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DELAYED NESTING DECREASES REPRODUCTIVE SUCCESS IN NORTHERN FLICKERS: IMPLICATIONS FOR COMPETITION WITH EUROPEAN STARLINGS

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Abstract.—I monitored 31 pairs of Northern Flickers (*Colaptes auratus*) during five nesting seasons in east-central Ohio in order to determine the effects of time and harassment by European Starlings (*Stumus vulgaris*) on reproductive output. Since flickers have proved to be highly vulnerable to competition with starlings for nest sites, flicker pairs are often forced to delay nesting until later in the season. If flicker reproductive success drops as the nesting season progresses, it is likely that flickers that loose nest cavities to starlings early in the season will produce fewer offspring than those which do not. Flicker clutch size for clutches completed before 1 June (early clutches), by which time most females that had not lost cavities to starlings had completed their initial clutches, was significantly larger than clutch size for clutches completed after 1 June (late clutches). Flicker nestling and fledgling numbers from early clutches were also significantly greater than those from late clutches. Flicker clutch size and number of fledglings were negatively correlated with date. Since at least 58% of flicker pairs that delayed clutch completion until after 1 June were forced to delay by starlings, their reductions in fecundity can be attributed to competition with starlings.

EL ANIDAMIENTO ATRASADO REDUCE EL ÉXITO REPRODUCTIVO DE *COLAPTES AURATUS*: IMPLICACIONES PARA LA COMPETENCIA CON *STURNUS VULGARIS*

Sinopsis.—Le di seguimiento a 31 parejas de *Colaptes auratus* a través de cinco temporadas de anidaje en la región centro-oriental de Ohio para determinar los efectos del tiempo y la molestia por *Sturnus vulgaris* en el rendimiento reproductivo. Ya que se ha comprobado que *Colaptes auratus* son altamente vulnerables a la competencia con *Sturnus vulgaris* por lugares para anidar, las parejas de *Colaptes auratus* a menudo son forzadas a retrasar su anidamiento hasta despues en la temporada. Si el éxito reproductivo de *Colaptes auratus* cae según prosigue la temporada reproductiva, es probable que los *Colaptes auratus* que pierdan las cavidades de anidar a los *Sturnus vulgaris* temprano en la temporada produzcan menos crías que aquellos que no las pierden. El tamaño de la camada de *Colaptes auratus* para camadas completadas antes de junio 1 (camadas tempranas), fecha para la cual las hembras que no perdieron sus cavidades a *Sturnus vulgaris* habían completado sus camadas iniciales, fueron significativamente mayores que el tamaño de camada para camadas completadas después de junio 1 (camadas tardías). Los números de pichones y volantones de *Colaptes auratus* en camadas tempranas fueron también significativamente mayores que los de camadas tardías. El tamaño de camada y el número de volantones de *Colaptes auratus* fueron correlacionados negativamente con la fecha. Ya que al menos 58% de las parejas de *Colaptes auratus* que retrasaron el completar su camada hasta después de junio 1 fueron forzadas a esto por *Sturnus vulgaris,* la reducción en su fecundidad se puede atribuír a la competencia con *Sturnus vulgaris*.

Although numerous studies document that European Starlings (*Stumus vulgaris*) usurp nest cavities from various primary and secondary cavity-nesting birds (Brenowitz 1978; Howell 1943; Ingold 1989, 1994; Ingold and Ingold 1984; Jackson 1976; Kerpez and Smith 1990; Kilham 1958, 1968; Polder 1963; Reller 1972; Tracy 1933; Troetschler 1976; Weitzel 1988; Wood 1924; Zeleny 1969), relatively few attempt to demonstrate actual reductions in reproductive success as a result of such competition. Ingold (1989) found that Red-bellied Woodpeckers (*Melanerpes carolinus*) in Mississippi suffered reproductive setbacks as a result of starling competition primarily for two reasons: (1) they were no longer able to raise a second brood after a successful first one due to delays resulting from interactions with starlings, and (2) many pairs were forced to delay their initial nest effort until later in the season to avoid starlings. Such delays were associated with significant reductions in woodpecker clutch sizes, nestling numbers, and fledgling numbers. Conversely, Ingold (1994) found that although Red-bellied woodpeckers and Northern Flickers (*Colaptes auratus*) in Ohio frequently lost nest cavities to starlings early in the season, they may not have suffered reductions in fecundity since they frequently successfully delayed their initial nest effort until June or July after starlings had completed nesting. Such pairs were at no apparent disadvantage since double broodedness by these species was relatively uncommon at that latitude (Ingold 1994).

