

WINTER DIET QUALITY, GUT MORPHOLOGY AND CONDITION OF NORTHERN BOBWHITE AND SCALED QUAIL IN WEST TEXAS

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Abstract.—Gut morphology and body condition of Northern Bobwhite (*Colinus virginianus*) and Scaled Quail (*Callipepla squamata*) were evaluated in relation to winter diet quality. When common broomweed (*Xanthocephalum dracunculoides*) seeds were available, Bobwhite ($n = 58$) and Scaled Quail ($n = 69$) consumed significantly less green vegetation and significantly more broomweed seeds. Of available foods, common broomweed seeds had the highest energy content per gram because of relatively high (25%) lipid content. Quail with high energy diets had significantly shorter small intestines (both species) and ceca (Scaled Quail) than quail consuming relatively low energy foods. It is postulated that Bobwhite and Scaled Quail that did not have access to high energy food (common broomweed seeds) increased intake of low energy food (green vegetation) to meet nutritional demands and thus expressed intestinal (both species) and cecal (Scaled Quail) hypertrophy. Scaled Quail feeding on low energy diets had significantly heavier livers and had levels of body fat similar to Scaled Quail with access to high energy foods. Bobwhite consuming low energy foods had similar liver masses and were unable to accumulate as much body fat as Bobwhite foraging on high energy diets. Scaled Quail seem more capable than Northern Bobwhite in adjusting digestive organs to extract energy and accumulate lipid reserves when seed availability is restricted.

CALIDAD DE LA DIETA DURANTE EL INVIERNO, MORFOLOGÍA VISCERAL Y LA CONDICIÓN DE INDIVIDUOS DE COLINUS VIRGINIANUS Y CALLIPEPLA SQUAMATA EN EL OESTE DE TEXAS

Sinopsis.—Se evaluó la condición corporal y la morfología visceral de individuos de la codorniz nortea (*Colinus virginianus*) y la codorniz crestiblanca (*Callipepla squamata*), en relación a su dieta invernal. Cuando estuvieron disponibles las semillas de *Xanthocephalum dracunculoides* ambas especies consumieron significativamente menor cantidad de vegetación verde y mayor cantidad de las semillas de *X. dracunculoides*. De los alimentos disponibles para estas aves las semillas de la planta antes mencionada, tienen el mayor valor energético por gramos debido a su alto contenido de lípidos (25%). Se encontró que las codornices con dietas con alto contenido energético tenían el intestino delgado (ambas especies) y el ciego (c. crestiblanca) significativamente más corto que codornices que consumieron alimentos bajos en energía. Los resultados apoyan la hipótesis de que ambas especies ajustan la ingestión de alimentos y la morfología de sus vísceras en respuesta a la variación en la calidad de la dieta. Las codornices de ambas especies que no tuvieron acceso a alimento de alto contenido energético, como las semillas de *X. dracunculoides*, incrementaron la ingesta de alimentos de bajo contenido energético para cumplir con sus demandas nutricionales. Además se encontró en estas hipertrofia intestinal (ambas especies) y de los ciegos (c. crestiblanca). Individuos de la codorniz crestiblanca que se alimentaron con una dieta baja en energía, tuvieron hígados significativamente más pesados y niveles de lípidos corporales similares a individuos que tuvieron acceso a dietas de alto contenido energético. Sin embargo las codornices nortea que consumieron una dieta baja en energía, no experimentaron cambios en el hígado y no fueron capaces de acumular lípidos de la misma forma que congéneres que se alimentaron

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de una dieta alta en energía. La cordoniz crestiblanca parece más capaz que la codorniz norteña en ajustar su sistema digestivo a extraer energía y a acumular reservas de lípidos cuando hay poca disponibilidad de semillas.

