12.2	5	20.0	5	22.7
4.5	20	23.5	16	14.2	7	17.1	3	12.0	4	18.2
5.5	11	12.9	7	6.2	2	4.9				
6.5	9	10.6	6	5.3	1	2.4			1	4.5
7.5	3	3.5	8	7.1	1	2.4	1	4.0	2	9.1
8.5	5	5.9	3	2.6			1	4.0	1	4.5
9.5 and +	2	2.4	3	2.6					2	9.1
Total Years Protected	33		8 - 9		7		10		18	
Average Age	4.58		3.86		3.21		2.94		4.59	
Standard Deviation	1.99		2.12		1.38		2.27		2.45	
Average Age Beyond 1.5	4.90		4.31		3.44		3.00		4.74	
Standard Deviation	1.81		2.02		1.37		2.21		2.35	

WEIGHTS OF MISSISSIPPI DOES

Live-wieght records are relatively few in most states because hunters have a tendency to clean their deer in the field. For that reason, the majority of weights available in many states are hog-dressed weights recorded at road-side checking stations during the hunting season.

Fairly accurate formulae are available for computing live weight from hog-dressed weight (Severinghaus, 1949; Park and Day, 1942). However, these formulae obviously have limited application because of diversified range conditions, because of the large number of subspecies of Odocoileus in the nation, and because many states, through restocking programs, have caused widespread hybridization between a number of subspecies.

Weights of female deer are particularly scarce in the southern United States. Many of the states of this region (e.g. Mississippi, Louisiana, Alabama, Tennessee, and South Carolina) are just beginning to experiment with antlerless hunts on a limited basis. Furthermore, no relatively large sample of female deer weights in spring is available for deer in the South so far as I know. Virtually all doe weights available were collected during the gun seasons in November and December.

a. Factors Influencing Weight

Weight varies with several factors, the most important being sex, age, and local range quality. Gill (1956) has shown that weight varies according to locality which, in turn, is related to range condition. Female weights fluctuate as a result of fawning.

This study provided an opportunity to collect accurate live weights on a relatively large sample of female deer. Weight was recorded on 324 does; 292 animals 1.5 years of age and older, and 32 fawns. The fawns varied in age from four to nine months, but most were six months old.

b. Doe Weights from the Batture Forest

293 does from Bolivar and Washington Counties (batture forest) were weighed. 108 adults were weighed in November and December (Table 17) and 147 adults were weighed during January, February, March, and April (Table 18). Nine fawn weights were collected during the winter-spring period and 20 during November and December.

Weights were separated into the November-December collection and the winter-spring collection for the following reason: Deer collected from the Bolivar and Washington County area in November and December represent animals fresh from lush summer browsing. Plenty of high-quality summer browse is available well through October and into November. Mast is normally plentiful through the remainder of November

and into late December. January is characterized by winter conditions, and February and early March is the critical period for deer in this region.

I felt that a significant difference could be demonstrated by separating winter-spring weights from November-December weights. This, however, was not true (Table 15). The mean weight of 152 adult does collected in November and December was 108 pounds with a standard deviation of 16 pounds. The average weight of 112 winter and spring collected does was 107 pounds with a standard deviation of 14 pounds (Table 15). The difference between the two sample means is not statistically significant at the 1% level (two-tailed test, calculated t = 0.639, tabled t for 262 degrees of freedom, 99% level = 2.326).

Since January is the transition period between good and poor natural browse conditions, I eliminated January weights and compared the average weight of adult does in November and December with the average weight in February, March and April. There was no significant difference between the two average weights.

Nearly all the February, March and April does were in advance stages of pregnancy. This could account for a four to 25 pound gain (Golley, 1957; Severinghaus and Cheatum, 1956). Consequently, in early spring a doe may lose 15 pounds of body fat due to inadequate diet, but this weight loss would be compensated for by the developing fetus

Table 15. Statistics by region on the live weights* of Mississippi does 1.5 years of age and older.

