To the Graduate Council:

I am submitting herewith a thesis written by Joseph M. Dabney entitled "An Evaluation of Physiological Condition of Bobwhite Quail in Southeastern United States." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Ralph W. Dimmick
Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

AN EVALUATION OF PHYSIOLOGICAL CONDITION OF BOBWHITE

QUAIL IN SOUTHEASTERN UNITED STATES

A Thesis

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Degree

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ABSTRACT

A total of 146 bobwhite quail (Colinus virginianus) was collected during the winters of 1972-73 and 1973-74, from three study areas in the southeastern United States. The quail were examined to determine levels of body fat, burden of gastrointestinal helminths, adrenal weights, body weight, and pancreas weight.

Fat was extracted using a Soxhlet ether extraction apparatus, and was expressed as a percent of oven-dry weight. Percent body fat differed significantly between all areas. Females were higher in fat than were males.

The burden of gastrointestinal helminths varied from area to area and showed fluctuations for 1972-73 to 1973-74. Only one species of nematode, Heterakis bonasae, was common to all three areas. A proventricular worm, Tetrameres pattersoni, was found on two of the areas during the second year only. The rate of cestode infection (19.3 percent) was lower than the rate of nematode infection (88.3 percent).

Adult quail had heavier adrenals than did juveniles. Heavier adrenals were associated with decreased fat levels. On one area, parasite load had a significant effect on adrenal weight.

Quail from the two northernmost areas were heavier than those from the southernmost area.

Quail from the two areas where soybeans (*Glycine max*) were available had heavier pancreas than did quail from the other area. This size difference has been attributed to the presence of an antitrypsin in raw soybeans.

Percent body fat, adrenal weight, and parasite burden in combination may provide a good and valid indicator of condition for a population, once norms, or base values, for that population are established.

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CHAPTER I

INTRODUCTION

The condition or "general state of health or well being" of an animal population is often of primary concern in making decisions dealing with habitat manipulation or other management practices. This is applicable whether the species under consideration is the whitetailed deer (<u>Odocoileus virginianus</u>) or the bobwhite quail (<u>Colinus virginianus</u>). Unfortunately, little research has been conducted to evaluate methods for determining condition in avian species. The primary objective of this study is to describe the following parameters which may serve as indicators of condition of bobwhites in the southeastern United States: (1) percent of body weight comprised of fat, (2) burden of gastointestinal helminths, (3) adrenal weight, (4) body weight, and (5) pancreas weight.

Most techniques for determining condition utilize some aspect of fat reserves. Harris (1945) and Cheatum (1949) found that marrow fat was the last fat reserve to be mobilized in deer (<u>Odocoileus spp.</u>) and was thus a good index of condition. Riney (1955) used kidney fat expressed as a percentage of kidney weight as an index of the total body fat, and thus an index of condition in the red deer (<u>Cervus</u>

elaphus). Ransom (1965) suggested a method for determining condition of deer which involved the complementary use of kidney and femur marrow fat. Bear (1971) used several fat measurements including depth of fat on the rump and brisket to determine fat levels in the pronghorn (*Antilocapra americana*). Nichols and Pelton (1972) attempted to develop a technique for evaluating condition in the whitetailed deer using fat from the mandibular cavity.

Robel (1972) used the percent of body weight represented by fat to evaluate the merits of food plots to bobwhites in Kansas. His study stressed the importance of fat reserves for survival of bobwhites during periods of severe weather. Moss and Lough (1968) and West and Meng (1968ab) related the composition of stored body fats in birds with the composition of fats present in their major food source.

The species of parasites which infect bobwhites are well documented (Kellogg and Doster, 1972). Unfortunately, however, little is known about the role of parasites in the high annual losses sustained by wild bobwhite populations. Kellogg and Prestwood (1968) stated that in southeastern United States, parasite burden is usually directly proportional to population density. Personnel of the Southeastern Cooperative Wildlife Disease Study (1972) reported that numbers and kind of gastrointestinal parasites of the white-tailed deer can be used as an indicator of environmental condition. But Parmalee (1952) and Blakeney (1970) reported that body weight of bobwhites apparently was not measurably influenced by intensity of gastrointestinal worm infection.

Adrenal size and weights often have been used as indicators of stress. Neave and White (1969) found a significant positive relationship between adrenal weight and population density in the ruffed grouse (*Bonasa umbellus*). Anderson (1968) reported similar findings for the ringnecked pheasant (*Phasianus colchicus*). This study examines the relationship between adrenal weight and population density for the bobwhite.

Chernick et al. (1948) reported that soybeans (*Glycine max*) in the diet of young chickens significantly retarded growth and increased the size of the pancreas. This relationship has never been examined in wild birds.

The present study examines the relationships which exist between fat levels, parasite burden, adrenal weight, body weight, and pancreas weight, as well as variation induced by the age or sex of the birds examined. Differences in the various variables between areas differing in habitat characteristics and population histories are also described.

CHAPTER II

DESCRIPTION OF STUDY AREAS

Quail for this study were collected from three major areas: the Ames Plantation in southwest Tennessee, two locations in east Tennessee, and the Tall Timbers Research Station in northern Florida. Initially these areas were selected to represent, respectively, high, low, and very high population densities. Population changes during the study, however, reduced most of the difference in population density which previously existed between the areas. A decline in quail numbers on the Tall Timbers area reduced the density from one bird per 0.6 acres in February of 1972 to one bird per 1.5 acres in February of 1974. Density on the Ames area dropped slightly from one bird per 1.3 acres in 1972-73 to one bird per 1.8 acres in 1973-74 (Dimmick, unpublished data). The population on the east Tennessee areas increased from an average of one bird per 9.5 acres in 1972-73 to one bird per 5.4 acres in 1973-74, with one portion of the area (the experimental unit on the Transition area) supporting a population of one bird per 1.7 acres, comparable to the Ames and Tall Timbers areas (Brown, 1974). Therefore, comparisons between areas having quite different population densities were not accomplished during this study, and the relationship between population density and physiological condition were somewhat obscured.

I. AMES PLANTATION

Southwest Tennessee

Description of area. The 18,600-acre Ames Plantation lies on the western part of the plateau slope of western Tennessee in Fayette and Hardeman Counties. Prior to 1820 much of the area was covered by virgin hardwood timber. The first settlers found the soils and climate suitable for cotton (*Gossypium hirsutum*), and substantial cotton acreage has been planted since the area was settled. In the past years cotton acreage has decreased and soybean acreage has increased. The 2,100-acre portion of the plantation on which the birds for this study were collected, however, is intensively managed for quail (Eubanks, 1972). For a more detailed description of this area see Eubanks (1972).

History of quail populations. In 1937, when Mr. Hobart Ames completed his purchases, there were approximately 300 tenant families living on the plantation. The small tract farming by tenants provided excellent habitat for quail and coveys were reportedly quite numerous. However, the plantation no longer has the small patch farming which was so compatible with quail. As mechanized farming practices were adopted, the tenants disappeared and so did the small fields. It is difficult to say what effect this mechanization has had on quail populations as no reliable estimates of quail densities are available for the early years of the plantation.

Since 1966, however, the Morning Field Trail course has been censused twice annually. These censuses have revealed that the quail population fluctuates moderately from year to year. Population trends show a peak in December of 1968 followed by a low in 1969, then followed by another peak in December of 1972. The estimated density for the two years of this study was one bird per 1.3 acres in 1972-73 and one bird per 1.8 acres in 1973-74. These estimates were derived from a flush census conducted by personnel of the Forestry Department, The University of Tennessee.

Through the two years of this study a population estimate using the Lincoln Index was obtained for a 550-acre portion of the study area. This index indicated that the flush counts revealed only 50 to 60 percent of the total population. Unpublished data collected over a period of several years by Kellogg and Dimmick indicate that flush counts invariably reveal only 50 or 60 percent of the population as determined by the Lincoln Index. This trend is true on both the Tall Timbers and Ames areas. Thus, though the population estimates derived by flush counts are probably lower than the true value, the relative densities on the three areas are probably adequate for comparison.

II. EAST TENNESSEE

The sample of birds taken from east Tennessee was collected from two areas with quite different topography and vegetation. Each area will be described separately.

Transition Area

Description of area. This portion of the east Tennessee study area was located on the Cumberland Plateau in Rhea County. The area was made up of three different units: (1) an experimental area of 220 acres which had food plots; (2) Control I which was adjacent to the experimental area and comprised 306 acres; and (3) Control II which was located three miles from the other two areas and was also 306 acres. All three areas are owned by the Hiwassee Land Company and are being managed as pine plantations for the production of pulpwood. These areas presently have the appearance of freshly disturbed areas in an early stage of succession, which they are. The young pines were beginning to show above the naturally occurring vegetation only at the end of the 1973-74 study period (Brown, 1974).

Prior to the fall of 1971 all three areas were covered with second-growth hardwoods. At this time the areas were cleared, and after site preparation by discing, were planted with loblolly pine (*Pinus taeda*). Only a sparse vegetative cover invaded the areas the first year (1972); however, a much more varied and advanced cover was found in the summer of 1973 (Brown, 1974).

History of quail populations. Prior to the clearing of these areas and their planting to pine there was probably only a sparse population of quail occupying the area. The clearing of the land and the subsequent invasion of early successional plants, as well as the special food plantings on the experimental area, provided excellent habitat for quail, and their numbers increased rapidly. A flush census of the experimental area in the fall of 1972 indicated a density of one bird per 11 acres. By the fall of 1973 the density on this same area had increased to one bird per 1.7 acres, an increase of 550 percent. The population density on Control I increased from one bird per 18 acres to one bird per 4.2 acres over the same period. The density on Control II, however, showed a decrease from one bird per 3.9 acres to one bird per 10.7 acres (Brown, 1974).

This increase on two of the areas is similar to the situation described by Brunswig and Johnson (1972) who censused and hunted young pine plantations in the Piedmont of Georgia. They found that the highest population densities usually occurred during the second fall after planting. Densities then began to drop off at an increasing rate. The continued study of this area will determine if the same trend will prevail in Tennessee.

Farm Lands Area

Description of area. The farmlands portion of the east Tennessee study area is located in Hamblen County, in the northeastern part of the state and is situated in the Great Valley of East Tennessee. This area is comprised of a 300-acre farm, adjacent to the Nolichucky River, a tributary of the Tennessee River (Brown, 1974).

