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Effect of Nestling Sex Ratio on the Provisioning Behavior of *Sialia sialis* (Eastern Bluebird)

Barbara E. Kieffer and Gary Ritchison

**Abstract** - To maximize reproductive success, parents may differentially invest in sons and daughters, i.e., sex-biased parental investment. Preferential provisioning behavior has been reported in one population of *Sialia sialis* (Eastern Bluebird) and attributed to local resource competition. We studied the provisioning behavior of Eastern Bluebirds in Madison County, KY in 2004. We experimentally manipulated brood sex ratios in 24 bluebird nests, creating female-biased (*n* = 8), male-biased (*n* = 5), and control (*n* = 11) nests. Following manipulation, nests were videotaped to record adult provisioning behavior. Brood sex ratio had no effect on the provisioning behavior of either male or female Eastern Bluebirds. Similarly, we found no effect of brood sex ratio on the provisioning rates of either male or female bluebirds for control broods that naturally differed in number of male and female nestlings (*n* = 9; 5 male-biased and 4 female-biased). Our results contrast with those of a previous study that found that male Eastern Bluebirds fed nestling males less than nestling females, possibly because sons were more likely to compete with them for resources in the future. However, local resource competition seems unlikely because Eastern Bluebirds exhibit low rates of philopatry. Given these conflicting results, additional study is needed to determine if factors such as latitude, food availability, or availability of other resources might influence the provisioning behavior of male Eastern Bluebirds.

**Introduction**

Sex-biased parental investment can potentially occur via sex-biased provisioning of nestlings and might be expected if male and female young differ in their energetic needs. For example, males are typically larger than females in sexually size-dimorphic species, and male offspring with greater energetic needs may be fed at higher rates than females (e.g., Green 2002, Magrath et al. 2007).

Differential provisioning might occur in species of birds with little or no sexual size dimorphism if the sexes differ in competitive abilities or physiological requirements (e.g., Boncoraglio et al. 2008). In addition, parents might differentially provision different-sexed young if male and female offspring differentially affect the reproductive success of parents after independence (Michler et al. 2010). For example, because male birds tend to be more philopatric than females (Greenwood 1980), males might differentially provision female nestlings because, after fledging, philopatric male offspring might represent potential competitors for important resources (Harper 1985, Stamps 1990). Alternatively, parents might differentially provision female offspring because females tend to disperse greater distances, and extra food during development might improve their chances of survival during and after dispersal (Stamps 1990).

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Most studies to date have reported little evidence of sex-biased provisioning in species of birds with little or no sexual size dimorphism (Lee et al. 2010, Leonard et al. 1994, Michler et al. 2010). However, Gowaty and Droge (1991) reported sex-biased provisioning by *Sialia sialis* L. (Eastern Bluebird) in South Carolina, with males provisioning female-biased broods at higher rates than male-biased broods and selectively provisioning females within broods. Differences in energetic needs do not explain this behavior because the metabolic rates of young male and female bluebirds are similar (Droge et al. 1991). Rather, Gowaty and Droge (1991) suggested that male Eastern Bluebirds fed female nestlings more frequently than male nestlings because males are more philopatric and, therefore, more likely to compete with the same-sexed parent for resources such as mates, territories, or food resources (i.e., local resource competition).

Because sex-biased provisioning has been reported in so few species and there is little evidence for local resource competition between adult birds and their offspring (Weatherhead and Montgomerie 1995), additional study is needed to determine if birds exhibit sex-biased provisioning and, specifically, to determine if male Eastern Bluebirds in other populations exhibit a sex-bias in their provisioning behavior. Our objective was to determine if the provisioning behavior of male and female Eastern Bluebirds in Kentucky is influenced by brood sex ratio.

**Methods**

We studied Eastern Bluebirds at the Blue Grass Army Depot (BGAD; 37°41’N, 084°13’W), located southeast of Richmond, Madison County, KY, from 10 May to 20 July 2004. The BGAD encompasses 5865 ha and consists of grasslands, open fields, pastures, and scattered woodlots.

