

# COMPARISON OF NORTHERN BOBWHITE CHICK FECAL AND CROP ANALYSES

Kristen Utz

Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602, USA

John P. Carroll

Daniel B. Warnell School of Forest Resources, University of Georgia, Athens, GA 30602, USA

Stephen J. Moreby

The Game Conservancy Trust, Fordingbridge, Hampshire, SP6 1EF, United Kingdom

## ABSTRACT

Impacts of modern agriculture on gamebird brood ecology have been studied in a number of species. One common factor cited has been the decline in available invertebrate food available to foraging chicks. In the United Kingdom, assessment of chick diet has been accomplished mainly through fecal analysis of wild chicks, whereas in North America crop analysis of human-imprinted chicks has become a commonly applied technique. We compared results of both techniques on groups of human-imprinted northern bobwhite (*Colinus virginianus*) chicks to determine if these different techniques provide similar results. Chicks were allowed to forage in groups of 6–8 in cotton fields with various cover crops. We euthanized half the chicks for crop analysis and isolated the other half of the chicks for 12 hours to collect feces. We found a positive relationship between total number of invertebrates/chick in crops and feces ( $P = 0.01$ ,  $R^2 = 0.51$ ). However, among important chick-food Orders the relationship varied greatly: Coleoptera ( $P = 0.10$ ,  $R^2 = 0.34$ ), Homoptera ( $P < 0.001$ ,  $R^2 = 0.41$ ), and Hymenoptera ( $P = 0.81$ ,  $R^2 = 0.05$ ). Our results suggest that there is a positive relationship between the 2 techniques, but that composition of the diet relative to what foods might be available in a particular site could be biased. We suggest more detailed research on technique development and standardization of techniques for assessing this important component of bobwhite life history.

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**Key words:** brood habitat, chicks, *Colinus virginianus*, fecal analysis, Georgia, insects, northern bobwhite

## INTRODUCTION

Gamebird biologists have developed a number of techniques to assess quality of brood habitat. For several species, especially those inhabiting agricultural ecosystems, a primary consideration has been to assess the importance of the invertebrate community to provide food resources. In northern bobwhites, it has been demonstrated in numerous studies that there is a significant link between invertebrate numbers and composition, and chick ecology (Handley 1931, Hurst 1972, Potts 1986, Jackson et al. 1987, Sotherton and Moreby 1992, DeVos and Mueller 1993, Palmer 1995).

Numerous techniques have been used over the years to assess numbers and types of invertebrates available to gamebird chicks in the field. Insect sampling techniques commonly employed include vacuum samplers (e.g., D-Vac systems), pit-fall trapping, and sweep-netting (Hurst 1972, Burger et al. 1993). Biologists have also employed more direct measures using data derived directly from chicks, including gut and fecal analysis (Moreby 1988, Palmer 1995). Human-imprinted chicks have also been employed to assess invertebrate availability (Kimmel and Healy 1987).

Some researchers using human-imprinted chicks have observed and identified foods consumed by chicks (Erpelding et al. 1987), whereas others have used esophageal stricture, and/or gut analysis (Palmer 1995). Palmer (1995) argued that mechanical sampling devices have limitations because even if they provide an unbiased sample of insects in a particular habitat they do not actually provide any estimate of those invertebrates available to or selected by gamebird chicks. Further, almost all other techniques that are applied commonly have untested assumptions and/or limitations in their application to gamebird management (Palmer 1995).

Use of quail chicks as the sampling tool offers the best opportunity for assessing habitat; however, this technique has logistical problems. For example, wild broods would provide the best opportunity to assess foods consumed, but sampling techniques require that this be done in an indirect way. Typically this has been done by sampling feces collected in the wild or by capturing wild chicks to extract crops and gizzards. Since wild chicks can be difficult to obtain, especially in ecosystems where biologists are trying to understand low population densities, the use of human-imprinted chicks has been viewed as a viable compro-

mise. Previous research done on wild broods using fecal analysis and human-imprinted quail using crops suggests that there is predictive value to both techniques (Sotherton and Moreby 1992, Palmer 1995).

As part of a research project investigating cotton cropping systems and quail brood habitat, we compared 2 commonly used techniques (crop and fecal analysis) to examine invertebrate abundance in brood habitat.

## STUDY AREA

The study was conducted in the Upper Coastal Plain ecological region, in Jefferson and Johnson counties, Georgia. This region is dominated by row crop agriculture and pine plantations. Dominant crops were cotton, peanuts, and corn. Forests consisted of hardwoods and loblolly pines (*Pinus taeda*).

## METHODS

### Study Design

The study consisted of 2 duplicate fields (about 10 ha) with each field divided into 4 treatments. Treatments consisted of: 1) conventional tillage, where cotton is tilled with a standard pesticide regime, 2) conservation tillage type A, where fields are strip-tilled and winter wheat is used as a cover crop with a standard pesticide regime, 3) conservation tillage type B, where fields are strip-tilled and clover and winter wheat are used as cover crops with a standard pesticide regime, and 4) clover-strip tillage, where fields are strip-tilled and clover is used as a cover crop, but no insecticides and minimal herbicides are sprayed on the field. A randomized complete block design was used to reduce variation among the fields.