The topography of the area is of two distinct types. Approximately 60 percent has a rolling to hilly relief, however, some portions are considered steep. The remaining 40 percent is river bottom land. The farm is managed primarily for the production of beef cattle and approximately 50 percent of the area is in pasture or hay production, another 50 acres are in second-growth hardwoods, and the remaining portion is in various stages of vegetational succession. Fourteen food plots totaling 3.7 acres were planted on the area (Brown, 1974). For a more detailed description of this area see Brown (1974).

History of quail populations. Reliable estimates of quail density on this area prior to the fall of 1972, when this study began, were unavailable. However, it would probably be safe to assume that the bobwhite has been a part of the area's fauna for sometime. Population densities greater than those observed during this study may well have occurred in the past. Present management practices, which are geared to the production of beef cattle and hay, are probably not as compatible with quail as were the practices in the past when more acreage was probably devoted to row crops and grain. Many of the pastures and hay fields have such a lush growth of grass, with several years accumulation of dead grass beneath, that it would be quite difficult for quail to walk through it. Situations such as this are not compatible with high quail populations. Density on the farm remained relatively stable during the two years of the study, with one bird per five or six acres (Brown, 1974).

III. FLORIDA

Tall Timbers Research Station

Description of area. The birds from Florida used in this study were collected on the Tall Timbers Research Station, Leon County, Florida. This 2,800-acre area is located in a limestone region of broken terrain in the northern part of the county. The area is in a region that is known for its large plantations which are managed primarily for quail hunting (Kellogg et al., 1972).

During the 1800's most of the upland sites in this area were in croplands, but by 1900 many of the fields had reverted back to pines, and annual burning was a common practice. This burning was responsible for the development of the rich herbaceous understory which is so conducive to high quail populations. The study area was managed primarily for quail from 1895 to 1964, when it became the Tall Timbers Research Station. For a more detailed description of the area and its quail populations see Kellogg et al. (1972).

History of quail populations. Quail populations in this general area have been high, due primarily to annual burning, for many years. These high populations were responsible for the establishment of the large quail shooting plantations in this region in the early 1900's, many of which are still managed for quail hunting.

Quail populations on this area just prior to the beginning of this study were quite high. Population estimates based on a Lincoln Index show that the density increased from 2.3 birds per acre in 1970 to a high of 3.1 birds per acre in 1972 (Kellogg et al., 1972). In comparison the population density as determined by a flush count in 1972 was 1.7 birds per acre, or approximately 50 percent of the density as determined by the Lincoln Index. During the two years of the study density on this area decreased slightly. The population in February 1973, based on a flush count, was one bird per 1.2 acres; in February of 1974 it was one bird per 1.5 acres (Dimmick and Kellogg, unpublished data).

CHAPTER III

METHODS

Quail were collected by shooting during the months of December through March. The birds were tagged with the date of collection and the area from which they came, then frozen for later analysis. The following information was collected from all birds: date collected, area, sex, age, total body weight, body weight minus crop weight, adrenal weight, pancreas weight, species and number of gastrointestinal helminths, and the percent of fat based on oven-dry weight.

I. COLLECTION

A total of 146 birds was collected and examined. Of these, 118 were collected by shooting; 28 were trapped on the Tall Timbers area. All birds were tagged with the date of collection and the area where collected, then frozen until further analysis could be completed.

II. LABORATORY PROCEDURES

Dissection

Birds were thawed overnight before dissection, which included the removal of the crop, removal and weighing of adrenals and pancreas, and the removal of the gastrointestinal tract for the purpose of collecting parasites.

Removal of crop. The total weight of all birds was recorded, the crop was then removed and the weight minus crop was recorded. The crop and its contents were removed to eliminate variability in body weight due to differing amounts of material in the crops. Care was taken during the removal to insure that any fat around or on the crop remained on the bird. The crops were saved for later examination of their contents.

Removal of viscera. The viscera were removed and placed on a wet paper towel. At this time the adrenals were exposed and were removed, weighed, and the combined weight of both glands recorded. The pancreas was removed from the loop of the duodenum and weighed. The gastrointestinal tract was stripped of the heart, liver, and lungs. These along with the adrenals and pancreas were returned to the body cavity of the bird.

Recovery and preservation of parasites. The gastrointestinal tract posterior to the crop was removed. The proventriculus and gizzard were separated. The proventriculus was opened and washed out over an 80 mesh screen, then examined under a dissecting scope for parasites which imbed in the walls or glands. These were removed by teasing them out with forceps and a teasing needle. The remainder of the tract was examined using the technique described by Blakeney (1970). After the proventriculus, gizzard, and intestine were examined under the dissecting scope, they were returned to the body cavity with the other viscera. All parasites were preserved in 70 percent ethyl alcohol.

Identification of parasites. Final identification of all nematode parasites was made by Gary L. Doster of the Southeastern Cooperative Wildlife Disease Study, School of Veterinary Medicine, University of Georgia. Cestodes were identified to genus using keys in Reid (1962) and Yamaguti (1961).

Fat Analysis

After dissection, the birds were cut into nine or ten small pieces; these pieces along with the viscera were refrozen for 24 hours. The frozen birds were then processed through a Hobart Model 4722 meat grinder using a one-fourth inch cutter head. This reduced the bird to the consistency of ground beef. To prevent the carry-over of fat from one bird to another, the grinding apparatus was thoroughly washed after the grinding of each bird. The macerated birds were placed in 9x9x2 inch aluminum pans and were dried in a forced air oven at 100 C for 24 hours to determine oven-dry weight.

The oven-dried samples were then divided into two equal parts by weight and each half was placed in a cellulose (123mm ?) fiber extraction thimble (43mm x 143mm) which had been dried at 100 C for three hours. The thimble and bird were weighed and their combined weights recorded.

The thimbles were then placed in a large Soxhlet ether extraction apparatus (two apparatus per bird) and extracted for 18 hours in a 5:1 mixture of petroleum ether and chloroform. At the end of the 18 hours the thimbles were removed from the Soxhlet and placed in a vacuum oven at 100 C for one hour, then placed in the forced air oven at 100 C for an additional three hours. At the end of this time the thimbles were weighed for the second time. This second weight was subtracted from the first weight to determine a calculated fat weight. This weight was not used to determine the fat percent for the bird, but was used only as a check against the actual fat weight.

At the end of the extraction time and after the thimbles had been removed, the ether-chloroform mixture was boiled from the flask, leaving only the accumulated fat. The flask was then placed in a forced air oven at 100 C for two hours to insure that all traces of ether and chloroform were gone. The flask was then removed from the oven and allowed to cool for one hour at room temperature. The flask was then weighed for the second time. The previously recorded flask weight was subtracted from the weight of the flask plus the fat to determine an actual fat weight for each half bird. The fat weights for the two halves were added together to determine the actual fat weight for the bird. This weight was used to calculate the percent of the birds oven-dry weight which was composed of fat.

III. STATISTICAL METHODS

The method used for collecting the quail resulted in a disproportionate distribution of specimens among the age, sex, and area subgroups. The data were analyzed by least squares analysis of variance and covariance as outlined by Harvey (1960). To assess the variability in body fat of birds the following mathematical model was deemed appropriate:

$$Y_{ijkl} = \mu + A_i + S_j + R_k + E_{ijkl}$$

where,

Y_{ijkl} = the observed percent body fat for the l^{th} bird in i^{th} age group, the j^{th} sex group and the R^{th} area.

μ = population mean

A_i = effect of the i^{th} age group

S_j = effect of the j^{th} sex group

R_k = effect of the k^{th} area

E_{ijkl} = random error portion of the value of $ijkl^{th}$ bird.

For the analysis of body weight, adrenal weight, and pancreas weight, body fat was added to the preceding model as a covariate. Due to differences in frequency and magnitude of parasite infection among the areas, the relationship between parasite infection and adrenal weight, body weight, and body fat were evaluated separately for each area. However, sex and age were included in the model for these analyses, again due to the disproportionate number of birds within these subcells.

CHAPTER IV

RESULTS

A total of 146 quail was collected from the three study areas: 80 were collected in the winter of 1972-73, and 66 more were taken in the winter of 1973-74 (Table I). All birds were examined to determine fat percentage, adrenal weight, gastrointestinal parasite burden, body weight, and pancreas weight.

Relationships were considered to be significant if probability was less than 0.05. However, in some cases, biological considerations dictated that levels of probability greater than 0.05 be considered significant. In such cases the level at which such relationships are considered statistically significant is given in the text.

I. BODY WEIGHT

Body weight was determined for all 146 quail examined during the study. The mean for all birds was 164.97 grams (Table II). The mean on the east Tennessee and Ames areas were 170.84 g. and 168.96 g. respectively. Both were significantly higher than the mean for Tall Timbers (156.55 g.), but were not significantly different from each

TABLE I

NUMBER OF BOBWHITE QUAIL EXAMINED, BY SEX, AGE, AREA, AND YEAR, 1972-74

Area	Year	Total	Number Adult	Juveniles	Number Male	Females
East Tennessee	1972-73	31	5	26	22	9
	1973-74	12	2	10	7	5
Ames Plantation	1972-73	24	9	15	12	12
	1973-74	26	8	18	15	11
Tall Timbers	1972-73	25	7	18	14	11
	1973-74	28	11	17	19	9
Total		146	42	104	89	57

TABLE II

MEAN BODY WEIGHT[a] OF BOBWHITE QUAIL BY SEX, AGE, AND AREA, 1972-74

			Age[b]				Sex[c]				Range	
Area	(n)	Total	(n)	Adult	(n)	Juvenile	(n)	Male	(n)	Female	Low	High
East Tennessee	(43)	170.84	(7)	170.98	(36)	170.55	(29)	171.39	(14)	170.14	150.0	191.2
Ames Plantation	(50)	168.96	(16)	167.86	(33)	169.36	(26)	170.02	(23)	167.19	152.7	200.9
Tall Timbers	(53)	156.55	(18)	159.48	(35)	155.84	(33)	155.54	(20)	159.77	139.8	180.2
Total	(146)	164.97	(42)	165.82	(104)	164.92	(89)	165.56	(57)	166.16	139.8	200.9

[a]Body weight represents total weight of bird less the crop and its contents.

