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EFFECTS OF TWO COMMERCIAL GAME BIRD FEEDS ON CAPTIVE NORTHERN BOBWHITE CHICK GROWTH RATES

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ABSTRACT

Supplemental feeding of northern bobwhites (*Colinus virginianus*) is a widespread management practice. Bobwhite chicks in the wild consume only arthropods for their first 30–60 days of life. Arthropods may become less abundant and managers have supplied bobwhites with supplemental feed during times of drought to mitigate the lack of arthropods. We compared growth rates of captive bobwhite chicks consuming a new, commercial 24% crude protein supplement to growth rates of bobwhites consuming a commercial 30% crude protein complete ration. There was no male/female bias related to chick growth. Chicks consuming the 24% protein diet grew slower and reached adult mass (150 g) 1 month later than birds on the 30% protein diet. Birds grew 4–6 times faster than documented rates from wild chicks in Florida, but this is attributed to captivity bias. A 24% protein supplement has insufficient protein to optimize growth of bobwhites and is a poor substitute for arthropods in time of drought. A 30% protein diet has sufficient nutrient levels to justify further research as a supplement to mitigate a lack of arthropods in times of drought.

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Key words: chicks, *Colinus virginianus*, growth, northern bobwhite, protein pellets, supplemental feed

INTRODUCTION

The practice of supplemental feeding of wild bobwhite populations is a common practice, despite equivocal results from research (Haines et al. 2004). Wild bobwhites in South Texas are supplementally-fed along roadsides in an attempt to mitigate harsh climatic conditions. Considerable research effort has been devoted to commercial production of bobwhites during the past 70 years (Nestler et al. 1942, 1944; Nestler 1949; Andrews et al. 1973), but researchers have yet to quantify the role of supplemental food on wild bobwhite chick growth.

Arthropods are the most important food source for wild bobwhite chicks from 1 to 60 days of age (Hurst 1972, Palmer et al. 2001). Arthropods contain high amounts of crude protein (> 46.5%) and provide the nutrients necessary for chick growth (Wood et al. 1986, Bell 1990). A bobwhite chick's diet consists of 80% insects in the first 2 weeks of life—primarily, Coleoptera, Hymenoptera, Diptera, and Hemiptera (Lehmann 1984, Brennan 1999). The diet gradually changes to seeds and other plant material over the next 6 to 8 weeks of life (Handley 1931, Nestler et al. 1945, Hurst 1972, Utz et al. 2001).

Bobwhite chicks have high crude protein requirements. Chicks require > 28% crude protein in their diet to optimize growth (Nestler et al. 1942, Andrews et al. 1973, Robbins 1983). Butler (2007) documented reduced growth rates of bobwhite chicks that did not consume a high proportion of insects in their diet. A bobwhite chick has few options for obtaining high quality food on South Texas rangelands. Legumes and arthropods are the most common sources of protein for bobwhite chicks in South Texas but availability of these resources is weather dependent (Varley et al. 1973, Brennan 2007) . Drought is common in South Texas (Brennan 2007). If arthropods are

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not abundant during drought, food available for chicks is poor quality and advocates of supplemental feeding claim that providing food will mitigate for the lack of arthropods (Varley et al. 1973, Smith 1982, Hawkins and Holyoak 1998).

Many wildlife managers contend that supplemental feed enables adult bobwhites to withstand harsh climatic events (i.e., drought or severe winters), and provide bobwhites with supplemental feed (commonly milo-corn mixtures) (Hernández and Guthery 2012). Bobwhites are also fed to increase survival and subsequent breeding; however, empirical evidence suggests supplemental feeding is a demographically neutral management practice, at best (Guthery 2000, 2002; Guthery et al. 2004). The importance of supplemental food for wild bobwhite chicks is unknown. Some commercial feed companies claim a commercially-formulated ration (16 or 24% crude protein) will produce healthy, fast-growing chicks (Lyssy and Eckel Feeds 2012). A commercial feed ration may increase available dietary protein and allow for optimized chick growth, assuming chicks in the wild will eat supplemental feed in times of low arthropod abundance.

Insect abundance is inherently low during drought (Varley et al. 1973). Supplemental feed may be a convenient foodstuff available to wild bobwhites during drought conditions on South Texas ranches (Haines et al. 2004). The impact of a new, commercial protein supplement (Quail Breeder Feeds; Lyssy and Eckel Feeds, Poth, TX, USA) on bobwhite chick growth has not been documented. We wanted to learn how the growth rate of captive bobwhite chicks would change when food is limited to only supplemental feeds. Our objective was to compare captive bobwhite chick growth on a weekly basis among chicks fed a new, commercially available supplement (24% crude protein) with chicks fed a commercially available (30% crude protein) complete ration in an effort to provide managers more information on the potential utility of supplementally providing protein feed to wild populations. We hypothesized that chicks consuming the 30% crude protein diet would grow faster and reach adult mass (150 g) faster than chicks consuming the 24% crude protein diet.