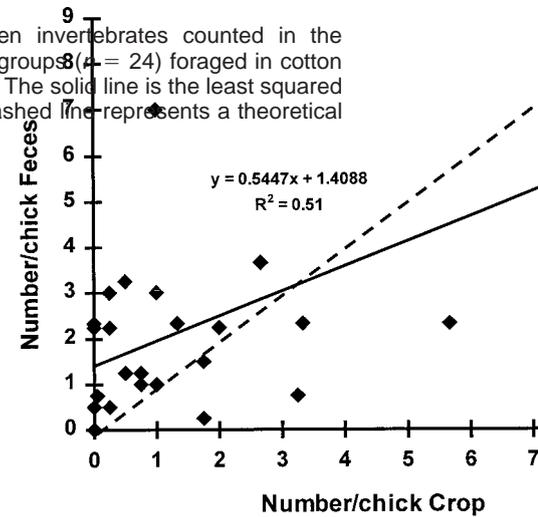
### Imprinting

We imprinted the chicks following Palmer (1995). Imprinting was used to allow the quail chicks to establish a bond with the researcher. We could then allow chicks to forage in a habitat for controlled periods of time, thereby standardizing our sampling techniques.

Two-hundred fifty quail eggs for each trial were obtained from a private breeder and were mechanically incubated for 21–23 days. On the last 2 days before hatching, we whistled to them to begin the imprinting process. As they hatched, the chicks were allowed to dry and were then placed in a brooder where the temperature was maintained at 35°C. They were fed commercial chick starter. During the first 2 days after hatch the quail handler spent up to 15 hours per day establishing a bond with the chicks using whistling and imitating hen calls. Approximately 130 chicks were imprinted in June 2000, 100 in July 2000, and 170 in August 2000.

After imprinting, we allowed chicks to forage at least once in each cotton cropping system. This allowed the chicks to practice foraging at each crop type

Fig. 1. Relationship between invertebrates counted in the crops and feces of bobwhite groups ( $n = 24$ ) foraged in cotton fields in Georgia during 2000. The solid line is the least squared regression of the data and dashed line represents a theoretical 1:1 relationship.



and to become familiar with the handler before the final trials. This was done for about 5 days.

### Data Collection

Field trials occurred when the chicks were 8–10 days old. Feed was removed 12 hours before the field trials to ensure chicks were hungry. Groups of 6–8 chicks were allowed to forage simultaneously on each of the field types for 30 minutes. After foraging, half of the chicks were collected in boxes for fecal collection while the other half were sacrificed using a carbon dioxide chamber. Due to low hatch success, the sample size in July (100 chicks) was less than June (130 chicks) and August (170 chicks). Therefore, 6 chicks were used per group instead of 8. Chicks that were used for fecal collection were isolated in divided brooders. Feces were collected for 12 hours and placed in vials containing 70% ethanol. Insect contents were identified in the feces and were categorized to taxonomic Order. We counted insects in feces following Moreby (1988). Use of quail chicks in this study followed protocols approved by the University of Georgia (IACUC Animal Use Permit #A34337-01).

### Data Analysis

We used regression analysis to assess the relationship and predictive ability of crop and fecal analysis.

## RESULTS

We tested groups of chicks in a total of 24 trials (3 time periods and 2 blocks with 4 cover types in each block). In most cases there were 8 chicks in each group. Our results suggest a positive relationship in numbers of insects consumed between fecal and crop contents ( $F = 7.88$ , 22  $df$ ,  $P = 0.01$ ,  $R^2 = 0.51$ ) (Fig. 1).

Fig. 2. Relationship between Coleoptera numbers counted in the crops and feces of bobwhite groups ( $n = 24$ ) foraged in cotton fields in Georgia during 2000. The solid line is the least squared regression of the data and dashed line represents a theoretical 1:1 relationship.

