The invertebrate diet of northern bobwhite chicks in Georgia, United States

D. A. Butler, W. E. Palmer & M. P. Cook

Butler, D. A., Palmer, W. E. & Cook, M. P., 2012. The invertebrate diet of northern bobwhite chicks in Georgia, United States. *Animal Biodiversity and Conservation*, 35.2: 415–418.

Abstract

The invertebrate diet of northern bobwhite chicks in Georgia, United States.— The establishment of brood–rearing habitats along field margins has become a popular agri–environmental prescription to help reverse population declines of northern bobwhite (*Colinus virginianus*) in Georgia, United States. Here, the invertebrate–diet of chicks foraging on farmland with established brood–rearing habitats is examined and compared to those of chicks on an intensively managed wild bobwhite shooting estate. In 2001 and 2002, faecal samples were collected and analysed from nocturnal roost sites of bobwhite broods. Differences in invertebrate composition between the study sites were investigated using compositional analysis. While the diet of chicks on both sites contained similar invertebrate groups, the composition of the diets varied significantly. Although chicks on farmland had eaten 1.7 times fewer Coleoptera, they had 1.7 times more Hemiptera in their diet. These data suggest that although the invertebrate composition in the diet of chicks differed between the two landscapes, both contained high proportions of important prey items.

Key words: Northern bobwhite, Chick–diet, Invertebrates, Agri–environmental scheme, Brood–rearing habitat.

Resumen

Dieta a base de invertebrados de las crías del colín de Virginia en Georgia, Estados Unidos.— El establecimiento de hábitats de cría a lo largo de los márgenes de los campos se ha convertido en una norma agro–medioambiental muy popular, para ayudar a invertir la disminución de las poblaciones del colín de Virginia (*Colinus virginianus*) en Georgia, Estados Unidos. En este estudio se examina la dieta a base de invertebrados de los pollos, con hábitats de cría bien establecidos, que forrajean en las tierras de labrantío, en comparación con la de las crías de un coto de caza de colines de Virginia salvajes gestionado intensivamente. En los años 2001 y 2002 se recogieron muestras fecales de los lugares de descanso nocturnos de las crías, y se analizaron. Se investigaron las diferencias en cuanto a la composición de invertebrados entre los lugares de estudio, utilizando un análisis composicional. Mientras que la dieta de los pollos de ambos lugares contenía grupos de invertebrados similares, la composición de las dietas variaba significativamente. A pesar de que las crías de los cultivos habían comido 1,7 veces menos coleópteros, habían devorado 1,7 veces más hemípteros. Estos datos sugieren que aunque la composición de invertebrados de la dieta de las crías difería entre los dos tipos de hábitat, en ambos contenía grandes proporciones de las presas más importantes.

Palabras clave: Colín de Virginia, Dieta de las crías, Invertebrados, Proyecto agro–medioambiental, Hábitat de cría.

Received: 23 II 12; Conditional acceptance: 8 V 12; Final acceptance: 6 VII 12

David A. Butler, Tall Timbers Research Station and Land Conservancy, 13093 Henry Beadel Drive, Tallahassee, Florida 32312 USA.– William E. Palmer, Tall Timbers Research Station and land Conservancy, 13093 Henry Beadel Drive, Tallahassee, Florida 32312, USA.– M. P. Cook, Warnell School of Forestry and Natural Resources, The Univ. of Georgia, 180 E Green Street, Athens, Georgia 30602, USA.

Corresponding author: D. A. Butler, Perdix Wildlife Solutions Ltd., Avenue R, Stoneleigh Park, Kenilworth, Warwickshire CV8 2LG, U.K. E–mail: dbutler@perdixwildlife.co.uk

ISSN: 1578–665X

Introduction

During the past 50 years northern bobwhite (*Colinus virginianus*) (hereafter bobwhite) populations have declined rapidly in the southeastern United States (Brennan, 1991). Declines have been notable on farmland where agricultural intensification has led to a reduction in habitat for bobwhite (Brennan, 1991). Of particular concern is the loss of brood–rearing habitats that harbour high densities of invertebrates important in the diet of chicks (Stromborg, 1982). Loss of quality brood–rearing habitat can prevent game bird chicks from obtaining sufficient quantities of prey items and consequently reduce survival rates (Potts, 1986).

