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Author: Mitrus, Cezary

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Temperature dependence of the breeding phenology of the Collared Flycatcher *Ficedula albicollis* in the Białowieża Forest (NE Poland)

Cezary Mitrus

Department of Zoology, University of Podlasie, Prusa 12, 08–110 Siedlce, POLAND, e-mail: ficedula@ap.siedlce.pl

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Abstract. The breeding phenology of Collared Flycatchers was monitored for 7 years (1993 and 1995–2000) in old-growth, oak-lime-hornbeam stands in the primeval Białowieża Forest. In most years, egg laying commenced in the second half of May. The earliest first-egg date (179 broods) was 1 May, the latest such date was 13 May; these dates differed from year to year. The associations between the first-egg date and the mean temperature of the last ten days of April indicated that birds were breeding earlier as a consequence of warmer April temperatures. The earliest hatching date was 21 May, the latest 1 June. Fledging usually started in the first half of June. The length of the breeding season varied from 40 to 53 days and the breeding cycle was negatively related to mean temperature in the first ten days of May.

Key words: Collared Flycatcher, *Ficedula albicollis*, ambient temperature, time of breeding, Białowieża Forest

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INTRODUCTION

The relationship between the onset of breeding and spring temperature has been described by many researchers (e.g. Slagsvold 1976, Schmidt 1984, Nager 1994, Wesołowski 1998). The timing of breeding in the Collared Flycatcher *Ficedula albicollis* has been studied on the island of Gotland, Sweden (Wiggins et al. 1998), in Ukraine (Peklo 1987), the Niepołomice Forest of southern Poland (Głowaciński 1973), and some other regions of Europe (Cramp 1993).

The Collared Flycatcher is a dominant species in the old oak-hornbeam stands of the Białowieża National Park and in areas devoid of nest-boxes reaches densities of up to 22 pairs/10 ha (Walankiewicz et al. 1997). Various aspects of the breeding ecology of this species have been investigated in the primeval Białowieża Forest (Walankiewicz 1991, Mitrus et al. 1996, Walankiewicz et al. 1997, Mitrus & Rogala 2001, Walankiewicz 2002), but no report of its breeding phenology has yet been published.

The purpose of the present study was to describe the timing of egg laying, hatching, and fledging, to determine the length of the breeding cycle, and to determine the influence of ambient spring temperature on the breeding phenology of the Collared Flycatcher in the Białowieża Forest.

STUDY AREA AND METHODS

Observations of breeding Collared Flycatchers were conducted in 1993 and from 1995 to 2000 in Bialowieża Forest (52°42'N, 23°52'E). The study plot (25.5 ha) was located in oak-hornbeam *Tilio-Carpinetum* stands characterised mainly by Hornbeam *Carpinus betulus*, Small-leaved Lime *Tilia cordata*, Pendunculate Oak *Quercus robur*, Norway Maple *Acer platanoides* and Norway Spruce *Picea abies* (Tomiałojć 1991). The nest-boxes (60) were fixed to trees, facing south c. 1.5 m above the ground, spaced at 25 m intervals in 4 rows, the rows being 50 m apart. The first egg laid in the season was recorded directly or by inspection of nests during the egg laying period and backdated on the assumption that one egg was laid per day. The hatching dates were determined as the day when the first nestling was found, fledging dates by observation of the first fledgling. Replacement clutches were not included in the analysis.

All meteorological data were obtained from the local weather station at Białowieża, situated 1 km south of the study plot. The first Collared Flycatchers usually arrived to the Białowieża Forest during the last ten days of April (Mitrus et al. 1996) and the first eggs appeared during the first ten days of May. The mean daily temperatures during these periods were therefore used in the calculations. For comparisons and correlation, standardised dates were used: 1 May was assumed to be day 1.

Standard statistical methods were used for the descriptive analysis. All statistical analyses were calculated using Statistica for Windows v.5.0.