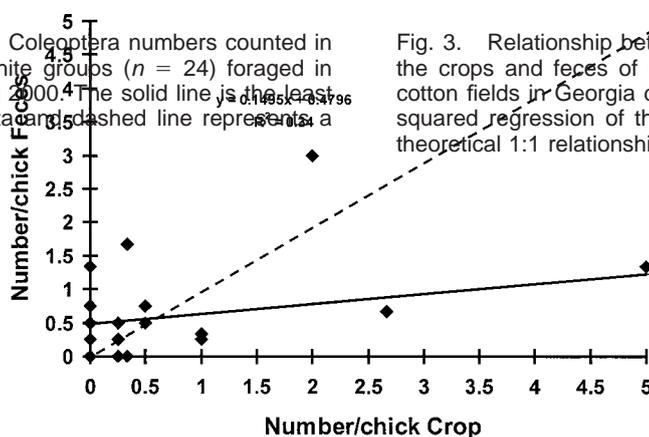
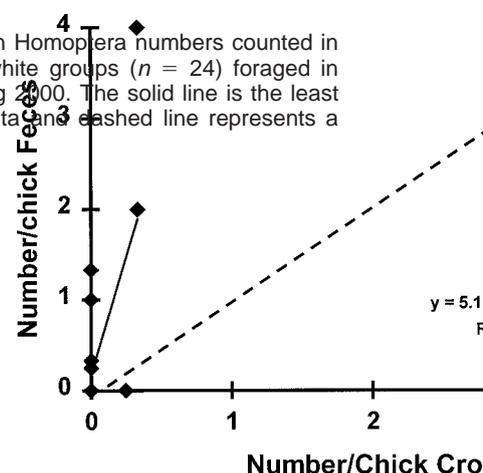


Fig. 3. Relationship between Homoptera numbers counted in the crops and feces of bobwhite groups ( $n = 24$ ) foraged in cotton fields in Georgia during 2000. The solid line is the least squared regression of the data and dashed line represents a theoretical 1:1 relationship.



Among Orders comprising important chick foods, relationships between the two techniques were variable. Comparison of feces and crop in Order Coleoptera suggested a positive relationship ( $F = 2.95$ , 22  $df$ ,  $P = 0.10$ ,  $R^2 = 0.34$ ); however, the regression suggested that 5 insects would be detected in the crop for each one detected in the feces (Fig. 2). Comparison of crops and feces in Order Homoptera suggested a positive relationship ( $F = 15.29$ , 22  $df$ ,  $P < 0.001$ ,  $R^2 = 0.41$ ). For this Order, we were more likely to find insects in the feces rather than the crops (Fig. 3). In the Order Hymenoptera, we found no relationship between the numbers found in the crops and feces ( $F = 0.0575$ , 22  $df$ ,  $P = 0.81$ ,  $R^2 = 0.05$ ) (Fig. 4).

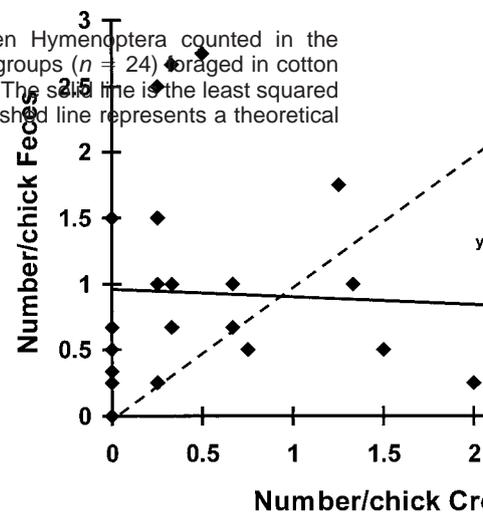
## DISCUSSION

Our results suggest that the total numbers of insects per chick in the feces and crop were significantly correlated. This is an important finding because studying fecal contents alone would be a non-destructive means of studying brood habitat without having to sacrifice the chicks for gut samples. However, it is apparent from this comparison that insects available to and/or selected by quail could yield significantly different results depending on the technique chosen. For instance, the Order Coleoptera consists of beetles which contain hard shells and mouth parts. The easily identifiable parts that are difficult for a chick to digest allow easy identification in the feces. However, our results also suggest that these insects might be retained in the gut longer than the 12 hours we collected feces. Most of the insects in the Order Hymenoptera consumed by chicks in our study were ants (Formicidae). These have soft bodies and hard mouth-parts, therefore might pass very quickly through the gut, yet be easily identified. Therefore, both techniques have potential biases associated with the relative passage and digestion of various invertebrates. Other factors, such as behavioral and/or physiological characteristics of the chicks could affect results. For example, when forag-

ing chicks with empty crops, chicks might fill and pass crop contents faster than the 30 minutes used in this study. Ambient temperature during foraging periods for these animals with limited thermoregulatory ability might also impact food passage rates and levels of digestion.

A weakness in our experiment is the possibility that there were significant differences in types of invertebrates consumed by the subsamples of chicks used for each technique. This is difficult to test, but we found our chicks foraged in relatively tight groups and were randomly assigned to a sampling method. Therefore, we believe that there should be little bias in foods consumed among chicks within groups.

Fig. 4. Relationship between Hymenoptera counted in the crops and feces of bobwhite groups ( $n = 24$ ) foraged in cotton fields in Georgia during 2000. The solid line is the least squared regression of the data and dashed line represents a theoretical 1:1 relationship.



## MANAGEMENT IMPLICATIONS

Our data suggest that 2 commonly employed techniques provide similar results when assessing total numbers of invertebrates consumed by bobwhite chicks. However, there were marked differences at the Order level. These results suggest that we need to investigate in more detail the assumptions we make with our invertebrate sampling techniques, especially those related to assessing habitat quality.

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