REGION	TIME OF COLLECTION	SAMPLE SIZE	MEAN WEIGHT	STANDARD DEVIATION	MINIMUM WEIGHT	MAXIMUM WEIGHT
Batture Forest (Bolivar and Washington Counties)	Nov. - Dec.	152	108	16	75	140
Batture Forest (Bolivar County)	Jan., Feb., March and April	112	107	14	73	138
Longleaf Pine Belt	Feb. - March	22	78	8	57	92
Upland Hardwood Forest (Lafayette County)	Feb. - March	6	96	8	88	110

*In pounds.

and embryonic structures. Presumably, therefore, adult does in the Bolivar and Washington County area do convert body weight into fawn weight between December and April.

c. Doe Weights from the Longleaf Pine Belt

On January 11, 1966, I weighed 164 adult does, 1.5 years old and older, from the Leaf River Game Management Area in Perry County. The average live-weight of these animals was 76 pounds.

22 adult and three fawn weights were taken in February and March (Table 18). The mean weight of adults was 78 pounds with a standard deviation of eight pounds. This is 29 pounds less than the mean weight of spring adults from the batture forest.

Mean spring weights from the batture forest and the longleaf pine belt when compared statistically indicated that the difference between the two means was highly significant at the 1% level (two-tailed test, calculated t = 9.490, tabled t at 99% level, 132 degrees of freedom = 2.326). This undoubtedly reflects the higher fertility of the batture forest soils.

d. Weights by Age Class

It appears (Tables 16, 17 and 18) that Mississippi does do not reach their maximum live weight until about 3.5 to 4.5 years of age. They then gradually decline in weight through the remaining age classes, although the number of

Table 16. Live weights* by age-class of female deer collected in Bolivar County, Mississippi, in January, February, March and April, 1960-1962.

Age (Years)	Sample Size	Mean Weight	Standard Deviation	Minimum Weight	Maximum Weight
0.5	9	54	14	32	79
1.5	12	90	11	73	106
2.5	16	109	15	80	138
3.5	24	113	12	81	129
4.5	24	112	11	89	138
5.5	11	104	16	70	128
6.5	10	108	16	93	133
7.5	4	111	7	105	119
8.5	4	110	8	89	119
9.5 and older	3	110	7	92	105

*In pounds.

Table 17. Live weights* by age-class of female deer collected in Bolivar and Washington Counties, Mississippi, in November and December, 1960-1962.

Age (Years)	Sample Size	Mean Weight	Standard Deviation	Minimum Weight	Maximum Weight
0.5	20	57	15	37	89
1.5	19	88	13	75	119
2.5	59	105	12	61	132
3.5	18	116	8	104	132
4.5	21	119	10	97	137
5.5	9	118	14	82	130
6.5	6	125	14	100	143
7.5	9	112	18	80	140
8.5	4	122	10	115	136
9.5 and older	2	116	-1	116	117

*In pounds.

Table 18. Live weights* by age-class, of female deer collected in the longleaf pine belt of Mississippi in February and March, 1960-1962.

Age (Years)	Sample Size	Mean Weight	Standard Deviation	Minimum Weight	Maximum Weight
0.5	3	52	22	35	77
1.5	1	57			
2.5	6	75	8	65	85
3.5	5	82	6	78	92
4.5	4	80	6	72	86
5.5					
6.5	1	88			
7.5	2	78	-1	78	79
8.5	1	74			
9.5 and older	2	76	3	74	78

*In pounds.

weights available for ages 6.5 years and older is too small to justify far-reaching conclusions.

Erickson et al. (1961) reported that Minnesota deer attain maximum weights between 4.5 and 6.5 years of age. Sweet and Wright (undated) found that maximum weight was reached by New Jersey Does at 4.5 years. Brown (1961) writing of black-tailed deer in Washington, stated that, " . . . does reach their maximum weight at about 3 to 4 years of age, then hold their own for a couple of years or start to decline in weight."

DEER MANAGEMENT IMPLICATIONS

Some of the findings of this study can be applied to the management of Mississippi deer.

a. Understanding the Mississippi Deer Herd

The Mississippi deer herd has come a long way in the last 39 years. From a low of a few hundred deer in 1929 (Leopold, 1929), Mississippi's deer population increased to an estimated 240,000 in 1967.