Northern Flickers are a common primary cavity-nesting species in most of eastern North America and a common to abundant breeding resident in east-central Ohio (Peterjohn and Rice 1991). Although flickers are one of the largest woodpecker species in North America they are vulnerable to competition with European Starlings for nest cavities (Bent 1939; Burns 1900; Dennis 1969; Erskine and Mclaren 1976; Ingold 1994; Kilham 1959, 1983; Shelley 1935; Short 1982). Ingold and Densmore (1992) and Ingold (1994) found that the nesting period of flickers in east-central Ohio overlaps considerably that of starlings. Moreover, flickers frequently lost nest cavities to starlings, usually before the onset of egg-laying, but occasionally after egg-laying or incubation had begun.

The purpose of this study was to determine whether reproductive success of Northern Flickers declines through the breeding season and, if so, whether nesting delays caused by starlings adversely affect flicker nest success. If such reductions do occur, then flickers that loose nest cavities to starlings early in the nesting season could ultimately produce fewer offspring than those that do not.

STUDY AREA AND METHODS

From May–July 1990–1992, and 1994–1995, I located active Northern Flicker nest cavities in and around New Concord, Muskingum County, Ohio (40°00′N, 81°46′W). The study area consists of about 1000 ha of residential areas, agricultural woodlands, and small patches of closed-canopy forests (see Ingold 1994 for a more thorough description of the study area). Although flickers were located in all three habitats, they occurred most frequently in woodlands (60%), followed by forests (30%) and residential areas (10%).

I climbed to flicker cavities that I could reach with a 10-m extension ladder once or twice weekly and examined the contents with a light and mirror. I determined the clutch size to be the number of eggs present after the onset of incubation. I considered the number of nestlings in a brood to be the number of nestlings that actually hatched, regardless of whether or not they survived to fledging. I considered the number of fledglings to be the number of nestlings present on my last cavity check prior to the young leaving (which usually occurred between day 20 and 24 of the nestling stage). In order to determine the status of a flicker nest cavity and to detect whether or not it was being contested by European Starlings, I monitored each cavity for a minimum of 30 min each week (cf. Ingold 1994).

Because sample sizes were small and variable between years, I used Kruskal-Wallis tests to analyze differences in flicker clutch sizes, nestling numbers, and fledgling numbers among years. I found that each of these measures of reproductive output had significantly greater values in 1995 than during any previous year ($P < 0.05$), as well as for all four previous years combined ($P < 0.05$). Thus, the 1995 data were analyzed separately. Because my sample sizes for 1990–1992 and 1994 were quite small I pooled these data.

I divided clutches into early nests (those completed before 1 June, the date by which at least 90% of uninterrupted flicker pairs had initiated their first clutch) versus late nests (completed after 1 June, by which time second nesting efforts were common, usually as a result of unsuccessful initial nest attempts). Because of small sample sizes, I tested for differences in clutch sizes, nestling numbers, and fledgling numbers between early and late nests, using Mann-Whitney U-tests. Data from flickers that lost cavities to starlings earlier in the season before they had begun egg-laying are included in the analyses. However, because one of my goals was to test the effects of time on flicker fecundity, all clutch size, nestling, and fledging data from nests interrupted by starlings were excluded from these analyses, since most such attempts resulted in no surviving offspring. Of 12 late flicker clutches, to my knowledge, only 2 were second clutches from pairs that had previously laid an initial clutch earlier in the season. Since it is probable that only 17% of late clutches were second clutches, I am confident that the temporal effects on flicker fecundity were not confounded by resource or energy depletion associated with pairs engaged in second nest attempts.

I performed linear regression analyses on flicker clutch sizes, nestling numbers, and fledgling numbers versus time (weeks). Because differences in these data from early versus late nests in 1990–1992 and 1994 were about the same as differences in data collected from early versus late nests in 1995, and because my sample size from 1995 was fairly small (n = 12 flicker pairs), the data were pooled prior to these analyses.

