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FOODS OF NORTHERN BOBWHITES (*COLINUS VIRGINIANUS*) IN SOUTHEASTERN NEW MEXICO

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Although several studies (Scott, 1985) have investigated feeding ecology of the northern bobwhite (*Colinus virginianus*), none have been conducted in New Mexico. The nearest study sites have been in northwestern Texas (Leif and Smith, 1993) and western Oklahoma (Schemnitz, 1964). New Mexico is on the western edge of the range of the northern bobwhite, where population levels can fluctuate dramatically (Judd, 1905; Rosene, 1969). Knowledge of food habits of this species may help wildlife agencies to better manage this important resource. The objectives of our study were to identify and quantify food items ingested by northern bobwhites in southeastern New Mexico and to investigate sexual, age, diel, monthly, and annual variation in diet.

Our study was conducted on the Los Medaños Waste Isolation Pilot Plant site in southeastern New Mexico in conjunction with studies of lead poisoning of game birds (Best et al., 1992*a*, 1992*b*). Investigations were centered at the southeast corner of section 20 (T22S, R31E), and extended outward a distance of 8 km; the study area covered ca. 20,000 ha. Most of the area is in eastern Eddy Co., but it also extends into extreme western Lea Co. All northern bobwhites were collected in uncultivated, shinnery oak-honey mesquite (*Quercus havardii-Prosopis glandulosa*) habitat, where extensive vegetation surveys have been conducted (Best and Jackson, 1982; Cockman, 1987, 1988).

A total of 131 northern bobwhites was collected by shooting as encountered in late summer and autumn 1985 to 1987. Extensive efforts were made to collect quail during 1978 to 1988, but northern bobwhites were found only in the 3 years reported herein. For each bird, sex, age, date, and time of collection were recorded. Birds were placed on ice within 10 min of collection to minimize effects of postmortem digestion (Farner, 1960; Dillery, 1965; Sedinger, 1986); no effects of digestion were observed in crop contents. Crop contents of each bird were placed into individually labeled vials and frozen until analysis. Contents of crops were later thawed, separated by type of food, dried for 48 h at 60°C, and analyzed separately.

Food items were identified by comparison with plant samples collected at the study site and with identification manuals (Martin and Barkley, 1961; Borror and White, 1970). Insects were identified to family; seeds to genus. Seeds that could not be identified (<0.1% of the total mass of crop contents) were classed as unknowns and were not considered in statistical analyses. Insect parts that could not be identified (<0.3% of the total mass of crop contents) also were classed as unknowns and deleted from statistical analyses. No attempt was made to identify leafy vegetative material (<5% of the total mass of crop contents), but it was lumped into a miscellaneous plant material category so that our results could be compared with other studies (e.g., Lehmann, 1984).

Discriminant-function analysis was used to evaluate sexual and temporal variation in food habits. Categories of food items served as variables in the analyses; mass of each food item in individual crops served as values. Statistical analyses were conducted using SPSS 8.0 for Windows (Green et al., 1997). Empty crops (n = 11) were not included in analyses.

Acridid grasshoppers accounted for 19.5% of the total mass of food and were present in 43% of crops (Table 1). *Helianthus* was present in 43% of crops and accounted for 16.6% of total mass. Of 51 food items detected, >50% were present in amounts <1% of total mass. Overall, plant material accounted for 71% of total mass, and animal material accounted for the remaining 29%.

The most important plants on the study site by amount of total cover in autumn 1985 (with

TABLE 1—Frequency, percent frequency, combined mass, and percentage of total mass of food items in crops (n = 120) of northern bobwhites (*Colinus virginianus*) in southeastern New Mexico.