Except for the 1,330,000 acres in 17 game management areas owned or leased and managed by the Mississippi Game and Fish Commission, U.S. Forest Service lands managed by the Commission, lands owned by the U.S. Corps of Engineers, 80,000 acres owned by the U.S. Fish and Wildlife Service and a few privately owned tracts scattered over the state, all deer hunting lands in Mississippi are controlled by private interests, mostly well-organized clubs. There are 30.5 million acres of land in Mississippi. 20 million acres could be classed as deer range. Less than two million acres are open to public hunting. The remaining 18 million acres is posted, mostly by clubs, and is therefore, classed as private hunting.

Many deer hunters of this state have seen the herds come from nothing to their present day abundance. They credit this increase in deer numbers to the total protection of does and fawns. They are partially right!

The total protection of antlerless deer is the best management known to establish a huntable deer population. Once large herds are developed, however, the total protection of antlerless deer is the worst possible management. It is no more practical to leave all does on a well-stocked deer range than to retain all cows on a beef-cattle range. In either instance, over-use of the range is sure to be followed by disaster for the herd and its range.

Too many deer in an area results in a lowered reproductive rate, reduced fawn survival, poorly developed antlers, damage to natural vegetation, increased crop depredation, poor nutrition and, in some instances, to severe mortality (among all age classes but especially to fawns) caused by parasites, disease, malnutrition or a combination of these factors.

One of the major objectives of present-day deer management is to prevent herds from overcrowding their ranges. The only way to control deer numbers in a well-managed herd is through regular harvest of does and fawns. The eventual need for antlerless-deer hunting in most herds results from years of "bucks only" hunting. Antlerless-deer hunting, however, is invariably a controversial issue. In

Mississippi, as in nearly every other part of the country (for example, see Harrington, 1961; Brunette, 1957) it is difficult for the average hunter to accept antlerless deer hunting.

b. The Time of Year to Hunt Antlerless Deer

Traditionally Mississippi has two deer seasons annually. The first regular season opens November 20 and, according to county, may extend through December 1. The second season opens December 26 and again depending upon the county, may run through January 11. These seasons have been in effect for many years. They were established for "bucks only" hunting. The recent need for the harvest of antlerless deer on many Mississippi deer ranges has prompted the question, "when is the best time of the year to harvest antlerless deer?"

The findings of this study indicate that the best time to hunt antlerless deer in north Mississippi is during the first week of the second regular season (December 26 - January 1). In south Mississippi does and fawns should be taken in mid-January.

The hunting of deer with dogs is legal and widespread in most of Mississippi. In north Mississippi most fawns are born in July, and in south Mississippi most fawns appear in late August. By early November, fawns are only three to four

months old. These fawns are not as capable of eluding dogs as are fawns a month or two older or fawns, of any age, following the dam.

The shooting of antlerless deer in early November before the first regular deer season opens (November 20) results in an unnecessary fawn mortality during the first regular season. In 1961, the Mississippi Game Commission held an antlerless deer hunt on Catfish Point (Bolivar County) during November 11-15 for the purpose of collecting female deer for this study. I observed during the following November 20-29 regular deer season that an unusually large number of fawns were captured and killed by hounds. This mortality in fawns can be reduced by delaying antlerless-deer hunting to the last week of December in north Mississippi and to mid-January in south Mississippi when fawns are four to six months old and better able to care for themselves if orphaned.

It has been suggested that antlerless deer be taken in north Mississippi during a special season late in January. Deer killed in this region late in January are in poor flesh compared to those killed in December. In addition and far more important, 20-25% of adult does in the region have visible fetuses in late January. The shooting of visibly pregnant deer can accentuate the problems of antlerless-deer hunting by turning many sportsmen against "doe hunting" in general. And finally, many bucks in north Mississippi shed

their antlers in late December and early January. Mississippi hunters do not like to see adult, antlerless bucks mistakenly shot for does. Such occurrences generate public resentment against antlerless deer hunting.