RESULTS

The earliest first-egg date was 1 May 2000, the latest was 13 May 1997 (Table 1). The latest clutch was initiated on 24 May 1995. The first-egg date thus differed between breeding seasons ($F_{6,163} = 13.65$, $p < 0.001$). The mean date of egg laying was highly correlated with the mean temperature of the last ten days of April; a lower temperature was associated with a later start of egg laying ($r_s = -0.84$, $p < 0.05$, n = 7, Fig. 1). The mean temperatures during the first and second ten-day periods of May had no influence on the onset of breeding ($r_s = -0.16$, p = 0.73; $r_s = -0.45$, p = 0.31, n = 7).

Egg laying usually commenced in the second ten-day period of May. Only in two breeding seasons (1993 and 2000) did most females start to breed earlier (Table 2). In those seasons, the mean temperature during the third week in April was the highest (Fig. 1). The onset of breeding was the most synchronous in 1996 (7 days), the least synchronous in 1998, 1999 and 2000 (19 days). There was a tendency for the egg-laying period to be shorter when temperatures during the second ten days of May were higher ($r_s = -0.71$, p = 0.07, n = 7), but no relationship was found with temperatures either during the last ten days of April ($r_s = 0.36$, p = 0.43, n = 7) or the second ten days of May ($r_s = -0.56$, p = 0.19, n = 7).

Hatching and fledging depended on the time when the first egg was laid. The earliest hatching date was 21 May 1993 and the same day in 2000, the latest was 1 June 1997 (Table 1). Fledging usually began in the first two weeks of June. In accordance with the egg laying and hatching dates, the earliest fledglings were sighted in 1993 and 2000 (5 June).

The length of the breeding season ranged from 40 days in 1996 to 53 days in 2000 (Table 1). This period depended on the mean temperature of the first ten days of May ($r_s = -0.79$, $p < 0.05$), but there was no relationship with temperature for the last ten days of April ($r_s = 0.32$, p = 0.76, n = 7) or the second two weeks of May ($r_s = -0.73$, $p > 0.05$, n = 7).

Table 1. Timing of breeding stages: 1 May = 1, length of the breeding cycle (B) in days, number of clutches.

Year	First egg $\bar{X}$ ± SD, (n)	Hatching $\bar{X}$ ± SD, (n)	Fledgling $\bar{X}$ ± SD, (n)	B
1993	9 ± 4.8 (16)	28 ± 5.9 (14)	42 ± 5.9 (14)	47
1995	16 ± 5.5 (26)	34 ± 4.9 (25)	49 ± 4.9 (25)	51
1996	15 ± 1.6 (24)	30 ± 1.5 (16)	45 ± 1.5 (14)	40
1997	15 ± 1.7 (20)	33 ± 2,5 (13)	49 ± 2,5 (13)	41
1998	12 ± 4.1 (34)	31 ± 3.2 (28)	46 ± 3.3 (28)	49
1999	16 ± 5.4 (25)	40 ± 3.7 (23)	54 ± 2.3 (23)	50
2000	8 ± 3.9 (34)	28 ± 4.0 (31)	42 ± 4.0 (30)	53
1993–2000	13 ± 4.9 (179)	32 ± 5.3 (150)	47 ± 5.3 (147)	47

Table 2. Distribution (% of clutches) of first egg laying in the first (I), second (II) and third (III) ten days period of May, numbers of clutches – see in Table 1.

	Year							
	1993	1995	1996	1997	1998	1999	2000	Total
I	66.6	35.7	5.0	0	32.1	21.1	82.4	38.8
II	28.6	53.6	95.0	100	64.3	73.7	17.6	57.7
III	4.8	10.7	0	0	3.6	5.2	0.0	3.5

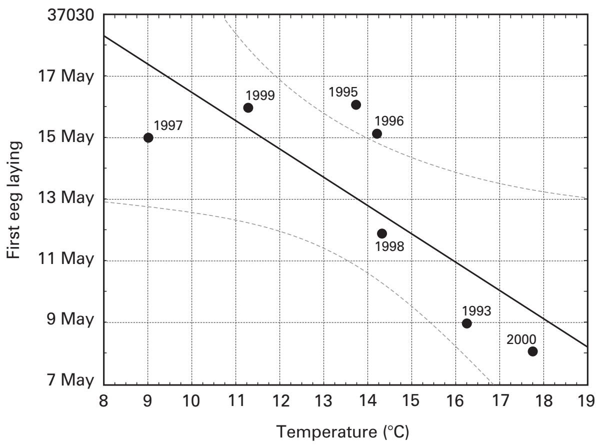

Fig. 1. Mean laying date of the first egg in relation to mean ambient temperature in the last decade of April.

