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August 7, 1972

To the Graduate Council:

I am submitting herewith a thesis written by Thomas Royal Eubanks entitled "Food Habits of Bobwhite Quail (Colinus virginianus) on Ames Plantation in West Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife Management.

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FOOD HABITS OF BOBWHITE QUAIL (*COLINUS VIRGINIANUS*) ON AMES PLANTATION IN WEST TENNESSEE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Thomas Royal Eubanks

August 1972

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ABSTRACT

The objective of this study was to delineate dietary patterns of bobwhite quail on the Ames Plantation with respect to seasonal variation in food selection and feeding preferences of different age and sex groups. Preliminary field studies began in July, 1966, while quail collections began in December, 1966.

The study was conducted on the 18,600-acre Ames Plantation located near Grand Junction, Fayette-Hardeman Counties, Tennessee. The research area encompassed 4,263 acres which are intensively managed for quail.

Major land use types on the study area were forest, 37 percent; idle, field border, and fallow, 22 percent; cultivated, 22 percent; hay and pasture, 17 percent; and food plots, 2 percent.

A total of 672 bobwhites were collected during December, 1966 through March, 1969. Males contributed 54.1 percent of the birds collected while females accounted for 45.9 percent.

The most important foods comprising the annual diet of bobwhites on the study area were soybeans (38.1 percent), corn (6.0 percent), Johnson grass (5.2 percent), grasshoppers (4.2 percent), and browntop millet (3.4 percent).

The acreage of soybeans grown in Fayette County has increased 1,022 percent from 1959 to 1969. The upward trend in total soybean acreage has increased the availability of soybeans as a source of food for quail.

Major winter foods consumed by quail were soybeans (71.1 percent), corn (9.7 percent), and Johnson grass (4.4 percent).

Important foods consumed by bobwhites during the spring were soybeans (39.9 percent), green leafy vegetation (6.9 percent), wood sorrell (6.8 percent), and violet (6.1 percent). Animal foods comprised 16.5 percent of the diet in spring.

Major summer foods consumed by quail were grasshoppers (9.4 percent), Johnson grass (9.1 percent), browntop millet (7.7 percent), and soybeans (6.2 percent). Animal foods were important in the diet during the summer, comprising 30.5 percent of the total volume.

The fall diet of quail consisted of 14.3 percent animal and 85.7 percent plant food. Soybeans comprised 53.2 percent of the food consumed by quail. Other important fall foods were grasshoppers (9.5 percent) and browntop millet (7.4 percent).

Food habits of juvenile quail were more similar to adult hens than to adult cocks during the summer season. Juvenile quail consumed 37.6 percent animal foods, adult hens 36.2 percent, and adult males 19.9 percent.

The four most important foods consumed by adult quail during the summer were grasshoppers (8.8 percent), Johnson grass (8.4 percent), soybeans (7.1 percent), and browntop millet (6.7 percent). Juvenile foods included sassafras (11.8 percent), grasshoppers (10.8 percent), Johnson grass (10.4 percent), and browntop millet (9.8 percent).

I examined 118 juvenile bobwhites which ranged in age from less than 1 week to 15 weeks. During the first two weeks of life, the chicks diet contained 94.1 percent animal food. As juvenile birds

progressed in age they utilized less animal foods and consumed more plant foods. By the fourth week animal food decreased to 60.4 percent and by the eighth week young consumed 38.9 percent animal food.

Crop contents from 443 quail were examined to determine use of "select" foods planted in food plots. Seventy-one percent of the birds shot less than 50 yards from a food plot had eaten "select" foods. Twenty-five percent of the bobwhites collected from 51-300 yards contained "select" foods. Birds which "lived" within 50 yards of a food plot were strongly influenced in their diet by foods planted in food plots.

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CHAPTER I

INTRODUCTION

The bobwhite quail (Colinus virginianus) utilizes a variety of habitats throughout its range in North America. It inhabits the southern portions of northern border states where winter storms of ice and snow strongly influence population densities. In the arid southwestern states, quail populations fluctuate widely in response to changes in annual rainfall. In the southeastern United States, bobwhite populations remain more stable than in most other parts of its range. Bobwhites are found associated with crop land, pasture land, forest land, wet swamps, and dry, arid uplands where various types of foods are generally available. Their dietary patterns vary accordingly.

The objective of this ~~study was~~ PAPER IS to delineate dietary patterns of bobwhite quail ~~on the Ames Plantation~~ in the Southeast with respect to seasonal variation in food selection and feeding preferences of different age and sex groups. Food habits of bobwhite quail have been reported by many workers; however, most studies were based on data obtained from birds shot during autumn hunting seasons. Limited information is available on dietary patterns of quail during other times of the year.

The earliest study of bobwhite food habits was conducted by Judd (1905) and was representative, in some degree, of every month in the year. Quail crops (1918) were chiefly from Maryland and Virginia; however, 21 states, Canada and Mexico were represented in the study. Since then fall and winter food habits were reported by: Allen and

Pearson (1945a, 1945b, 1949a, and 1949b), 1,362 crops from southeastern Alabama; Baldwin and Handley (1946), 495 crops from Virginia, Barbour (1951), 331 crops from Kentucky; Barnes and Klimstra (1964), 195 crops from southern Illinois; Cady (1944), 553 crops from quail occupying abandoned farm land near Norris Reservoir in east Tennessee; Davison (1942), 5,189 crops from several southeastern states; Goodrum and Reid (1954), 3,053 crops in south central Louisiana; Gray (1938), 440 crops from central Alabama; Handley (1931), 1,659 crops were examined from seven states in the southeast; Hood (1955), 360 crops from Mississippi; Johnson and Pearson (1948 and 1949), 567 crops from northern Alabama; Johnson (1941), 1,835 crops from northern Mississippi; Korschgen (1948), 5,472 crops in Missouri; Laessle and Frye (1956), 375 crops from Florida; Larimer (1960), 4,606 crops from southern Illinois; Lett and Pearson (1942), 611 crops from Alabama; Martin (1935), 2,000 crops collected throughout the year from southeastern states; McConnell (1965), 457 crops from Alabama; and Reeves (1954), 831 crops from Indiana.

Agricultural practices in the Southeast have gradually changed from tenant, patch farming to large field, mechanized operations in the past several decades. Automation and mechanization are influencing land use by changing small farms and fields into large, cultivated tracts eliminating many fence rows, corners, and woody coverts formerly utilized by wildlife. Since most food habit studies on bobwhites were conducted before 1950, this study should illustrate changes in the habits of the quail brought about by changes in farming operations.

CHAPTER II

DESCRIPTION OF STUDY AREA

I. LOCATION

The study was conducted on a portion of the 18,600-acre Ames Plantation located in Fayette-Hardeman Counties in west Tennessee. The Ames Plantation is 60 miles east of Memphis, ten miles north of the Mississippi state line (Fig. 1).

When Mr. Hobart Ames completed his land purchases in 1937, he had acquired 18,600 acres of forest and agricultural land with approximately 300 tenant families living on the land. The traditional small tract farming by tenants provided bobwhite quail with excellent habitat and coveys were numerous on the Plantation.

The 4,263-acre research area on the Ames Plantation encompasses grounds utilized in the National Field Trial Championship for pointing bird dogs (Fig. 2). This area is intensively managed for quail; during the study period density of the quail population varied from about one bird per 2.0 acres to one bird per 1.3 acres.

II. TOPOGRAPHY

Fayette and Hardeman counties lie in the western part of the Plateau slope of western Tennessee (Flowers, 1964). The topography of the counties during the early Ice Age was much like the topography today. Only Coastal Plain material or sediments deposited by old seas during the Tertiary period, were exposed.

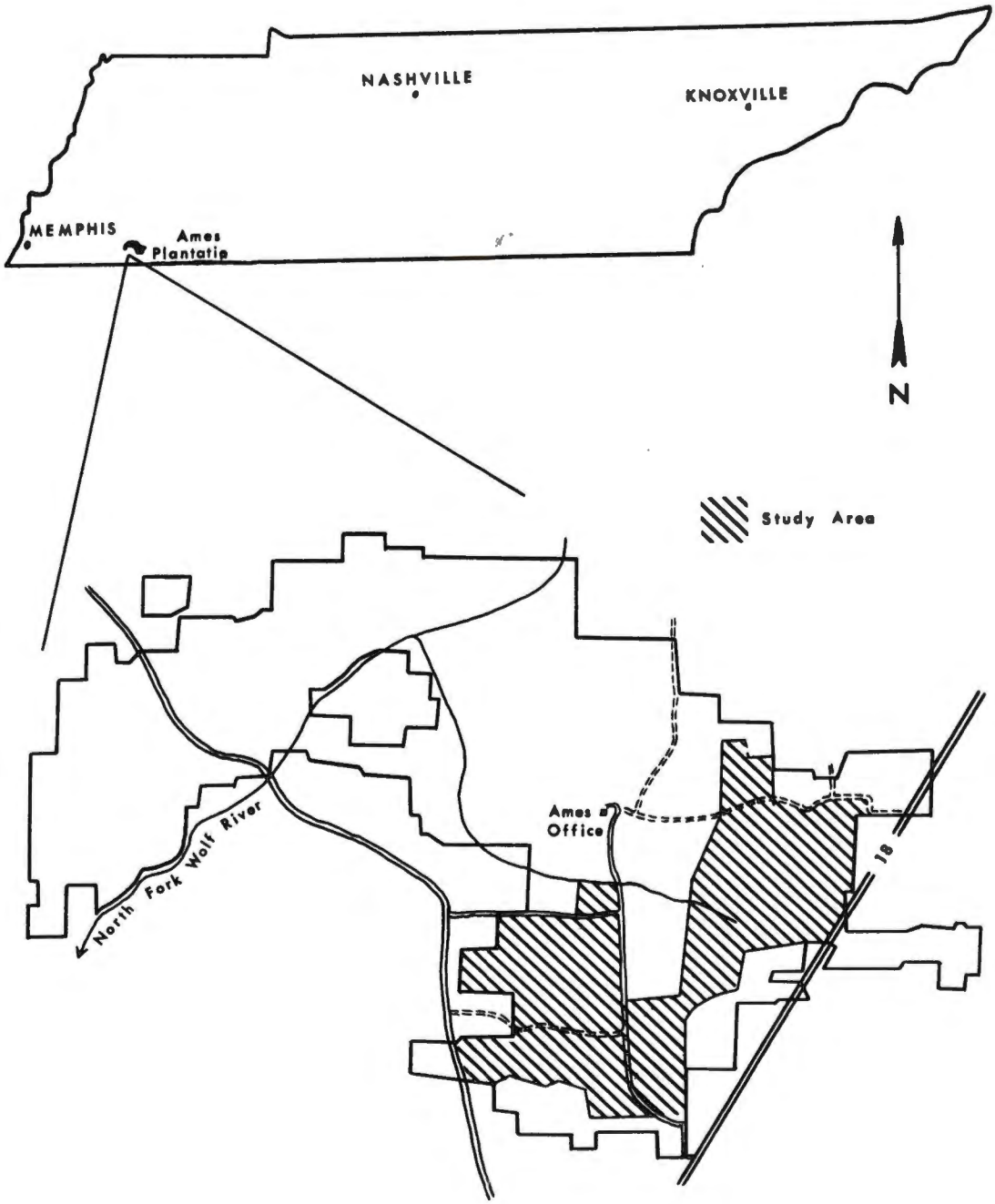


Figure 1. The Ames Plantation and bobwhite quail research area, Grand Junction, Fayette-Hardeman Counties, Tennessee.

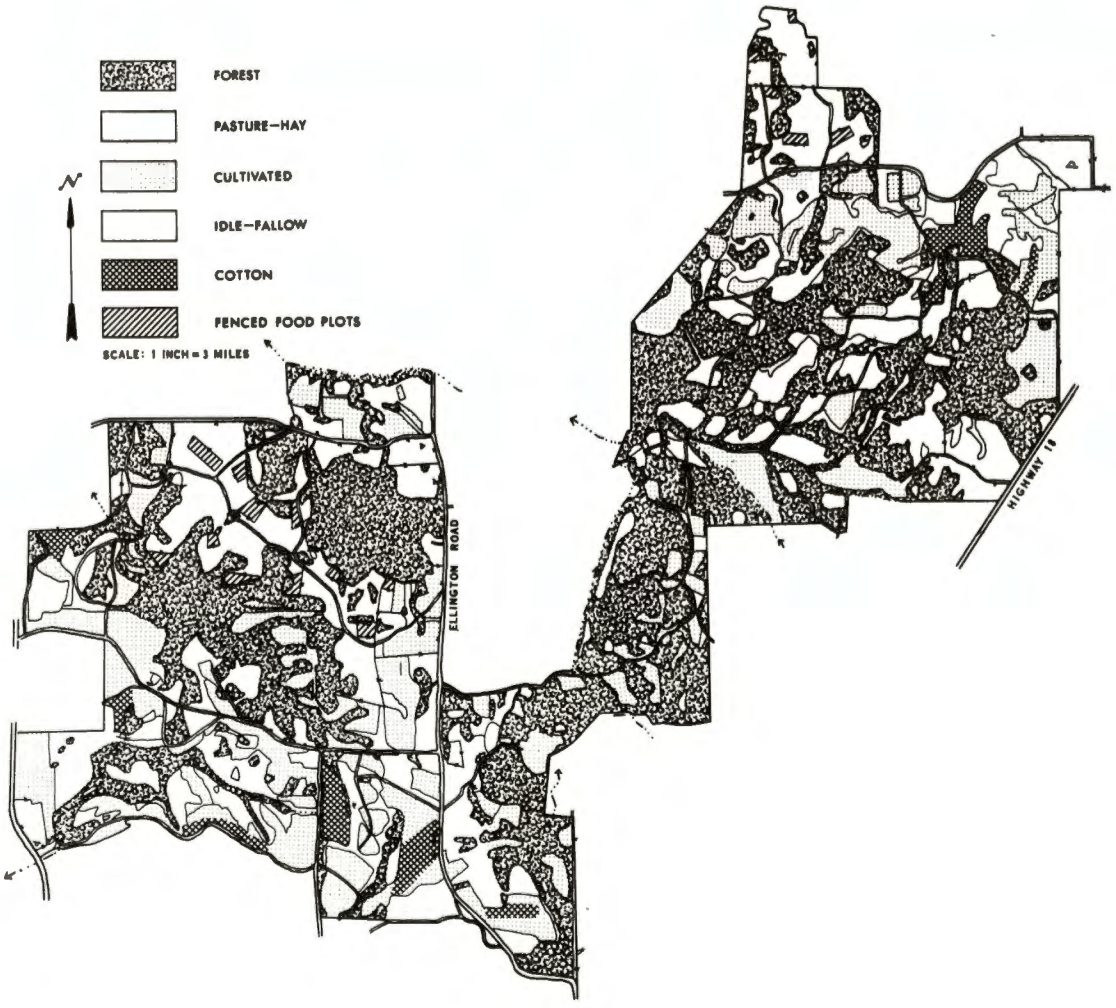


Figure 2. Vegetation types on the research area, 1967, Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Part of Fayette County is highly dissected and generally hilly, but most of it is only moderately dissected and gently rolling. The average altitude is about 400 feet above sea level (range about 270 feet near Galloway to about 600 feet near La Grange) (Flowers, 1964).