Consumptive levels and nutritional composition of dietary components are important factors influencing gut morphology of birds (Dykstra and Karasov 1992, Moss 1983). Increased energy assimilation, through enlarged gizzards and livers, and hindgut elongation, has been documented in field and laboratory studies for Tetraonidae species (Moss 1983, Pendergast and Boag 1973, Redig 1989). Redig (1989) reported that domestic turkeys (*Meleagris gallopavo*) and Japanese Quail (*Coturnix coturnix*) were less efficient in dietary induced intestinal adjustments than various grouse species. Japanese Quail that consumed higher volumes of food, regardless of quality, had longer small intestines and ceca (Fenna and Boag 1974). Diet and gut morphology relationships and their influence on body condition of other Phasianidae are lacking.

Field investigations of dietary and physiological variations require variations in habitat conditions. Fire occurred naturally in the Rolling Plains of Texas prior to settlement and is currently used to reduce canopy cover of redberry juniper (*Juniperus pinchottii*) in this area (Steuter and Wright 1983). These brush control burns are commonly as large as 1000 ha. The variation in habitat associated with these burns allowed us to evaluate diets, diet quality, gut morphology and body condition of Northern Bobwhite (*Colinus virginianus*) and Scaled Quail (*Callipepla squamata*) collected from three stages of redberry juniper habitat. We tested the hypothesis that quail would respond to variations in diet composition resulting from habitat manipulation through adjustments in gut morphology. We also assessed quail carcass composition (body condition) to evaluate physiological success in dietary induced gut adjustments.

STUDY AREA

The study was conducted in northeastern King County, in northwest Texas. The site is characterized by hot (mean daily maximum, 35.4 C) summers and cool (mean daily minimum, -1.2 C) winters (Richardson et al. 1974). Mean annual precipitation is 59 cm with most falling in May, June, September and October. Topography varies from level to steep with rough bottomlands and flat uplands (mean elevation 550 m). Soils are lithic and of the Talpa series (Steuter 1982). Common woody species are redberry juniper, honey mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*), skunkbush (*Rhus aromatica*), littleleaf sumac (*R. microphylla*), catclaw mimosa (*Mimosa biuncifera*) and catclaw acacia (*Acacia greggii*). Dominant grasses on the site include perennial three-awns (*Aristida* spp.), sideoats grama (*Bouteloua curtipendula*), buffalograss (*Buchloe dactyloides*), rough tridens (*Tridens muticus*), tall dropseed (*Sporobolus asper*) and Texas wintergrass (*Stipa leucotricha*). Common forb species are basket flower (*Centaurea americana*), rabbit-tobacco (*Evax prolifera*), white aster (*Leucelene ericoides*), flax (*Linum* sp.), plantains

(*Plantago* spp.), silver-leaf nightshade (*Solanum elaeagnifolium*), scarlet globe-mallow (*Sphaeralcea coccinea*), green-thread (*Thelesperma filifolium*), western ragweed (*Ambrosia psilostachya*) and common broomweed (*Xanthocephalum dracunculoides*) (Leif 1987).

Study sites were a 1200-ha pasture burned in spring 1983 (new burn), an 800-ha pasture burned in spring 1979 (old burn), and a 1200-ha unburned pasture. All three sites were chained in 1974 or 1975, were dominated by piles of chained debris and juniper resprouts, and had similar plant associations prior to fire treatment (Steuter 1982). Prescribed burning removed the majority of brush piles and decreased canopy cover of redberry juniper (Leif 1987, Steuter 1982).

METHODS

Vegetation.—We placed 10 0.5-m² plots along 10 randomly placed 50-m lines in each treatment in June 1986, and grass and forb species' presence/absence were recorded for each plot. We used analysis of variance and least-significant difference tests to compare numbers of forb and grass species per plot and Chi-squared tests of independence to test for differences in frequency of occurrence of grass and forb species that were found in quail diets. We used individual Chi-squared tests to separate treatments if the test statistic among all three areas was significant ($P < 0.05$).