[b]Means adjusted for sex and parasite burden.

[c]Means adjusted for age and parasite burden.

other. Females were not heavier than males, nor were adults heavier than juveniles.

A positive relationship occurred between body weight and fat percentage. For each one percent increase in fat, body weight increased approximately 1.17 g. ($r = 0.39$).[1]

Body weight was affected by parasite burden on two of the areas. On the east Tennessee area, as the number of parasites increased, body weight also increased ($P < 0.15$), while on the Tall Timbers area body weight decreased as number of parasites increased ($P < 0.15$).

II. BODY FAT

A fat percentage was determined for all 146 quail examined during this study; mean for all birds was 12.17 percent. The mean for each area was: East Tennessee, 13.73; Ames, 12.77 percent; and Tall Timbers, 10.40 percent (Table III). The difference in body fat was significant between all three areas.

When birds from all areas were combined in a single sample, females (13.12 percent) had significantly more fat than males (11.72 percent) (Table IV). Neither sex, however, had significantly more fat when the areas were analyzed separately.

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[1]Partial r, age, sex, and fat held constant.

TABLE III

MEAN FAT PERCENTAGES OBSERVED IN BOBWHITE QUAIL BY AREA AND YEAR, 1972-74

Area	Year	Average Fat Percent[a]	Range	
			Low	High
East Tennessee	1972-73	13.84	8.11	20.35
	1973-74	13.33	6.34	19.84
Subtotal		13.73	6.34	20.35
Ames Plantation	1972-73 (Early)	13.55	6.83	19.67
	1972-73 (Late)	9.57	6.05	13.74
Subtotal		11.56	6.05	19.67
	1973-74 (Early)	19.14	13.32	25.12
	1973-74 (Late)	8.82	6.32	14.14
Subtotal		13.98	6.32	25.12
Subtotal	(Early)	16.37	6.83	25.12
	(Late)	9.18	6.32	14.40
Subtotal		12.77	6.32	25.12
Tall Timbers	1972-73	10.61	4.32	17.72
	1973-74	10.09	6.26	13.75
Subtotal		10.40	4.32	17.72
Total		12.17	4.32	25.12

[a]Average fat percent adjusted for age and sex.

When all birds were analyzed as a single sample, the age of the birds did not affect their body fat. Neither was age a factor when the areas were analyzed separately (Table IV).

Date of collection had a significant effect on fat level on the Ames area only. Mean fat percentage of birds collected in December and January was 16.37 percent, while those collected in March had a mean of 9.18 percent. This difference occurred in both years of the study (Table IV).

III. PARASITE BURDEN

Of the 146 quail collected, 145 were examined to determine the number of gastrointestinal helminths present. Statistical analysis to determine the effects of parasite burden was conducted by area only, due to the great variability in mean parasite burden between the areas (Table V). Nematode values represent numbers of parasites, while values for cestodes represent volumes.

Nematodes

The rate of infection by nematodes was 88.3 percent (Table VI). Twenty-five (59.5 percent) of the birds from east Tennessee were infected, while 100 percent of those from Ames and Tall Timbers were infected with at least one species.

TABLE IV

MEAN FAT PERCENTAGES OBSERVED IN BOBWHITE QUAIL BY SEX, AGE, AREA, AND YEAR, 1972-74

Area	Year	(n)	Adult	(n)	Juvenile	(n)	Males	(n)	Females
East Tennessee	1972-73	(5)	13.20	(26)	14.06	(22)	13.43	(9)	13.83
	1973-74	(2)	14.49	(10)	13.31	(7)	13.01	(5)	14.72
Subtotal		(7)	13.85	(36)	13.69	(29)	13.22	(14)	14.28
Ames Plantation	1972-74 (Early)	(8)	15.39	(17)	16.96	(13)	14.94	(12)	18.10
	1972-74 (Late)	(9)	9.65	(16)	8.92	(14)	8.94	(11)	9.49
Subtotal		(17)	12.52	(33)	12.94	(27)	11.94	(23)	13.80
Tall Timbers	1972-73	(7)	10.11	(18)	11.04	(14)	9.11	(11)	12.05
	1973-74	(11)	9.72	(17)	10.32	(19)	10.03	(9)	10.01
Subtotal		(18)	9.92	(35)	10.68	(33)	9.57	(20)	11.03
Total		(42)	12.10	(104)	12.74	(89)	11.72	(57)	13.12

TABLE V

MEAN NUMBERS OF TOTAL NEMATODE PARASITES FOUND IN BOBWHITE QUAIL BY SEX, AGE, AREA, AND YEAR, 1972-74

Area		Range per Infected Bird		Total[a]	Age[b]		Sex[b]	
		Low	High		Adult	Juvenile	Male	Female
East	1972-73	1	85	7.9	16.9	9.2	12.9	13.2
Tennessee	1973-74	1	145	15.7	74.8	3.9	30.8	47.9
Subtotal				11.7	45.9	6.6	21.9	30.5
Ames	1972-73	21	576	209.4	294.6	158.3	213.0	239.8
Plantation	1973-74	46	1583	279.7	263.3	294.9	229.6	328.6
Subtotal				244.6	279.0	226.6	221.3	284.2
Tall Timbers	1972-73	22	979	276.9	450.7	206.1	347.6	309.2
	1973-74	55	353	142.8	142.4	150.3	134.2	158.4
Subtotal				209.9	296.5	178.2	240.9	233.8

[a]Arithmetic means.

[b]Means adjusted for sex, age, date of collection.

TABLE VI

INCIDENCE OF PARASITES FOUND IN BOBWHITE QUAIL ON THE THREE MAJOR STUDY AREAS, 1972-74

		Nematodes			Cestodes		
Area	Year	n	No. Birds Infected	%	n	No. Birds Infected	%
East Tennessee	1972-73	31	17	54.8	31	0	0.0
	1973-74	11	8	72.7	11	2	18.2
Subtotal		42	25	59.5	42	2	4.8
Ames Plantation	1972-73	24	24	100.0	24	3	12.5
	1973-74	26	26	100.0	26	4	15.4
Subtotal		50	50	100.0	50	7	14.0
Tall Timbers	1972-73	25	25	100.0	25	7	28.0
	1973-74	28	28	100.0	28	12	42.9
Subtotal		53	53	100.0	53	19	35.8
Total		145	128	88.3	145	28	19.3

A cecal worm, Heterakis bonasae, was common to all three areas. The intensity of infection by H. bonasae was: East Tennessee, 11.7; Ames, 236.9; and Tall Timbers, 55.6 (Table VII). Other species were found on the areas but were not common to all three (Table VIII). The mean total number of nematodes for the three areas was: East Tennessee, 11.7; Ames, 244.6; and Tall Timbers, 209.9 (Table V). Another species of cecal worm, Trichostrongylus tenuis, found on the Tall Timbers area, was responsible for the increase in total nematode numbers on this area to a level near that found on the Ames area.

On the east Tennessee area in 1973-74, and on the Ames area in 1972-73 adults had higher numbers of H. bonasae than juveniles. The number of this species was affected by sex only on the Tall Timbers area, where females had more parasites than males (Table VII).

Neither males nor females had significantly higher numbers of total nematode parasite on any of the areas. A significant age difference did occur, however, on all three areas in at least one year of the study. In 1973-74, on the east Tennessee area, adults had more nematodes than did juveniles (74.8/3.9). Similar differences occurred in 1972-73 on both the Ames (294.6/158.3) and Tall Timbers (450.7/206.1) areas (Table V, page 26).

TABLE VII

MEAN NUMBERS OF HETERAKIS BONASAE FOUND IN BOBWHITE QUAIL BY SEX, AGE, AREA, AND YEAR, 1972-74

Area	Year	Range per Infected Bird		Total[a]	Age[b]		Sex[b]	
		Low	High		Adult	Juvenile	Male	Female
East Tennessee	1972-73	1	85	7.8	16.7	9.1	12.7	13.1
	1973-74	1	145	15.7	74.8	3.9	30.8	47.9
Subtotal				11.7	45.8	6.5	21.8	30.5
Ames Plantation	1972-73	21	572	206.1	290.3	155.6	209.8	236.2
	1973-74	44	1508	267.7	254.2	282.2	216.7	319.8
Subtotal				236.9	272.3	218.9	213.2	278.0
Tall Timbers	1972-73	2	141	45.4	53.8	40.6	56.7	37.7
	1973-74	21	163	66.9	62.6	84.4	48.4	98.6
Subtotal				55.6	58.2	62.5	52.6	68.2

[a]Arithmetic means.

[b]Means adjusted for sex, age, date of collection.

Cestodes

Only 28 (19.3 percent) of the quail examined were infected with cestodes. Members of three genera were found (Table VIII). Tall Timbers had the highest rate of infection, 35.8 percent (19/53), while Ames had 14.0 percent (7/50), and east Tennessee only 4.8 percent (2/42)(Table V, page 26). On the Ames area cestodes were not found in birds collected in December or January (Table XIII).

Only five of the 28 infected birds contained a volume of cestodes greater than 0.4 cc., all from the Tall Timbers area. Volumes less than 0.3 cc. were not accurately determined.

IV. FAT-PARASITE BURDEN RELATIONSHIP

Parasite burden was considered to affect body fat significantly ($P < 0.20$) only on the Tall Timbers area. The relationship was negative, with fat levels decreasing as parasite burden increased. Parasite burden had little effect on fat levels on either the east Tennessee or Ames areas. Although not significant, the fat-parasite relationship on these two areas was different, with the east Tennessee area having a positive relationship, while the Ames area had a negative one.

TABLE VIII

SPECIES OF PARASITES FOUND IN BOBWHITE QUAIL
BY YEAR AND AREA, 1972-74

Area	Year	Nematode Species	Cestode Species
East Tennessee	1972-73	Heterakis bonasae Cheilospirura spinosa	
	1973-74	Heterakis bonasae	Rhabdometra spp.
Ames Plantation	1972-73	Heterakis bonasae Cheilospirura spinosa	Rhabdometra spp. Raillietina spp.
	1973-74	Heterakis bonasae Cheilospirura spinosa Tetrameres pattersoni	Rhabdometra spp. Raillietina spp.
Tall Timbers	1972-73	Heterakis bonasae Cyrnea colini Tricholstrongylus tenuis	Hymenolepis spp.
	1973-74	Heterakis bonasae Cyrnea colini Tricholstrongylus tenuis Tetrameres pattersoni	Hymenolepis spp.

