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FEMALE CHARACTERISTICS AND BREEDING SUCCESS OF THE COLLARED FLYCATCHER *FICEDULA ALBICOLLIS* (TEMM., 1815) IN NATURAL FOREST (BIAŁOWIEŻA FOREST, EAST POLAND)

ABSTRACT: The relation between Collared Flycatcher females' selected characteristics (age, body condition and wing length) and breeding success was studied during seven breeding seasons (1995–2001) in nest-boxes in old-growth oak-lime-hornbeam of Białowieża Forest (Eastern Poland). Yearling females started laying almost three days later and produced smaller clutches (6.1 *vs.* 6.4 eggs) with fewer nestlings (5.4 *vs.* 6.1) and fledglings (5.1 *vs.* 5.7) than did older females. No differences were found in partial losses (i.e. proportion of eggs or nestlings that did not fledge). Body condition had influence only on time of egg laying. Wing length of young females was positively correlated with number of fledglings but no relations were found with other reproductive parameters. Age may be a key factor influencing breeding success in female Collared Flycatchers in the natural conditions in Białowieża Forest.

KEY WORDS: female, collared flycatcher, age, breeding success, Białowieża Forest

1. INTRODUCTION

Breeding success depends, among others, on environmental quality and characteristics of male and female. Features of the female may directly determine clutch and egg size (Trivers 1972, Murphy 1986, Mitrus and Rogala 2001, Hipfner *et al.* 2003), and in case of most small birds, incubation and protection of the clutch (Clutton-Brock 1991). Female characteristics can be expressed in terms of body condition, size, genetic traits and age (Seather 1990, Veiga 1993, Kokko 1997). Usually larger females lay more or bigger eggs (Potti 1993, Sedinger *et al.* 1995, Mitrus and Rogala 2001) and produce more fledglings (Askenmo 1982, Slagsvold and Lifjeld 1988, Yerkes 2000). Many authors also reported better reproduction by older individuals (Pianka and Parker 1975, Seather 1990, Martin 1995). Older, more experienced females possess better skills, which allow them to produce more offspring (Stutchbury and Robertson 1987, Burger 1988, Pyle *et al.* 1991).

The Collared Flycatcher (*Ficedula albicollis*) is a cavity nesting bird using tree holes or nest-boxes for nesting. The species breeds in Central and Eastern Europe and winters in Central Africa (Cramp and Perrins 1993). It is one of the most numerous species in primaeval oak-hornbeam stand of Białowieża National Park (Eastern Poland), where the

average density amounts to 1.21 pairs ha^{-1} (Wesołowski *et al.* 2002) and in some years even up to 2.53 pairs ha^{-1} (Walankiewicz *et al.* 1997)

I expected that older and in better condition females of the Collared Flycatcher, like other small Passerines, breed earlier, produce larger clutches (Perrins 1965, 1970, Barba *et al.* 1995), and raise more fledglings (Harvey *et al.* 1984, Harvey *et al.* 1985, Järvinen 1991, Lundberg and Alatalo 1992, Enokson 1993).

Therefore I examined the relation between female features (age, body condition and wing length) and breeding success.

2. STUDY AREA AND METHODS

Data were collected during seven breeding seasons (1995–2001) in Białowieża Forest (52°41'N, 23°52'E). The study plot (25.5 ha) was covered by old-growth oak-lime-hornbeam forest. These stands are characterized by three canopy layers that include: pedunculate oak (*Quercus robur)*, lime (*Tilia cordata)*, hornbeam (*Carpinus betulus)*, maple (*Acer platanoides)*, elm (*Ulmus* spp.), spruce (*Picea abies)*, and hasel (*Coryllus avellana)*. The abundant taxa in the herb layer include: nettle (*Urtica dioica)*, anemone (*Anemone* spp.), and Ground Elder (*Aegopodium podagraria*). Many standing and laying dead trees occur in the study area (Tomiałojć 1991) of which one side is bordered by the forest edge.

In the study area 60 nest-boxes were mounted on trees, 1.5 m above the ground and facing south. The boxes were placed 25 m from each other in 4 rows, 50 m apart. Active nest-boxes were visited regularly to determine the onset of laying, clutch size, brood size and number of nestlings that fledged. The onset of laying was recorded by inspection of nests during the egg laying period.

Females were captured during incubation or when feeding young. The following measurements were taken: body mass (to the nearest gram), wing length (maximum wing chord in mm, Kelm 1970) and tarsus length (tenth of mm). Individual body condition index was calculated using the residual on the regression of tarsus length and body mass of all birds measured (Veiga 1993, Merilä 1996). The age (first-year or older) of captured birds was determined on basis of plumage (Svensson 1992). For most of the broods, body mass data from individual nestlings were collected 13 days after hatching.

Losses due to predation were assessed by observation of: shells or perforated eggs, dead nestlings with damaged bodies, loss of eggs or nestlings prior to the expected fledging date, and removed or violated nest material.