Food habits.—We evaluated quail diet quality and body condition in winter (January) because it is a physiologically stressful time of year (Rosene 1969). We collected birds from at least seven different coveys in each treatment in 1987. We removed their crops and froze both quail and crops within 8 h. Crop contents were thawed, washed, separated and identified using Jackson (1969), Martin and Barkley (1961) and reference collections. We dried food items for ≥ 48 h at 60 C and weighed them to the nearest 0.0001 g. We expressed foods as aggregate percentages of crop totals (Korschgen 1980) and used Kruskal-Wallis tests to examine differences in diet composition among areas. When the test statistic was significant ($P < 0.05$), we separated ranked data means with least-significant difference tests (Conover 1980).

Diet quality.—Consumed foods that were available in sufficient quantity (≥ 6 g of homogenate) for chemical analyses were ground in a Wiley mill and analyzed for cell wall, protein, lipid and mineral content. We sequentially removed triplicate 0.5-g samples of cell contents with neutral-detergent, hemicellulose with acid-detergent, and lignin with potassium permanganate (United States Department of Agriculture 1970). Cellulose was removed by heating samples at 500 C for 4 h. The remaining residue was acid-insoluble ash (United States Department of Agriculture 1970). Triplicate 0.5-g samples of seed homogenate were analyzed for crude protein (micro-Kjeldahl) and ash was determined by heating duplicate 0.5-g samples at 500 C for 12 h. Lipids were extracted from duplicate 1.0-g samples using petroleum ether solvent in a Soxhlet apparatus (Dobush et al. 1985). Percentages of food constituents were expressed on a dried mass basis.

To evaluate quail diets, we constructed nutritional profiles using diet compositions and individual foods' constituencies. We calculated a nutritional profile for each quail species within each treatment by:

$$C_{jk} = \sum_{i=1}^n H_{ij} F_{ik}, \quad (1)$$

where C_{jk} = aggregate percent dried mass of the j th nutritional component for the diet of each quail species collected from the k th treatment, H_{ij} = percent dried mass of the j th nutritional component for the i th food constituent, F_{ik} = aggregate percent dried mass of the i th food constituent for the diet of each quail species collected from the k th treatment, and n = total number of food types.

As only major food types were available in sufficient quantity for chemical analysis, C_{jk} was adjusted for the percentage of the diet accounted for by the nutritional analysis with:

$$AC_{jk} = C_{jk}/P_k, \quad (2)$$

where AC_{jk} = adjusted aggregate percent dried mass of the j th nutritional component for the diet of each quail species collected from the k th treatment, and P_k = percent of the diet analyzed for each quail species collected from the k th treatment.

Morphological measurements and body condition.—We thawed quail, measured small intestines and cecal lengths (cecal measurements were later added together) to the nearest 0.1 cm and removed GI contents. We weighed quail gizzards and livers and the entire bird (without ingesta) before refreezing. We sectioned frozen birds with a band saw, and ground them in a meat grinder. We then freeze-dried and reground quail and removed samples of the homogenate for lipid and ash-free lean dry mass (AFLD) analyses. We extracted lipids from 6–11 g samples for ≥ 40 h using petroleum ether solvent in a Soxhlet apparatus (Dobush et al. 1985). We heated duplicate 2–4 g samples for 48 h at a maximum temperature of 600 C to estimate ash. We calculated AFLD, an index of protein reserves (Raveling 1979) by subtracting ash and lipid percentages from 100. We tested for differences in body masses, GI variables, lipid, and AFLD using three-way (treatment, sex and age) analyses of variance and least-significant difference mean separation tests when the F -test was significant. We included sex and age in statistical models but did not present these data because treatment effects were independent ($P > 0.05$) of sex and age of quail.

RESULTS

Vegetation.—Forbs were found more ($P < 0.05$) frequently in the new burn (4.37 ± 0.19 [SE] species per plot) than the old burn (3.23 ± 0.17) or the unburned areas (2.95 ± 0.21). Conversely, grasses were less ($P < 0.05$) common in the new burn (2.17 ± 0.11) than old burn (2.61 ± 0.12) or unburned (2.59 ± 0.11) areas.

