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A Three Year Analysis of Sex Ratios Among Sialia sialis Nestlings

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A Three Year Analysis of Sex Ratios Among *Sialia sialis* Nestlings: An Investigation into Seasonal Resource Availability and Facultative Brood Manipulation by Maternal Eastern Bluebirds in Knox County, Ohio

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A male bluebird with color bands.

Questions:

•How have *Salia sialis* clutch sex ratios varied over the last three seasons?
•Do maternal Eastern Bluebirds facultatively bias brood sex ratios?
•Are more males produced when resources are abundant?

Abstract:

In the summer of 2003, I found a male biased sex ratio among offspring that was attributed to maternal choice of zygote sex. This was an unusual finding, because other eastern bluebird studies have often revealed female biased sex ratios among young (Gowaty & Plissner 1998). However, the study population in Knox County did not exhibit a biased sex ratio among young in either the summer of 2004 or 2005. My study this year is the culmination of three years of data collected on sex ratios, feeding rates and health status in this bluebird population. The feeding rate data collected is not indicative of chick growth due to parental providing; although the calculated rates of feeding decreased over the years, the average chick weight remained constant. We therefore used a Fat Index (weight: wing length ratio) to indicate parental provisioning to chicks. Data compiled over the last three years indicate a facultative shift of sex ratios favoring males when parents are able to provide more food to their clutch.

Introduction:

Eastern bluebirds (*Sialia sialis*) are a monogamous species with some individuals exhibiting extrapair paternity behavior. According to Gowaty, extra-pair copulations are responsible for as high as 20-30% of nestlings in some populations of eastern bluebirds (Gowaty & Plissner 1998). According to the Trivers Willard hypothesis, species with polygynous life history strategies may produce a male biased sex ratio (Trivers & Willard 1973). Because some males are able to copulate with multiple females, whereas others may have no mates, male reproductive success is more variable than female reproductive success. Attractive males will be more fecund than unattractive males and most females. However, unattractive males will be less attractive than most females. In zebra finches, Gorman and Nager have shown that female condition directly impacts chick health and that this affects chick fecundity later in life (2004). Therefore, a female will theoretically produce males only if they are of good quality so that they will be maximally fecund later in life. Because healthy adult females can produce attractive offspring, it is in their best interest to produce the most fecund offspring, which are attractive males. In short, a male biased chick sex ratio is anticipated for adult females in good condition, whereas adult females in poor condition are more likely to produce a female biased clutch. Results consistent with these predictions were found in a population of house wrens in Wisconsin studied in 1998 & 1999 (Whittingham et al. 2002).

My research focuses on parental provisioning for nestlings as the basis for a sex ratio bias. This study implies that adult females can accurately assess environmental conditions to bias their offspring sex ratio accordingly, a condition necessary for adaptive clutch sex ratio manipulation (West & Sheldon 2002).

Methods:

In summer of 2005 (June 1st-August 8th), we monitored approximately 50 boxes bi-weekly in Wolf Run Park, the Brown Family Environmental Center, Pleasant Street Elementary School in Mount Vernon, and a few private residences within Knox County. Monitoring consisted of checking the species residing in the box, counting chicks and eggs and checking for bot fly larvae.

We also counted feeding visits, attached leg-bands, and measured adults and chicks at the nest boxes. Measurements were taken of tarsus length, wing length, and weight.

Adults were captured in mist nets or within the box using a trap door triggered by remote control.

During feeding observations, most broods were observed twice for one hour within the 14 day period (between days 4-6 and days 11-14) before chicks fledged; number of feeding trips by both parents was recorded.

At approximately day 12, the chicks were sexed by plumage (eastern bluebirds are sexually dimorphic between days 12-14 after hatching), and chicks were banded and checked for parasites (bot fly larvae).

The Fat Index indicated weight scaled by body size (represented by wing length). Year effects were analyzed using MINITAB 14.0 GLM, and variation in sex ratios by regression. For estimating the effect of the Fat Index on sex ratios we eliminated broods infested by parasites, because parasitism is not indicative of parental provisioning for nestling. Additionally, only broods in which there were three or more chicks are included because of the reduced sample size of the non-parasitized broods.