Drainage is well established in Fayette-Hardeman counties. Streams are numerous, although many of the smaller streams are intermittent. The North Fork of the Wolf River is the only permanent stream on the Plantation. Both counties are in the Mississippi River watershed, and all the larger streams flow westward.

III. CLIMATE

The average annual precipitation of 53.1 inches for Fayette County is somewhat higher than the statewide average of 50.5 inches. More precipitation occurs in winter and early spring than in other seasons. January has the highest average rainfall, 6.18 inches and October has the lowest average rainfall, 2.78 inches (Table 1) (Flowers, 1964).

During the study the highest monthly rainfall occurred in July, 1967 with 8.14 inches and December, 1967 with 8.52 inches. The lowest monthly rainfall occurred during June, 1967 with 0.36 inches and June, 1966 with 1.10 inches (Table 2) (U. S. Weather Bureau, 1966, 1967, 1968, and 1969). The heaviest snowfall during the study occurred on March 22, 1968. Memphis recorded 17.3 inches, Moscow 14.0 inches, Ames Plantation 12.0 inches, and Bolivar, 9.0 inches, during the same storm (U. S. Weather Bureau, 1968).

Table 1. Temperature and precipitation from 1931 through 1955 at Moscow, Fayette County, Tennessee (elevation 352 feet; latitude 35°05" N., longitude 89°24" W.).

	Temperature[a] °F			Precipitation[b] Inches			
Month	Average	Absolute maximum	Absolute minimum	Average	Minimum monthly	Maximum monthly	Average snowfall
January	42.6	80	-11	6.18	1.28	14.98	2.6
February	44.8	81	-14	5.44	1.39	14.23	1.1
March	52.4	86	10	5.76	1.48	12.32	0.2
April	61.2	90	27	4.53	.93	10.62	0
May	69.2	98	33	4.11	.41	11.99	0
June	77.3	107	44	4.21	.00	11.34	0
July	80.3	106	46	4.01	1.08	8.99	0
August	79.6	106	45	3.51	.48	8.42	0
September	72.9	105	29	3.08	.08	10.71	0
October	62.4	95	21	2.78	.00	7.98	0
November	50.4	86	5	4.38	.90	11.79	0.2
December	43.3	80	2	5.13	1.17	12.89	0.5
Year	61.4	107	-14	53.12	.00	14.98	4.6

[a]Temperature measured 4.5 feet above the ground in standard instrument shelters of the U. S. Weather Bureau. Average temperature is based on a record of the period 1931-1955; highest temperature and lowest temperature based on a record of the period between June, 1920 and December, 1958.

[b]Average precipitation based on a record of the period 1931-1955; snowfall based on an 18-year record between 1931 and 1952; driest months were October, 1924 and June, 1953; wettest month was January, 1937.

Table 2. Temperature and precipitation from June, 1966 through May, 1969 at Bolivar, Hardeman County, Tennessee.

Month	Temperature °F			Precipitation Inches			
	Average	High average	Low average	Average	Minimum monthly	Maximum monthly	Average snowfall
January	39.3	52.0	27.1	4.47	2.33	6.26	1.7
February[a]	38.9	54.2	24.8	2.63	1.36	3.85	0.7
March	49.5	68.7	31.3	4.29	2.35	6.46	3.0
April	62.3	76.9	48.6	5.75	4.75	6.30	0
May	67.7	82.4	55.2	3.84	2.88	5.08	0
June	75.7	89.1	60.7	1.00	0.36	1.53	0
July	78.3	94.7	64.6	4.14	1.34	8.14	0
August	75.8	92.0	61.8	4.42	1.82	6.19	0
September[a]	68.9	83.0	55.0	3.93	2.43	6.69	0
October	58.1	73.4	42.9	2.96	2.02	3.45	0
November	48.7	62.6	32.0	3.55	2.06	6.17	T
December	41.4	53.7	29.5	6.62	4.95	8.52	0.3
Year	58.7	73.6	44.5	47.60	0.36	8.52	5.7

[a]September, 1967 and February, 1969 figures were from the Moscow weather station.

Southwestern Tennessee generally has hot summers and mild winters. During summer in Fayette County the average daily minimum temperature is between 65° and 70°F and average daily maximum is near 90°F. In winter the average daily temperature ranges from 32° to between 50° and 55°F (Flowers, 1964).

During the study the highest monthly average maximum temperature occurred in July, 1966 with 94.7°F. The lowest monthly average minimum temperature occurred in February, 1968 with 24.8°F (Table 2) (U. S. Weather Bureau, 1968).

The growing season, or the period between the last freezing temperature in spring and the first in fall, ranges from about 200 days in the southeastern part of Fayette County to about 220 days in the northwestern part. At Moscow, the average date of the last freezing temperature in spring is April 2 and that of the first freezing temperature in fall is October 24 (Flowers, 1964).

IV. SOILS

The soils of Fayette County were formed from three general kinds of material. These were Coastal Plain sediment, loess, and alluvium. The Coastal Plain material is made up of marine sediment, sandy in texture; loess is made up of silty windblown material; and the alluvium is material that washed from nearby uplands (Flowers, 1964).

When the glaciers melted in the north, flooding increased and each time the water receded, bottoms along the Mississippi River were exposed. Winds from the west picked up loose silt from these flood

plains and deposited the soil in other counties, such as Fayette and Hardeman.

Since the silt was blown from the west, the loess in Fayette County is deeper than in Hardeman County. The loess in Fayette County has an average depth of about 12 feet in the western part of the county and about 7 feet in the eastern part (Flowers, 1964). The eastern portion of Hardeman County was originally covered by 6 to 10 feet of loess; now loess occurs only in well protected woodlands (Shelby, personal communication).

Where poor land-use practices have removed the vegetation, erosion from wind and water has removed the loess from the moderate and steeper slopes and deposited it on the more gentle slopes. Deep gullies have formed where poor land-use practices were not checked in time.

The research area is in the Loring-Memphis-Lexington-Ruston soil association. The association is typically rolling to hilly soils in loess of variable thickness (3-1/2 to 8 feet), or in sandy materials of the Coastal Plain (Flowers, 1964).

V. VEGETATION

Some of the finest hardwoods in Tennessee once covered the uplands and bottomlands of Fayette County. As early as 1890 the timber in the western part of the county was logged in scattered operations. On the uplands were many kinds of trees including yellow-poplar (*Liriodendron tulipifera*), white and red oaks (*Quercus* spp.), black walnut (*Juglans nigra*), and hickory (*Carya* spp.). Along the bottomlands were oak, cottonwood (*Populus deltoides*), cypress (*Taxodium distichum*),

sweetgum (Liquidambar styraciflua), hickory and beech (Fagus grandifolia) (Flowers, 1964).

Planting pines (Pinus spp.) has helped slow erosion caused from extensive cultivation, overgrazing, and wildfires. These practices had materially reduced the dense protective vegetation on very erodable soils.

Fields used for agricultural crops remained about the same every year on the study area. However, approximately 100 acres of pasture land was converted to soybean production during the study. Cotton (Gossypium sp.) is normally grown in the same field year after year. Winter wheat (Triticum aestivum) is rotated with soybeans (Glycine max) and corn (Zea mays) in a double cropping program.

When disked field borders or cropped fields are permitted to remain idle plants such as buttonweed (Diodea teres), common ragweed (Ambrosia artemesufolia), lanceleaf ragweed (A. bidentata), broom-sedge (Andropogon virginicus), bidens (Bidens spp.), Johnson grass (Sorghum halepense), panicum (Panicum spp.), and crabgrass (Digitaria spp.) take over during the first successional stage. Within three years the following woody plants begin invading the field: blackberry (Rubus spp.), winged sumac (Rhus copallina), smooth sumac (R. glabra), plum (Prunus angustifolia), honeysuckle (Lonicera japonica), rose (Rosa spp.), trumpet creeper (Campsis radicans), and Virginia creeper (Parthenocissus quinquefolia). The first tree species to begin invading idle fields include oaks, winged elm (Ulmus alata), sassafras (Sassafras albidum), persimmon (Diospyros virginiana) and Eastern red cedar (Juniperus virginiana).

Oaks, hickory, American elm (Ulmus americana), hackberry (Celtis occidentalis) and shortleaf pine (Pinus echinata) are common in mature forests. Loblolly pine (P. taeda) plantations on the research area are 12 to 14 years old and have a complete canopy which excludes sunlight and most understory growth.

Management techniques used for maintaining early stages of plant succession include controlled burning and disking. In addition to the plants mentioned above, partridge pea (Chamaecrista spp.), beggartick (Desmodium spp.), goldenrod (Solidago spp.), and legumes occur on disturbed areas.

VI. AGRICULTURAL TRENDS

In 1822 the first white settlers arrived from Virginia in the area that is now Fayette County. Soils and climate were suitable for cotton and there has been substantial cotton acreage planted since the county was settled.

The farms in this association are large general farms with cash crops of cotton, corn, soybeans, and sorghum (Sorghum vulgare). Chief plants grown for hay and pasture are annual lespedezas (Lespedeza stipulacea and L. striata), fescue (Festuca spp.), ladino clover (Trifolium ladino), alfalfa (Medicago sativa), and small grains. According to the U. S. Department of Commerce (1972), the number of farms in Fayette County has been declining since 1929. The average size of a farm has been gradually increasing (108.9 acres in 1959). Many formerly cultivated, severely eroded areas on hillsides are now idle or have

been planted to pine trees. Many areas on hillsides, however, have never been cleared and are in hardwoods.

Some important agricultural trends have occurred in Fayette County. Corn has decreased from 63,149 acres in 1879 to 20,820 acres in 1969. Cotton has decreased from 92,231 acres in 1879 to 32,384 acres in 1969. In contrast, soybean acreage has increased from 2,629 in 1939 to 56,300 in 1969 (Table 3).

Table 3. Agricultural crop acreage and number of farms in Fayette County, Tennessee, from 1897 to 1969.

	1879	1919	1939	1954	1959	1964	1969
Corn	63,419	58,416	42,538	45,529	32,513	27,801	20,820
Sorghum	(1)	(1)	885	3,346	1,884	664	322
Small grain	7,398	1,404	20	2,551	504	1,047	2,570
Soybeans	(1)	(1)	2,629	2,595	5,284	26,573	56,300
Cotton	92,231	85,194	56,952	47,190	41,479	41,562	32,384
Hay	(1)	10,683	24,677	11,633	14,646	15,806	10,261
Number of Farms	(1)	(1)	5,669	4,188	3,451	2,495	1,442

NOTE: (1) represents data not available.

SOURCE: U. S. Department of Commerce, 1880, 1920, 1940, 1955, 1960, 1965 and 1972.

CHAPTER III

METHODS

I. COLLECTION

Bobwhite quail were collected by shooting. Laessle and Frye (1956) found that crops of all birds of a covey were essentially similar, thus the writer collected one or two birds per covey during any one month. This insured a sample from a large number of coveys and cover types on the research area. Quail were collected after the morning feeding period to insure that all birds had ample opportunities to feed.

II. PRESERVATION AND STORAGE

Crops either were removed immediately or the whole quail was frozen until a later date. Crop contents were weighed, volumetric measurements taken, and plant contents were oven dried at 70°C before being placed in glass vials. Animal contents were stored in glass vials in 70 percent ethyl alcohol.

III. CROP ANALYSIS

The analysis of crop content was similar to that described by Korschgen (1948), whereby the amount of each food item was estimated by volume displacement in water. The total volume of food was measured by water displacement to the nearest 0.1 cc.

A zoom lens, binocular, dissecting microscope was helpful in counting and in identifying the food items. Plant food items in the crops were identified to the lowest taxon possible. Animal foods usually were identified only to order. The following characteristics were determined for each food item eaten.

Relative volume - total volume of one item as a percentage of the total volume of all items (grit excluded).

Relative frequency - number of occurrences of one item as a percentage of the total occurrences of all items.

Relative number - number of individuals of one item as a percentage of the total number of individuals of all items.

Frequency of occurrence - percentage of crops in which an individual food occurred.

Food items contributing a volume of 0.01 percent or more are listed in Appendix A (Table 16). Forty-three foods contributing trace amounts (less than 0.01 percent volume) are listed in Appendix A (Table 17). A complete list of common and scientific names is presented in Appendix B (Table 18).

The following literature was used to identify food items, and to provide a source for common and scientific names: Britton and Brown (1913), Burch (1962), Fernald (1950), Grimm (1966), Hitchcock (1950), Jaques (1947), Martin (1954), Martin and Barkley (1961), Musil (1963), Petrides (1958), Sargent (1965), and Underwood (1965).

The following literature was used as a guide to aging juvenile quail: Haugen (1955), Murray and Frye (1964), Stanford (1952), and Stoddard (1931:72-83).

The seed collection of the Forestry Department, The University of Tennessee was also used for seed identification. The following individuals aided in identifying several seeds. Mr. Leroy J. Korschgen, Research Biologist, Missouri Department of Conservation; Mr. James L. Buckner, Assistant Project Leader, Wildlife Research, International Paper Company; and Mr. Ron Simpson, Game Biologist, Georgia Game and Fish Commission.

CHAPTER IV

RESULTS AND DISCUSSION

A total of 672 bobwhites were collected during December, 1966 through March, 1969 (Table 4). Crops of 631 birds contained food; the remaining 41 were empty. Males contributed 54.1 percent of the birds collected while females accounted for 45.9 percent.

The number of adult quail collected monthly ranged from 6 to 116 and averaged 24 birds per month. Quail 16 weeks old and older were considered adults for the purpose of this food habits study. All quail under 16 weeks of age were considered juveniles (young-of-the-year). The number of juvenile quail collected per month ranged from 1 to 22, and averaged 13 birds per month during June through November of each year.

Johnson (1941) and Korschgen (1948) stated that a minimum of 100 and preferably 200 or more crops should be obtained from an area of similar plant growth for any one season in order to obtain an adequate representation of the foods quail are utilizing. Davison (1940) indicated that a minimum of 50 crops and preferably 100-200 are needed to determine the importance of foods in a single locality. Judged by these criteria, all seasons except fall were adequately represented in my study.