Prior to the breeding season, nest boxes mounted on 1.5-m poles were placed throughout the BGAD. Beginning in May 2004, boxes were checked every 7 to 10 days to determine if boxes were being used by bluebirds. If so, nests were checked every 3 to 6 days to determine laying dates, hatching dates, and nestling age.

Adult bluebirds were captured and uniquely banded with a numbered USGS aluminum color banded plus a unique combination of 3 colored plastic leg bands. Adults were captured in mist nets, either by luring adults into nets by playback of bluebird songs or nestling distress calls or by placing nets in front of nest-box entrances. All adults were captured a minimum of two days before provisioning rates were determined (see below).

We determined the sex of nestling bluebirds by plumage coloration (Gowaty and Plissner 1998, Pinkowski 1974). Emerging primary and tail feathers of male nestlings are bright blue, whereas those of females are dull, gray-black with a faint blue hue. Primary and tail feathers are sufficiently emerged from sheaths to allow sex determination by 11–13 days post-hatching (B.E. Kieffer and G. Ritchison, pers. observ.; Gowaty and Plissner 1998; Pyle 1987).

We performed manipulations at 24 bluebird nests, with nests placed in one of three categories: control, female-biased, and male-biased. Manipulation involved changing the sex ratios of nests from the original ratio to either male- or female-
biased (Lessells et al. 1998). Control nests were subjected to the same procedure as manipulated nests, but nestlings were switched between boxes without changing sex ratios.

Manipulations occurred when nestlings were old enough to be sexed, but sufficiently young so they would not fledge prematurely due to handling (Droge et al. 1991). Nestlings were exchanged between nests with similar brood sizes (± 1 nestling) and nestlings of similar age (± 1 day). For example, if nest box A had three female and two male nestlings and nest box B had two female and two male nestlings similar in age, then two males from box A would be moved to box B and two females from B would be moved to box A. This manipulation would create one female-biased box (box A) and one male-biased (box B). Control boxes were subjected to the same procedure, but equal numbers of nestlings of the same sex were exchanged.

Nests were videotaped to record adult provisioning behavior. A plastic container (64 cm x 36 cm x 34 cm high; hereafter camcorder box) mounted on poles was attached to the back of nest boxes 1–3 days before videotaping began to acclimate the birds to its presence. A black cardboard box, comparable in size to the camcorder, was placed in camera boxes to simulate the presence of a camcorder. Backs of nest boxes were removed when camcorder boxes were attached and were replaced with wire mesh to prevent adults and nestlings from entering camcorder boxes. Manipulation of boxes and broods had no apparent effect on adult behavior; provisioning rates of bluebirds in our study were similar to those reported previously (Gowaty and Plissner 1998, Pitts 1976).

When videotaping, camcorders were placed in the camcorder boxes and focused on the inside of nest boxes. Nests were videotaped for 2 to 4 hours daily, with all taping during the period from sunrise to 12:00 EDT.

We subsequently reviewed videotapes and, for each nest, determined the total number of visits by each adult and the total time each nest was videotaped. We used one-way analysis of variance to examine the possible effects of nestling age and brood size on the provisioning rates (feedings/hour/nestling) of male and female Eastern Bluebirds. Possible differences among treatments and by season (months) in provisioning rates of male and female bluebirds were analyzed using a two-way analysis of variance. All statistical analyses were performed using the Statistical Analysis System (SAS Institute 2002). Values are presented as means ± SE.