NORTHERN BOBWHITE

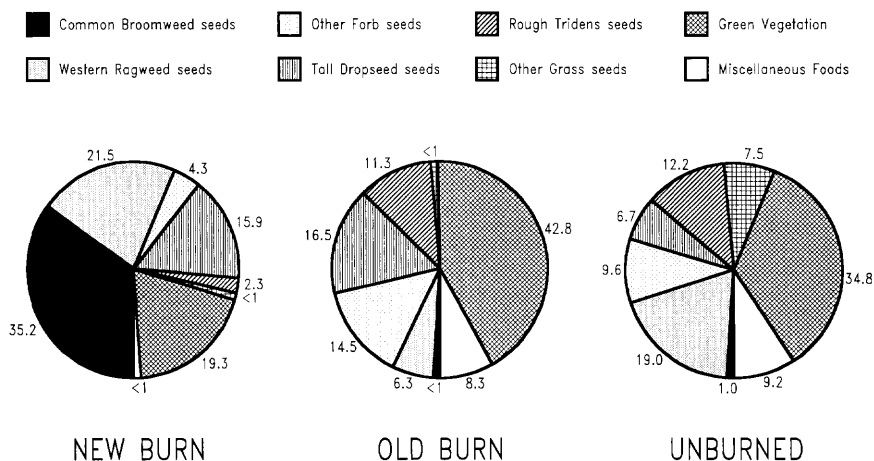


FIGURE 1. Aggregate percent dried mass of Northern Bobwhite ($n = 58$) winter foods in burned (new burn = 4 yr and old burn = 8 yr following fire treatment) and unburned redberry juniper-dominated rangelands on the Rolling Plains of Texas, 1987.

Seeds of two of 16 grass (tall dropseed, rough tridens) and two of 18 forb (common broomweed, western ragweed) species found in treatment areas were important in quail diets (Figs. 1 and 2). Common broomweed occurred more ($P = 0.001$) frequently and rough tridens less ($P = 0.03$) frequently in the new burn than the old burn or unburned areas (Table 1).

Food habits.—Seeds of common broomweed comprised a greater (Bobwhite, $P < 0.05$; Scaled Quail, $P < 0.05$) portion of quail diets collected from the new burn ($35.2 \pm 7.0\%$ and $42.2 \pm 6.1\%$, respectively) than the old burn ($0.1 \pm 0.1\%$ and $0.4 \pm 0.4\%$, respectively) or unburned ($1.0 \pm 1.0\%$ and $0.1 \pm 0.1\%$, respectively) areas (Figs. 1 and 2). Bobwhite in the old burn ($42.8 \pm 9.1\%$) and unburned areas ($34.8 \pm 6.0\%$) consumed more ($P < 0.05$) leaves of sprouting vegetation than those in the new burn ($19.3 \pm 1.9\%$). Proportion of green vegetation differed ($P = 0.001$) between all treatments for Scaled Quail, comprising the largest portion of quail diets in the unburned area ($66.0 \pm 6.2\%$), intermediate in the old burn ($39.8 \pm 6.3\%$) and the smallest portion in the new burn ($22.2 \pm 3.7\%$) (Fig. 2). This diet component (mostly dicotyledonous species) was not quantified for the different treatments (because they were new sprouts) during the quail collection period but was visibly widespread and available throughout each study site.