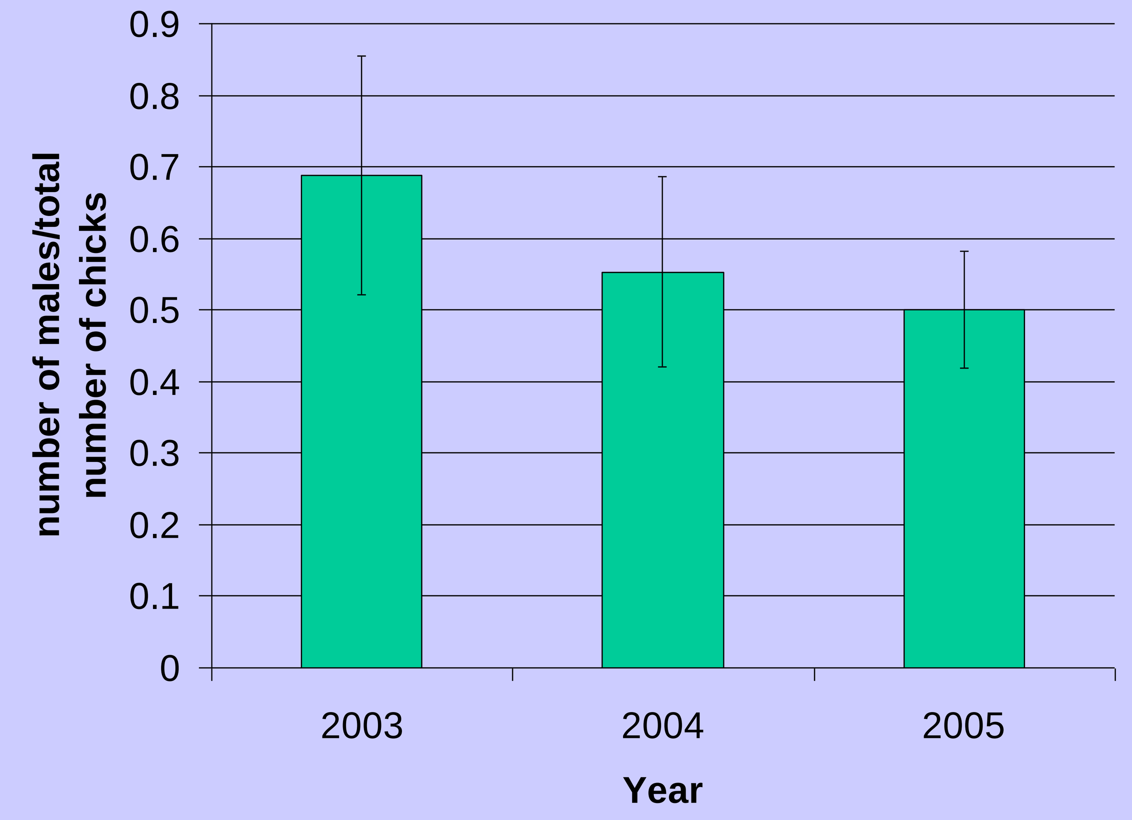

Figure 1. Average number of males/total number of chicks per brood (male sex ratio) in relationship to year. Error bars represent a 95% CI. (GLM, N=30 broods, F=3.76, P=0.036).