Partial egg loss is defined as the proportion of eggs that did not hatch in nests in which at least one chick hatched. Partial broods loss is the percentage of nestlings that died before reaching an age of 14 days in nests from which at least one chick fledged. A brood was assumed to be successful when at least one chick fledged. Breeding success was determined on the basis of direct observation of fledged nestlings, observation of nestlings in the nest box just prior to fledging and from lack of traces of predation in the nest.

To translate individual weights of chicks into one value per nest the mean weight of all chicks within a brood was used.

The effects of age and body condition on the breeding performance of females were analysed with an ANCOVA. In these analyses, age (in two categories) was included into the model as a main factor and condition index as a covariate. Biometric data from females captured again in next years were excluded from these analyses. The breeding parameters of the same females caught in subsequent years were compared using the Mann-Whitney U-test. The influence of wing length was calculated in two age groups of females separately using the Spearman rang correlation. All statistical analyses were performed with version 5.0 of Statistica for Windows.

3. RESULTS

Second year and older females had longer wings ($z=2.08$, $P=0.04$) than yearlings but no differences were found in weight ($z=0.27$, $P=0.79$), tarsus length ($z=0.72$, $P=0.47$) and body condition index (Table 1).

Young females started laying on average almost three days later, laid smaller clutches, produced fewer nestlings and fledglings (Table 2). Body condition had influence only on egg laying date (Table 3).

Partial losses of eggs ranged from 0% to 33% both in clutches of young and older females, and partial losses of nestlings varied between 0–40% in young females and 0–75% in old females. On average nestling loss was not significantly higher in broods of older females, but related neither with age nor with body condition (Table 3). Furthermore weight of nestlings was similar in nests of yearling and older females (Table 2) and no relation was found between weight of nestlings and body condition of females (Table 3). Significant correlation was observed only between wing length and number of fledglings in young females (Table 4).

Breeding attempts of older females were more frequently successful than of yearlings (Table 2), but the difference was not significant (χ^2=3.50, df=1, *P*=0.06).

Only in 15 cases the same female was caught in consecutive years. In most breeding parameters females performed better in the next year, but differences were not significant (Table 5).

Table 1. The biometric characteristics of one-year old and older females of the Collared Flycatcher (*Ficedula albicollis*).

	Yearling				Old			
	n	Mean	Range	SD	n	Mean	Range	SD
Wing length (mm)	29	82.7	80–86	1.77	78	83.6	80.0–87.0	1.56
Tarsus length (mm)	24	17.43	16.7–18.6	0.50	76	17.44	16.4–18.5	0.44
Weight (g)	22	14.4	12.0–18.0	1.74	62	14.7	12.0–19.0	1.68
Condition index	17	–0.51	–2.56–3.34	1.85	60	–0.16	–2.84–3.82	1.67

Table 2. Breeding parameters of the one-year old and older females of the Collared Flycatcher (*Ficeudla albicollis*).

	Yearling				Old			
	n	Mean	Range	SD	n	Mean	Range	SD
Egg lying (day of May)	30	13.9	8–26	4.58	70	11.25	1–20	4.64
Clutch size	29	6.1	5–7	0.75	71	6.4	5–8	0.96
Partial losses of eggs (%)	27	8.2	0–33.0	11.87	64	5.0	0–33.0	9.49
Number of nestlings	28	5.4	4–7	0.94	64	6.1	4–8	0.96
Partial losses of nestlings (%)	20	9.5	0–40.0	13.92	61	9.8	0–75.0	17.3
Mean weight of nestlings	15	14.0	10.6–15.6	1.22	61	14.4	13.0–15.8	0.63
Number of fledglings	20	5.1	3–7	1.07	61	5.7	3–8	1.24
Breeding success (%)	27	66.7			66	84.8		

Table 3. Effect of age and body condition of females on breading parameters of the Collared Flycatcher (*Ficedula albicollis*).

Breeding parameter	Condition				Age			
	df	SS	F	P	df	SS	F	P
Egg lying (day of May)	1	132.631	5.94*	0.02	1	307.993	13.81*	<0.001
Clutch size	1	0.051	0.12	0.74	1	3.278	7.37*	0.009
Partial losses of eggs (%)	1	126.37	1.27	0.26	1	200.815	2.02	0.16
Number of nestlings	1	0.039	0.03	0.87	1	13.143	9.14*	0.003
Partial losses of nestlings (%)	1	26.720	0.079	0.78	1	14.414	0.04	0.84
Mean weight of nestlings	1	0.678	1.486	0.23	1	0.004	0.01	0.93
Number of fledglings	1	0.250	0.14	0.71	1	14.239	8.07*	0.006

* – significant effect.

Table 4. Correlation coefficients between female wing length and breading parameters of young and old females of the Collared Flycatcher (*Ficedula albicollis*).