Rough tridens seeds comprised a higher ($P < 0.05$) percentage of Bobwhite diets in the old burn and unburned areas than the new burn. This grass seed along with seeds of tall dropseed each comprised larger

SCALED QUAIL

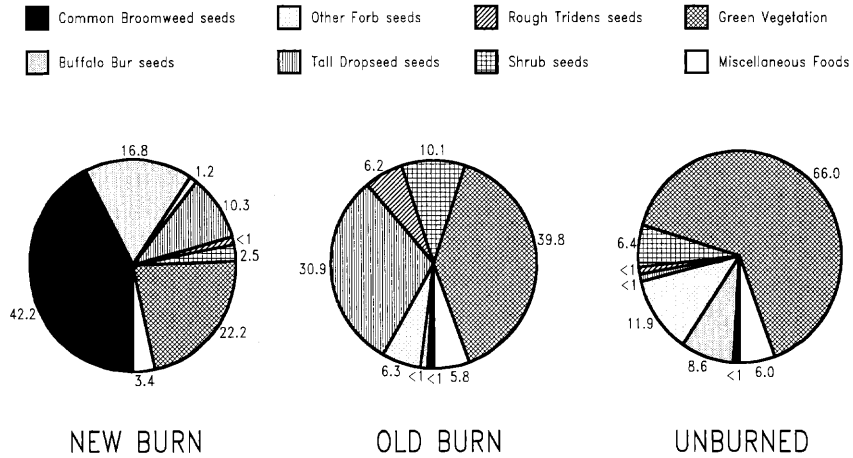


FIGURE 2. Aggregate percent dried mass of Scaled Quail ($n = 69$) winter foods in burned (new burn = 4 yr and old burn = 8 yr following fire treatment) and unburned redberry juniper-dominated rangelands on the Rolling Plains of Texas, 1987.

($P < 0.05$) components of Scaled Quail diets in the old burn than the new burn or unburned areas. Seeds of buffalo bur (*Solanum rostratum*), a forb not recorded in vegetation sampling, were smaller ($P < 0.05$) components of Scaled Quail diets in the old burn than the new burn or unburned areas; seeds of this species did not appear in Bobwhite diets.

Diet quality.—The six dominant foods (Table 2) analyzed for nutritional composition accounted for 94, 77 and 74% of Bobwhite diets in the new burn, old burn and unburned areas, respectively. Similarly, these food items respectively represented 93, 80 and 77% of Scaled Quail diets.

Sedinger (1984) reported that the Kjeldahl procedure overestimated protein content of green plants by 22–52% but more accurately reflected seed protein content. Thus, protein content of green vegetation consumed

TABLE 1. Percent occurrence of herbaceous plants ($n = 300$) bearing seeds important (Figs. 1 and 2) to Northern Bobwhite and Scaled Quail during winter in burned (new burn = 4 yr and old burn = 8 yr following fire treatment) and unburned redberry juniper-dominated rangeland on the Rolling Plains of Texas, 1986.

Species	New burn	Old burn	Unburned
Common broomweed	65A ¹	11B	8B
Western ragweed	3A	1A	5A
Tall dropseed	2A	8A	6A
Rough tridens	13A	25B	27B

¹ Means within species denoted by the same letter are not different ($P > 0.05$).

TABLE 2. Nutrient levels (% dried mass) of Northern Bobwhite and Scaled Quail winter foods in redberry juniper-dominated rangeland on the Rolling Plains of Texas, 1987.

Nutrient constituent	Western ragweed ¹	Buffalo bur ¹	Tall dropseed ²	Rough tridens ²	Green vegetation	Common broomweed ¹
Protein	16.52	17.59	25.11	17.09	31.26	20.67
Lipids	10.45	12.49	3.70	2.36	4.35	24.92
Mineral	4.08	9.49	5.96	14.54	11.78	11.12
Plant cell wall	60.93	62.56	42.97	64.87	32.72	48.38
Cellulose	43.45	38.05	19.25	26.03	10.99	17.48
Hemicellulose	7.83	10.84	12.85	17.08	6.08	12.49
Lignin	9.23	10.56	9.61	14.13	11.59	14.02
Acid insoluble ash	0.42	3.11	1.26	7.63	4.07	4.41

¹ Seeds.