METHODS

This study was conducted at the Duane Leach Aviary on the campus of Texas A&M University–Kingsville, TX, USA from 1 May to 8 October 2009. We purchased 60, 1 day-old bobwhites from a commercial game farm (Wes' Game Birds, Orange Grove, TX, USA). We used a completely randomized design to assign chicks to 1 of 2, 8.9-m^2 pens (30 chicks per pen). We recorded the gender of each individual and banded each chick with an aluminum leg band (American Band and Tag, Co., Newport, KY, USA), numbered so that each individual could be identified. Each pen was outfitted with a 100W brooder lamp, water dispenser, and feeder tray. A 1-cm layer of cedar shavings was spread on the floor to reduce odor and maintain sanitation. Brooder lamps remained on 24 hrs/day for 30 days until bobwhites could self-thermoregulate (Borchelt and Ringer 1973). All birds were fed turkey starter feed *ad libitum* (30% crude protein; Purina Mills LLC, New Brighton, MN, USA; Appendix) for the first week to acclimate chicks to consuming a commercial feed. Water was provided *ad libitum*. We recorded the mass (g) of each bird after 1 week and commenced the experiment.

We used 2 different commercial feeds in this experiment. The 30% crude protein (Appendix, 30% CP) had all of the nutrients required for bobwhite chick growth, simulating the diet of a chick feeding on insects (Nestler 1949). The new, commercial supplement diet (Appendix) was a 24% crude protein (24% CP), commercial bobwhite pellet marketed to increase chick growth, among other claims. The 24% CP was ground into $\sim$ 1-mm^3 pieces for ease of consumption for the first 30 days of the experiment. The 30% CP came pre-ground into $\sim$1-mm^3 pieces. Thirty bobwhite chicks were fed the 24% CP ration and 30 bobwhites were fed the 30% CP ration until termination of the experiment; both groups were fed *ad libitum*. We used a spring scale (Pesola Co., Baar, Switzerland) to record bobwhite mass to the nearest gram each week for 15 weeks. Quail were euthanized at the end of the experiment according to procedures outlined by Texas A&M University–Kingsville's Institutional Animal Care and Use Committee (IACUC # 2008-09-30A). If birds died, we tried to ascertain the cause of death.

We analyzed the data using the repeated measures analysis of variance (ANOVA) procedure (PROC MIXED) in SAS 9.1.3 (SAS Institute, Cary, NC, USA). We used Akaike's Information Criterion with small sample size correction (AIC*c*, Burnham and Anderson 2002) to identify the best variance-covariance matrix for our data. We considered all models within < 4 ΔAIC as possible matrices. We had no reason to assume that male or female bobwhite chicks grow at the same rates. We used gender as a fixed effect in the model to account for any potential differences. Our random effect was subject (individual bird) and our fixed effects were feed type and gender. We tested for interactions between feed type and week after adjusting for gender. We calculated means and confidence intervals for feed type by week interaction to interpret the effect of feed on bobwhite growth for each week. We compared the masses of our bobwhites to the adult mass of bobwhites from 4 different states based on review of the literature. Adult bobwhite mass of Illinois bobwhites is 178 $\pm$ 0.52 g SE (n = 847 bobwhites; Roseberry and Klimstra 1971), adult mass of Kansas bobwhites is 186 $\pm$ 1.03 g SE (n = 368 bobwhites; Robel 1969), Oklahoma adult bobwhite mass was 151 g (no SE provided, n = 136 bobwhites; Lusk et al. 2005), and South Texas adult bobwhite mass is 158 $\pm$ 0.47 g SE (n = 72,797 bobwhites; Brazil 2006).

RESULTS

The effect of bobwhite gender on growth was not significant (Table 1). There was a significant feed type by week interaction (Table 1), and the main effects could not

Table 1. Repeated measures ANOVA of a captive northern bobwhite (*Colinus virginianus*) feed trial comparing commercially available quail supplement (24% crude protein) to a commercial nutritionally complete ration (30% crude protein) during May–October, 2009 in Kleberg County, Texas, USA.