The daily number of prey–items required by gamebird chicks depends upon the size and nutritional value of the invertebrates within the diet (Southwood & Cross, 2002). In grey partridge, *Perdix perdix,* for example, Southwood & Cross (2002) reported that a nine–day–old grey partridge chick feeding entirely on Heteroptera requires 4,500 fewer items than one eating only Coleoptera. For bobwhite chicks to attain normal growth rates, feeding trials conducted by Palmer (1995) suggest that a 7–10 day old chick requires approximately 6 g of invertebrates daily. In addition to protein, invertebrates also provide chicks with essential amino acids. The amino acids methionine and lysine have been identified as particularly important in feather development (Potts, 1986). Consequently, chicks that are unable to eat sufficient quantities of invertebrates suffer from poorer feather development as well as reduced growth rates (Southwood & Cross, 2002).

The importance of providing invertebrate–rich brood rearing habitats for bobwhite has been recognised by land managers of game–shooting estates in southern Georgia and northern Florida for many years (Stoddard, 1931). Through the use of management prescriptions such as prescribed burning and cultivation of fallow fields, land managers annually create and maintain a patchwork of invertebrate–rich brood–rearing habitats across their estates. The provision of these and other habitats required by bobwhite has prevented population declines similar to those seen on agricultural landscapes (Brennan et al., 2000).

To counteract the loss of bobwhite habitat on farmland in Georgia, farmers in selected areas are now able to enrol in the Bobwhite Quail Initiative (BQI), an agri–environmental scheme where payments are made for creating and managing habitats specifically for bobwhite (Cook, 2004). The establishment of brood–rearing cover along field margins is a key component of this scheme. While the number of farms that provide brood–rearing habitat through this scheme has increased, no studies have investigated the diet of bobwhite chicks foraging on this farmland. Here, the invertebrate composition in the diet of bobwhite chicks on farms enrolled in the BQI scheme was examined and then compared to the diet of chicks on a wild bobwhite shooting estate.

Material and methods

During spring 2002 and 2003, adult bobwhites were captured and fitted with a 6–g mortality sensing radio–transmitter on two sites in Georgia, United States. The first study site was located across two farms in central Georgia. Predominant crop types on both farms were cotton, peanuts, soya beans and maize. Both farms were participants in the BQI agri–environmental scheme and brood–rearing habitats had been established along field margins. The second site was a shooting estate intensively managed for wild bobwhite and other game species located in southern Georgia. The landscape is dominated by pine trees with an understory of grasses, forbaceous plants and shrubs. Between March and May each year, approximately 40–50% of the land area is burned in controlled fires. These fires encourage the growth of weedy vegetation that can harbour high densities of invertebrates (Hurst, 1972). In addition, small fields located across the estate, are also cultivated annually to encourage weed growth and create additional foraging areas for bobwhite broods.

During the breeding season, April until September, nocturnal roosting sites (hereafter roost sites) of radio–collared adults with chicks were located until the brood was 14 days old. All chick–faecal matter found at each roost site was placed in a labelled plastic container and then frozen. Faecal samples were collected from 22 broods on the shooting estate and 19 broods on farmland.

Analysis of faecal samples was conducted according to Moreby (1988). To account for differential recovery of diagnostic fragments from different invertebrates within a faecal sample, the proportion of each prey type in faecal samples was calculated using the formula described by Green & Tyler (1989) and correction factors described by Butler (2007). For each radioed–brood, the corrected data were pooled before the proportions of each invertebrate group in the diet were calculated. Statistical comparisons of these data were carried out using compositional analysis (Aebischer et al., 1993). As proportional data must sum to 1, the proportions are not linearly independent. To overcome this unit–sum constraint the proportional data can be converted to log–ratios. The log–ratios are independent of the category used as the denominator. To allow log–ratios to be calculated, all zero values are replaced by a very small proportion (0.001) (Aebischer et al., 1993). The log–ratio differences were calculated and tested simultaneously using MANOVA to reveal differences in the invertebrate composition between sites. If a significant difference was found, a ranking matrix was produced to determine where the differences lay (Aebischer et al., 1993). The differences between samples for all possible pairs of log–ratios were examined using *t*–tests. All analyses were conducted using Systat 8.0 (SPSS Inc., 1998).