Item	Frequency	Percent frequency	Combined mass (g)	Percentage total mass
Plant material				
Amaranthaceae				
Amaranthus	4	3.3	0.054	0.1
Boraginaceae				
Lithospermum	17	14.2	0.555	0.6
Cactaceae				
Opuntia	3	2.5	0.097	0.1
Caesalpinaceae				
Caesalpinia	4	3.3	0.104	1.2
Chenopodiaceae				
Chenopodium	7	5.8	0.475	0.5
Cycloloma	4	3.3	0.118	0.1
Commelinaceae				
Commelina	20	16.7	0.791	0.9
Compositae				
Ambrosia	13	10.8	7.981	9.2
Arctium	1	0.8	1.043	1.2
Helianthus	52	43.3	14.469	16.6
Heterotheca	47	39.2	5.842	6.7
Verbesina	1	0.8	0.030	<0.1
Euphorbiaceae				
Croton	32	26.7	2.932	3.4
Euphorbia	50	41.7	10.570	12.1
Fagaceae				
Quercus	16	13.3	7.541	8.7
Gramineae				
Andropogon	12	10.0	0.189	0.2
Panicum	27	22.5	0.480	0.5
Paspalum	28	23.3	0.534	0.6
Labiatae				
Monarda	1	0.8	0.001	<0.1
Leguminosae				
Astragalus	28	23.3	1.550	1.8
Prosopis	10	8.3	2.469	2.8
Loasaceae				
Mentzelia	4	3.3	0.071	0.1
Molluginaceae				
Mollugo	1	0.8	0.071	0.1
Onagraceae				
Oenothera	1	0.8	0.278	0.3
Unknown seeds	4	3.3	0.068	0.1
Miscellaneous plant material	43	35.8	3.684	4.2

TABLE 1—Continued.

Item	Frequency	Percent frequency	Combined mass (g)	Percentage total mass
Animal material				
Acanaloniidae	12	10.0	0.077	0.1
Acrididae	52	43.3	17.012	19.5
Aphididae	1	0.8	<0.001	<0.1
Carabidae	1	0.8	0.005	0.1
Chrysomelidae	1	0.8	0.002	<0.1
Cicadellidae	15	12.5	0.129	0.2
Cicadidae	1	0.8	0.234	0.3
Coccinellidae	27	22.5	1.631	1.9
Curculionidae	7	5.8	0.382	0.4
Diptera	3	2.5	0.035	<0.1
Elateridae	3	2.5	0.108	0.1
Formicidae	40	33.3	1.141	1.3
Kermidae	14	11.7	2.508	2.9
Lygeidae	4	3.3	0.132	0.2
Margarodidae	2	1.7	0.378	0.4
Rhopalidae	1	0.8	0.014	<0.1
Scarabaeidae	7	5.8	0.085	0.1
Scutellaridae	1	0.8	0.008	<0.1
Tenebrionidae	6	5.0	0.149	0.2
Insect eggs	8	6.7	0.040	0.1
Insect larvae	13	10.8	0.219	0.3
Unknown insect	10	8.3	0.235	0.3
Acari	1	0.8	0.005	<0.1
Aranae	15	12.5	0.403	0.5
Gastropoda	1	0.8	0.062	0.1

percentage of total cover—Cockman, 1987) were: *Quercus* (9.35), *Prosopis* (2.58), *Artemesia* (2.11), *Aristida* (1.58), *Heterotheca* (1.25), *Digitaria* (1.25), *Cenchrus* (0.86), *Sporobolus* (0.74), *Triplasis* (0.55), *Yucca* (0.45), *Senecio* (0.36), *Erigonum* (0.34), *Reverchonia* (0.32), *Paspalum* (0.23), *Dalea* (0.22), *Croton* (0.20), *Salsola* (0.11), *Setaria* (0.11), *Gutierrezia* (0.10), and *Euphorbia* (0.09). Plant cover for 1986 and 1987 was not appreciably different from 1985 (Cockman, 1987, 1988).