V. ADRENALS

Adrenals were removed from 140 of the 146 quail examined. Weights were adjusted for the body size of each bird, and values given represent a percentage of body weight.

Mean adrenal value for all birds was 0.0131. Mean value for east Tennessee, Ames, and Tall Timbers was 0.0119, 0.0136, and 0.0133 respectively (Table IX).

When the birds from all areas were analyzed in a single group, the adrenals of adults (0.0144) were significantly heavier than those of juveniles (0.0126). However, when each area was examined separately age was a factor only on the Ames area where adults (0.0158) had adrenals significantly heavier than juveniles (0.0127)(Table IX).

When all birds were analyzed as a single sample, neither males nor females had larger adrenals. On the Ames area, however, females had larger adrenals than males (Table IX).

For each percent decrease in fat, adrenal weight increased significantly ($r = -0.27$), when all birds were grouped together.[2] When the three areas were examined

[2]Partial r, age, sex, fat, and total parasite burden held constant.

TABLE IX

MEAN ADRENAL WEIGHTS[a] OF BOBWHITE QUAIL BY SEX, AGE, AND AREA, 1972-74

Area	(n)	Total	Age[b]				Sex[c]				Range	
			(n)	Adult	(n)	Juvenile	(n)	Male	(n)	Female	Low	High
East Tennessee	(40)	0.0119	(4)	0.0127	(36)	0.0121	(28)	0.0117	(12)	0.0132	0.0032	0.0203
Ames Plantation	(47)	0.0136	(15)	0.0158	(32)	0.0127	(26)	0.0132	(21)	0.0154	0.0047	0.0280
Tall Timbers	(53)	0.0133	(18)	0.0135	(35)	0.0130	(33)	0.0136	(20)	0.0129	0.0081	0.0235
Total	(140)	0.0131	(37)	0.0144	(103)	0.0126	(87)	0.0135	(53)	0.0135	0.0032	0.0280

[a] Adrenal weights have been adjusted for body size, and represent a percentage of body weight.

[b] Means adjusted for sex, fat, and total parasite load.

[c] Means adjusted for age, fat, and total parasite load.

TABLE X

MEAN PANCREAS WEIGHTS[a] OF BOBWHITE QUAIL BY AGE, SEX, AREA, AND YEAR, 1972-74

Area	Year	Range				Age[b]				Sex[c]			
		Low	High	(n)	Total	(n)	Adult	(n)	Juvenile	(n)	Male	(n)	Female
East Tennessee	1972-73	0.0861	0.4370	(31)	0.2135	(5)	0.2144	(26)	0.2073	(22)	0.2232	(9)	0.1986
	1973-74	0.1816	0.7405	(11)	0.4034	(1)	0.2692	(10)	0.4236	(6)	0.3298	(5)	0.3600
	Subtotal			(42)	0.2537[d]								
Ames Plantation	1972-73	0.1427	0.3533	(24)	0.2466	(9)	0.2337	(15)	0.2544	(12)	0.2524	(12)	0.2366
	1973-74	0.3363	0.9783	(25)	0.5494	(7)	0.5531	(18)	0.5523	(15)	0.5333	(10)	0.5718
	Subtotal			(49)	0.3962[d]								
Tall Timbers	1972-73	0.0650	0.1800	(25)	0.1021	(7)	0.0870	(18)	0.1091	(14)	0.0917	(11)	0.1044
	1973-74	0.1431	0.3798	(28)	0.2274	(11)	0.2070	(17)	0.2541	(19)	0.2077	(9)	0.2534
	Subtotal			(53)	0.1629[d]								
Total				(144)	0.2756								

[a]Pancreas weights have been adjusted for body size, and represent a percentage of body weight.

[b]Means adjusted for sex.

[c]Means adjusted for age.

[d]Means adjusted for age and sex.

CHAPTER V

DISCUSSION AND CONCLUSIONS

The primary objective of this study was to evaluate several aspects of the physiology of the bobwhite as indicators of condition. Results indicated that some of the variables examined are sensitive to environmental and physiological changes and thus may be used as indicators of condition.

I. BODY WEIGHT

Quail from the two areas in Tennessee averaged 13.35 g. heavier than those from Tall Timbers. Body weight on the two Tennessee areas was not significantly different. Bergmann's Rule states that as one travels from colder to warmer climates the body size of animals within a species decreases, with the change related to need for heat conservation. Animals with larger bodies have a lower surface area-mass ratio which aids in heat conservation, thus the larger body size in colder climates (Allee and Schmidt, 1951:462). Assuming that the difference in body weight between Tennessee and Florida birds is synonymous with a decrease in body size, the difference in body weight is possibly explained by Bergmann's Rule, as the climate in

Tennessee is colder than in Florida. Data reported by Robel (1972) adds even more credence to this rule. Quail collected by him in Kansas, during the same months, averaged 20 g. heavier than those collected in Tennessee.

The positive relationship between body weight and parasite burden on the east Tennessee area, despite its level of statistical significance ($P < 0.15$), is not believed to be biologically important. The parasite burden on this area was probably too small to have any real effect. The negative relationship observed on the Tall Timbers area could, however, be important though lacking statistical significance, due primarily to the large numbers of parasites carried by quail on this area. Also, it was noted that as percent body fat increases, so does body weight. Therefore, it is reasonable to assume that if increased parasite loads reduce fat levels, they will also reduce body weight.

II. BODY FAT

Quantitative techniques for evaluating condition in practically all species are based on some aspect of fat reserves, whether one is looking at kidney fat in the white-tailed deer or marrow fat in a cottontail rabbit. For the bobwhite, unfortunately, there does not appear to be a single region of the body where quantitative measurement of body fat is readily obtained. Therefore, in the present study all ether extractable fat was extracted to determine percent body fat for each bird.

The trend toward higher percent body fat of quail in areas with colder climates may be extended by comparing my data with those reported by Robel (1972). The climate in the Tallahassee, Florida area is quite mild, with temperatures near or below freezing uncommon. The Ames area has more severe weather with the mean monthly temperature for December, January, and February averaging in the low 40's (Eubanks, 1972). Mean temperature for these months on the east Tennessee area average approximately five degrees colder than the Ames area (Brown, 1974). Winters in Kansas are quite severe, with temperatures less than 15 F being representative (Robel, 1972). If one examines the percent body fat which correspond to each area the trend is quite clear. Body fat increases as one travels from areas of warmer weather to areas which are colder. On the Tall Timbers area, where the winters are mild, mean percent body fat was 10.40, on the Ames area mean fat level was 12.77 percent, in east Tennessee it was 13.72 percent, and in Kansas, where the winters are most severe, percent body fat was 17.16 (Robel, 1972). These higher fat reserves in areas of more severe weather are probably needed for survival. The importance of such reserves to the survival of quail during severe weather was stressed in Robel's (1972) study. For example, he stated that a bird with 17.0 percent body fat has a potential "starvation protection" 79.0 percent greater than a bird with only 10.0 percent body fat, meaning that the fatter bird could survive 79.0 percent longer without food than the bird with less fat.

Females had higher fat levels than did males, as has been observed for many species. Jordan (1953) reported that hen mallards (*Anas platyrhynchos*) had higher fat levels than drakes, and were thus able to withstand starvation much better than males. This same resistance to starvation by females has also been reported for ring-necked pheasants, ruffed grouse, and wild turkeys (*Meleagris gallopavo*) (Latham, 1947). Latham (1947), however, reported in the same study that bobwhite and Hungarian partridge (*Perdix perdix*) females were less resistant to starvation than males, despite their higher fat levels.

On the Ames area birds collected in December and January were fatter than those collected in March. A similar decrease was documented in Kansas by Robel (1972). He found that fat reserves reached a peak in December and January, then steadily dropped until April or May.

In 1972-73 on the Ames area, the decrease from December to March was 29.4 percent, in 1973-74 the decrease was 50.8 percent. The decrease on the Ames area in 1972-73 compared favorably with the decrease observed by Robel (1972) in Kansas (28.2 percent); however, the decrease in 1973-74 was much greater than that observed in Kansas. Therefore, one could suspect that the decrease in 1973-74 was unusually high.

This unusually high decrease in fat is believed to be the result of abnormal weather conditions on the Ames area in the winter of 1973-74. The months of November and December were unseasonably warm, with temperatures in the high 60's and low 70's quite common. During this unseasonably warm weather, soybeans left in the fields during harvest sprouted and died thus becoming unusable as food for quail. As soybeans comprise 71.1 percent of the bobwhite's winter diet on this area (Eubanks, 1972), the warm weather and subsequent sprouting of beans removed a large portion of the quail's winter food supply. During the first week in January a severe ice storm covered the area for two days. This undoubtedly put some stress on the fat reserves of the birds. Weather conditions after the storm reverted to former trends, with abnormally warm weather.

Field work conducted on the area in March revealed practically no food sources available. Soybeans, which are usually quite abundant at this time were in low supply. Examination of the crops removed from birds in both 1972-73 and 1973-74 revealed a difference in the incidence of beans between the two years. Fifty-four percent (13/24) of the birds collected in 1972-73 had beans in their crop, while only 27 percent (7/26) of those collected in 1973-74 contained beans. Soybeans taken from the crop of birds collected in 1973-74, particularly those taken in March, were in poor condition, with many beans showing signs of rot and decay. This poor condition was not evident in beans from birds taken in 1972-73.

A flush census conducted on the area in March revealed a greater than usual seasonal decrease in bird numbers from a census conducted the previous December. Birds collected at this time disclosed the unusually large fat loss which had occurred over a remarkably short time (seven weeks).

III. PARASITE BURDEN

Kellogg and Prestwood (1968) suggested that as population density increases, so does parasite load. This trend occurred in a general fashion on the areas in the present study.

Nematodes

A cecal worm, *Heterakis bonasae*, was the only nematode common to all three areas. On the east Tennessee area, with the exception of two specimens of a gizzard worm (*Cheilospirura spinosa*) this was the only nematode found.