Table 4. Bobwhite quail collected on Ames Plantation, Hardeman-Fayette Counties, Tennessee, from December, 1966 through March, 1969.

Months	Adult[a]	Juvenile	Total
1966			
December	54		54
1967			
March	23		23
April	16		16
May	16		16
June	15	1	16
July	16	21	37
August	17	22	39
September	15	19	34
December	41		41
1968			
January	36		36
February	24		24
March	23		23
April	18		18
May	22		22
June	15		15
July	17	10	27
August	12	17	29
September	18	20	38
October	6	6	12
November	7	2	9
December	116		116
1969			
January	19		19
March	8		8
TOTAL	554	118	672

[a]Quail 16 weeks old and older were considered adults for the purpose of this food habits study.

I. FOOD HABITS

Annual Diet

Soybeans (Glycine max) comprised 38.1 percent by volume of all foods eaten by bobwhites on the study area (Table 5). Other important foods were corn (Zea mays) (6.0 percent), Johnson grass (Sorghum halepense) (5.2 percent), grasshoppers (Orthoptera) (4.2 percent), browntop millet (Panicum fasciculatum) (3.4 percent), and beetles (Coleoptera) (3.3 percent).

Soybeans are an increasingly important crop throughout the southeast; since 1929 acreage devoted to this crop in 12 southeastern states has increased 1,080 percent (Figure 3). In Tennessee soybean acreage more than doubled in the last decade, increasing from 492,000 acres in 1960 to 1,293,000 in 1970. The acreage of soybeans grown in Fayette County increased 1,022 percent from 1959 to 1969 according to U. S. Department of Commerce (1972) (Table 3, page 14). Thirteen percent of the study area was planted to soybeans (Table 6).

Previous food habit studies have indicated soybean consumption by quail has increased with the increasing importance of soybeans as an agricultural crop. Soybeans did not occur in bobwhite crops examined by Judd (1905) in the early 1900's. In the 1930's and 1940's soybeans were reported occasionally, but did not make up a substantial part of the diet of quail (Handley, In Stoddard, 1931, pp. 113-165; Martin, 1935; Gray, 1938; Errington, 1939; Johnson, 1941; Wright, 1941; Davison, 1942; Lett and Pearson, 1942; Cady, 1944; Allen and Pearson, 1945a, 1945b, 1945c; Baldwin and Handley, 1946; Johnson and

Table 5. Major foods from crop analysis of 672 bobwhite quail collected on the Ames Plantation, Fayette-Hardeman Counties, Tennessee, December, 1966 - March, 1969.

Food Items	Volume		Frequency			Number	
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number
PLANT FOODS							
Soybeans	676.6	38.05	254	37.57	6.16	4,444	2.76
Corn	106.5	5.99	56	8.28	1.36	954	0.60
Johnson grass	91.9	5.17	82	12.13	1.99	15,236	9.45
Browntop millet	60.9	3.43	35	5.18	0.85	15,848	9.83
Sassafras	43.2	2.43	47	6.95	1.14	328	0.20
Black cherry	41.0	2.30	59	8.73	1.43	377	0.23
Wheat	38.8	2.18	23	3.40	0.56	1,667	1.03
Cowpeas	36.9	2.08	18	2.66	0.44	230	0.14
Wood sorrell	31.9	1.79	109	16.12	2.64	2,703	1.68
Common Lespedeza	31.2	1.75	162	23.97	3.93	11,393	7.06
Acorn	29.1	1.64	35	5.18	0.85	115	0.07
Green leafy vegetation	28.8	1.62	119	17.60	2.96	1,289	0.79
Violet	23.6	1.33	34	5.04	0.83	3,308	2.05
Smooth crabgrass	22.9	1.29	78	11.54	1.89	23,073	14.30
Buckwheat	22.1	1.24	20	2.97	0.49	719	0.44

Table 5 (continued).

Food Items	Volume		Frequency			Number	
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number
Other plant foods	199.9	11.25	1,489		36.06	70,974	43.85
SUB-TOTAL	1485.3	83.54	2,620		63.58	152,658	94.48
ANIMAL FOODS							
Grasshoppers	74.9	4.21	149	22.04	3.61	518	0.32
Beetles	57.9	3.26	205	30.33	4.97	1,695	1.05
Snails	33.1	1.86	130	19.35	3.24	1,453	0.89
Insect larvae	30.2	1.71	130	19.35	3.24	563	0.35
Ants	24.0	1.35	212	31.36	5.14	1,855	1.15
True bugs	20.5	1.15	134	19.92	3.25	794	0.49
Bugs	19.6	1.10	145	21.45	3.52	1,042	0.65
Other animal foods	32.6	1.82	397		9.45	987	0.62
SUB-TOTAL	292.8	16.46	1,502		36.42	8,907	5.52
TOTAL	1788.1	100.00	4,122		100.00	161,565	100.00

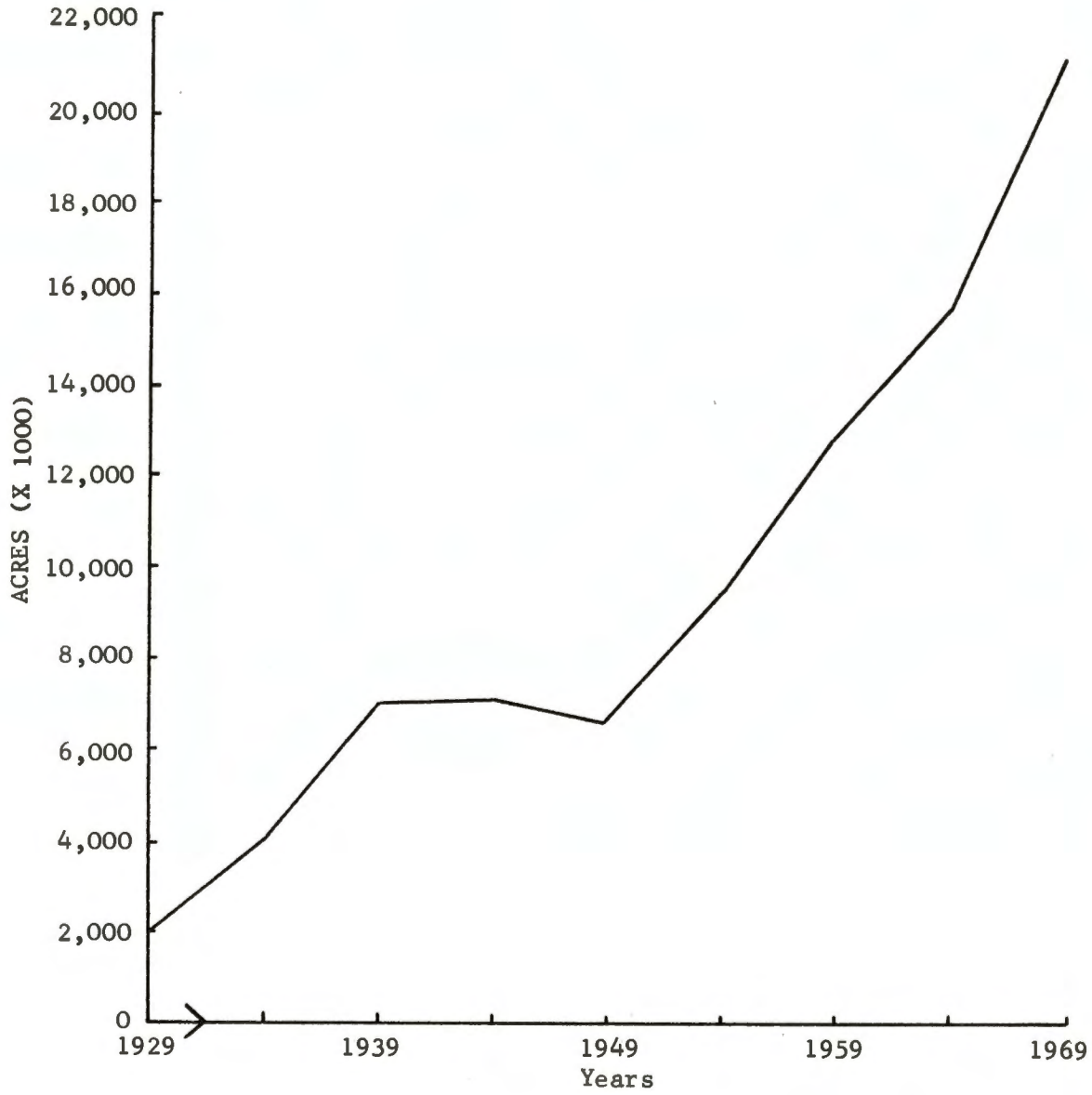


Figure 3. Soybean production in twelve southeastern states from 1929 to 1969.

SOURCE: U. S. Department of Commerce, Bureau of the Census.

Table 6. Land use types on the study area Ames Plantation, Fayette-Hardeman Counties, Tennessee, 1967.

Land-Use Type	Acres	Percent
Forest	1,588.7	37.3
Idle	665.2	15.6
Soybeans	556.1	13.0
Pasture	517.6	12.1
Hay	220.6	5.2
Corn	200.8	4.7
Fallow	143.7	3.4
Cotton	117.1	2.8
Field border	105.2	2.5
Winter wheat	51.9	1.2
Fenced food plots	53.0	1.2
Unfenced food plots	33.4	0.8
Ponds and houses	9.3	0.2
Total	4,262.6	100.0

Pearson, 1948; Korschgen, 1948; Allen and Pearson, 1949a, 1949b; and Johnson and Pearson, 1949).

However, since about 1950 soybean acreage has been increasing at a rate of nearly 16 percent per year. Paralleling its importance as an agricultural crop, the soybean has appeared with increasing frequency and abundance in the diet of quail (Stollberg and Hine, 1952; Reeves, 1954; Larimer, 1960; and Barnes and Klimstra, 1964).

On Ames Plantation soybeans were a preferred food, comprising 38 percent of the diet by volume and occurring in 38 percent of the quail crops. Though occupying only 13 percent of the study area, soybean fields were widely distributed throughout, making soybeans readily available as a source of food.

Corn ranked second in volume consumed and occurred in 8 percent of the crops (Table 5, page 21). Corn acreage has been steadily declining in Fayette County since 1879 yet it remains an important food for quail on Ames Plantation.

Johnson grass and grasshoppers were important by-products of cultivated land and crops (Table 5). Johnson grass was widely distributed on the Ames Plantation and was prevalent in cultivated fields, disturbed field borders, food plots, fallow, and idle lands. Grasshoppers were abundant where green, succulent plants were available for food, such as burned areas, certain cultivated crops, field borders, and food plots.

Food plots planted for quail were an important source of food on the study area. Browntop millet, cowpeas (Vigna sinensis), buckwheat (Fagopyrum esculentum), milo (Sorghum vulgare), bicolor

lespedeza (Lespedeza bicolor), and German millet (Setaria italica) together contributed 7.6 percent of the food consumed by bobwhites on the study area (Table 5, page 21, and Appendix A, Table 16). Browntop millet was the fifth most important quail food on the study area despite a very limited distribution (0.2 percent of the study area).

Seasonal Dietary Patterns

Winter (December - February). During three winter seasons 290 quail were collected from the research area; these birds consumed 51 different food items.

Soybeans were the most important food during all three winter seasons, ranging from 62.6 to 80.0 percent each year, and contributing 71.1 percent of all foods during this season (Table 7). Soybeans occurred in 57.2 percent of the crops. Other important winter foods were corn (9.7 percent), Johnson grass (4.4 percent), common lespedeza (Lespedeza striata) (3.0 percent), and acorns (Quercus spp.) (2.4 percent).

The use of acorns was quite variable, ranging from 22.2 percent (1966-67) to 0.0 percent (1968-1969). The acorn crop in the fall of 1966 was a bumper crop while in 1967 and 1968 acorns were not plentiful. The increased availability of acorns probably accounted for the greater volume consumed during 1966-1967.

Soybean consumption was somewhat decreased during the same year acorns were abundant, yet remained high during all years. The use of soybeans during winter was greater than in any study the writer found reported in the literature. Soybeans comprised 22.4 percent of

Table 7. Nineteen important food items of bobwhites collected during winter, December - February, 1966-67, 1967-68, and 1968-69, on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Food Item	Percent of Volume			
	1966-67 (54)[a]	1967-68 (101)	1968-69 (135)	TOTAL (290)
PLANT FOODS				
Soybeans	62.62	80.01	64.46	71.10
Corn	0.15	5.17	14.28	9.74
Johnson grass		0.39	7.69	4.44
Common lespedeza	4.21	0.68	4.15	3.00
Acorn	22.22	0.05		2.41
Black cherry	0.60	3.31	0.09	1.21
Cowpeas	3.00	0.10	0.60	0.69
Partridge pea	1.50	0.63	0.46	0.63
Milo		1.80	0.03	0.61
Sweetgum		1.80		0.60
Common ragweed	0.45		0.83	0.52
Bicolor lespedeza		1.17	0.09	0.44
Sericea lespedeza		1.10	0.55	0.34
Smooth sumac		0.49	0.31	0.34
German millet			0.49	0.27
Green leafy vegetation	0.48	0.21	0.21	0.28
Browntop millet			0.40	0.23
Kidney bean	1.95			0.21
Other plant foods	2.80	1.56	1.64	1.69
SUB-TOTAL	99.55	97.46	99.27	98.70
ANIMAL FOOD				
Slugs	0.15	2.05	0.23	0.92
Other animal foods	0.30	0.49	0.50	0.38
SUB-TOTAL	0.45	2.54	0.73	1.30
TOTAL	100.00	100.00	100.00	100.00

[a]Sample size.

the bobwhites diet in southern Illinois during November and December (Larimer, 1960), but only 7.2 percent during January through March (Barnes and Klimstra, 1964).

Corn comprised 9.7 percent of the winter diet of quail and was present in 9.7 percent of the crops examined on the Ames study area. Corn was apparently a preferred food as only 5 percent of the study area was in corn fields. In many other regions, corn supplants soybeans as a major food item for quail during winter: Korschgen (1948)--16.8 percent; Barbour (1951)--8.9 percent; Reeves (1954)--27.4 percent; Larimer (1960)--27.8 percent; and Barnes and Klimstra (1964)--34.6 percent.

Johnson grass, an important by-product of cultivated fields, contributed 4.4 percent of the winter diet of quail on the study area, while occurring in 8.6 percent of the crops. Johnson grass was very abundant on the study area; however, it was probably not a preferred food as indicated by its low occurrence in relation to its abundance.