Results

Using a six–part compositional analysis, relative differences in the proportions of Araneae, Hemiptera, Orthoptera, Hymenoptera, Coleoptera, and Others (predominately Lepidopteran larvae) in the diet of chicks from the two study sites were examined. The composition of these invertebrate groups in the diet of chicks varied between the two study sites ($\Lambda = 0.590$, $F_{5, 35} = 4.858$, $P = 0.002$)

Table 1. Relative differences in the invertebrate composition in the diet of northern bobwhite chicks on a shooting estate and on farmland in Georgia, USA, 2002–2003. Invertebrate groups with a high rank were more abundant in the diet of broods on the shooting estate than in that of farmland broods. Different letters in the 'Ranks differ' column indicate an invertebrate group that differs significantly from another at P = 0.05. Invertebrate groups with the same letter do not differ significantly.

Tabla 1. Diferencias relativas en la composición de invertebrados en la dieta de las crías septentrionales de colín de Virginia en un coto de caza y en cultivos de Georgia, EUA, 2002–2003. Los grupos de invertebrados con un número de rango alto fueron más abundantes en la dieta de las crías del coto de caza que en las de las tierras de labrantío. Las distintas letras de la columna "Ranks differ" indican que un grupo de invertebrados difiere significativamente de otro con P = *0,05. Los grupos de invertebrados con la misma letra no difieren significativamente.*

			Mean invertebrate composition (%)	
Rank	Invertebrate group	Ranks differ	Shooting estate	Farmland
1	Coleoptera	A	43.8	26.2
2	Hymenoptera	A	19.0	17.2
3	Araneae	AC	7.2	2.8
4	Orthoptera	AC	7.3	6.9
5	Hemiptera	AC	20.1	33.5
6	Others	B	2.6	13.4

(table 1). While > 44% of the invertebrates eaten by chicks on the shooting estate were beetles, this prey group accounted for only a quarter of the invertebrates in the diet of chicks foraging on farmland. Conversely, chicks foraging on farmland had eaten 1.7 times more Hemiptera and five times more Others than chicks on the shooting estate. Despite these differences in composition, Coleoptera, Hemiptera and Hymenoptera collectively formed approximately 80% of the invertebrate diet of bobwhite chicks on both sites.

Discussion

While chicks on both sites ate similar invertebrate groups, the composition of the diets differed. These differences are probably a reflection of the availability of prey items in the habitats used by broods on each landscape. Consistent with previous dietary studies, greater numbers of Hemiptera were found in the diet of chicks foraging on farmland than in forested landscapes (Palmer, 1995). Lepidoptera larvae were also five times more abundant in the diet of broods on the farmland. As shown in a companion radio–tracking study, the broods on the farmland site often used the brood–rearing habitats established under the BQI agri–environmental scheme, particularly the 6m non–sprayed headlands surrounding cropped fields (Cook, 2004). These types of habitats have been found to harbour high densities of these important chick–prey invertebrates (Rands, 1985; Chiverton & Sotherton, 1991; Palmer, 1995).

The greater numbers of Coleoptera found in the diet of chicks on the shooting estate is consistent with the results of other dietary studies where broods had been foraging in grass dominated habitats (Ford et al., 1938; Hurst, 1972). Large areas of wiregrass, *Aristida stricta*, were present on the shooting estate and many of the roost sites were located in or near these areas (Butler, 2007). The diet of broods on the shooting estate also consisted of 20% Hemiptera and 19% Hymenoptera, of which > 90% were Formicidae. While high numbers of Hemipetra have previously been reported in the diet of bobwhite chicks on shooting estates in this region, Formicidae have only previously been recorded as a trace item (Stoddard, 1931). The abundance of Formicidae in chick foraging habitats in this region may have increased over the last 70 years due to changes in habitat management techniques (Brennan, 1993) or because of the colonisation of the area by fire ants, *Solenopsis* spp. (Porter & Savignano, 1990).

By increasing the availability of preferred prey items, the establishment of brood–rearing habitat on farmland has been shown to increase the proportion of these items in the diet of gamebird chicks (Sotherton et al., 1993). This, in turn, has also been found to increase chick–survival. The results of this study suggest that brood rearing habitats established under the BQI agri–environmental scheme provide bobwhite chicks with invertebrates known to be important dietary–items and could therefore improve chick survival rates on this landscape. However, due to the constraints of financial budgets and co–operation by farmers (Conover, 1998), it is difficult to envisage a sufficient quantity of BQI brood–rearing habitat being established on farmland in Georgia to reverse the dramatic declines of bobwhite populations seen over the last

50 years (Brennan, 1991). Consequently, it is therefore important that the foraging–value of the cropped areas of arable fields is also improved. By also using crop management techniques such as conservation tillage with legume cover crops (Cederbaum et al., 2004) in conjunction with establishing brood–rearing habitats through BQI, farmers could vastly increase the availability of invertebrates in arable fields to bobwhite and other farmland birds.