On the Ames area it made up 96.8 percent of the total nematode load. On the Tall Timbers area, however, this species accounted for only 26.5 percent of the total nematode load. Another species of cecal worm, Trichostrongylus tenuis, was more abundant and increased total nematode numbers to a level similar to the Ames area (Table XIV, Appendix B). The decreased numbers of H. bonasae on the Tall Timbers area may be due to competition with T. tenuis or perhaps physical environmental conditions in this region are not ideal for the reproduction of H. bonasae.

A proventriculus worm, Tetrameres pattersoni, was found on the Ames and Tall Timbers areas in 1973-74 only. This is the first time this species has been reported in Tennessee. On the Ames area the incidence of this parasite increased dramatically from zero in 1972-73 to 88.5 percent (23/26) in 1973-74. The reason for this dramatic increase of a nematode which had not been previously reported in Tennessee is not fully known. Perhaps it was introduced through the release of infected pen-reared birds.

Neither of the sexes had significantly more nematodes than the other. This suggest that males and females do not differ sufficiently in their feeding habits to influence their gastrointestinal parasite burden.

Parmalee (1952) reported that age was not a factor in determining parasite burden in the bobwhite. During the present study, age was found to have a significant effect on all of the areas in at least one of the years. In all cases adults had more parasites than juveniles. However the difference in parasite burden between juveniles and adults did not occur in all years on all areas. One possible reason for this inconsistency could be the effect of environmental conditions on the parasites themselves. Perhaps inclement weather, which decreased the numbers of an intermediate host, or affected the survival of the parasite's eggs or larvae in the soil could be responsible for decreased parasite numbers in some years. Also, most of the adult birds in one year were juveniles the previous year. If these birds picked up a large number of parasites as juveniles in a year when conditions were ideal for the reproduction of parasites, they would probably carry a large burden over into the next year as adults. If the next year was a poor year for parasites, juvenile birds of that year probably would have reduced parasite burdens. Therefore, in this second year adult birds would have higher parasite burdens than juveniles.

Cestodes

No cestodes were found on the Ames area in December or January. This concurs with the findings of Blakeney (1970) on this area.

The effect of cestodes on body fat was not evaluated statistically due to the low number of infected birds (19.3 percent). The mean percent body fat of birds which had cestodes was only slightly less (under 1.0 percent) than those which had no cestodes.

Changes in parasite burden in conjunction with changes in population density were observed on all areas. One portion of the east Tennessee area (Transition area) had a substantial population increase from 1972-73 to 1973-74. The parasite burden increased slightly and the first cestode infection on the east Tennessee area was also found on this area after the population increase. The total nematode burden on the Tall Timbers area decreased 48.6 percent, with a corresponding decrease in population. However, on the Ames area the total number of nematodes increased 34.4 percent, yet the population decreased slightly. The only explanation offered for this variation from the trend exhibited on the other two areas is that conditions on the Ames area in the summer of 1973 may have been ideal for the reproduction of nematodes, resulting in the high intensity of infection.

Little work has been done to determine the effect of parasites on the thriftness of the bobwhite. Kellogg and Doster (1972) reported only two parasite problems in hundreds of wild bobwhites which they examined; severe distention of the small intestine by tapeworms, and the occlusion of the lumen of the proventriculus due to large numbers of nematodes (Tetrameres spp.) were observed, although rarely. Whether or not these problems could have caused death is not really known.

Blakeney (1970) reported that gastrointestinal parasite burden apparently had little effect on the body weight of quail on the Ames area. Similar results were found on the Ames area during this study; however, on the Tall Timbers area body weight did decrease as parasite burden increased ($P < 0.15$).

IV. FAT-PARASITE BURDEN RELATIONSHIP

Parasite load had little effect on percent body fat on the east Tennessee and Ames areas. The effect of parasites was much closer to statistical significance on the Tall Timbers area, where fat decreased as parasites increased. The greater significance on this area could be caused in part by the higher incidence and volume of cestodes, or by the different species of nematodes. Unfortunately, little is known about the pathogenic effects of the various parasites on the bobwhite.

The east Tennessee area was unusual in that it had a positive fat-parasite relationship. This relationship is probably spurious rather than biologically significant, due to the low number of parasites and high fat levels found on this area. On the Ames area, as on Tall Timbers, a negative effect appeared evident.

V. ADRENALS

Selye (1956:88) reported that stress, whether caused by extreme cold, over-population, or other factors, caused an increase in adrenal size of the affected animal. Neave and White (1968) reported larger adrenals associated with areas of higher population density in the ruffed grouse. Anderson (1969) reported similar findings in the ring-necked pheasant. However, there was no significant difference in the mean adrenal weights of bobwhite quail from the three areas in the present study. Perhaps the difference in population density between the three areas was not sufficient to reflect a significant difference in adrenal weight, or perhaps density (stress) on neither of the areas was great enough to cause an increase in adrenal size above normal (unstressed) levels. It was found, however, that adrenal weight increased as fat levels decreased. Apparently the loss of fat itself, or more likely the environmental or physiological factors which caused the loss of fat represented a stressful situation, and resulted in increased adrenal weight. Adults, also, had heavier adrenals than juveniles. The only explanation offered for this is that increase in adrenal size may be associated with sexual maturity. This same age-adrenal weight relationship was reported by Anderson (1969) in ring-necked pheasants.

On the Tall Timbers area adrenal weight increased as parasite load increased. This is probably related to the relationship between fat and parasite burden on this area. If a fat decrease brings about an increase in adrenal weight, and an increase in parasite burden causes a decrease in fat, it is reasonable that an increase in parasite burden would be reflected by an increase in adrenal weight.

The adrenal-parasite relationship on the east Tennessee and Ames areas was negative. These relationships are probably spurious, and not biologically important.

VI. PANCREAS

The purpose of this portion of the study is somewhat different from the remainder. Research conducted by Chernick et al. (1948) revealed that an antitrypsin present in uncooked soybeans significantly retarded growth and caused an increase in pancreas size, when included in the diet of young chickens. Growth was affected for only the first 12 weeks, and the chickens eventually attained their full growth. Pancreas size remained large as long as uncooked soybeans were included in the diet.

As soybeans are available to wild quail on the east Tennessee and Ames areas, but unavailable on the Tall Timbers area, this study offered an excellent opportunity to determine if the pancreas of the bobwhite was affected by the ingestion of soybeans. Apparently soybeans do affect pancreas size, as the birds from both areas in Tennessee had substantially larger pancreas than did the birds from Tall Timbers. It should be noted, however, that no soybeans were found in the crops of birds collected on the Transition portion of the east Tennessee area in 1972-73, yet pancreas size was significantly greater than for birds collected in Florida. Two factors are offered as a possible explanation. First, the production of soybeans on this area during 1972-73 was minimal. Secondly, as the majority of birds from this area were collected late in January and February, it is likely that all available soybeans had been consumed earlier in the winter and thus were not present in the crops of the birds which were examined.

A significant increase in pancreas weight on all areas from 1972-73 to 1973-74 is believed to be due to the difference in the time birds from the two years were frozen before being examined. Birds collected in 1972-73 were stored for six months, while those collected in 1973-74 were stored only two months. The pancreas has a high moisture content, therefore those birds stored for a longer period of time probably dehydrated to a greater degree. The important point is that the relationship between the areas did not change from 1972-73 to 1973-74.

The positive relationship between pancreas weight and body fat is believed to be due to the larger amount of mesenteric fat inadvertently removed with the pancreas of fatter birds. This is unavoidable due to the pancreas not being a well defined organ.

The significance of this increase in pancreas size is not fully known. However, it is doubtful if any adverse effects occur. If they did, they would undoubtedly be evident on the Ames area where soybeans are a very important food source, yet quail populations are quite high.

VII. CONCLUSIONS

All of the parameters evaluated in this study, except possibly pancreas weight, are indicators of condition, as all may affect or be affected by one or more of the others, either directly or indirectly. All may also be affected by environmental or physiological conditions. For example, high adrenal weights are associated with low fat levels, which are in turn associated with high parasite burdens (at least on the Tall Timbers area). Therefore it is reasonable to expect that the high parasite burden on the Tall Timbers area will be associated with large adrenals, as the results indicate. It is felt that based on results from the present study a usable and valid indicator of condition can be developed for a bobwhite population using a combination of percent body fat, parasite burden, and adrenal weight, once norms, or base values, for that population are established. The establishment of such norms for each population is very important because different populations may have inherent differences in fat requirements or adrenal weight. These differences may mask adrenal-fat relationships, and thus be responsible for this relationship not being statistically significant on the east Tennessee and Tall Timbers areas.

The use of all three parameters, due to their interrelationship, can provide a much clearer picture of a quail population's response to an environmental or physiological change, than could any one parameter. Fat levels, however, probably would be the best single indicator of condition, particularly if the levels at which fat reserves become critical are determined for each population being studied.

CHAPTER VI

SUMMARY

A total of 146 bobwhite quail was collected by shooting on three geographically different areas in the southeastern United States during the winters of 1972-73 and 1973-74. Forty-three birds were collected from two locations in east Tennessee, 50 were taken from the Ames Plantation in southwest Tennessee, and 53 came from the Tall Timbers Research Station near Tallahassee, Florida. The birds were examined to determine the percentage of body fat, parasite burden of gastrointestinal helminths, adrenal weight, body weight, and pancreas weight.

The mean fat percentage for all birds was 12.17 percent. Females had significantly higher fat percentages than males. No correlation was found between fat percent and age of bird. On the Ames area birds collected in December and January were significantly higher in fat than birds collected in March. This is a regularly occurring seasonal decrease; however, the decrease in 1973-74 was approximately two times as great as in 1972-73. This unusually large decrease in fat percentage has been attributed to decreased food sources in that year.

The effect of parasite load on fat levels was minimal on the east Tennessee and Ames areas. On the Tall Timbers area the effect did approach significance, with the relationship being negative.

Mean fat levels differed on all three areas. Trends suggest a negative relationship between fat levels and mean winter temperatures of the areas studied. The mildest winters occurred on the Tall Timbers area, as did the lowest fat levels, while the east Tennessee area had the most severe winters and the highest body fat percentages.