Results

We conducted experiments with 24 pairs of bluebirds, including 11 controls, 8 female-biased broods, and 5 male-biased broods. Mean brood size was 4.0 ± 0.1 (range = 3–5) and the mean age of nestlings when we videotaped nests was 14.2 ± 0.3 days post-hatching (range = 12–17 days). Nests were taped for an average of 6.8 ± 0.5 hrs (range = 2–12 hours). Control, male-biased, and female-biased nests did not differ in either age of young when videotaped ($F_{2, 21} = 0.5, P = 0.63$) or brood size ($F_{2, 21} = 0.7, P = 0.49$).
Among experimentally skewed broods (i.e., all male, all female, or control broods), brood sex ratio had no effect on the provisioning rates of either male ($F_{2,15} = 0.4, P = 0.66$) or female ($F_{2,15} = 0.2, P = 0.84$) Eastern Bluebirds (Fig. 1). In addition, provisioning rates of male ($F_{2,15} = 1.9, P = 0.19$) and female ($F_{2,15} = 2.5, P = 0.15$) bluebirds did not vary among months (May, June, and July), and interactions between treatment and month were not significant (males: $P = 0.59$; females: $P = 0.67$). For control broods that naturally differed in the number of male and female nestlings ($n = 9$; 5 male-biased and 4 female-biased), we also found no effect of brood sex ratio on the provisioning rates of either male ($F_{1,7} = 0.1, P = 0.72$) or female ($F_{1,7} = 1.7, P = 0.30$) bluebirds.

**Discussion**

We found that brood sex ratios did not affect the provisioning behavior of male and female Eastern Bluebirds. Similar results have been reported for *Parus major* L. (Great Tit) (Michler et al. 2010), *Paradoxornis webbianus* Gould (Vinous-throated Parrotbill) (Lee et al. 2010), and *Sialia mexicana* Swainson (Western Bluebird) (Leonard et al. 1994). In contrast, Gowaty and Droge (1991) reported that male Eastern Bluebirds fed female-biased broods at higher rates than male-biased broods in a population in South Carolina. In general, young males tend to be more philopatric than females (Greenwood 1980) and, therefore, may be more likely to compete with male parents for food, nest sites, and other resources (local resource competition). If so, adult males might be expected to preferentially provision female nestlings, i.e., the non-competing sex (Koenig and Dickinson 1996). Gowaty and Droge (1991) suggested the preferential feeding of female nestlings by male Eastern Bluebirds could be explained by the possibility of such local resource competition.
Leonard et al. (1994), however, suggested that it was not clear for any species why competition with kin would be worse than competition with non-kin and, in some situations, competition with kin would seem preferable to competition with non-kin. For example, losing a portion of a territory to a son that could then breed would be preferable, in terms of a parent’s fitness, to losing a portion of a territory to an unrelated male (Leonard et al. 1994). In addition, local resource competition seems unlikely because birds in general, including male birds, exhibit low rates of philopatry (Weatherhead and Montgomerie 1995). For Eastern Bluebirds in South Carolina, Gowaty and Plissner (1998) reported that, of 3798 banded and fledged young, only 0.6% bred at their natal boxes and only 1.7% bred in territories adjacent to natal territories. In addition, return rates to natal areas are even lower at higher latitudes (Gowaty and Plissner 1998). Available evidence, therefore, indicates that, for Eastern Bluebirds and other songbirds, local resource competition is unlikely to occur and unlikely to influence adult provisioning behavior.

Provisioning of nestlings by parents may be influenced more by nestling behavior than parental behavior, particularly in cavity-nesting birds where older young are fed at the cavity entrance. Leonard et al. (1994) found that nestlings that were fed by cavity-nesting adult Western Bluebirds were closer to entrance holes and started begging sooner than their siblings. Similarly, Hofstetter and Ritchison (1998) found that nestling *Megascopsasio* L. (Eastern Screech-Owl) fed by adults arriving at cavity entrances started begging earlier and positioned their bills closer to adults. In these species, and perhaps other cavity-nesting birds including Eastern Bluebirds, the ability of parents to selectively feed particular offspring or offspring of a certain sex may be limited, particularly later in the nestling period when parents may not enter cavities to feed young, but, rather, feeding the nestling closest to, or actually extending their head or bill out of, the cavity entrance.

Empirical evidence for sex-biased provisioning by free-living birds is limited to a single study of Eastern Bluebirds (Gowaty and Droge 1991), and the reasons for differences between the results of other studies, including our results, and those of Gowaty and Droge (1991) are unclear. Additional studies of the possible effect of brood sex ratios on the provisioning behavior of Eastern Bluebirds and other species are needed to determine if factors such as latitude (e.g., variation in degree of natal philopatry), food availability, or availability of other resources (e.g., suitable cavities) might influence male behavior.

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**Literature Cited**