RESULTS

I collected data from 36 Northern Flicker clutches laid from the first week of May through the fourth week of June. Clutch sizes of early clutches ($\bar{x}$ = 6.18, n = 17) were significantly larger than those of late clutches ($\bar{x}$ = 4.71, n = 7) in 1990–1992 and 1994 (U = 17; $P < 0.01$, Mann-Whitney U-test). The same was true of 1995 clutch sizes ($\bar{x}$ = 9.00 vs. 6.20, respectively; n = 7, 5; U = 0.5; P < 0.01, Mann-Whitney U-test). Nestling numbers from early clutches were significantly larger than those from late clutches in 1990–1992 and 1994 ($\bar{x}$ = 5.27 vs. 3.25, respectively; n = 11, 4; U = 5; P < 0.05, Mann-Whitney U-test), and in 1995 ($\bar{x}$ = 7.43 vs. 5.40; n = 7, 5; U = 3; P < 0.05, Mann-Whitney U-test). Similarly, fledgling numbers from early clutches were significantly larger than those from late clutches in 1990–1992 and 1994 ($\bar{x}$ = 5.09 vs. 2.75, respectively; n = 11, 4; U = 2.5; P < 0.05, Mann-Whitney U-test), and in 1995 ($\bar{x}$ = 6.67 vs. 4.50; n = 6, 4; U = 0; P < 0.05, Mann-Whitney U-test). A negative association existed between flicker clutch size and time (F = 9.88, P < 0.05, df = 1,5; r^2 = 0.80), and between fledgling numbers and time (F = 8.54, P < 0.05, df = 1,5; r^2 = 0.75). No significant relationship between flicker nestling numbers and time was detected (F = 7.04, P = 0.06, df = 1,4; r^2 = 0.71).

At least 7 of 12 (58%) flicker pairs that initiated late nests (after 1 June), lost cavities to starlings earlier in the season (all in late April or May) before the onset of egg laying. Three additional flicker pairs maintained control of their cavities early in the season, but were periodically forced to defend them against starlings. These pairs, to my knowledge, did not initiate their first clutch until after 1 June.

DISCUSSION

These data demonstrate that flicker clutch sizes, nestling numbers, and fledgling numbers decrease significantly with the progression of time during the nesting season. Using a similar cutoff date to separate early and late clutches, Moore and Koenig (1986) reported a similar trend within various flicker populations across a hybrid zone extending from western Nebraska to southeastern Wyoming. Ingold (1989) detected a significant negative association between Red-bellied Woodpecker clutch and brood sizes and progression of the nesting season in Mississippi. Although flickers are capable of producing two broods in a single season, double-broodedness is more likely to occur in southern populations (Bent 1939, Burns 1900). To my knowledge, only one of the 31 flicker pairs in this study successfully raised two broods (a pair that nested in the absence of starlings) (cf. Ingold 1994). Moore and Koenig (1986) likewise did not report double-broodedness among flickers in Nebraska and Wyoming at about the same latitude. For pairs with one brood, those that initiate nesting early should be at a reproductive advantage. However, in this study, European Starlings frequently delayed the nesting efforts of flickers until later in the season. Consequently, in these particular instances starling competition for nest cavities resulted in a reduction in flicker fecundity.

Ingold (1989, 1994) suggested that woodpeckers harassed by starlings early in the nesting season might benefit by delaying nesting until later in the season. However, reductions in reproductive output as documented by this study present a serious disadvantage to this strategy. Several factors, ranging from seasonal fluctuations of resources (Koenig 1984) to warmer temperatures, could contribute to decreased reproductive success among late-nesting flickers. Howe et al. (1987) reported that air temperatures inside flicker nest cavities are elevated an average of 7.1 C compared to outside the cavity, and suggest that such elevated cavity temperatures may reduce energy requirements of nestlings. Later in the season, however, when outside ambient temperatures are even higher, elevated cavity temperatures could adversely affect nestling development. Van Balen and Cave (1970) and Mertens (1977) for example, reported that Great Tit (*Parus major*) nestlings hatching after the end of May were more likely to suffer from hyperthermia. Furthermore, delayed nesting may be detrimental in other ways. For example, those nestlings that fledge from late nests could be at a disadvantage since they have less time to mature before the onset of winter, particularly at more northern latitudes (cf. Ingold 1994). Thus, although starling competition could apply selection pressure for later flicker nesting (cf. Ingold 1989, 1994), the deleterious effects of later nesting would oppose it.

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