Seeds eaten by northern bobwhites appear to be selected rather than taken as encountered. Of the 20 most important plants in terms of total cover, only *Quercus, Prosopis, Heterotheca, Paspalum, Croton,* and *Euphorbia* appeared in crops of northern bobwhites; these 6 plants made up less than half of the plant material in crops. Miscellaneous plant material accounted for 4.2% of total mass, less than the 12.7% reported for northern bobwhites in the Rio Grande Valley by Lehmann (1984) and much less than the 72% reported for northern bobwhites in southwestern Texas by Campbell-Kissock et al. (1985). Differences in miscellaneous plant material among studies may be due in part to differences in methods; the 2 papers cited reported volume of miscellaneous plant material rather than mass. The study in southwestern Texas took place during a severe drought, which may have forced northern bobwhites to consume green vegetation to compensate for low availability of seeds and insects (Campbell-Kissock et al., 1985).

Discriminant-function analyses of crop contents in our study indicated no significant differences in feeding habits by sex ($P = 0.709$) or age ($P = 0.094$). Discriminant-function analysis of crop contents based on separation into morning ($n = 86$) and afternoon ($n = 34$) collections indicated a significant difference in diet ($P = 0.025$); 87% of individuals were correctly classified as to time of collection based on crop contents. Of the most important food items, only acridid grasshoppers exhibited a significant difference (Student's *t*-test; $t =$

7.323; $P = 0.008$). The mean total mass of grasshoppers in crops collected in morning was 0.179 g, whereas mean total mass of grasshoppers in crops collected in afternoon was 0.038 g. This probably was related to cooler morning temperatures, which have been shown to make grasshoppers more sluggish and easier to catch (Chapman, 1969).

Northern bobwhites were collected in August ($n = 38$), October ($n = 69$), and December ($n = 13$). There was a significant difference in diet among these 3 months and in the mass of all major food items among years ($P < 0.001$). Monthly differences were attributed to changing availability of food items, e.g., mean mass of grasshoppers in crops decreased from 0.341 g in August to 0.057 g in October, to zero in December. This is in contrast to Lehmann (1984), who showed that northern bobwhites ate more insects in winter than in summer or autumn in southern Texas.

Annual variation in diet may be due to differences in availability of food items associated with annual differences in precipitation. Rainfall at the study site was 37.32 cm in 1985, 52.63 cm in 1986, and 30.94 cm in 1987 (NOAA, 1984–1987). Variation in availability of food items due to differences in rainfall may contribute directly to fluctuation in population levels of northern bobwhites (Schemnitz, 1964; Campbell-Kissock et al., 1985). Although extensive attempts were made 1978 to 1988, no northern bobwhites were collected before 1985; total precipitation in 1984 was 50.88 cm, which is well above average for the area (NOAA, 1984–1987). Precipitation in 1987 was more normal and populations of northern bobwhites dropped precipitously in 1988. This decline may have been due to lower availability of food items and exacerbated by the presence of other medium-sized, ground-feeding birds known to inhabit the site, e.g., mourning doves (*Zenaida macroura*; Davis, 1974, Best and Smartt, 1986) and scaled quail (*Callipepla squamata*; Best and Smartt, 1985).

Resumen—Se colectó un total de 131 codornices-cotui norteñas (*Colinus virginianus*) en el sureste de Nuevo Mexico, E. U., a finales del verano y principios del otoño, durante el periodo 1985–1987, con el objetivo de determinar los tipos y cantidad de alimento ingerido, así como evaluar la variación en hábitos alimenticios por sexo, edad, hora del día, mes y año. Las codornices fueron selectivas en el tipo de comida que consumieron, los elementos dominantes de su dieta fueron saltamontes y semillas de *Helianthus*, *Heterotheca*, y *Euphorbia*. No hubo diferencias en la dieta debidas a sexo o edad. Las codornices consumieron más saltamontes por la mañana que por la tarde, el consumo de los restantes elementos fue similar para los dos horarios considerados. Se encontraron diferencias en la dieta debidas a mes y año, las cuales pueden deberse a la variación anual en la precipitación.

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