One hundred and twenty-eight (88.3 percent) of the birds examined were infected with at least one species of nematode. Of the 43 birds from east Tennessee, 25 (59.5 percent) were infected with nematodes. All birds from Ames and Tall Timbers were infected.

One species of cecal worm, Heterakis bonasae, was common to all three areas. This species accounted for greater than 95 percent of all nematodes on the east Tennessee and Ames areas. However, it accounted for only 27 percent of the nematode load on the Tall Timbers area. Another cecal worm, Trichostrongylus tenuis, accounted for the bulk of the nematode load on this area.

A proventriculus worm, Tetrameres pattersoni, was found on the Ames and Tall Timbers areas in 1973-74 only. This was the first time this species has been reported in Tennessee.

Cestodes were far less common than nematodes with only 19.3 percent of the total sample being infected. Members of three genera were found. The Tall Timbers area had the highest rate of infection, with 35.8 percent of all birds having tapeworms; Ames had 14.0 percent, and east Tennessee only 4.8 percent. Volume of cestodes per bird ranged from less than 0.3 cc., the least volume accurately determined, to 1.3 cc. Only five birds, all from Tall Timbers, contained a volume of cestodes greater than 0.4 cc.

Adrenal weight was recorded for 140 of the 146 quail examined. Actual weights were adjusted for the size of each bird, and represent a percentage of body weight. The mean for all birds was 0.0131. Means by area were: East Tennessee, 0.0119; Ames, 0.0136; and Tall Timbers, 0.0133. Adults had larger adrenals than juveniles. Females had larger adrenals than males on the Ames area only. A negative relationship occurred between adrenal weight and fat levels. It is believed that factors causing the fat loss, not the loss itself, are responsible for the increase in adrenal weight. A positive adrenal-parasite relationship occurred on the Tall Timbers area.

The mean body weight for all quail was 164.97 grams. Birds from east Tennessee and Ames were significantly heavier than birds from the Tall Timbers area. This difference may well be an example of Bergmann's Rule in operation.

A positive fat-body weight relationship occurred on all areas. For each one percent increase in fat, body weight increased approximately 1.17 g. A negative parasite-body weight relationship occurred on the Tall Timbers area.

Pancreas weights were recorded for 144 of the 146 quail examined; these also were adjusted for body size. Birds from east Tennessee and Ames had pancreas which were significantly heavier than those from Tall Timbers. This increased size was attributed to the inclusion of soybeans in the diet of the birds from the two Tennessee areas. An antitrypsin present in the beans is believed to be the causative agent. Mean pancreas weight on all areas increased approximately 100 percent from 1972-73 to 1973-74. Different freezer storage times for the samples, six months in 1972-73 versus two months in 1973-74, are believed to be responsible, with increased dehydration over the six month period accounting for the lower weights in that year. The relationship between areas remained the same in both years. A positive relationship between fat and pancreas weight is believed to be due to the larger amount of mesenteric fat inadvertently removed with the pancreas of fatter birds.

All factors observed, except pancreas weight, are indicators of condition. Most may affect or be affected by each other, either directly or indirectly. All may also be affected by environmental conditions. Fat percentage, adrenal weight, and parasite load in combination may provide a good and valid indicator of condition for a population, once norms, or base values, for that population are established.

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APPENDICES

APPENDIX A

TABLE XI

BIOLOGICAL INFORMATION COLLECTED FROM BOBWHITE QUAIL FROM THE SOUTHEASTERN UNITED STATES, 1972-74

Bird No.	Area[a]	Date Collected Month	Year	Age	Sex	Body Weight	Adrenal Weight[b]	Pancreas Weight[b]	Fat %
1	la	Feb.	1973	J	M	178.2	0.0069	0.0923	14.05
2	la	Feb.	1973	J	M	187.1	0.0032	0.3221	19.00
3	la	c		J	F	170.3	0.0148	0.1448	14.48
4	la	Jan.	1973	J	M	161.3	0.0154	0.1585	13.37
5	la	Feb.	1973	J	F	182.7	0.0121	0.2637	12.95
6	la	Jan.	1973	J	M	185.1	0.0118	0.0873	18.68
7	la	c		A	F	181.3	--	0.3068	19.46
8	la	Feb.	1973	J	M	163.6	0.0155	0.2194	15.94
9	la	Feb.	1973	J	M	167.3	0.0185	0.3452	14.33
10	la	Jan.	1973	J	F	167.0	0.0129	0.1475	15.31
11	la	Feb.	1973	J	M	176.2	0.0089	0.1994	13.86
$\overline{X}$						174.6	0.0121	0.2079	15.58
12	lb	Jan.	1973	A	M	179.0	0.0096	0.1651	12.90
13	lb	Jan.	1973	A	F	160.8		0.1714	9.88
14	lb	Jan.	1973	J	M	173.0	0.0135	0.1234	14.90
15	lb	Dec.	1972	J	F	178.9	0.0151	0.0861	20.35
16	lb	Dec.	1972	J	M	169.6	0.0121	0.1620	9.94
17	lb	Jan.	1973	J	M	191.2	0.0098	0.3790	14.96
18	lb	Jan.	1973	J	M	162.8	0.0124	0.3430	10.80
19	lb	Jan.	1973	J	M	171.4	0.0095	0.1784	11.76
20	lb	Jan.	1973	A	M	157.8	0.0109	0.2677	8.81
21	lb	Jan.	1973	J	F	172.0	0.0106	0.3663	17.64
22	lb	Dec.	1972	J	M	178.6	0.0136	0.2644	15.33
23	lb	Jan.	1973	A	M	186.3	0.0172	0.1730	14.72
24	lb	Jan.	1973	J	M	169.0	0.0096	0.1150	13.72
25	lb	Jan.	1973	J	M	154.4	0.0172	0.3080	11.41
26	lb	Jan.	1973	J	F	160.9	0.0113	0.1107	8.49
27	lb	Dec.	1972	J	M	172.0	0.0073	0.4370	15.39
28	lb	Jan.	1973	J	F	151.0	0.0112	0.1712	8.11
29	lb	Jan.	1973	J	M	169.5	0.0102	0.1050	11.05
30	lb	Jan.	1973	J	M	164.0	0.0095	0.1277	14.33
31	lb	Jan.	1973	J	M	163.6	0.0159	0.2767	13.96

TABLE XI (continued)

Bird No.	Area[a]	Date Collected Month	Year	Age	Sex	Body Weight	Adrenal[b] Weight	Pancreas[b] Weight	Fat %
$\bar{X}$						169.3	0.0118	0.2166	12.92
32	3	Feb.	1973	J	F	165.8	0.0123	0.0721	12.33
33	3	Feb.	1973	J	F	151.9	0.0207	0.1213	13.43
34	3	Feb.	1973	J	F	156.9	0.0127	0.0650	17.06
35	3	Feb.	1973	A	M	146.2	0.0162	0.0822	8.60
36	3	Feb.	1973	A	M	154.8	0.0150	0.0779	7.55
37	3	Feb.	1973	J	F	164.7	0.0081	0.0913	16.45
38	3	Feb.	1973	J	M	155.0	0.0088	0.0921	9.85
39	3	Feb.	1973	J	F	173.8	0.0120	0.1322	16.82
40	3	Feb.	1973	A	F	156.3	0.0142	0.0756	11.21
41	3	Feb.	1973	A	M	175.3	0.0123	0.1034	7.23
42	3	Feb.	1973	J	F	139.8	0.0143	0.1446	4.66
43	3	Feb.	1973	J	M	150.7	0.0124	0.0728	8.08
44	3	Feb.	1973	A	M	174.0	0.0121	0.0767	10.33
45	3	Feb.	1973	J	F	180.2	0.0102	0.0997	15.19
46	3	Feb.	1973	J	M	152.7	0.0152	0.1146	5.38
47	3	Feb.	1973	J	F	166.0	0.0085	0.1303	14.62
48	3	Feb.	1973	J	F	146.3	0.0171	0.1800	6.26
49	3	Feb.	1973	J	M	143.9	0.0115	0.1105	7.05
50	3	Feb.	1973	J	M	153.9	0.0106	0.0795	12.94
51	3	Feb.	1973	A	M	148.2	0.0232	0.0843	10.00
52	3	Feb.	1973	J	M	147.0	0.0224	0.1489	10.87
53	3	Feb.	1973	A	M	159.6	0.0158	0.0770	8.53
54	3	Feb.	1973	J	M	141.0	0.0235	0.1025	4.32
55	3	Feb.	1973	J	M	167.7	0.0085	0.0832	17.72
56	3	Feb.	1973	J	F	163.0	0.0126	0.1353	8.66
$\bar{X}$						157.4	0.0140	0.1021	10.61
57	2b	Mar.	1973	A	M	173.9	0.0184	0.1632	11.13
58	2b	Mar.	1973	J	F	173.2	0.0110	0.1427	12.26
59	2b	Mar.	1973	J	F	160.0	0.0139	0.1921	7.09
60	2b	Mar.	1973	A	M	161.5	0.0146	0.1801	8.60
61	2b	Mar.	1973	J	F	168.4	0.0114	0.1869	13.74
62	2b	Mar.	1973	J	F	152.7	0.0219	0.3237	6.05
63	2b	Mar.	1973	A	M	182.4	-	0.2601	9.27
64	2b	Mar.	1973	J	M	166.0	0.0092	0.3010	8.44
65	2b	Mar.	1973	A	M	169.0	0.0154	0.3043	13.18
66	2b	Mar.	1973	J	M	166.3	0.0208	0.1992	7.87
67	2b	Mar.	1973	A	F	162.7	0.0184	0.2186	9.51
68	2b	Mar.	1973	J	F	166.5	-	0.2347	7.71

TABLE XI (continued)