Several species of lespedeza comprised 3.8 percent of the diet, while occurring in 48.6 percent of the crops on the study area. Lespedeza plants were relatively abundant on the study area, though seed producing stands of this plant were scattered. Many other studies have shown lespedezas to be important as food for bobwhites: Korschgen (1948)--18.5 percent; Barbour (1951)--29.5 percent; Allen and Pearson (1949b)--33.8 percent; Hood (1955)--34.3 percent; and Cady (1944)--62.4 percent in east Tennessee. The low volume contributed by lespedezas to the bobwhite's diet on Ames Plantation probably reflects the abundance of the easily obtained soybean.

Plant foods comprised 98.7 percent of the winter diet of quail on the study area. Particularly significant were legumes, both annuals (72.0 percent) and perennials (4.4 percent). Animal foods totaled 1.3 percent with slugs (Philomycidae) constituting over two-thirds of the total animal food. All other studies of quail dietary patterns reported similar heavy reliance on plant foods during the winter.

Spring (March - May). Of 68 foods eaten during spring, soybeans ranked first even though they declined to 39.9 percent by volume (Table 8). The majority of soybeans eaten in spring came from the previous year's crops which had been harvested during late fall, as soybean planting did not begin until May each year. The continued availability of soybeans into late spring was reflected by their significance in the bobwhite's diet. The varieties used on Ames Plantation remained palatable even after being exposed to weathering and wet soil for three to five months.

Other important foods, by volume, included green leafy vegetation (6.9 percent), wood sorrell (Oxalis stricta) (6.8 percent), violet (Viola sp.) (6.1 percent), beetles (Coleoptera) (4.6 percent), snails (Gastropoda) (4.4 percent), and serinea (Serinea oppositifolia) (4.2 percent).

Corn and Johnson grass, like soybeans, declined significantly from winter to spring, perhaps indicating a decline in the availability of these foods. However, Robel (1969) found the opposite to occur in Kansas; corn increased from 4.9 percent during winter to 28.7 percent during spring. Thus perhaps the change reflected increased abundance

Table 8. Thirty-eight important food items of bobwhites collected during summer, fall, winter, and spring seasons 1966-1969, on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Food Items	Percent of Volume				
	Summer (235)[a]	Fall (21)	Winter (290)	Spring (126)	Total (672)
PLANT FOODS					
Soybeans	6.20	53.22	71.10	39.92	38.05
Corn	6.00	3.98	9.74	0.26	5.99
Johnson grass	9.05	0.82	4.44		5.17
Browntop millet	7.66	7.41	0.23	0.03	3.43
Sassafras	6.10		0.03		2.43
Black cherry	4.30	0.14	1.21	0.80	2.30
Wheat	5.49			0.03	2.18
Cowpeas	3.75	4.11	0.70	0.83	2.08
Wood sorrell	0.80	0.27		6.77	1.79
Common lespedeza	0.33	1.37	3.00	2.41	1.75
Acorn	1.21	2.33	2.41	1.04	1.64
Green leafy vegetation	0.03	0.28	0.42	6.92	1.62
Violet				6.12	1.33
Smooth crabgrass	2.95	2.74	0.02		1.29
Buckwheat	2.91	0.82	0.16		1.24
Serinea	0.01			4.17	0.91
Blackberry	1.80			0.54	0.83
Sedge	0.81			1.27	0.59
Carolina geranium	0.37			1.92	0.56
Plant galls	0.30	0.69		1.79	0.55
Partridge pea	0.07		0.63	1.35	0.54
Milo	0.75		0.61		0.51
Fall panicum	0.91	0.14	0.03		0.38
Common ragweed		4.11	0.52		0.35
Sedges	0.11			1.30	0.32
Bicolor lespedeza			0.44	0.52	0.26
Smooth sumac	0.26		0.34	0.18	0.26
Sericea lespedeza	0.06		0.34	0.39	0.22
Sweetgum		0.27	0.60		0.22
Trailing lespedeza	0.16	2.47	0.05		0.18
Other plant foods	7.09	0.56	1.82	4.90	4.57
SUB-TOTAL	69.48	85.73	98.70	83.46	83.54

Table 8 (continued).

Food Items	Percent of Volume				
	Summer (235)[a]	Fall (21)	Winter (290)	Spring (126)	Total (672)
ANIMAL FOODS					
Grasshoppers	9.44	9.46	0.06	0.29	4.21
Beetles	5.46	2.19		4.61	3.26
Snails	2.11	0.14	0.21	4.35	1.86
Insect larvae	3.56	0.14	0.02	1.24	1.71
Ants	2.51	0.69		1.50	1.35
True bugs	2.22	0.82	0.03	1.04	1.15
Bugs	2.41	0.14	0.02	0.62	1.10
Slugs	0.10	0.41	0.92	1.58	0.72
Other animal foods	2.71	0.28	0.04	1.31	1.10
SUB-TOTAL	30.52	14.27	1.30	16.54	16.64
TOTAL	100.00	100.00	100.00	100.00	100.00

[a]Sample size.

of "warm weather" food items in the more moderate southern environment at Ames Plantation.

Green leafy vegetation was the second most important food in the spring season (Table 8). This food item may be an important source of Vitamin A, and consequently may influence reproductive performance in quail (Hungerford, 1964).

Handley (1931:132) examined a small sample of quail from Ames Plantation during the 1920's and concluded that violet seeds formed an important item of food in spring. During this study, violet seeds (6.1 percent) also were important during the spring season. Availability of violets was greatest during the spring, and violet seeds did not occur in crops during any other season.

Handley (1931:133) also reported that birds collected at Ames during February through May had fed extensively on seeds and green leaves of common mouseear chickweed (Cerastium vulgatum), and on fireweed (Erechtites hieracifolia) seed during April through June. This writer found chickweed to contribute only 0.1 percent while fireweed did not occur in the crops.

Animal foods in the spring included 19 different items, and comprised 16.5 percent of the diet. Other workers also indicated that animal foods formed an important part of the spring diet of quail (Handley, 1931:124; Glading et al., 1940; Parmalee, 1953; Bishop and Hungerford, 1965; and Robel, 1969).

Summer (June - September). During two summer seasons 235 quail were collected from the research area; these birds consumed 105

different food items. Quail utilized a greater variety of food during summer than any other period. The importance of animal foods in the diet was noticeable; 30.5 percent by volume was animal matter (Table 8, page 30.).

In keeping with this trend toward animal foods grasshoppers ranked highest during summer (9.4 percent volume, 54.0 percent occurrence) (Table 8). Other important foods were Johnson grass (9.1 percent), browntop millet (7.7 percent), and soybeans (6.2 percent).

These four foods, contributing more than 30 percent of the bobwhite's summer diet, reflect the birds preference for feeding in cultivated fields during summer. All four items are common in soybean fields and in food plots planted for quail.

Johnson grass, unimportant to quail in fall and spring, was utilized frequently during the summer months. Allen and Pearson (1945a) noted that Johnson grass was not a preferred food during the fall and winter months when other foods, such as mast (oak, sweetgum, and pine), cultivated crops (peanuts, cowpeas, corn, and soybeans), and other legume seeds were available in abundance.

Fall (October - November). The fall diet of quail on this study area consisted of 14.3 percent animal and 85.7 percent plant food (Table 8). Soybeans comprised 53.2 percent by volume and occurred in 71 percent of the crops (Table 8). Grasshoppers ranked second with 9.5 percent, slightly more than during the summer season. Other important fall foods included browntop millet (7.4 percent), cowpeas (4.1 percent), common ragweed (Ambrosia artemisiifolia) (4.1 percent), and corn (4.0 percent).

The presence of recently harvested fields of soybeans heralded a marked change in the diet, from a highly varied one in summer (105 items) to a rather monotonous one in fall (32 items, dominated by soybeans).

Browntop millet and cowpeas, especially planted for quail, were important fall foods, though occurring on a very small percent of the total study area. Common ragweed was a frequently occurring plant on the study area but formed an important part of the diet only during the fall season.

Sex and Age-Related Dietary Patterns

A total of 124 adult and 110 juvenile bobwhites were collected during the summers of 1967 and 1968. Adult quail included 43 (34.7 percent) females and 81 (65.3 percent) males. The sex of 99 juveniles included 58 (58.6 percent) females and 41 (41.4 percent) males. The reproductive organs of 11 very young quail were not developed sufficiently to permit sex determination.

Dietary patterns of adult females versus adult males. The diet of female bobwhites during summer contained 63.8 percent plant foods and 36.2 percent animal foods; the diet of males was comprised of 80.1 percent plant foods and 19.9 percent animal foods (Table 9).

The physiological requirements of female quail, during the nesting season, demand a much greater intake of high protein foods than males (Nestler et al., 1944, and Nestler, 1949). Female quail in the present study apparently adjusted their diet to provide for proper protein intake during the nesting season; females consumed 16 percent

Table 9. Important foods from adult bobwhites collected during summer, 1967 and 1968 on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Food Items	Percent of Volume		
	Female (43)[a]	Male (81)	Total (124)
PLANT FOODS			
Johnson grass	6.78	9.87	8.44
Soybeans	5.68	8.27	7.07
Browntop millet	7.33	6.21	6.70
Wheat	5.92	6.51	6.23
Corn	6.69	5.60	6.08
Black cherry	1.14	9.49	5.77
Cowpeas	4.01	5.14	4.61
Buckwheat	6.19	2.25	4.03
Smooth crabgrass	3.23	4.30	3.81
Sassafras	3.37	3.58	3.48
Blackberry	2.32	2.86	2.61
Bull paspalum	0.00	2.21	1.20
Sedge	0.27	1.90	1.16
Wood sorrell	1.59	0.80	1.16
White-haired panicum	0.00	2.10	1.14
Acorn	1.59	0.42	0.95
Kidney-bean	1.50	0.00	0.68
Other plant foods	6.19	8.58	7.51
SUB-TOTAL	63.80	80.09	72.63
ANIMAL FOODS			
Grasshoppers	11.25	6.78	8.83
Beetles	7.74	3.96	5.67
Insect larvae	2.41	3.24	2.85
Ants	3.78	1.26	2.40
Snails	4.69	0.23	2.25
True bugs	1.27	2.93	2.17
Bugs	2.69	0.53	1.51
Spiders	1.46	0.23	0.79
Other animal foods	0.55	0.75	0.90
SUB-TOTAL	36.20	19.91	27.37
TOTAL	100.00	100.00	100.00

[a]Sample size.

more animal matter than did males. Rosene (1969:108) stated that wild bobwhites seem to regulate their diet to include as many insects as needed to maintain higher summer protein requirements. Nice (1910) estimated that female bobwhites consumed more insects than males.

Adult females averaged 1.9 cc per crop more food than adult males (Fig. 4). Nestler et al. (1944), stated that consumption of feed increased in direct proportion to the increase in crude protein content of the diet. While the food present in a bird's crop at any single moment is not truly indicative of its total daily intake, this data suggest that during the breeding season females consumed more animal food and greater total volume of food than males.

Dietary patterns of adult versus juvenile quail. Sixty-three juvenile bobwhite quail were collected in 1967 and forty-seven juveniles were collected during the 1968 summer season. Juveniles consumed 62.4 percent plant foods and 37.6 percent animal foods while adults consumed 72.6 percent plant foods and 27.4 percent animal foods during the summer season (Tables 9 and 10).

Food habits of juvenile quail were more similar to adult hens than to adult cocks during the summer season. Juvenile quail consumed 37.6 percent animal foods, adult hens 36.2 percent, and adult males 19.9 percent (Tables 9 and 10).

In this study, juveniles consumed 10.2 percent more animal food than did adults during June through September. Anthony (1970) found animal foods comprised a larger part of the diet of juveniles (4.5 percent) than that of adult (1.2 percent) California quail (Lophortyx

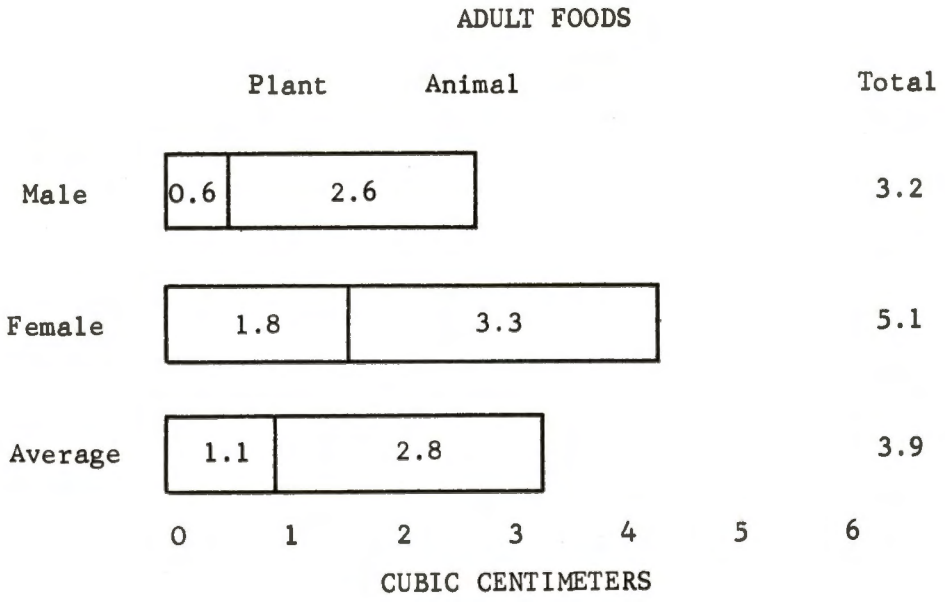


Figure 4. Average volume of food (cubic centimeters) in crops of adult bobwhites during summer on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Table 10. Important foods from juvenile bobwhites collected during summer, 1967 and 1968 on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Food Items	Percent of Volume		
	1967 (63)[a]	1968 (47)	Total (110)
PLANT FOODS			
Sassafras	17.23	6.20	11.84
Johnson grass	0.97	20.28	10.40
Browntop millet	10.95	8.52	9.77
Corn	7.69	3.89	5.83
Soybeans		8.80	4.30
Wheat	2.91	4.91	3.89
Fall panicum	1.50	2.78	2.13
Cowpeas		3.79	1.85
Acorns	3.44		1.76
Lindheimer panicum	1.86	1.02	1.45
Black cherry	0.97	1.20	1.09
Smooth crabgrass	1.59	0.56	1.09
Milo	2.03		1.04
Smooth sumac		1.67	0.81
Common lespedeza	1.32		0.68
Other plant foods	5.32	3.67	4.43
SUB-TOTAL	57.78	67.29	62.36
ANIMAL FOODS			
Grasshoppers	9.45	12.13	10.76
Insect larvae	6.80	3.43	5.15
Beetles	5.65	4.35	5.02
Bugs	6.18	2.50	4.39
Spiders	6.71	1.67	4.25
Ants	2.03	3.52	2.76
True bugs	2.03	2.69	2.35
Snails	2.21	1.39	1.81
Other animal foods	2.03	1.57	1.81
SUB-TOTAL	42.22	32.71	37.64
TOTAL	100.00	100.00	100.00

[a]Sample size.

californicus). Rosene (1969:108) stated that young quail require more protein than adults and young consume a larger percentage of insects in summer to obtain needed protein.