² Seeds and hulls.

by quail was probably between 15–25% (we used 20% for nutritional profiles), similar to values of the seeds analyzed (Table 2). Seeds of western ragweed, buffalo bur, and rough tridens had higher levels of cell wall material than common broomweed and tall dropseed because of more rigid seed coats (comprised mainly of cellulose and hemicellulose [Maynard et al. 1977]).

Differences in food protein and mineral components were slight (<2%) among treatments (within each species). Ether extract levels of new burn nutritional profiles, however, were more than twice those of old burn profiles and triple those of unburned profiles for both quail species (Fig. 3). Cell wall levels of Bobwhite nutritional profiles in the old burn and unburned areas were 12% and 3% lower than new burn profiles, respectively. Cell wall content for Scaled Quail diets was 14% and 22% smaller in the old burn and unburned areas' nutritional profiles than the new burn profile, respectively.

Morphological measurements and body condition.—Both quail species collected from the new burn had shorter ($P < 0.05$) small intestines than their counterparts collected from the old burn and unburned areas (Table 3). Scaled Quail from the new burn also had shorter ($P < 0.05$) ceca than Scaled Quail from the old burn and unburned areas, but Bobwhite cecal lengths did not differ ($P = 0.15$) among treatments.

Liver masses of Bobwhite did not differ ($P = 0.11$) among treatments, but Scaled Quail from the old burn and unburned areas had heavier ($P < 0.05$) livers than those collected from the new burn (Table 3). Bobwhite collected from the new burn had more ($P < 0.05$) lipid reserves than conspecifics in the old burn or unburned areas. Lipid reserves did not differ ($P = 0.11$) among treatments for Scaled Quail (Table 3).

DISCUSSION

Our results support the hypothesis that Northern Bobwhite and Scaled Quail adjust gut morphology in response to variation in diet quality. Quail that consumed more common broomweed seeds had shorter small

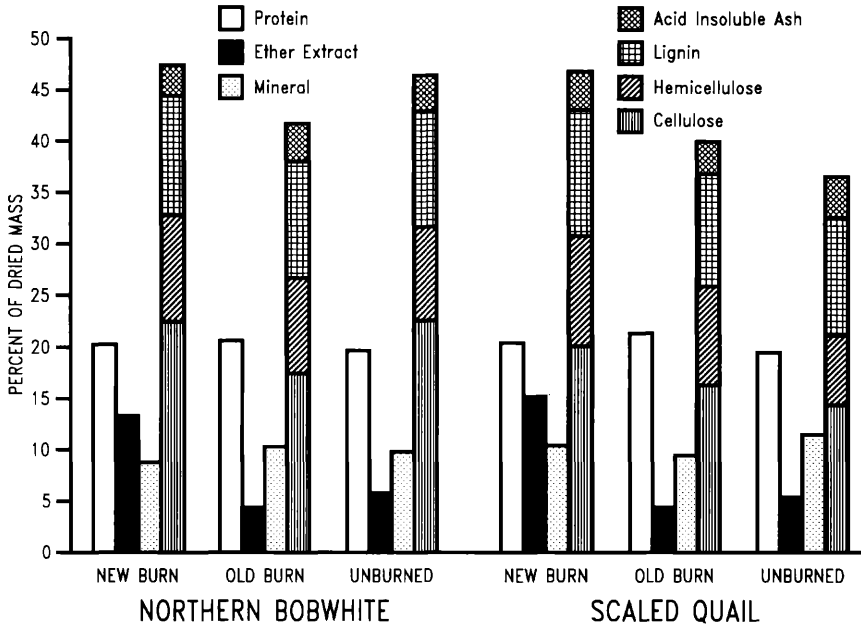


FIGURE 3. Nutritional profiles of Northern Bobwhite ($n = 58$) and Scaled Quail ($n = 69$) winter diets in burned (new burn = 4 yr and old burn = 8 yr following fire treatment) and unburned redberry juniper-dominated rangelands on the Rolling Plains of Texas, 1987.

intestines (both species) and ceca (Scaled Quail) than quail with diets dominated by green vegetation. Similarly, California Quail (*Callipepla californica*) that had high proportions of green material in the diet also had longer small intestines and ceca than quail with diets dominated by seeds (Leopold 1953).