DISCUSSION

The dates of the onset of egg laying for the Collared Flycatcher in the Białowieża Forest were similar to those recorded in the Niepołomice Forest (Kraków province, S Poland), where the earliest first-egg date was 3 May (Głowaciński 1973). In Europe as a whole, the earliest start to the breeding season was recorded at the end of April in Germany (Löhrl 1976), and the latest in the second half of May on Gotland, Sweden (Wiggins et al. 1998).

Some authors have indicated that, by inducing gonadal development, photoperiodicity is the major factor governing the onset of breeding (e.g. Murton & Westwood 1977). However, differences in temperature between seasons and in the mean time of egg laying indicate that other environmental factors may also be responsible for the onset of breeding. In many species, especially non-migratory ones, researchers have shown that ambient temperatures influence the timing of the breeding season (Slagsvold 1976, Schmidt 1984, Wesołowski 1998, Meijer et al. 1999). Temperature may influence the timing of the onset of egg laying either directly or indirectly. Low temperature may cause an increase in energy expenditure for thermoregulation. However, the cost of egg production to small birds is only 3-5% of their daily energy expenditure (Meijer & Drent 1999). In addition to energy, protein is necessary for egg formation and the demand for protein may increase up to 70% during laying (Robins 1981). Because increasing ambient temperature affects the activity of arthropods, this will increase the availability of protein for females. Temperature also influences the phenology of plants and can thus indirectly stimulate the abundance of caterpillars during the period of nestling feeding (Slagsvold 1976, Rowiński & Wesołowski 1999). This is probably the main reason why most birds initiate egg laying in a synchronous manner.

Competition with other species may be one more factor that influences the time of breeding. Avoidance of competition for nesting sites and food resources may be a compelling reason for breeding later in the season (Minot 1981, Nilsson 1984, 1986). In fact, flycatchers do initiate breeding later than resident secondary hole-nesting species but data collected in the Białowieża Forest suggest that the competition for those resources is not very strong (Wesołowski 1989, Walankiewicz 1991, Mitrus et al. 1996).

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STRESZCZENIE

[Zależność między temperaturą a fenologią lęgów muchołówki białoszyjej w Puszczy Białowieskiej]

Obserwacje prowadzono w latach 1993 oraz 1995–2000 w lesie grądowym z użyciem 60 skrzynek lęgowych. Daty złożenia pierwszego jaja oraz klucia określano na podstawie bezpośrednich obserwacji bądź obliczając je przy założeniu, że samica składa jedno jajo dziennie. Pierwsze jajo najwcześniej odnotowano 1 maja 2000, a najpóźniej 13 maja 1997 roku. Średnia data złożenia pierwszego jaja w istotny sposób zależała od średniej temperatury ostatniej dekady kwietnia, im wyższa była ta temperatura tym wcześniej samice przystępowały do lęgów (r_s = -0.84, p = 0.02, n = 7; Fig. 1). Natomiast nie stwierdzono istotnego wpływu średnich temperatur pierwszej i drugiej dekady maja (Tab. 1). Średnie daty przystąpienia do lęgów różniły się istotnie miedzy sezonami (Tab. 1). Samice zwykle przystępowały do lęgów w drugiej dekadzie maja, tylko w dwóch sezonach lęgowych (1993 i 2000) większość samic złożyła pierwsze jaja w pierwszej dekadzie (Tab. 2). Fenologia kolejnych etapów lęgów była związana z datą złożenia pierwszego jaja (Tab. 1). Długość sezonu lęgowego wahała się od 40 w 1996 r. do 53 dni w 2000 r. (Tab. 1). Okres ten skracał się wraz z wyższą temperaturą pierwszej dekady maja (r_s = -0.79, $p < 0.05$, n = 7).

T. Cofta