Bird No.	Area[a]	Date Collected Month	Year	Age	Sex	Body Weight	Adrenal[b] Weight	Pancreas[b] Weight	Fat %
$\overline{X}$						167.3	0.0155	0.2256	9.57
69	2a	Dec.	1972	J	F	166.0	0.0161	0.2522	13.31
70	2a	Dec.	1972	A	M	160.7	0.0200	0.1738	10.48
71	2a	Dec.	1972	J	F	164.9	0.0144	0.3441	17.97
72	2a	Dec.	1972	J	M	176.6	0.0101	0.2583	16.63
73	2a	Dec.	1972	J	F	179.0	0.0173	0.2735	17.09
74	2a	Dec.	1972	A	M	160.2	0.0211	0.2944	10.69
75	2a	Dec.	1972	J	F	200.9	0.0123	0.1507	19.67
76	2a	Dec.	1972	J	F	181.3	0.0098	0.3273	13.24
77	2a	Dec.	1972	J	M	169.1	0.0094	0.3533	6.83
78	2a	Dec.	1972	A	M	177.3	0.0135	0.2868	13.21
79	2a	Dec.	1972	J	M	174.8	0.0140	0.2371	8.60
80	2a	Dec.	1972	A	F	174.4	0.0147	0.2613	14.93
$\overline{X}$						174.2	0.0144	0.2677	13.55
81	1a	Feb.	1974	J	M	167.2	0.0101	0.1816	10.71
82	1a	Feb.	1974	J	M	158.0	0.0134	0.3553	9.89
83	1a	Feb.	1974	J	F	150.0	0.0203	0.3343	6.34
84	1a	Jan.	1974	A	M	164.0	-	-	18.49
85	1a	Feb.	1974	A	F	181.5	0.0093	0.2824	10.49
86	1a	Feb.	1974	J	M	164.2	0.0068	0.5346	16.42
87	1a	Jan.	1974	J	F	184.8	0.0139	0.3739	19.84
$\overline{X}$						167.1	0.0123	0.3437	13.16
88	1b	Dec.	1973	J	M	185.7	0.0122	0.2839	9.78
89	1b	Jan.	1974	J	M	171.9	0.0116	0.5713	12.19
90	1b	Jan.	1974	J	M	165.5	0.0107	0.5276	10.67
91	1b	Feb.	1974	J	F	163.4	0.0122	0.7405	18.00
92	1b	Feb.	1974	J	F	184.0	0.0087	0.3068	17.15
$\overline{X}$						174.1	0.0111	0.4860	13.56
93	2b	Mar.	1974	J	F	156.8	0.0125	0.4547	7.80
94	2b	Mar.	1974	J	F	154.9	0.0137	0.5874	8.60
95	2b	Mar.	1974	J	F	168.1	0.0133	0.5588	9.65
96	2b	Mar.	1974	J	M	162.0	0.0156	0.6006	7.54
97	2b	Mar.	1974	A	M	167.0	0.0149	0.7280	9.77
98	2b	Mar.	1974	J	M	171.5	0.0133	0.6235	6.73

TABLE XI (continued)

Bird No.	Area[a]	Date Collected Month	Year	Age	Sex	Body Weight	Adrenal[b] Weight	Pancreas[b] Weight	Fat %
99	2b	Mar.	1974	A	F	160.0	0.0156	-	7.86
100	2b	Mar.	1974	A	M	164.0	0.0280	0.5024	7.54
101	2b	Mar.	1974	J	M	156.1	0.0124	0.4876	6.32
102	2b	Mar.	1974	J	F	165.9	0.0114	0.4738	14.14
103	2b	Mar.	1974	A	M	174.8	0.0151	0.3365	9.96
104	2b	Mar.	1974	J	M	161.0	0.0114	0.3363	9.93
105	2b	Mar.	1974	J	M	168.0	0.0092	0.5455	8.87
$\overline{X}$						163.9	0.0143	0.5919	8.82
106	2a	Jan.	1974	J	F	167.4	0.0168	0.6559	21.73
107	2a	Jan.	1974	A	F	154.8	0.0152	0.4547	13.32
108	2a	Jan.	1974	J	M	173.9	0.0047	0,4948	22.47
109	2a	Jan.	1974	J	M	177,9	0.0090	0.8085	14.12
110	2a	Jan.	1974	J	F	168.8	0.0121	0.4621	21.95
111	2a	Jan.	1974	J	M	187.0	0.0102	0.5233	21.97
112	2a	Jan.	1974	A	M	180.0	0.0083	0.4333	18.89
113	2a	Jan.	1974	A	M	163.0	0.0116	0.3914	16.46
114	2a	Jan.	1974	J	F	156.0	0.0128	0.6377	18.66
115	2a	Jan.	1974	J	M	171.0	0.0143	0.6309	15.05
116	2a	Jan.	1974	J	M	172.8	0.0117	0.5649	18.83
117	2a	Jan.	1974	J	F	180.1	0.0110	0.4636	20.23
118	2a	Jan.	1974	A	F	172.2	-	0.9783	25.12
$\overline{X}$						171.1	0.0115	0.5769	19.14
119	3	Mar.	1974	J	M	149.8	0.0108	0.2005	11.40
120	3	Mar.	1974	J	M	158.0	0.0085	0.2934	12.36
121	3	Mar.	1974	J	M	154.0	0.0119	0.2409	9.67
122	3	Mar.	1974	J	F	147.0	0.0113	0.2376	11.12
123	3	Mar.	1974	A	F	167.2	0.0120	0.2622	7.01
124	3	Mar.	1974	A	F	158.7	0.0151	0.2243	10.82
125	3	Mar.	1974	A	M	162.0	0.0184	0.2144	12.52
126	3	Mar.	1974	A	M	171.0	0.0136	0.1431	6.26
127	3	Mar.	1974	J	M	142.8	0.0127	0.1631	6.52
128	3	Mar.	1974	J	M	148.0	0.0151	0.1464	10.70
129	3	Mar.	1974	J	M	145.6	0.0122	0.2914	8.93
130	3	Mar.	1974	J	M	163.1	0.0104	0.2541	9.60
131	3	Mar.	1974	J	M	166.0	0.0116	0.1901	10.52
132	3	Mar.	1974	A	F	156.7	0.0103	0.1739	12.51
133	3	Mar.	1974	A	M	144.4	0.0187	0.1610	8.22

TABLE XI (continued)

Bird No.	Area[a]	Date Collected Month	Date Collected Year	Age	Sex	Body Weight	Adrenal[b] Weight	Pancreas[b] Weight	Fat %
134	3	Mar.	1974	J	F	151.4	0.0099	0.2236	8.12
135	3	Mar.	1974	J	M	144.8	0.0114	0.2948	10.59
136	3	Mar.	1974	A	F	159.2	0.0119	0.1991	11.69
137	3	Mar.	1974	J	F	162.5	0.0110	0.3415	10.12
138	3	Mar.	1974	A	M	154.9	0.0122	0.2305	8.84
139	3	Mar.	1974	A	M	154.5	0.0129	0.1436	11.27
140	3	Mar.	1974	A	F	154.9	0.0135	0.2261	8.97
141	3	Mar.	1974	J	M	157.0	0.0107	0.1970	9.99
142	3	Mar.	1974	J	M	152.1	0.0113	0.2305	13.75
143	3	Mar.	1974	J	M	165.9	0.0096	0.2090	11.22
144	3	Mar.	1974	J	M	148.5	0.0207	0.1749	11.25
145	3	Mar.	1974	J	M	164.3	0.0142	0.3798	9.62
146	3	Mar.	1974	A	F	158.4	0.0109	0.3214	8.84
$\overline{X}$						155.8	0.0126	0.2274	10.09

[a]Area code.
1a--East Tennessee, Transition Area
1b--East Tennessee, Farm Lands Area
2a--Ames early--December or January
2b--Ames late--March
3 --Tall Timbers

[b]Weights adjusted for body size of bird, values represent percentage of body weight. Where no weight is given, organ was too badly shot up to be removed and weighed.

[c]Bird collected by another person, exact date of collection unknown.

APPENDIX B

TABLE XII

NUMBERS OF NEMATODES AND CESTODES FOUND IN BOBWHITE QUAIL FROM EAST TENNESSEE, 1972-74

Bird No.	Area[a]	Date Collected Month	Year	Nematodes Heterakis bonasae	Cheilospirura spinosa	Cestodes[b] Rhabdometra spp.
1	la	Feb.	1973	85	-	-
2	la	Feb.	1973	16	-	-
3	la	- c	-	4	-	-
4	la	Jan.	1973	12	-	-
5	la	Feb.	1973	1	-	-
6	la	Jan.	1973	23	-	-
7	la	- c	-	50	-	-
8	la	Feb.	1973	5	-	-
9	la	Feb.	1973	29	-	-
10	la	Jan.	1973	3	-	-
11	la	Feb.	1973	1	-	-
$\bar{X}$				20.82	0.0	0.0
Rate of infection--				100%	0%	0%
12	lb	Jan.	1973	-	-	-
13	lb	Jan.	1973	3	-	-
14	lb	Jan.	1973	-	-	-
15	lb	Dec.	1972	1	-	-
16	lb	Dec.	1972	-	-	-
17	lb	Jan.	1973	1	-	-
18	lb	Jan.	1973	1	-	-
19	lb	Jan.	1973	3	-	-
20	lb	Jan.	1973	-	-	-
21	lb	Jan.	1973	-	-	-
22	lb	Dec.	1972	-	-	-
23	lb	Jan.	1973	-	-	-
24	lb	Jan.	1973	-	-	-
25	lb	Jan.	1973	-	-	-
26	lb	Jan.	1973	-	-	-
27	lb	Dec.	1972	4	2	-
28	lb	Jan.	1973	-	-	-
29	lb	Jan.	1973	-	-	-
30	lb	Jan.	1973	-	-	-
31	lb	Jan.	1973	-	-	-
$\bar{X}$				0.60	0.0	0.0

TABLE XII (continued)

Bird No.	Area[a]	Date Collected Month	Date Collected Year	Nematodes Heterakis bonasae	Nematodes Cheilospirura spinosa	Cestodes[b] Rhabdometra spp.
Rate of infection--				30.0%	0.0%	0.0%
81	la	Feb.	1974	15	-	-
82	la	Feb.	1974	2	-	-
83	la	Feb.	1974	3	-	-
84	la	Jan.	1974	-	-	-
85	la	Feb.	1974	145	-	0.3
86	la	Feb.	1974	11	-	0.3
87	la	Jan.	1974	9	-	-
$\bar{X}$				26.43	0.0	0.086
Rate of infection--				85.7%	0.0%	28.6%
88	lb	Dec.	1973	-	-	-
89	lb	Jan.	1974	1	-	-
90	lb	Jan.	1974	-	-	-
91	lb	Feb.	1974	2	-	-
92	lb	Feb.	1974	-	-	-
$\bar{X}$				0.60	0.0	0.0
Rate of infection--				40.0%	0.0%	0.0%

[a]Area Code
la--East Tennessee, Transition Area
lb--East Tennessee, Farm Lands Area

[b]Value represents volume of cestodes in cubic centimeters.