The four most important foods consumed by adult quail were grasshoppers, Johnson grass, soybeans, and browntop millet (Table 9, page 35). Juveniles included sassafras, grasshoppers, Johnson grass, and browntop millet as major foods in their diet (Table 10). Grasshoppers, Johnson grass, and browntop millet were present in essentially the same volume for both age groups. Adults consumed more soybeans by volume than juveniles and the occurrence of soybeans in adult crops was greater than for juveniles.

Frequency of occurrence of sassafras, was about the same for adults (18.4 percent) and juveniles (20.9 percent); however, juveniles consumed approximately 3.3 times as much as adults (Tables 9 and 10). Sassafras fruit was available, but adult quail were apparently less selective for sassafras food than juvenile quail.

Black cherry was eaten by 23.2 percent of the adults and 6.4 percent of the juveniles. On the study area, black cherry ripened during June when most broods were small or had not hatched; thus, juveniles did not have an opportunity to feed on large numbers of black cherry fruits and seeds. Black cherry comprised 4.7 percent, by volume, of the juvenile diet during July; however, after July the use of cherry fruit declined to less than 1.0 percent.

The most frequently occurring plant foods from crops of adult birds were wood sorrel (Oxalis stricta) 33.6 percent and Lindheimer panicum 25.6 percent while the most frequently occurring plant foods

from crops of juvenile birds were Lindheimer panicum 35.5 percent, and carpet weed 34.5 percent. Wood sorrel did not occur in crops of juvenile quail, while carpet weed occurred in 24.0 percent of adult quail crops. These plants were abundant on the study area; the seed and capsules were small and did not contribute much to the total volume of food eaten. For example, wood sorrel present in one-third of adult crops contributed only 1.2 percent of the food eaten by adults; Lindheimer panicum contributed only 0.6 percent. Carpet weed comprised only 0.4 percent of the juvenile diet.

Grasshoppers, beetles, ants, true bugs, and snails comprised approximately the same percent volume of food for adult and juvenile quail. Insect larvae, bugs, and spiders comprised a larger percent volume of food for juveniles than adults. Juveniles apparently selected insect larvae, bugs, and spiders for food to a greater extent than did adult quail.

The seed from forbs, wild legumes, and mast were not important quail foods during the summer season for adults or juveniles (Table 11). Fleshy fruit, grasses, and cultivated crops provided the basic source of plant food for adult and juvenile quail on the study area during the summer months.

Juvenile dietary patterns. The writer of this study examined 118 juvenile bobwhites which ranged in age from less than one week to fifteen weeks. The diet of juvenile bobwhites is presented in Table 12. Age classes one and two weeks were combined because only one two-week-old bird was collected. There were five birds in weekly age class ten and

Table 11. Important groups of plant foods consumed by adult and juvenile quail during summer 1967 and 1968 on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Plant Food Group	Percent of Volume	
	Adult (124)[a]	Juvenile (110)
Fruit	12.39	14.31
Grasses	19.30	16.37
Cultivated Crops	19.37	14.02
Food Plots	15.96	13.11
Forbs	2.55	1.44
Wild Legumes	1.63	1.17
Mast	0.95	1.76
TOTAL	72.15	62.18

[a]Sample size.

Table 12. Dietary patterns of juvenile bobwhite age groups (1-15 weeks of age) during summer and fall, 1967-1968 on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

	Percent of Volume									
Food Items	1-2[a] (11)[b]	3 (10)	4 (15)	5 (9)	6 (20)	7 (16)	8 (13)	9 (10)	10-11 (9)	12-15 (5)
PLANT FOODS										
Sassafras			1.22	4.72	8.08	31.87	6.79	9.77	10.24	
Johnson grass				7.87	4.14	21.09		25.12	13.74	
Browntop millet			12.80		8.70	5.49	21.78	15.35		4.57
Soybeans					3.93	6.04		22.33	21.29	0.57
Corn		17.55		1.57			2.86	1.86	3.77	64.57
Wheat			6.70		5.59		5.36			18.86
Acorns						0.55			9.97	6.86
Fall panicum					3.52	6.32	2.86			
Cowpeas							14.64			
Smooth crabgrass				3.94				3.49	2.42	2.86
Lindheimer panicum			3.05	7.87	2.69		1.07		0.27	
Black cherry			3.66		2.48	1.10		0.23	0.54	
Milo		8.77	5.49						2.42	
Smooth sumac								4.19		
Common lespedeza					1.24	0.28		0.46	2.16	
Buckwheat				0.79	0.62		2.14		1.62	
Panicums	5.88		1.83		0.62	0.27			0.27	
Carpet weed		3.51	0.61	0.79	0.41		0.71			
Spotted spurge				5.51					0.27	
Other plant foods			4.27	2.37	1.66	1.93	2.86	1.61	7.02	
SUB-TOTAL	5.88	29.83	39.63	35.43	43.68	65.94	61.07	84.41	76.00	98.29

Table 12 (continued).

Food Items	Percent of Volume									
	1-2[a] (11)[b]	3 (10)	4 (15)	5 (9)	6 (20)	7 (16)	8 (13)	9 (10)	10-11 (9)	12-15 (5)
ANIMAL FOODS										
Grasshoppers	17.65	24.56	22.56	21.26	8.49	9.89	10.36	6.75	19.14	1.14
Beetles	35.30	15.79	4.88	8.66	7.04	4.94	6.07	4.42	1.08	
Bugs	35.29	5.26	8.53	7.87	2.48	6.04	10.00	0.46		
Spiders		7.02	5.49	5.51	13.46	0.82	2.14	0.23		
Insect larvae	5.88	3.51	7.32	5.52	13.87	3.01	2.86	1.63		
Ants			2.44	4.72	4.97	4.94	1.07	1.40	0.27	0.57
True bugs		10.53	1.83	5.51	2.69	1.37	5.71	0.23	0.54	
Snails		3.50	4.88	3.94	2.49	1.64	0.36	0.23	1.62	
Unknown insects			1.22		0.41	1.10		0.24	0.54	
Insect egg case				1.58					0.27	
Other animal foods			1.22		0.42	0.31	0.36		0.54	
SUB-TOTAL	94.12	70.17	60.37	64.57	56.32	34.06	38.93	15.59	24.00	1.71
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a]Juvenile age classes by weeks.

[b]Sample size.

four birds in week eleven, therefore ten and eleven were combined. Age classes twelve (one bird), thirteen (two birds), and fifteen (two birds) also were combined; no fourteen-week-old birds were collected.

As juvenile birds progressed in age they utilized less animal foods and consumed more plant foods. During the first two weeks of life, the chick's diet contained 94.1 percent animal food. By the fourth week animal food decreased to 60.4 percent and by the eighth week young consumed 38.9 percent animal food (Fig. 5).

Several other authors also reported a high percentage of animal foods in the diet of birds less than two weeks old (Judd, 1905; Handley, 1931:160; Dalke, 1935; Ford et al., 1938; Beer, 1943; Peterson, 1970; and Hurst, 1972).

Handley (1931:159) stated that young bobwhites on leaving their nest begin feeding at once, though they eat only a small quantity of food during the first 24 hours after hatching. During the first two weeks of existence, young bobwhites, as with the young of practically all other land birds, consume a much greater proportion of animal food than do their parents.

When the chicks are seven weeks old the pattern of their diet resembles that of their female parent during summer with respect to the relative proportions of animal and plant foods. At nine weeks the average volume of animal food in the crops was comparable to the amount in adult quail. Handley (1931:161-162) stated that the characteristic high animal diet of young birds changed to the vegetable diet of adults during the third week. During the summer months (June, July, August, and September) animal food consumed by adults which he examined ranged

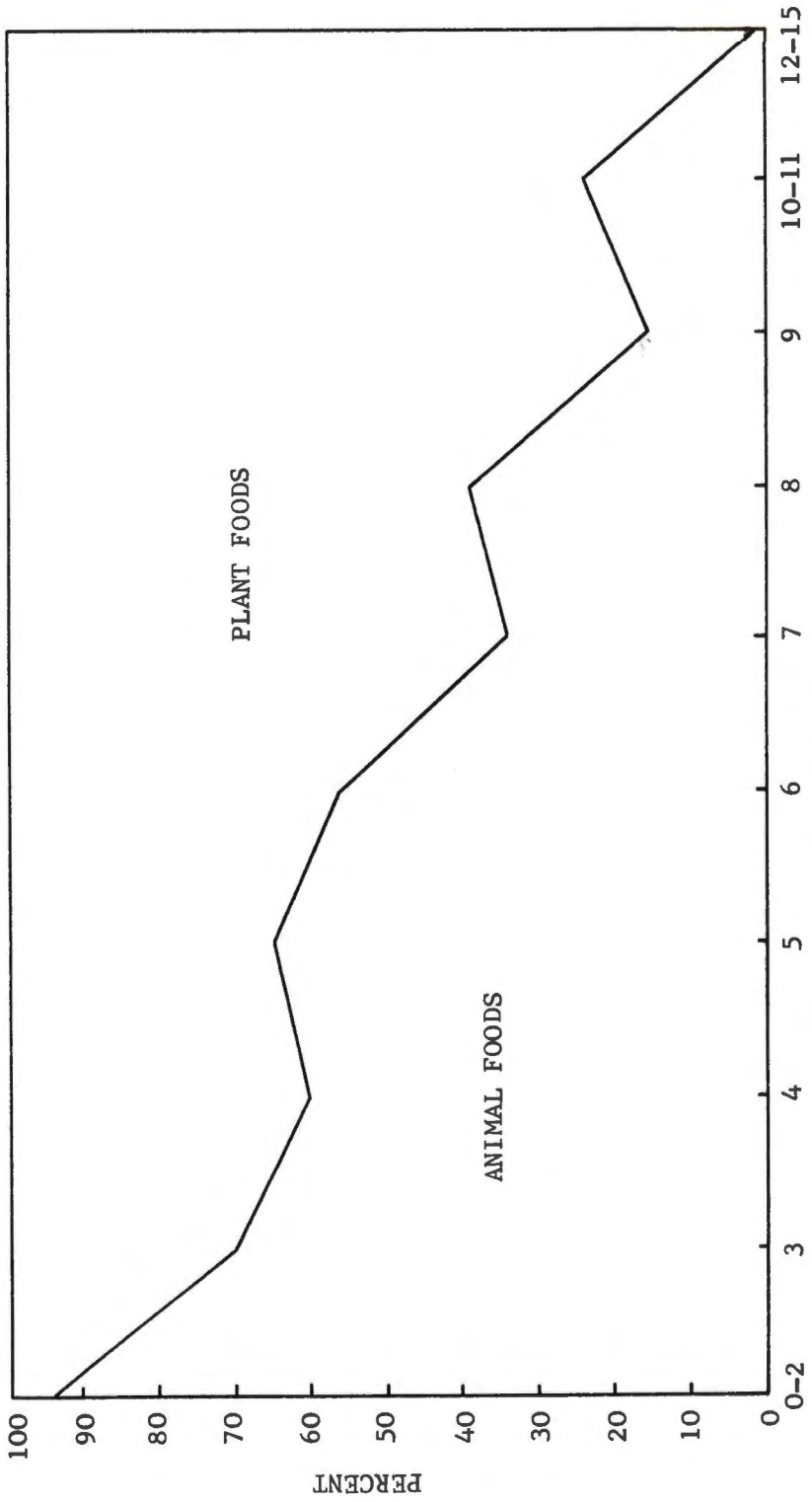


Figure 5. Relative percentages (volume) of animal foods consumed by 118 juvenile bobwhites from one to fifteen weeks old at Ames Plantation, Fayette-Hardeman Counties, Tennessee, during summer and fall, 1967 and 1968.

from 13.9 percent to 23.3 percent (Handley, 1931:124). However, Handley (1931:162) indicated by graph that the diet of three to four week-old juveniles contained 39 percent animals, by volume. If Handley had interpreted his data as this writer does, the diet of juveniles was similar to adults at approximately eight weeks rather than three weeks.

The decreased use of insects with increasing age may be due to a decline in availability or a decline in physiological requirements of older juvenile birds for high protein food. Hurst (1970) determined that peak density for most important anthropod types was during mid-June to early July, with a second peak occurring during mid-August. Menhinick (1967) concluded that arthropod total biomass was approximately the same from June 1 to October 1 in Georgia. Peak periods of biomass for arthropods in a longleaf forest type was the middle of July and the middle of August with a decline in biomass by the first part of September (Hurst, 1972).

Animal foods of juvenile quail comprised 56.1 percent of the monthly diet in July, 42.5 percent in August, 25.7 percent in September, and 27.0 percent for October through November. Though invertebrate populations were not measured, the abundance of this class of food was roughly similar for each of the summer months. Thus, the declining use of insect foods was apparently a function of feeding selectivity rather than availability.

The most important animal foods in the diet of one two-week-old juvenile quail were beetles and bugs, each comprising 35.3 percent of the diet. Grasshoppers comprised 18 to 25 percent of the juvenile diet

during the first five weeks of age. In eight of ten juvenile age sub-groups, grasshoppers ranked as the most important insect food.

Important plant foods consumed by juvenile quail during the summer season, included sassafras (11.8 percent), Johnson grass (10.4 percent), browntop millet (9.8 percent), corn (5.8 percent), soybeans (4.3 percent), and wheat (3.9 percent) (Table 10, page 38). Generally, smaller seeds such as browntop millet and Johnson grass were more heavily used by intermediate age-classes of juveniles and larger seeds such as sassafras, soybeans, and corn were used by older age-classes.

Fenced Food Plots

There were 16 fenced food plots (53 acres) on the study area. Twenty-nine of these acres (54.7 percent) were planted in 1967 and 33 acres (62.3 percent) were planted in 1968 (Table 13). The area planted to foods inside the fenced plots comprised 0.7 percent of the study area.

Food plots were planted May 24, 1967, and June 15, 1968. "Select" species planted only in fenced food plots were browntop millet, buckwheat, German millet, and milo. Soybeans and cowpeas were also planted in fenced food plots; however, they occurred outside food plots as well.