Intake of green vegetation by Bobwhite (32%) and Scaled Quail (43%) was intermediate to levels previously reported. Green vegetation comprised 8% (Campbell et al. 1973) and 15% (Davis et al. 1975) of Scaled Quail winter diets in New Mexico, and only 3% of Bobwhite winter diets in north-central Texas (Parmalee 1955). Green vegetation, however, constituted 73% and 52% of Bobwhite and Scaled Quail fall-winter diets, respectively, during a southwest Texas drought (Campbell-Kissock et al. 1985). In our study, both quail species consumed less green vegetation and more common broomweed seeds when the latter were available. Although common broomweed is undesirable in cattle operations (Gordon 1982), seeds of this forb were an important Bobwhite food on the west Texas Rolling Plains (Jackson 1969). Increased consumption of broomweed seeds when available and a corresponding decrease in consumption of green vegetation indicated preference for these forb seeds over green vegetation in the winter diets of Bobwhite and Scaled Quail.

TABLE 3. Body, organ, and body constituent masses (g) and gastrointestinal lengths (cm) of Northern Bobwhite and Scaled Quail (\pm SE) collected from burned (new burn = 4 yr and old burn = 8 yr following fire treatment) and unburned redberry juniper-dominated rangeland on the Rolling Plains of Texas, 1987.

Variable	Northern Bobwhite			Scaled Quail		
	New burn (n = 19)	Old burn (n = 17)	Unburned (n = 21)	New burn (n = 23)	Old burn (n = 21)	Unburned (n = 21)
Body mass	167.6 \pm 1.9A ¹	158.0 \pm 2.9A	166.8 \pm 2.7A	183.0 \pm 2.7A	189.9 \pm 2.9A	179.3 \pm 2.3A
Liver mass	2.7 \pm 0.2A	2.9 \pm 0.1A	3.1 \pm 0.1A	3.3 \pm 0.1A	3.8 \pm 0.1B	3.9 \pm 0.1B
Gizzard mass	5.8 \pm 0.2A	6.1 \pm 0.2A	6.1 \pm 0.2A	5.3 \pm 0.2A	5.4 \pm 0.2A	5.5 \pm 0.1A
Small intestine length	59.8 \pm 2.5A	71.1 \pm 1.8B	73.2 \pm 2.1B	70.8 \pm 1.4A	79.9 \pm 1.2B	78.2 \pm 1.3B
Caeca length	24.1 \pm 0.7A	27.6 \pm 0.9A	27.5 \pm 0.8A	21.1 \pm 0.5A	24.6 \pm 0.6B	25.6 \pm 0.9B
Lipid mass	8.7 \pm 0.6A	6.7 \pm 0.8B	6.4 \pm 0.4B	7.5 \pm 0.5A	7.6 \pm 0.6A	5.8 \pm 0.4A
Mineral mass	5.5 \pm 0.1A	5.1 \pm 0.1A	5.4 \pm 0.1A	6.2 \pm 0.1A	6.3 \pm 0.1A	6.1 \pm 0.1A
Ash-free lean dry mass	42.7 \pm 0.6A	40.7 \pm 0.8A	44.1 \pm 0.8A	47.6 \pm 0.7A	49.7 \pm 0.7A	47.3 \pm 0.7A

¹ Variables within each species of quail denoted by the same letter are not different ($P > 0.05$).