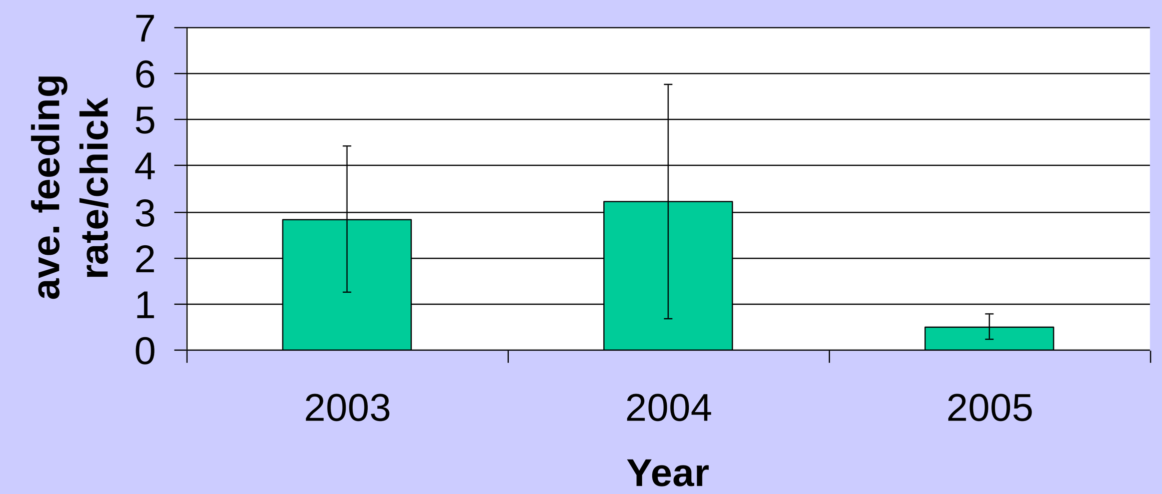

Figure 2. Average feeding rate/chick in relationship to year. Error bars represent a 95% CI. (GLM, N=30 broods, F=3.76, p=0.036).

Figure 3. Male sex ratio by brood in years 2003-2005 in relationship to Fat Index (ave. wing length/ave. weight). y= - 0.453 + 2.02x (ANOVA, N=18, F=7.89, P=0.015).

Two 11 day old chicks.

Results:

There was a pronounced male biased sex ratio in 2003, and no bias in 2004 or 2005 (Fig. 1).

Average chick weights did not differ from year to year (GLM, N=29, F=0.08, P=0.922) even though feeding rates varied considerably within years (Fig. 2). Feeding rates in 2005 appear to be lower, but feeding rates did not vary predictably with either chick weight or sex ratio. Parasitism did effect average chick weight (GLM, N=29, F=4.28, P=0.046,).

The sex ratio of males per brood increased as the Fat Index increased (Fig. 3).

Discussion:

Overall, the population exhibited a drastically male biased clutch sex ratio in 2003, this is the first study to our knowledge to show a seasonal male biased sex ratio among Eastern Bluebird chicks

Average chick weights did not differ from year to year. However, feeding rates did differ by year. Perhaps the quality of the food for 2005 was higher, so less feeding trips were necessary. More likely, the amount of time we allocated to feeding rate observations was too short in duration for our feeding data to be a good indicator of the ability of parents to provide resources for chicks. This indicates that this methodology for assessing parental investment should be changed in future studies.

Instead of using feeding rates, we used the Fat Index as an indicator of chick condition, because Fat Index better reflects the parental provisioning of resources delivered over the entire nesting period. The average weight/average wing length for chicks in a brood is indicative of resources provided by the parents since it is a measure of environmental dependant growth divided by a body size element.

The increase of male sex ratio with increased Fat Index indicates that this population uses facultative sex ratio shifts by brood over all three years. As the parental ability to provide for their chicks increased, they skewed the sex ratio in favor of males (Fig 3). It is important to note that facultative manipulation occurs even though the clutch sex ratio is 50/50 in 2004 and 2005.

To our knowledge, this is the first study in which the Eastern Bluebird has been found to show facultative brood sex ratio manipulations in favor of a biased male sex ratio.

Bluebird chick at age 14 days.

Future Directions:

My research in summer 2005 also focused on determining the rate of extrapair paternity within this bluebird population to examine if high rates of extrapair paternity are found, as predicted by the Trivers-Willard hypothesis (Trivers & Willard 1973).

Blood samples were taken in addition to the body measurements made for individual bluebirds. Currently, I have completed DNA extractions for all of the blood samples I collected this summer (~80 birds) using Puregene protocol from Gentra Systems Inc. These samples are being stored until I perform microsatellite analysis.

I have recently received the microsatellite sequences from Professor Herman Mays at Auburn University, for the paternity testing I will be doing this fall to determine avian parentage. Our collaboration will result in a co-authored paper I plan to submit with Professor Ray Heithaus in spring of 2006.

Tarsus measurement of an adult bluebird.

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