Crop contents from 443 quail were examined to determine use of "select" foods planted in food plots. Ninety-three birds collected before the food plots were planted the first year were not used in the analysis. Also, 136 quail collected by hunters, for which exact kill location was not known, were not used in the analysis. Distance from

Table 13. "Select" foods[a] grown in fenced food plots during 1967 and 1968 on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Plant Foods	1967			1968		
	Acres	Percent of planted food	Percent of study area	Acres	Percent of planted food	Percent of study area
Browntop millet	9.2	32.1	0.22	6.6	20.1	0.15
Buckwheat	4.5	15.7	0.11	5.0	15.2	0.12
Cowpeas	10.2	35.5	0.24	none		
German millet	none			1.5	4.6	0.04
Milo	4.8	16.7	0.11	1.5	4.6	0.04
Soybeans	none			18.2	55.5	0.43
TOTAL	28.7	100.0	0.68	32.8	100.0	0.78

[a]Foods planted in fenced food plots specifically for quail.

the kill location to the closest food plot was determined with aid of aerial photographs. The discrete radii and related data used for evaluating the impact of food plots on quail diets are presented in Table 14.

Seventy-one percent of the birds shot less than 50 yards from a food plot had eaten "select" foods (Table 15 and Fig. 6). Twenty-five percent of the quail collected from 51 to 300 yards contained "select" foods, and slightly less than 4 percent of the quail shot at distances from 301 to 1,300 yards contained "select" foods. Quail collected farther than 1,300 yards from any food plot had not utilized the food in these plots. Thus, birds which "lived" within 50 yards of a food plot were strongly influenced in their diet by foods planted in food plots, bobwhites living within 300 yards were moderately influenced, and quail living beyond 300 yards were virtually independent of the food plots for their livelihood. During the winter season, no quail collected at distances greater than 200 yards contained food items from the food plots. These data correlate closely with data provided by Yoho (1970) who reported that during winter quail on Ames travel an average of 427 yards each day. Quail in Kansas illustrated similar relationships to food plots: 69 percent of the birds collected within 300 meters of a food plot had fed there (Rǫbel, 1969).

The "select" foods were first utilized during the month the seed matured and fell to the ground (Fig. 7). In 1967 food plots were planted three weeks earlier than in 1968. Utilization of browntop millet and buckwheat occurred approximately four weeks earlier in 1967 than in 1968, indicating that the time of planting closely determines

Table 14. Volume (percent) of "select" foods in crops related to distance from nearest food plot on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

	Distance from Nearest Food Plot (Yards)								
	0-50	51-100	101-200	201-300	301-400	401-500	501-600	601-1300	1300 +
	(56)[a]	(19)	(29)	(8)	(13)	(14)	(6)	(103)	(195)
	(40)[b]	(6)	(6)	(2)	(1)	(1)		(3)	
Browntop millet	29.84	8.07	0.55	2.58		T		0.04	
Buckwheat	9.49	5.38	1.32	0.97	0.69				
German millet	0.92		T						
Milo	4.15								
Soybeans	19.89	19.26	4.19	c	c	c	c	c	c
Cowpeas	0.38		4.42		c			c	c
TOTAL	64.67	32.71	9.98	3.55	0.69	T		0.04	

[a]Total number of quail which were collected specified distances from the fenced food plots. Quail collected previous to the planting of food plots the first year were not considered in this total figure.

[b]Number of quail crops containing food from the fenced food plots.

[c]Quail crops contained soybeans and cowpeas in indicated distance categories; however, the birds were collected closer to other sources of these seeds than the fenced food plots.

Table 15. Presence of "select" food in crops of 443 quail collected at varying distances from food plots on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

Distance Class (Yards)	Total Birds Collected	Birds With Select Foods	
		Number	Percent
0- 50	56	40	71.4
51-100	19	6	31.6
101-200	29	6	20.7
201-300	8	2	25.0
301-400	13	1	7.7
401-500	14	0	7.1
501-600	6	0	
601-1300	103	3	2.9
1300 +	195	0	
TOTAL	443	59	13.3

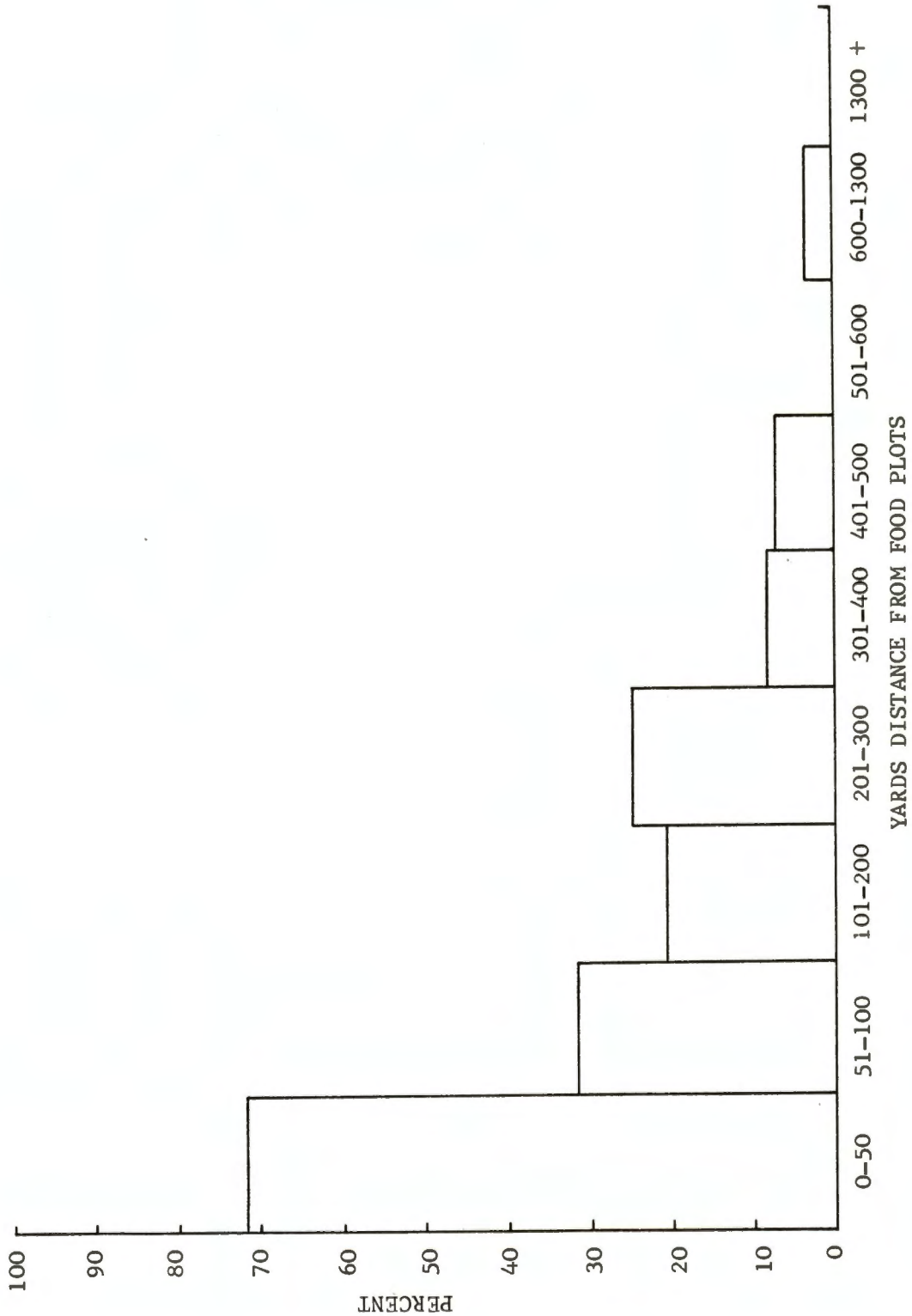


Figure 6. Percent of bobwhite crops containing food from food plots related to proximity of birds to food plots on the Ames Plantation, Fayette-Hardeman Counties, Tennessee.

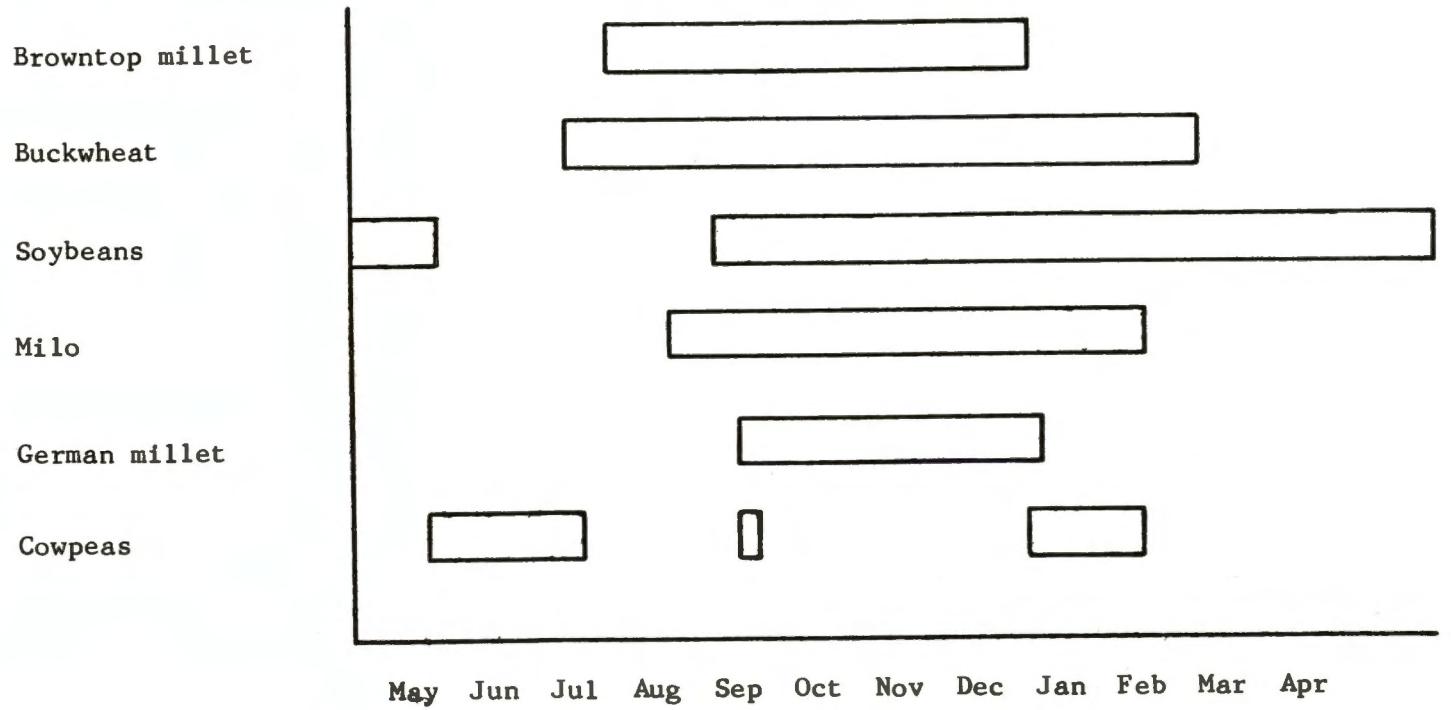


Figure 7. Availability of "select" foods as indicated by food occurring in bobwhite crops.

the approximate date these seeds will be available for utilization.

The first foods available for utilization by quail were buckwheat and browntop millet during July. Milo was first available in August while soybeans, cowpeas, and German millet were not available until September.

Browntop millet and German millet were not consumed by quail after December. Cowpeas and milo were not utilized after January; buckwheat was available through February and soybeans were available and utilized as food through late spring.

Food plots also produce an abundance of insects for young quail during the summer season. Thus, it appears desirable to plant food plots as early as possible so that insects will be available by mid-summer for juveniles feeding in the food plots.

CHAPTER V

SUMMARY

The objective of this study was to delineate dietary patterns of bobwhite quail on the Ames Plantation with respect to seasonal variation in food selection and feeding preferences of different age and sex groups. Preliminary field studies began in July, 1966 while quail collections began in December, 1966.

The study was conducted on the 18,600 acre Ames Plantation located near Grand Junction, Fayette-Hardeman Counties, Tennessee. The research area encompassed 4,263 acres which are intensively managed for quail. During the study period density of the quail population varied from about one bird per 2.0 acres to one bird per 1.3 acres.

Major land use types on the study area were forest, 37 percent; idle, field border, and fallow, 22 percent; cultivated, 22 percent; hay and pasture, 17 percent; and food plots, 2 percent.

A total of 672 bobwhites were collected during December, 1966 through March, 1969. Crops of 631 birds contained food; the remaining 41 were empty. Males contributed 54.1 percent of the birds collected while females accounted for 45.9 percent.

Quail 16 weeks old and older were considered adults for the purpose of this food habits study.

The most important foods comprising the annual diet of bobwhites on the study area were soybeans (38.1 percent), corn (6.0 percent), Johnson grass (5.2 percent), grasshoppers (4.2 percent), and browntop millet (3.4 percent).

Soybeans are an increasingly important crop throughout the southeast; since 1929 acreage devoted to this crop in 12 southeastern states has increased 1,080 percent. The acreage of soybeans grown in Fayette County has increased 1,022 percent from 1959 to 1969. The upward trend in total soybean acreage has increased the availability of soybeans as a source of food for quail.

Major winter foods consumed by quail were soybeans (71.1 percent), corn (9.7 percent), and Johnson grass (4.4 percent). During the winter of 1966-1967, after a bumper acorn crop, acorns comprised 22 percent of the diet; however, during 1967-1968 and 1968-1969, when the acorn crop was minimal, acorns did not occur in the diet.

Major foods consumed by quail during the spring were soybeans (39.9 percent), green leafy vegetation (6.9 percent), wood sorrell (6.8 percent), and violet (6.1 percent). Animal foods comprised 16.5 percent of the diet in spring.

The majority of soybeans eaten in spring came from the previous year's crops which had been harvested during late fall, as soybean planting did not begin until May each year. The continued availability of soybeans into late spring was reflected by their significance in the bobwhite's diet.

Important foods consumed by quail during the summer were grasshoppers (9.4 percent), Johnson grass (9.1 percent), browntop millet (7.7 percent), and soybeans (6.2 percent). All four food items were common in either soybean fields or food plots. Animal foods were important in the diet during the summer season, comprising 30.5 percent of the total volume.

The fall diet of quail consisted of 14.3 percent animal and 85.7 percent plant food. Soybeans comprised 53.2 percent of the food consumed by quail. Other important fall foods were grasshoppers (9.5 percent) and browntop millet (7.4 percent).

A total of 124 adult (65.3 percent males) and 110 juvenile bobwhites were collected during the summer seasons.

The diet of female bobwhites during summer contained 63.8 percent plant foods and 36.2 percent animal foods; the diet of males was comprised of 80.1 percent plant foods and 19.9 percent animal foods.

Food habits of juvenile quail were more similar to adult hens than to adult cocks during the summer season. Juvenile quail consumed 37.6 percent animal foods, adult hens 36.2 percent, and adult males 19.9 percent.