Past studies attributed variations in gut morphology of birds to levels of crude fiber in diets and/or consumptive levels (Dykstra and Karasov 1992, Fenna and Boag 1974, Moss 1983, Redig 1989). Nutritional profiles of Bobwhite and Scaled Quail do not suggest that levels of cell wall (fiber), protein or minerals in the diet affected quail gut lengths. Lipids, which have more available energy (9.4 kcal/g) for metabolism than protein (5.7 kcal/g) (Maynard et al. 1977) were the only nutritional component that varied appreciably (2–3 times) among quail nutritional profiles. Nutritional profiles of quail collected from the new burn had relatively high lipid levels because of the large portion of common broomweed seeds consumed (Figs. 1 and 2). Consumptive levels, which were not monitored in this field study, likely caused the gut elongations we detected. We postulate that Bobwhite and Scaled Quail that did not have access to high energy food (common broomweed seeds) increased consumptive levels of low energy food (green vegetation) to meet nutritional demands and thus expressed intestinal (both species) and cecal (Scaled Quail) hypertrophy.

Quail body masses did not vary in relation to diet but Bobwhite consuming higher quality foods (broomweed seeds) accumulated more lipid reserves than those with diets dominated by green vegetation. Robel et al. (1974) also noted higher lipid reserves in Bobwhite with access to food plots than birds collected far from food plantings. Although Scaled Quail were subject to similar diet variations, neither body mass nor carcass composition differed among treatments.

Pendergast and Boag (1973) proposed that diet variation and physiological condition caused variation in liver masses of Spruce Grouse (*Cathartes canadensis*). Also, Drobney (1984) reported Wood Duck (*Aix sponsa*) livers were larger during periods of increased food intake and high lipid and protein metabolism. Larger livers and elongated small intestines and ceca may have enabled Scaled Quail to extract more energy from a lower energy diet and accumulate lipid reserves similar to conspecifics foraging on higher energy foods. Bobwhite on lower energy diets did not make similar adjustments in liver masses. This may have contributed to their inability to accumulate stored energy at levels similar to Bobwhite consuming higher energy foods.

Levels of lipid reserves could affect survival of quail when extended cold periods and/or winter snow storms limit quail foraging time and increase dependence on stored reserves (Robel et al. 1974). Quail with higher lipid reserves should be able to survive longer in adverse weather. Also, quail that exited winter with higher lipid reserves presumably would be able to survive stresses associated with pair bond formation, territorial defense, and egg production better than birds with low lipid reserves. Pre-breeding condition influenced productivity of female Blue Grouse (*Dendragapus obscurus*) (Zwicker and Bendell 1967) and Red Grouse (*Lagopus scoticus*) (Jenkins et al. 1967).

Although Bobwhite (Jackson 1969, Lehmann 1953) and Scaled Quail (Campbell et al. 1973) production is enhanced by above-average precipitation, Campbell-Kissock et al. (1985) hypothesized that Scaled Quail

were better able to exploit habitat resulting from drought than Bobwhite. Associations between precipitation and quail populations are probably closely related with quail nutrition (Campbell et al. 1973, Campbell-Kissock et al. 1985). Our research into the nutritional aspects of sympatric Bobwhite and Scaled Quail supports and offers some explanation for these hypotheses. Spring precipitation has little direct effect on quail but is critical to growth and seed production of annual forbs (Campbell et al. 1973), most notably, common broomweed (Gordon 1982). When seed availability is restricted by land management or climatic conditions, both species of quail adjust gut morphology in response to changes in diets. Scaled Quail, however, seem more capable in adjusting digestive organs to extract energy and accumulate lipid reserves than Northern Bobwhite.

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DR. RICHARD CONNER ELECTED PRESIDENT OF THE WILSON ORNITHOLOGICAL SOCIETY

Dr. Richard Connor was elected president of the Wilson Ornithological Society during its 1993 annual meeting in Guelph, Ontario. Dr. Connor has served as an associate editor of the *Wilson Bulletin*, the scientific journal published by the Society, and on the editorial board of the Society for the past 10 yr. He has been an elected council member (1986-1989), second vice-president (1989-1991) and first vice-president (1991-1993) of the Society. Dr. Connor is a research wildlife biologist with the United States Department of Agriculture Southern Forest Experiment Station in Nacogdoches, Texas since 1977.