	Repeated measures ANOVA values			
Effect	Numerator df	Denominator df	*F*	*P*
Gender	1	57	0.25	0.6194
Week	14	781	713.2	<0.0001
Diet	1	57	58.03	<0.0001
Diet by week	14	781	116.2	<0.0001

be interpreted individually. Bobwhite chicks on the 30% CP diet reached Oklahoma adult mass at week 8, South Texas adult mass at week 9, Illinois adult body mass at week 11, and Kansas adult mass at week 12 (Fig. 1). Bobwhite chicks on the 24% CP diet reached Oklahoma adult mass at week 12, South Texas adult mass at week 12, Illinois adult body mass at week 15, and did not reach Kansas adult mass (Fig. 1). Chicks on the 24% reached mean adult bobwhite mass 4–7 weeks later than chicks on the 30% CP diet. Mean bobwhite masses were similar during the first 4 weeks, differed during weeks 5–14, and converged during week 15 (Fig. 1). Growth rate peaked in weeks 4 and 5 for birds on the 30% CP diet and in week 5 for birds on the 24% CP diet (Fig. 2). Four birds on the 24% CP diet died and 3 birds on the 30% diet died. The cause of mortality for all dead birds was hen-pecking and cannibalism from the other birds in the pen.

DISCUSSION

Protein deficiencies, caused by a diet containing < 28% crude protein, can slow bobwhite chick growth (Nestler et al. 1942, Andrews et al. 1973). Nestler's study was conducted in captivity with methods similar to ours, but with a larger sample size ($n = 816$) and more treatments (5 protein levels). Bobwhites fed a 24% CP diet in our study grew at a slower rate than those fed a diet containing 30% CP protein. However, both mean weekly growth rates from our study were greater than growth rates of wild bobwhites (Lusk et al. 2005). Mean weekly growth rates were similar between diets when averaged across all weeks, but bobwhites fed the 24% CP diet reached adult mass 1–1.5 months later than bobwhites fed the 30% CP diet. The lack of adequate protein in the diet of chicks on the 24% CP diet was similar to the pattern observed by Nestler et al. (1942). They found a threshold of crude protein (> 28%) that optimized chick growth in captivity. Birds in their study had a lower growth rate and died when fed solely a low (20% CP) protein diet; body mass was lower for birds on the 20% CP diet than those on the highest protein (36%) diet (Nestler et al. 1942).

Mean weekly chick mass in our study exhibited a semi-logistic growth curve, similar to those documented by Robbins (1983) and Lusk et al. (2005). Logistic growth

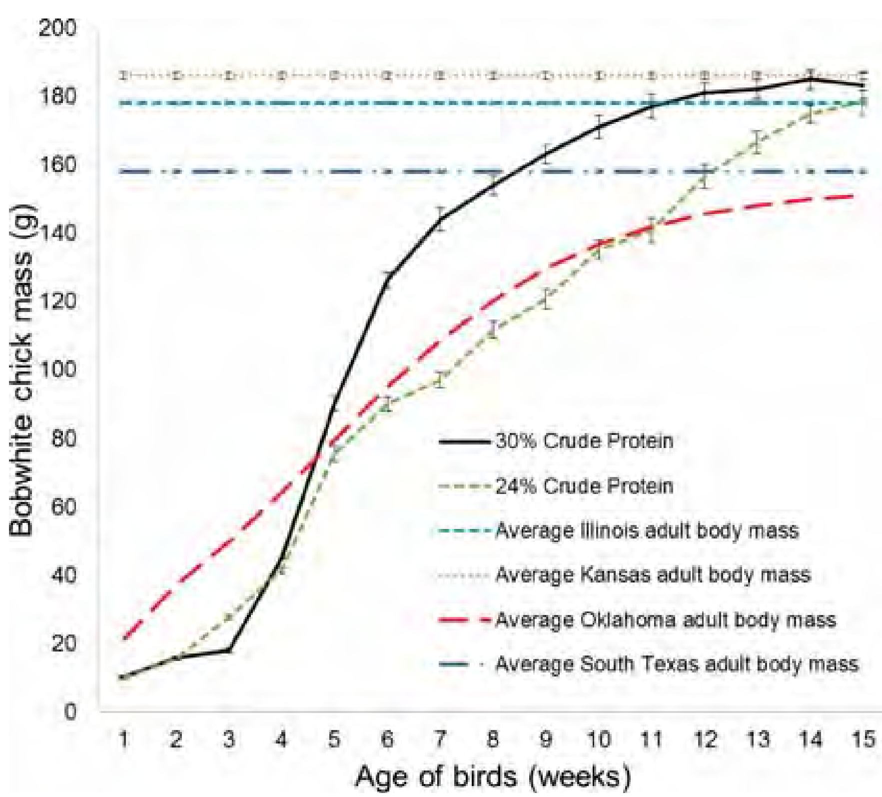

Fig. 1. Cumulative weekly mass accumulation (mean ± SE) of northern bobwhite chicks on diets with two different protein levels compared to adult bobwhite mass estimates (mean ± SE) from Kansas (Robel 1969), Oklahoma (Lusk et al. 2005), Illinois (Roseberry and Klimstra 1971), and South Texas (Brazil 2006).