References

Aebischer, N. J., Robertson, P. A. & Kenward, R. E., 1993. Compositional analysis of habitat use from animal radio–tracking data. *Ecology,* 74: 1313–1325.

Butler, D. A., 2007. The role of invertebrates in the diet, growth and survival of northern bobwhite, *Colinus virginianus,* chicks in the southeastern United States. Ph. D. Thesis, Liverpool John Moores Univ.

Brennan, L. A., 1991. How can we reverse the northern bobwhite population decline? *Wildlife Society Bulletin*, 19: 544–555.

– 1993. Strip–disking: The forgotten bobwhite habitat management technique. *Quail Unlimited Magazine,* 12: 20–22.

Brennan, L. A., Lee, J. M. & Fuller, R. S., 2000. Long–term trends of northern bobwhite populations and hunting success on private shooting plantations in northern Florida and southern Georgia. In: *Quail IV: Proceedings of the Fourth National Quail Symposium:* 75–77 (L. A. Brennan, W. E. Palmer, L. W. Burger, Jr & T. L. Pruden, Eds.). Tall Timbers Research Station, Tallahassee, Florida, USA.

Cederbaum, S. B., Carroll, J. P. & Cooper, R. J., 2004. Effects of alternative cotton agriculture on avian and arthropod populations. *Conservation Biology,* 18: 1272–1282.

Chiverton, P. A. & Sotherton, N. W., 1991. The effects on beneficial arthropods of the exclusion of herbicides from cereal crop edges. *Journal of Applied Ecology*, 28: 1027–1039.

Conover, M. R., 1998. Perceptions of American agricultural producers about wildlife on their farms and ranches. *Wildlife Society Bulletin,* 26: 597–604.

Cook, M. P., 2004. Northern bobwhite breeding season dispersal, habitat use, and survival in a southeastern agricultural landscape. M. S. Thesis, Univ. of Georgia.

Ford, J., Chitty H. & Middleton, A. D., 1938. The food of Partridge Chicks (*Perdix perdix*) in Great Britain. *Journal of Animal Ecology,* 7: 251–265.

Green, R. E. & Tyler, G. A., 1989. Determination of the diet of the stone curlew (*Burhinus edicnemus*) by faecal analysis. *Journal of Zoology (London),* 217: 311–320.

Hurst, G. A., 1972. Insects and bobwhite quail brood habitat management. In: *Proceedings First National Bobwhite Quail Symposium:* 65–82 (J. A. Morrison & J. C. Lewis, Eds.). Oklahoma State Univ., Stillwater, Oklahoma, USA.

Moreby, S. J., 1988. An aid to the identification of arthropod fragments in the faeces of gamebird chicks (Galliformes). *Ibis,* 130: 519–526.

Palmer, W. E., 1995. Effects of modern pesticides and farming systems on northern bobwhite quail brood ecology. Ph. D. Thesis, North Carolina State Univ.

Porter, S. D. & Savignano, D. A., 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. *Ecology,* 71: 2095–2106.

Potts, G. R., 1986. *The Partridge: pesticides, predation and conservation.* Collins, London, UK.

Rands M. R. W., 1985. Pesticide use on cereals and the survival of grey partridge chicks: A field experiment. *Journal of Applied Ecology*, 22: 49–54.

Stoddard, H. L., 1931. *The Bobwhite Quail: its habits, preservation and increase*. Charles Scribner's Sons, New York.

Stromborg, K. L., 1982. Modern pesticides and bobwhite populations. In: *Proceedings* Second *National Bobwhite Quail Symposium:* 69–73 (K. Schitoskey, Jr., E. C. Schitoskey & L. G. Talent, Eds.). Oklahoma State Univ., Stillwater, Oklahoma, USA.

Sotherton, N. W., Robertson, P. A. & Dowell, S. D., 1993. Manipulating pesticide use to increase the production of wild game birds in Britain. In: *Quail III: national quail symposium*: 92–101 (K. E. Church & T. V. Dailey, Eds.). Kansas Dept of Wildlife and Parks, Pratt, Kansas, USA.

Southwood, T. R. & Cross, D. J., 2002. Food requirements of grey partridge *Perdix perdix* chicks: *Wildlife Biology*, 8: 175–183.