The four most important foods consumed by adult quail were grasshoppers (8.8 percent), Johnson grass (8.4 percent), soybeans (7.1 percent), and browntop millet (6.7 percent). Juvenile foods included sassafras (11.8 percent), grasshoppers (10.8 percent), Johnson grass (10.4 percent), and browntop millet (9.8 percent).

Fleshy fruits, grasses, and cultivated crops provided the basic source of plant food for quail on the study area during the summer months.

The writer examined 118 juvenile bobwhites which ranged in age from less than one week to fifteen weeks. During the first two weeks of life, the chick's diet contained 94.1 percent animal food. As juvenile birds progressed in age they utilized less animal foods and consumed more plant foods. By the fourth week animal food decreased to

60.4 percent and by the eighth week young consumed 38.9 percent animal food. At eight weeks the diet of juveniles was similar to that of adults.

Crop contents from 443 quail were examined to determine use of "select" foods planted in food plots. Seventy-one percent of the birds shot less than 50 yards from a food plot had eaten "select" foods. Twenty-five percent of the quail collected from 51 to 300 yards contained "select" foods. Birds which "lived" within 50 yards of a food plot were strongly influenced in their diet by foods planted in food plots, and quail living within 300 yards were moderately influenced. During the winter season, no quail collected at distances greater than 200 yards contained food items from the food plots.

The time of planting certain foods, such as browntop millet and buckwheat, closely determines the approximate date these seeds will be available for utilization.

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APPENDICES

APPENDIX A

Table 16. All food items (except trace amounts)[a] occurring in crops of 672 bobwhites collected on the Ames Plantation, Hardeman-Fayette Counties, Tennessee, December, 1966 - March, 1969.

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
PLANT FOODS								
Glycine max soybeans	676.6	38.05	254	37.57	6.16	4,444	2.760	22.05
Zea mays corn	106.5	5.99	56	8.28	1.36	954	0.600	3.66
Sorghum halepense Johnson grass	91.9	5.17	82	12.13	1.99	15,236	9.450	3.56
Panicum fasciculatum browntop millet	60.9	3.43	35	5.18	0.85	15,848	9.830	2.13
Sassafrass albidum sassafras	43.2	2.43	47	6.95	1.14	328	0.200	1.77
Prunus serotina black cherry	41.0	2.30	59	8.73	1.43	377	0.230	1.85
Triticum aestivum wheat	38.8	2.18	23	3.40	0.56	1,667	1.030	1.36
Vigna sinensis cowpeas	36.9	2.08	18	2.66	0.44	230	0.140	1.25
Oxalis stricta wood sorrell	31.9	1.79	109	16.12	2.64	2,703	1.680	2.19

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Lespedeza striata common lespedeza	31.2	1.75	162	23.97	3.93	11,393	7.060	2.80
Quercus spp. acorn	29.1	1.64	35	5.18	0.85	115	0.070	1.23
Viola sp. violet	23.6	1.33	34	5.04	0.83	3,308	2.050	1.07
Digitaria ischaemum smooth carbgrass	22.9	1.29	78	11.54	1.89	23,073	14.300	1.57
Fagopyrum esculentum buckwheat	22.1	1.24	20	2.97	0.49	719	0.440	0.86
Green leafy vegetation	17.6	0.99	119	17.60	2.89	928	0.580	1.91
Serinea oppositifolia Serinea	16.2	0.91	41	6.07	0.99	1,936	1.200	0.94
Rubus sp. blackberry	14.8	0.83	31	4.59	0.75	1,520	0.940	0.78
Lespedeza sp. leaves	11.2	0.63	28	4.14	0.68	361	0.220	0.64
Carex sp. sedge	10.6	0.59	34	5.03	0.83	7,198	4.480	0.70
Geranium carolinianum carolina geranium	10.0	0.56	59	8.73	1.43	1,463	0.910	0.98
Plant galls	9.7	0.54	57	8.43	1.38	1,272	0.790	0.95

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Chamaecrista fasciculata partridge pea	9.6	0.54	88	13.02	2.13	1,181	0.730	1.32
Sorghum vulgare milo	9.1	0.51	8	1.18	0.19	244	0.150	0.35
Panicum dichotomiflorum fall panicum	6.7	0.38	39	4.77	0.95	6,324	3.920	0.65
Ambrosia artemisiifolia common ragweed	6.2	0.35	40	5.92	0.97	964	0.600	0.65
Panicum lindheimeri Lindheimer panicum	6.1	0.34	75	11.09	1.82	5,817	3.610	1.06
Paspalum boscianum bull paspalum	5.8	0.32	10	1.48	0.25	2,546	1.580	0.28
Cyperus sp. flat sedges	5.8	0.32	45	6.66	1.10	10,959	6.800	0.70
Panicum villosissimum white-haired panicum	5.6	0.31	11	1.63	0.27	2,165	1.340	0.29
Phaseolus vulgaris kidney-bean	5.5	0.31	4	0.59	0.10	35	0.020	0.20
Lespedeza bicolor bicolor lespedeza	4.7	0.26	12	1.78	0.29	619	0.370	0.27
Rhus glabra smooth sumac	4.6	0.25	39	5.77	0.95	169	0.100	0.59

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Lespedeza cuneata sericea	4.0	0.22	50	7.40	1.21	1,559	0.970	0.71
Liquidambar styraciflua sweetgum	3.9	0.22	21	3.11	0.51	355	0.220	0.36
Ranunculus abortivus smallflower buttercup	3.9	0.21	4	0.59	0.10	3,532	2.190	0.16
Scleria pauciflora few flowered nutrush	3.6	0.20	22	3.25	0.53	684	0.410	0.36
Unk flowering head	3.3	0.18	20	2.97	0.48	202	0.120	0.33
Lespedeza procumbens trailing lespedeza	3.2	0.17	44	6.15	1.08	708	0.430	0.61
Lespedeza sp. lespedeza seeds	3.1	0.17	18	2.66	0.44	637	0.390	0.30
Toxicodendron radicans poison ivy	2.4	0.13	8	1.18	0.20	83	0.050	0.16
Desmodium sp. tick-trefoil	1.9	0.11	31	4.59	0.75	224	0.140	0.42
Potentilla sp. cinquefoil	1.9	0.11	2	0.30	0.05	301	0.180	0.08
Unk seeds	1.7	0.10	53	7.84	1.29	269	0.170	0.68
Lespedeza stipulacea korean lespedeza	1.7	0.10	70	10.36	1.70	742	0.460	0.88

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Eleusine indica goose grass	1.7	0.10	23	3.40	0.56	4,317	2.670	0.32
Vicia angustifolia vetch	1.7	0.10	9	1.33	0.22	125	0.080	0.15
Setaria italica German millet	1.7	0.10	5	0.74	0.12	783	0.480	0.11
Euphorbia maculata spotted spurge	1.6	0.09	10	1.48	0.25	1,186	0.740	0.16
Ranunculus parviflora sticktight buttercup	1.6	0.09	3	0.44	0.07	660	0.400	0.08
Mollugo verticillata carpetweed	1.4	0.08	78	11.54	1.89	517	0.310	0.97
Paspalum ciliatifolium fringed paspalum	1.4	0.08	46	6.80	1.12	593	0.360	0.59
Bidens sp. beggar-tick	1.3	0.08	18	2.66	0.44	306	0.190	0.25
Panicum implicatum slender-stemmed panicum	1.2	0.07	1	0.15	0.02	1,000	0.620	0.05
Panicum huachucae Huachucae panicum	1.2	0.07	1	0.15	0.02	1,250	0.780	0.05
Panicum sp. panicum	1.2	0.07	44	6.51	1.08	652	0.400	0.56

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Lonicera japonica Japanese honeysuckle	1.0	0.05	10	1.48	0.25	39	0.020	0.15
Lonicera japonica leaves	0.9	0.05	1	0.15	0.02	24	0.010	0.04
Panicum xalapense jalapa panicum	0.9	0.05	2	0.30	0.05	299	0.180	0.05
Panicum angustifolium narrow-leaved panicum	0.9	0.05	12	1.78	0.29	304	0.190	0.17
Stylosanthes biflora sidebeak pencilflower	0.9	0.05	19	2.81	0.46	198	0.080	0.25
Ambrosia bidentata lanceleaf ragweed	0.8	0.04	1	0.15	0.02	59	0.040	0.03
Paspalum laeve field paspalum	0.8	0.04	20	2.96	0.48	194	0.120	0.26
Panicum flexile wiry witchgrass	0.8	0.04	1	0.15	0.02	242	0.150	0.03
Parthenocissus quinquefolia Virginia creeper	0.7	0.04	1	0.15	0.02	12	0.007	0.03
Gossypium hirsutum cotton	0.7	0.04	1	0.15	0.02	2	0.001	0.03
Scleria sp. nutrush	0.7	0.04	6	0.89	0.14	121	0.070	0.09

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Phytolacca americana common pokeberry	0.6	0.03	4	0.59	0.10	41	0.030	0.06
Lespedeza fructescens wand lespedeza	0.6	0.03	12	1.78	0.29	156	0.100	0.16
Myosotis virginica spring forget-me-not	0.7	0.03	17	2.51	0.41	1,098	0.680	0.22
Digitaria sanguinalis hairy crabgrass	0.5	0.03	8	1.18	0.20	606	0.370	0.11
Sida spinosa prickly sida	0.4	0.02	23	3.40	0.55	101	0.060	0.28
Lindera sp. wild allspice	0.4	0.02	1	0.15	0.02	5	0.003	0.02
Sambucus canadensis American elder	0.4	0.02	2	0.30	0.05	28	0.020	0.04
Oenothera sp. Evening primrose	0.4	0.02	2	0.30	0.05	20	0.010	0.04
Scleria ciliata fringed nutrush	0.4	0.02	3	0.44	0.07	55	0.030	0.05
Diodea teres buttonweed	0.3	0.02	21	3.11	0.51	45	0.030	0.26
Panicum anceps beaked panicum	0.3	0.02	2	0.30	0.05	26	0.020	0.03

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Setaria lutescens yellow bristlegrass	0.3	0.02	3	0.74	0.12	90	0.060	0.07
Chamaecrista nictitans sensitive pea	0.2	0.01	5	0.74	0.12	31	0.020	0.07
Cerastium sp. mouse-ear chickweed	0.2	0.01	2	0.30	0.05	7	0.004	0.03
Amaranthus sp. amaranth	0.2	0.01	8	1.18	0.20	164	0.100	0.10
Galactia sp. milk pea	0.2	0.01	14	2.07	0.34	25	0.020	0.17
Paspalum floridanum Florida paspalum	0.2	0.01	2	0.30	0.05	50	0.010	0.03
Smilax glauca greenbrier	0.2	0.01	1	0.15	0.02	1	0.001	0.02
Panicum virgatum switchgrass	0.2	0.01	1	0.15	0.02	24	0.010	0.02
Plantago sp. plantain	0.2	0.01	3	0.44	0.07	377	0.230	0.04
Digitaria filiformis slender fingergrass	0.2	0.01	1	0.15	0.02	215	0.130	0.02
Panicum malacophyllum soft leave panicum	0.1	0.01	3	0.44	0.07	7	0.004	0.04

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Salix sp. willow	0.1	0.01	1	0.15	0.02	1	0.001	0.01
Paspalum sp. paspalum	0.1	0.01	3	0.44	0.07	26	0.020	0.04
Fraxinus americana white ash	0.1	0.01	3	0.44	0.07	3	0.002	0.04
Maclura pomifera Osage-orange	0.1	0.01	1	0.15	0.02	4	0.002	0.01
Stellaria sp. starwort	0.1	0.01	2	0.30	0.05	12	0.007	0.03
Setaria verticillata bur bristlegrass	0.1	0.01	1	0.15	0.02	13	0.008	0.01
Strophostyles helvolva trailing wildbean	0.1	0.01	2	0.30	0.05	3	0.002	0.03
Cerastium viscosum sticky chickweed	0.1	0.01	9	1.33	0.22	180	0.110	0.11
Strophostyles umbellatum perennial wildbean	0.1	0.01	12	1.78	0.29	22	0.010	0.15
Setaria sp. bristlegrass	0.1	0.01	1	0.15	0.02	19	0.010	0.01
Passiflora incarnata passion-flower	0.1	0.01	1	0.15	0.02	2	0.001	0.01

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Acalypha gracilens slender copperleaf	0.1	0.01	22	3.25	0.53	161	0.100	0.26
Argemone sp. poppy	0.1	0.01	1	0.15	0.02	7	0.004	0.01
Chenopodium sp. goosefoot	0.1	0.01	4	0.59	0.10	204	0.120	0.05
Eleocharis sp. spike-rush	0.1	0.01	1	0.15	0.02	331	0.200	0.01
Leptoloma sp. witchgrass	0.1	0.01	3	0.44	0.07	83	0.050	0.04
Unknown grass	0.1	0.01	1	0.15	0.02	22	0.010	0.01
Panicum capillare common witchgrass	0.1	0.01	4	0.59	0.10	100	0.060	0.05
Panicum scribnerianum Scribner panicum	0.1	0.01	1	0.15	0.02	15	0.009	0.01
Ipomoea sp. morning glory	0.1	0.01	1	0.15	0.02	1	0.001	0.01
Smilax sp. greenbrier	0.1	0.01	1	0.15	0.02	2	0.001	0.01
SUB-TOTAL	1485.3	83.54	2,620		63.58	152,658	94.480	

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
ANIMAL FOODS								
Orthoptera Grasshoppers	74.9	4.21	149	22.04	3.61	518	0.320	3.88
Coleoptera Beetles	57.9	3.26	205	30.33	4.97	1,695	1.050	4.07
Hymenoptera Ants	24.0	1.35	212	31.36	5.14	1,855	1.150	3.19
Gastropoda Succineidae Snails	23.5	1.32	99	14.64	2.40	1,000	0.620	1.83
Lepidoptera Larvae	21.9	1.23	61	9.02	1.48	192	0.12	1.34
Hemiptera True bugs	20.5	1.15	134	19.92	3.25	794	0.49	2.17
Homoptera Bugs	19.6	1.10	145	21.45	3.52	1,042	0.650	2.27
Gastropoda Philomycidae Slugs	12.8	0.71	82	12.13	1.99	319	0.200	1.34
Arachnida Spiders	10.1	0.56	105	15.53	2.55	275	0.170	1.53
Gastropoda Polygyridae Snails	7.2	0.40	37	5.47	0.90	118	0.070	0.64

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Coleoptera Larvae	6.0	0.34	64	9.47	1.55	291	0.180	0.93
Unknown insects	5.1	0.29	72	10.65	1.75	275	0.170	0.99
Hymenoptera Bees	1.2	0.007	13	1.92	0.32	37	0.020	0.19
Millipedes Millipedes	1.1	0.06	10	1.48	0.25	21	0.010	0.15
Diptera Larvae	1.0	0.06	9	1.33	0.22	27	0.020	0.13
Orthoptera Cricket	1.0	0.06	5	0.74	0.12	5	0.003	0.09
Gastropoda Snails	0.9	0.05	19	2.81	0.46	198	0.120	0.25
Gastropoda Pupillidae Snails	0.7	0.04	24	3.55	0.58	97	0.060	0.30
Egg shell pieces	0.6	0.03	12	1.18	0.20	67	0.040	0.11
Gastropoda Zonitidae Snails	0.4	0.02	2	0.30	0.04	12	0.007	0.03
Orthoptera Larvae	0.3	0.02	6	0.89	0.14	11	0.006	0.08
Insect egg cases	0.3	0.02	2	0.30	0.05	4	0.002	0.03
Insect larvae	0.6	0.03	12	1.78	0.29	17	0.010	0.16

Table 16 (continued).