Late January antlerless deer hunting is recommended, however, for south Mississippi. Fawns are old enough to care for themselves, browse is available well into late December, does there generally do not contain visible fetuses and bucks do not shed their antlers until February or early March.

c. How to facilitate the Harvest of Bucks

Whether still-hunting or dog-hunting, bucks are more easily killed during the height of the rut than at any other time, yet on too many private clubs bucks are underharvested. If the seasons were set so that hunting was permitted during the height of the rut, more bucks would be taken. Bucks are more wary and remain hidden during the daylight hours of the hunting season when hunting does not coincide with the rut. This is particularly true in the batture forest where many bucks remain hidden in old lakes and sloughs during the day when the rut is not in progress. However, during the height of the rut these bucks venture out in search of does and thereby increase the chance of being taken by a hunter.

The ideal season to facilitate the harvest of bucks in north Mississippi would be December 15-30; in south Mississippi, mid-January.

d. Recommended Hunting Seasons for Adequately Stocked and Understocked Deer Ranges

On properly stocked or understocked ranges, however, deer should not be hunted during the height of the breeding season.

For north Mississippi, the season on such ranges should be open to "bucks only" hunting November 15 - December 1. When antlerless deer hunting is justified from a management standpoint, seasons for all deer may coincide with the rut.

In south Mississippi, the season on above described ranges should be December 1 - 15. Earlier seasons (e.g., late October or early November) even for "bucks only" hunting are out of the question there due to heavy foliage and hot weather.

e. Need for the Enforcement of Laws Against Free-Ranging Dogs

Mississippi has laws against free-ranging dogs, and state game wardens have the responsibility for enforcing these statutes. No such enforcement actually exists, however, except to a very limited extent on some state game management areas. The people of Mississippi will not tolerate the shooting of free-ranging hounds, and nearly every deer-hound owner releases his dogs at least twice a month and many do not confine them at all. Consequently on many

deer ranges one can hear a "good deer race" almost any morning in the year.

Free-ranging dogs do little harm to deer in the batture during the late fall, winter and early spring. But during the summer when does are heavy with fawns, hounds frequently pull down and kill deer. During seven years as Mississippi's deer biologist, I have seen dozens of deer caught and killed by dogs. Many of these were pregnant does killed in late June, July and August.

The dog-law should be rigidly enforced in May, June, July and August. The State Game and Fish Commission should insist that dog owners pen their dogs during the period that does are heavy with fawn.

f. No shortage of Breeding Bucks On Well-Stocked Ranges

Deer numbers cannot be controlled by "bucks only" hunting. On club areas where 75%-80% or more of the bucks killed each year are 1.5 years old, I found the frequency of pregnancy of adult does to be over 90%. There was no shortage of breeding males in spite of the heavy harvest of legal bucks.

APPENDIX

APPENDIX

HUNTING METHODS

110 deer were shot during this study under a special deer collecting permit. During 63 days of collecting, 223 deer were fired upon, 110 were killed, 46 were definitely hit and escaped and 67 were assumed to have been missed.

The 30.06 was found to be the best weapon for deer collecting. 52 (47.3%) of the shot animals were taken with a 30.06 Remington Woodmaster using 180 gr silvertip cartridges and open sights. Its tremendous knockdown power coupled with the ability of a good marksman to take long shots, proved the superiority of this caliber over smaller guns.

21 (19.1%) of the shot animals were killed with a 7.7 mm Japanese rifle using special loaded, 180 gr controlled expansion bullets and a 3.5 power scope. The 30.06 and the 7.7 Japanese are almost identical weapons.

Very few "chance" shots were taken. Deer killed diurnally were largely ambushed from blinds constructed at food plots, watering holes or salt licks.

The distance of the shot was recorded on 58 animals. 32 (55.2%) were shot at a distance of 75 yards or less. The distance the deer ran after being shot was recorded on 60 animals, and 33 (55.0%) ran 30 yards or less. The anatomical

location of the fatal gunshot wound was recorded on 52 deer. 38 (73.1%) were shot in the thoracic region. A thoracic shot was usually a sure kill although the animal invariably ran a few yards before falling. A spine shot drops the animal immediately but is difficult to make, and several animals were missed completely in attempting this shot. The eight deer shot through the spine region fell in their tracks but all had to be dispatched with a second shot since a wound in the spinal region always resulted, not in immediate death, but in total paralysis in the posterior end.

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