	Yearling			Old		
	n	r	P	n	r	P
Egg lying (day of May)	29	0.02	0.90	75	–0.06	0.63
Clutch size	29	0,17	0.38	71	0.07	0.56
Partial losses of eggs (%)	27	–0.18	0.38	64	0.14	0.27
Number of nestlings	28	0.25	0.20	64	–0.04	0.75
Partial losses of nestlings (%)	20	–0.28	0.23	61	–0.09	0.49
Mean weight of nestlings	15	0,08	0.18	36	–0.01	0.99
Number of fledglings	21	0.50*	0.02	61	–0.03	0.83

* – significant relationship.

Table 5. Comparison of breeding parameters of the same females (N=15) of the Collared Flycatcher (*Ficedula albicollis*) in subsequent years.

	Previous attempt			Next attempt				
	Mean	Range	SD	Mean	Range	SD	U-test	P
Egg lying (day of May)	13.6	7–23	5.09	11.6	5–25	4.70	1.13	0.26
Clutch size	6.3	5–7	0.73	6.5	5–8	0.86	0.45	0.65
Partial losses of eggs (%)	5.1	0–28.6	9.36	7.1	0–33.3	6.07	0.48	0.63
Number of nestlings	5.9	4–7	0.88	6.1	4–8	1.04	0.32	0.75
Partial losses of nestlings (%)	9.7	0–50	15.84	27.2	0.75	27.17	0.36	0.71
Mean weight of nestlings	14.8	13.93–15.85	0.78	14.56	13.83–15.50	0.57	0.51	0.61
Number of fledglings	5.5	3–7	1.19	5.3	3–8	1.44	0.49	0.62

4. DISCUSSION

Among the examined parameters age of female Collared Flycatchers was proofed to be the main factor influencing breeding success. Older females of the Collared had a higher reproductive output, as was found in many other bird species (Harvey *et al.* 1979, McCleery and Perrins 1988, Lundberg and Alatalo 1992, Enokson 1993,). In migratory species usually older individuals arrive earlier in the breeding area then younger ones (Hill 1989, Thompson and Hale 1991, Lozano *et al.* 1996, Mitrus *et al.* 1996, Mitrus 2004). In this way they can mate with older partners, occupy better territories and start breeding earlier. As in this study, older females in many species were observed to lay earlier (Perrins 1965, 1970, Newton *et al.* 1981, Barba *et al.* 1995, Verhulst *et al.* 1995, Blums *et al.* 1997). More specific this pattern was also found in other secondary cavity nesting birds like Pied Flycatcher (*Ficedula hypoleuca*) (Lundberg and Alatalo 1992), Great Tit (*Parus major*) and other cavity-nesters (Harvey *et al.* 1979, McCleery and Perrins 1988, Enokson 1993).

Better reproduction success by older birds may be not only the result of earlier arrival, but also because of better skills. Older birds may be better able to find more suitable and safer nest sites (Pyle *et al.* 1991) and they may be better able to find and explore food resources (Stutchbury and Robertson 1987, Burger 1988, Desrochers 1992), leading to higher reproductive success. This study however was restricted to nest boxes, which differ in safety from natural holes (Mitrus 2003), so better experience in nest site choice by older birds can be ruled out as a factor influencing breeding success.

Body condition of adult as well as of yearling females was similar and may explain the similar amount of partial losses of eggs and nestlings of the females in both age categories. This may indicate that in a natural forest with an abundance of food, yearling females are able to reach the same level of physical condition as do older ones. This may however be partly due to the males, who feed their partner during incubation (Nilsson and Smith 1988, Potti and Merino 1996).

Nestlings losses may depend on abundance of food, on weather conditions (Järvinen 1993, Siikamäki 1995), as well as on the quality of parents. In the Collared Flycatcher it maybe influenced by the female and male quality because both participate in feeding nestlings, although no differences were found in feeding rate young and old males (Mitrus 2004).

In this study body condition and wing length of females did not influence almost on any of the researched reproductive parameters. Only date of first egg laying was depend on body condition of female. Older and in higher condition females started egg laying significantly earlier. The Collared Flycatcher is a migratory species and as in many other species older individuals arrived earlier, which allow to start earlier breeding. Probably older females can faster adjust physical condition after exhausting migration and in this way they can start egg laying early.

Many authors reported influence of wing length on reproduction in birds (e.g. Alatalo and Lundberg 1986, Ollason *et al.* 2003). Although in this paper only in young individuals the correlation of this character with number of fledglings was observed. Probably young females, because of lack of experience, are more profitable from longer wings. This trait can help them in effective prey catching. The lack of relations with other characteristics of breeding success in the present study can be explained mainly by environmental conditions. Białowieża National Park is characterised by diverse and rich list of European predators (Jędrzejewska and Jędrzejewski 1998). Under natural conditions, predation caused by mustelids, rodents and woodpeckers is the main environmental factor determining breeding success in birds (Wesołowski 2003). It seems that in Białowieża Forest, with its high density of predators, age and skill to avoiding predation could play an important role and in this way overrule the influence of body condition and wing length.

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