Food Items	Volume		Frequency			Number		Index Number
	Total cc	% Rel. Vol.	Times Occur.	% Freq. Occur.	% Rel. Freq.	Total No. of Items	% Rel. Number	
Diptera Flies	0.2	0.01	4	0.59	0.09	5	0.003	0.05
Gastropoda Endodontidae Snails	0.2	0.01	2	0.30	0.05	3	0.002	0.03
Gastropoda Helicellidae Snails	0.2	0.01	3	0.44	0.07	25	0.010	0.04
Hymenoptera Larvae	0.2	0.01	2	0.30	0.05	6	0.003	0.02
Lepidoptera Pupae	0.1	0.01	2	0.30	0.05	2	0.001	0.03
Unknown pupae	0.1	0.01	6	0.89	0.14	17	0.010	0.07
Centipedes Centipedes	0.1	0.01	7	1.04	0.17	8	0.004	0.09
Small mammal vertebrae	0.1	0.01	1	0.15	0.02	1	0.001	0.01
SUB-TOTAL	292.8	16.46	1,502		36.42	8,907	5.520	
TOTAL	1,778.1	100.00	4,122		100.00	161,565	100.000	

Table 17. Food items that occurred as trace amounts[a] in the crops of bobwhites collected on the Ames Plantation, Fayette-Hardeman Counties, Tennessee, December, 1966 - March, 1969.

PLANT FOOD	
Caryophyliaceae	
Silene antirrhina	sleepy catchfly
Silene sp.	catchfly
Compositae	
Iva xanthifolia	coarse sumpweed
Iva sp.	marsh elder
Krigia virginica	Virginia dwarf dandelion
Cruciferae	
Alyssum Alyssoides	alyssum
Cyperaceae	
Eleocharis obtusa	blunt spike-rush
Ericaceae	
Vaccinium sp.	blueberry
Euphorbiaceae	
Crotonopsis sp.	rushfoil
Gramineae	
Digitaria sp.	crabgrass
Glyceria striata	fowl mannagrass
Panicum boscii	Bosc panicum
Guttiferae	
Ascyrum Hypericoides	St. Andrew's Cross
Juncaceae	
Juncus sp.	rush
Leguminosae	
Amphicarpa bracteata	hog-peanut
Crotalaria sp.	rattlebox
Lespedeza stuevei	Stueves lespedeza
Robinia pseudoacacia	black locust
Strophostyles leiosperma	smooth wild bean
Trifolium sp.	trefoil clover
Vicia sp.	Vetch
Liliaceae	
Allium sp.	wild onion

Table 17 (continued).

Onagraceae	
Circaea quadrisulcata	four-furrowed Circaea
Pinaceae	
Juniperus virginiana	Eastern red cedar
Pinus echinata	shortleaf pine
Polygonaceae	
Polygonum aviculare	prostrate knotweed
Polygonum hydropiper	common smartweed
Polygonum lapathifolium	curltop smartweed
Polygonum longistylum	longstyle smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Rumex crispus	curled dock
Ranunculaceae	
Ranunculus sp.	buttercup
Rhamnaceae	
Ceanothus americanus	Jersey tea
Solanaceae	
Physalis sp.	ground-cherry
Ulmaceae	
Celtis sp.	hackberry
Verbenaceae	
Verbena sp.	verbena
ANIMAL FOOD	
Arachnida	Ticks
Dermaptera	earwig
Insecta	insect egg cases

[a]Trace amount was considered as less than 0.01 percent volume.

APPENDIX B

Table 18. A complete list of scientific and common names used in this thesis.

PLANTS	
Amaranthaceae	
Amaranthus sp.	amaranth
Anacardiaceae	
Rhus copallina	winged sumac
Rhus glabra	smooth sumac
Toxicodendron radicans	poison ivy
Bignoniaceae	
Campsis radicans	trumpet creeper
Boraginaceae	
Myosotis virginica	spring forgetmenot
Caprifoliaceae	
Lonicera japonica	Japenese honeysuckle
Lonicera japonica	Japanese honeysuckle leaves
Sambucus canadensis	American elder
Caryophyllaceae	
Cerastium viscosum	sticky chickweed
Cerastium vulgatum	mouse-ear chickweed
Cerastium sp.	chickweed
Silene antirrhina	sleepy catchfly
Silene sp.	catchfly
Stellaria sp.	starwort
Chenopodiaceae	
Chenopodium sp.	goosefoot
Compositae	
Ambrosia artemisiifolia	common ragweed
Ambrosia bidentata	lanceleaf ragweed
Bidens sp.	beggarticks
Erechtite hieracifolia	fireweed
Iva xanthifolia	coarse sumpweed
Iva sp.	marsh elder
Krigia virginica	Virginia dwarf dandelion
Serinia oppositifolia	Serinea
Solidago sp.	goldenrod

Table 18 (continued).

Convolvulaceae	
Ipomoea sp.	morning glory
Cruciferae	
Alyssum Alyssoides	alyssum
Cyperaceae	
Carex sp.	sedges
Cyperus sp.	flat sedges
Eleocharis obtusa	blunt spike-rush
Eleocharis sp.	spike-rush
Scleria ciliata	fringed nutrush
Scleria pauciflora	few flowered nutrush
Scleria sp.	nutrush
Ebenaceae	
Diospyros virginiana	persimmon
Ericaceae	
Vaccinium sp.	blueberry
Euphorbiaceae	
Crotonopsis sp.	rushfoil
Euphorbia maculata	spotted spurge
Fagaceae	
Acalypha gracilens	slender copperleaf
Fagus grandifolia	beech
Quercus sp.	oaks
Geraniaceae	
Geranium carolinianum	Carolina geranium
Gramineae	
Andropogon virginicus	broomsedge
Digitaria filiformis	slender fingergrass
Digitaria ischaemum	smooth crabgrass
Digitaria sanquinalis	hairy crabgrass
Digitaria sp.	crabgrass
Eleusine indica	goose grass
Festuca sp.	fescue
Glyceria striata	fowl mannagrass
Leptoloma sp.	witchgrass
Panicum anceps	beaked panicum
Panicum angustifolium	narrow-leaved panicum
Panicum boscii	Bosc panicum
Panicum capillare	common witchgrass
Panicum dichotomiflorum	fall panicum
Panicum fasciculatum	browntop millet
Panicum flexile	wiry witchgrass

Table 18 (continued).

Panicum huachucae	Huachucae panicum
Panicum implicatum	slender stemmed panicum
Panicum lindheimeri	Lindheimer panicum
Panicum malacophyllum	soft leaved panicum
Panicum scribnerianum	Scribner panicum
Panicum villosissimum	white-haired panicum
Panicum virgatum	switch grass
Panicum xalapense	jalapa panicum
Panicum sp.	panicum
Paspalum boscianum	bull paspalum
Paspalum ciliatifolium	fringed paspalum
Paspalum floridanum	Florida paspalum
Paspalum laeve	field paspalum
Paspalum sp.	paspalum
Setaria italica	German millet
Setaria lutescens	yellow bristlegrass
Setaria verticillata	bur bristlegrass
Setaria sp.	bristlegrass
Sorghum halepense	Johnson grass
Sorghum vulgare	milo
Triticum aestivum	wheat
Zea mays	corn
Guttiferae	
Ascyrum Hypericoides	St. Andrew's Cross
Hamamelidaceae	
Liquidambar styraciflua	sweetgum
Juglandaceae	
Carya sp.	hickory
Juglans nigra	black walnut
Juncaceae	
Juncus sp.	rush
Lauraceae	
Lindera sp.	wild allspice
Sassafras albidum	sassafras
Leguminosae	
Amphicarpa bracteata	hog-peanut
Chamaecrista fasciculata	partridge pea
Chamaecrista nictitans	sensitive pea
Crotalaria sp.	rattle box
Desmodium sp.	beggartick
Galactia sp.	milk-pea
Glycine max	soybeans
Lespedeza bicolor	bicolor lespedeza

Table 18 (continued).

Lespedeza cuneata	sericea
Lespedeza fructescens	wand lespedeza
Lespedeza procumbens	trailing lespedeza
Lespedeza stipulacea	Korean lespedeza
Lespedeza striata	common lespedëza
Lespedeza stuevei	steuves lespedeza
Lespedeza sp.	lespedeza seeds
Lespedeza sp.	lespedeza leaves
Medicago sativa	alfalfa
Phaseolus vulgaris	kidney-bean
Robinia pseudoacacia	black locust
Strophostyles helvolva	trailing wildbean
Strophostyles leiosperma	smooth wildbean
Strophostyles umbellatum	perennial wildbean
Stylosanthes biflora	sidebeak pencilflower
Trifolium ladino	ladino clover
Trifolium sp.	trefoil clover
Vicia angustifolia	narrowleaf vetch
Vicia sp.	vetch
Vigna sinensis	cowpeas
Liliaceae	
Allium sp.	wild onion
Smilax glauca	cat greenbrier
Smilax sp.	greenbrier
Magnoliaceae	
Liriodendron tulipifera	yellow-poplar
Malvaceae	
Gossypium hirsutum	cotton
Sida spinosa	prickly sida
Moraceae	
Maclura pomifera	Osage-orange
Oleaceae	
Fraxinus americana	white ash
Onagraceae	
Circaea quadrisulcata	four-furrowed Cireaea
Oenothera sp.	evening primrose
Oxalidaceae	
Oxalis stricta	wood-sorrell
Papaveraceae	
Argemone sp.	poppy
Passifloraceae	
Passiflora incarnata	passion-flower

Table 18 (continued).

Phytolaccaceae	
Phytolacca americana	common pokeberry
Pinaceae	
Juniperus virginiana	Eastern red cedar
Pinus echinata	shortleaf pine
Pinus taeda	loblolly pine
Plantaginaceae	
Plantago sp.	plantain
Polygonaceae	
Fagopyrum esculentum	buckwheat
Polygonum aviculare	prostrate knotweed
Polygonum hydropiper	common smartweed
Polygonum lapathifolium	curltop smartweed
Polygonum longistylum	longstyle smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Rumex crispus	curled dock
Portulacaceae	
Mollugo verticillata	carpetweed
Ranunculaceae	
Ranunculus abortivus	smallflower buttercup
Ranunculus parviflora	sticktight buttercup
Ranunculus sp.	buttercup
Rhamnaceae	
Ceanothus americanus	Jersey tea
Rosaceae	
Potentilla sp.	cinquefoil
Prunus angustifolia	plum
Prunus serotina	black cherry
Rosa sp.	rose
Rubus sp.	blackberry
Rubiaceae	
Diodea teres	buttonweed
Salicaceae	
Populus deltoides	cottonwood
Salix sp.	willow
Solanaceae	
Physalis sp.	ground cherry
Taxodiodeae	
Taxodium distichum	bald cypress

Table 18 (continued).

Ulmaceae	
Celtis occidentalis	common hackberry
Celtis sp.	hackberry
Ulmus alata	winged elm
Ulmus americana	American elm
Verbenaceae	
Verbena sp.	verbena
Violaceae	
Viola sp.	violet
Vitaceae	
Parthenocissus quinquefolia	Virginia creeper
Unidentified plants	Green leafy vegetation
	plant galls
	unknown flowering head
	unknown seeds
ANIMALS (INVERTEBRATES)	
Chilopoda	
Centipedes	centipedes
Diplopoda	
Millipedes	millipedes
Insecta	
Coleoptera	beetles
Coleoptera	larvae
Dermaptera	earwig
Diptera	flies
Diptera	larvae
Hemiptera	true bugs
Homoptera	bugs
Hymenoptera	ants
Hymenoptera	bees
Hymenoptera	larvae
Lepidoptera	larvae
Lepidoptera	pupae
Orthoptera	cricket
Orthoptera	grasshoppers
Orthoptera	larvae
Arachnida	
Acarina	ticks
Araneida	spiders

Table 18 (continued).

Gastropoda	
Endodontidae	snails
Helicellidae	snails
Philomycidae	slugs
Polygyridae	snails
Pupillidae	snails
Succineidae	snails
Zonitidae	snails
	unknown snails
Unidentified Invertebrates	
	insect egg cases
	unknown larvae
	unknown pupae
	unknown insects
	egg shell pieces
ANIMALS (VERTEBRATES)	
Phasianidae	
Colinus virginianus	bobwhite quail
Cyrtonyx montezumae mearnsi	mearns quail
Lophortyx californicus	California quail
Lophortyx gambelii	Gambel's quail
Perdix perdix	Hungarian partridge
Unidentified Vertebrates	
	small mammal vertebrae

VITA

Thomas Royal Eubanks, son of Royal Lewis Eubanks (deceased) and Mary (Latimore) Eubanks Baer, was born in Boise, Idaho, on April 4, 1939. He is married to the former Margaret Jane Kloss, of Boise and they have one son, Richard Royal Eubanks. He attended elementary and junior high school in Boise, and graduated from Boise High School in 1957. He entered six months active duty with the U. S. Army in October, 1957 and was honorably discharged from the U. S. Army Reserve in March, 1965. He entered Boise Junior College in 1958 and received a diploma in 1961. He entered the University of Idaho in 1961, where he received the degree of Bachelor of Science in Forestry (major--wildlife management; minor--range management) in February, 1964. He was employed as a Game Biologist on the Catoosa Wildlife Management Area by the Tennessee Game and Fish Commission from September, 1964 until June, 1966. In July, 1966 he entered The University of Tennessee on a three-year research assistantship in the Forestry Department. He was employed by the Oklahoma Department of Wildlife Conservation in October, 1969 and is presently employed in Oklahoma as a Habitat Research Biologist at the Wildlife Research Center. He received the degree of Master of Science in Wildlife Management in August, 1972 (minor--Zoology).