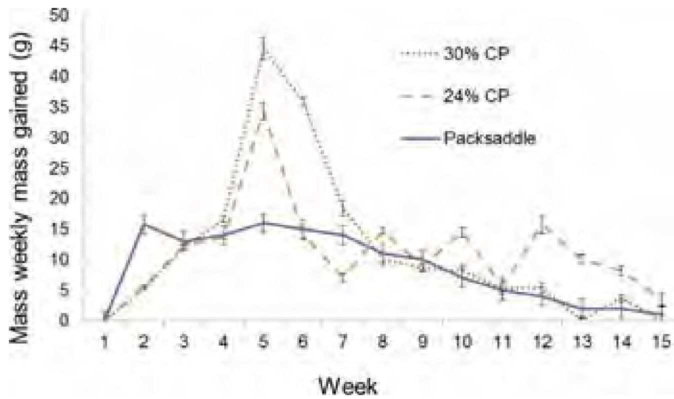

Fig. 2. Mean weekly mass gained by captive northern bobwhite chicks for diets with 2 different protein levels (30% crude protein and 24% crude protein) compared to mean weekly mass gained by wild bobwhites on the Packsaddle Wildlife Management Area, Oklahoma, USA (Lusk et al. 2005).

curves are also common in most bird species (Ricklefs 1968, 1969, 1979, 1984; Bryant and Hails 1983). Logistic growth curves have been documented in other captive bobwhite chick growth studies (Nestler et al. 1942, 1945; Andrews et al. 1973; Blem and Zara 1980; Lochmiller et al. 1993). This growth curve is similar in (both wild and captive) red grouse (*Lagopus lagopus scotica*; Park et al. 2001), dusky (blue) grouse (*Dendragapus obscurus*; Stiven 1961), gray partridge (*Perdix perdix*; Potts 1986), and greater sage-grouse (*Centrocercus urophasianus;* Johnson and Boyce 1990).

Chicks on both diets had a higher growth rate than wild bobwhite chicks documented by Lusk et al. (2005) on the Packsaddle Wildlife Management Area in Oklahoma; however, the difference only lasted 1–3 weeks depending on feed type. Additionally, chicks in our study grew, on average, 4–6 times faster than imprinted bobwhites in Florida on the Tall Timbers Research Station (Palmer et al. 2001). The *ad libitum* feeding and the controlled environment of our captive study likely explain their faster growth. Bobwhites in commercial game farms, such as those used in this study, are selectively bred to grow faster than wild birds to improve profit and decrease time from hatch to market. Our use of commercially-farmed bobwhite chicks may have biased the growth rates compared to wild growth rates. Chicks in the wild must hunt for arthropods, avoid predators, and thermoregulate through cold nights—rather than consume feed from a trough in a temperature-controlled environment—resulting in higher metabolic costs and slower growth rates in wild birds. We believe the 30% CP would increase the likelihood that more bobwhites will attain adult body mass quickly, and then move to a plant-based diet enabling higher rates of survival in times of low arthropod abundance relative to the 24% CP ration. Making a direct connection between captive and wild bobwhite chicks is one that cannot be made without caution. Wild bobwhites need a high amount of protein in their first 2 months of life, but assuming that chicks get all of their protein from supplemental feed is not likely true in wild populations.

MANAGEMENT IMPLICATIONS

Managers who wish to provide supplemental feed in times of food stress should provide the 30% CP ration because wild conditions require higher energetic costs due to thermoregulation, predator avoidance, and foraging caloric needs, based on our results. However, wild birds will presumably be foraging for natural foodstuffs and likely do not need a complete ration. A true field test of the 24% and the 30% CP ration using truly wild bobwhite chicks is needed to make inferences about effects of supplemental feed on their growth and the role of supplemental feed in their overall diet.

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APPENDIX. Feed tag information for a feed trial comparing a new, commercially available quail supplement (Lyssy and Eckel Foods' Quail Breeder 24 [24% crude protein in captive trial]) to a commercial nutritionally complete ration (Purina Mills Show Turkey Chow; denoted 30% crude protein in captive trials) during May–October 2009 in Kleberg County, Texas, USA.

	Feed type	
	Quail Breeder 24	Show Turkey Chow
Crude protein, % (min)	24.0	30.0
Lysine, % (min)	1.0	1.4
Methionine, % (min)	0.7	0.6
Crude fat, % (min)	3.0	3.0
Calcium, % (Ca) (min)	1.0	1.2
Calcium, % (Ca) (max)	1.2	1.7
Phosphorus, % (P) (min)	1.0	0.8
Salt, % (Na Cl) (min)	0.3	0.1
Salt, % (Na Cl) (max)	0.5	0.5