[c]Bird collected by another person, exact date of collection unknown.

TABLE XIII

NUMBERS OF NEMATODES AND CESTODES FOUND IN BOBWHITE QUAIL FROM THE AMES PLANTATION, WEST TENNESSEE, 1972-74

Bird No.	Area[a]	Date Collected Month	Date Collected Year	Nematodes: *Heterakis bonasae*	Nematodes: *Cheilospirura spinosa*	Nematodes: *Tetrameres pattersoni*	Cestodes[b]: *Rhabdometra* spp.	Cestodes[b]: *Raillientina* spp.
57	2b	Mar.	1973	568	2	-	0.3	-
58	2b	Mar.	1973	160	3	-	-	-
59	2b	Mar.	1973	239	-	-	0.3	-
60	2b	Mar.	1973	228	-	-	-	-
61	2b	Mar.	1973	177	3	-	-	-
62	2b	Mar.	1973	273	20	-	-	-
63	2b	Mar.	1973	402	-	-	-	-
64	2b	Mar.	1973	191	1	-	-	-
65	2b	Mar.	1973	264	3	-	-	-
66	2b	Mar.	1973	151	8	-	-	-
67	2b	Mar.	1973	240	2	-	0.3	-
68	2b	Mar.	1973	139	1	-	-	-
$\bar{X}$				252.67	3.58	0.0	0.075	0.0
Rate of infection--				100.0%	75.0%	0.0%	25.0%	0.0%
69	2a	Dec.	1972	138	4	-	-	-
70	2a	Dec.	1972	21	-	-	-	-
71	2a	Dec.	1972	78	-	-	-	-
72	2a	Dec.	1972	158	-	-	-	-
73	2a	Dec.	1972	73	-	-	-	-
74	2a	Dec.	1972	38	1	-	-	-
75	2a	Dec.	1972	95	-	-	-	-
76	2a	Dec.	1972	111	1	-	-	-
77	2a	Dec.	1972	278	-	-	-	-

TABLE XIII (continued)

Bird No.	Area[a]	Date Collected		Nematodes			Cestodes[b]	
		Month	Year	Heterakis bonasae	Cheilospirura spinosa	Tetrameres pattersoni	Rhabdometra spp.	Raillientina spp.
78	2a	Dec.	1972	255	25	-	-	-
79	2a	Dec.	1972	98	-	-	-	-
80	2a	Dec.	1972	572	4	-	-	-
$\bar{X}$				159.58	2.92	0.0	0.0	0.0
Rate of infection--				100.0%	41.7%	0.0%	0.0%	0.0%
93	2b	Mar.	1974	302	-	-	-	-
94	2b	Mar.	1974	258	9	-	-	-
95	2b	Mar.	1974	720	3	-	-	-
96	2b	Mar.	1974	261	26	14	-	0.3
97	2b	Mar.	1974	155	-	-	-	-
98	2b	Mar.	1974	287	6	2	-	-
99	2b	Mar.	1974	464	5	3	-	-
100	2b	Mar.	1974	1,508	56	19	0.3	-
101	2b	Mar.	1974	47	-	6	0.3	-
102	2b	Mar.	1974	113	4	10	-	-
103	2b	Mar.	1974	122	3	4	-	-
104	2b	Mar.	1974	504	5	8	-	-
105	2b	Mar.	1974	112	1	9	0.3	-
$\bar{X}$				373.31	9.08	5.77	0.069	0.023
Rate of infection--				100.0%	76.9%	69.2%	23.1%	7.7%
106	2a	Jan.	1974	158	4	17	-	-
107	2a	Jan.	1974	559	8	-	-	-
108	2a	Jan.	1974	547	3	11	-	-

TABLE XIII (continued)

Bird No.	Area[a]	Date Collected		Nematodes			Cestodes[b]	
		Month	Year	*Heterakis bonasae*	*Cheilospirura spinosa*	*Tetrameres pattersoni*	*Rhabdometra* spp.	*Raillientina* spp.
109	2a	Jan.	1974	264	4	4	-	-
110	2a	Jan.	1974	421	4	2	-	-
111	2a	Jan.	1974	199	4	17	-	-
112	2a	Jan.	1974	139	1	13	-	-
113	2a	Jan.	1974	86	-	5	-	-
114	2a	Jan.	1974	44	-	2	-	-
115	2a	Jan.	1974	221	11	6	-	-
116	2a	Jan.	1974	173	20	9	-	-
117	2a	Jan.	1974	346	1	10	-	-
118	2a	Jan.	1974	191	6	20	-	-
$\bar{X}$				257.54	5.08	8.92	0.0	0.0
Rate of infection--				100.0%	84.6%	92.3%	0.0%	0.0%

[a]Area code
2a--Ames early--December or January
2b--Ames late--March

[b]Value represents volume of cestodes in cubic centimeters.

TABLE XIV

NUMBERS OF NEMATODES AND CESTODES FOUND IN BOBWHITE QUAIL FROM THE TALL TIMBERS RESEARCH STATION, TALLAHASSEE, FLORIDA, 1972-74

Bird No.	Area[a]	Date Collected Month	Date Collected Year	Nematodes: *Heterakis bonasae*	Nematodes: *Cyrnea colini*	Nematodes: *Trichostrongylus tenuis*	Nematodes: *Tetrameres pattersoni*	Cestodes[b]: *Hymenolepis* spp.
32	3	Feb.	1973	10	-	167	-	-
33	3	Feb.	1973	52	1	141	-	-
34	3	Feb.	1973	14	-	67	-	0.5
35	3	Feb.	1973	32	2	443	-	-
36	3	Feb.	1973	42	3	250	-	0.3
37	3	Feb.	1973	26	3	76	-	0.3
38	3	Feb.	1973	2	4	16	-	0.3
39	3	Feb.	1973	17	-	30	-	-
40	3	Feb.	1973	63	6	910	-	0.3
41	3	Feb.	1973	45	-	133	-	0.3
42	3	Feb.	1973	57	6	128	-	-
43	3	Feb.	1973	88	5	186	-	-
44	3	Feb.	1973	30	-	606	-	-
45	3	Feb.	1973	17	2	43	-	-
46	3	Feb.	1973	30	5	406	-	0.3
47	3	Feb.	1973	44	3	78	-	-
48	3	Feb.	1973	44	4	197	-	-
49	3	Feb.	1973	31	3	123	-	-
50	3	Feb.	1973	41	1	62	-	-
51	3	Feb.	1973	109	4	212	-	-
52	3	Feb.	1973	141	5	624	-	-
53	3	Feb.	1973	103	2	256	-	-
54	3	Feb.	1973	64	2	415	-	-
55	3	Feb.	1973	22	11	63	-	-
56	3	Feb.	1973	11	-	83	-	-

TABLE XIV (continued)

Bird No.	Area[a]	Date Collected Month	Date Collected Year	Heterakis bonasae	Cyrnea colini	Nematodes Trichostrongylus tenuis	Tetrameres pattersoni	Cestodes[b] Hymenolepis spp.
$\overline{X}$				45.4	2.88	228.60	0.0	0.092
Rate of infection--				100.0%	76.0%	100.0%	0.0%	28.0%
119	3	Mar.	1974	53	4	151	-	-
120	3	Mar.	1974	34	5	19	-	1.0
121	3	Mar.	1974	41	3	78	2	1.3
122	3	Mar.	1974	98	12	31	-	-
123	3	Mar.	1974	109	14	28	-	0.3
124	3	Mar.	1974	49	13	34	2	0.3
125	3	Mar.	1974	35	12	61	2	-
126	3	Mar.	1974	64	6	30	10	-
127	3	Mar.	1974	31	2	37	-	-
128	3	Mar.	1974	32	9	24	-	-
129	3	Mar.	1974	47	3	5	-	-
130	3	Mar.	1974	23	9	131	-	0.3
131	3	Mar.	1974	66	4	16	3	-
132	3	Mar.	1974	60	22	8	-	-
133	3	Mar.	1974	71	7	272	3	0.3
134	3	Mar.	1974	97	9	91	1	0.4
135	3	Mar.	1974	59	9	94	-	-
136	3	Mar.	1974	161	20	17	5	0.3
137	3	Mar.	1974	163	5	61	3	-
138	3	Mar.	1974	21	2	55	-	0.3
139	3	Mar.	1974	26	2	43	13	-
140	3	Mar.	1974	45	3	97	-	-
141	3	Mar.	1974	103	11	73	-	-
142	3	Mar.	1974	22	4	46	-	-
143	3	Mar.	1974	24	16	21	-	0.6

TABLE XIV (continued)

Bird No.	Area[a]	Date Collected Month	Year	Nematodes Heterakis bonasae	Cyrnea colini	Trichostrongylus tenuis	Tetrameres pattersoni	Cestodes[b] Hymenolepis spp.
144	3	Mar.	1974	163	8	57	-	0.3
145	3	Mar.	1974	102	9	198	-	0.3
146	3	Mar.	1974	73	11	66	6	-
$\bar{X}$				66.86	8.36	68.86	1.79	0.204
Rate of infection--				100.0%	100.0%	100.0%	39.3%	42.9%

[a]Area Code
3--Tall Timbers

[b]Weights adjusted for body size of bird, values represent percentage of body weight.

VITA

Joseph M. Dabney, son of the late Mr. and Mrs. G. O. Dabney, was born in Lake City, Tennessee, on July 14, 1946. He attended elementary school in Lake City and was graduated from Lake City High School in 1964. In May 1965, he entered the U. S. Army and was permanently retired April 1971. He entered the University of Tennessee in June 1968 and received the degree of Bachelor of Science in Forestry in June 1972. In September 1972, he was awarded a graduate research assistantship and began graduate studies in the Department of Forestry, The University of Tennessee, with emphasis in wildlife biology. He received the Master of Science Degree in Wildlife and Fisheries Science in December 1974.