EFECT OF HABITAT ON THE CLUTCH SIZE AND EGG DIMENSIONS OF THE GREAT TIT *(PARUS MAIOR)*

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Abstract

A. Báldi and T. Csörgő: Effect of habitat on the cluth size and egg dimensions of the Great Tit (Parus maior)

Clutch and egg sizes of Great Tits were measured in alder, beech, oak and spruce forests in Hungary. Clutch size increased with improving habitat quality. Egg size was small in both poor and good habitats, but large in intermediate habitats. An adaptive explanation for these observations is that females try to raise as many good quality offspring as the environmental constraints allow.

Introduction

The study of the breeding biology of the Great Tit *(Parus maior)* and those factors that regulate it have generated a large literature (see *Perrins, 1979, Perrins, 1991).* These studies have revealed differences in the parameters of breeding phenology between different habitats *(Dhondt et al. 1984, Hamann et al. 1989, Lemel, 1989,* but see *Orell and Ojanen 1983),* altitudes *(Hamann et al. 1989),* and between different geographical areas *(Berndt et al. 1983, Isenmann, 1987, Sasvári and Orell 1992).* However, the comparisons of habitats usually include only markedly different habitat types, such as deciduous and coniferous (e. g., *Krebs 1971, Balen 1973, Lemel 1989),* or deciduous and evergreen habitats (e. g., *Clamens et al. 1991).*

In the present study we investigated the variability of clutch sizes and egg dimensions of Great Tits between habitats of different quality. We compared four habitats, all in the same geographical area, to avoid geographical variations in breeding biological parameters. We studied the breeding of the Great Tit along a 'habitat quality gradient' where the oak forest was considered as optimal *(Dhondt et al. 1990, Perrins 1979),* the spruce as the poorest *(Lemel 1989, Perrins 1979)* and the beech forest as of intermediate quality *(Dhondt et al. 1990).* The alder forest was also assumed to be of intermediate quality (better than conifer, but poorer than oak), however direct surveys are lacking.

Study area and methods

Field observations were conducted in the Ócsa Landscape Conservation Area, about 30 km from Budapest in Central Hungary (47° 15' N, 19° 15' E). The area is a 7 ha forest fragment of Alder *(Alnus qlutinosa)*. One hundred nestboxes with an entrance diameter of 32 mm have been spaced out in the forest patch. The forest is surrounded by a bushy area with reeds *(Báldi 1991)*.

The other three habitats were in the Pilis Mountains (47° 43' N, 18° 54' E) (see *Török and Csörgő, 1988)*. These were an oak forest *(Ouerco petraeae-Carpinetun)*, a beech forest *(Melliti Fagetum silvaticae)* and a spruce forest *(Picea abies)*. The data from these areas are partly unpublished, and were collected by *T. Csörgő* and *J. Török*, and partly derived from *Csörgő* and *Török (1988)* and *Török* and *Csörgő, (1988)*.

Various breeding biological parameters were measured in the alder forest in 1986, 1988, 1989 and 1990 (Table 1). The length and breadth of eggs were measured only for the first clutches. We used the maximum egg length (EL) and breadth (EB) to calculate the volume of each egg (EV) using the formula developed by *Ojanen et al. (1978)*. The EV based on *Ojanen et al. (1978)* is:

$$EV = 0{,}042 + 0{,}46^{x}EL^{x}EB^{2}$$

This equation accounts for 97% of the overall variance in egg volume *(Ojanen et al. 1978)*.

Clutch means were used as sampling units to avoid the over emphasise of large clutches *(Ojanen et al. 1978, Järvinen and Pryl, 1989)*.

During the breeding season of 1989 and 1990 male Great Tits were captured by mistnetting, placed close to the nest boxes.

The program package SPSS/PC + *(Norusis, 1986)* was applied to calculate summary statistics, significance tests and regression analysis.

Results

The breeding biological parameters of the Great Tits living in the alder wood are shown in Table 1. The females were smaller than the males (wing length), which is the normal relation between the sexes.

The clutch sizes increased with habitat quality (Fig 1 a). This increase was significantly linear (stepwise regression analysis; regression coefficient = 0,360 t = 3,897 p = 0,030). The value from the alder wood deviates, however, the breeding density was extremely high in this study plot *(Báldi, 1991)*, thus a density-dependent regulation may decrease clutch size *(Perrins, 1965)* in relation to the other data.

Two groups are formed based on egg dimensions (Fig. 1 b c d), one consists of the alder and the beech, the other of the oak and the spruce habitats. The differences in egg dimensions between habitats of the two groups are significant in many cases (Table 2).

Table 1. Breeding biological parameters of the Great Tit in a Hungarian Alder wood. First egg laying (1. April = 1), egg length and breadth in mm, egg volume in cm^3, wing length in mm.

1. táblázat. Széncinegék költésbiológiai paraméterei egy ócsai égeresben. Az első tojás lerakását április elsejétől számoltuk, tojáshossz és -szélesség mm-ben, térfogat cm^3-ben, szárnyhossz mm-ben megadva.

year	variable	mean	std dev	minimum	maximum	N
1986	clutch size	9.80	1.08	8.00	11.00	15
	egg length	18.03	0.38	17.30	18.70	15
	egg breadth	13.61	0.28	13.20	14.30	15
	egg volume	1.60	0.09	1.49	1.80	15
	♀ wing length	74.75	2.25	73.0	79.00	8
1988	first egg	11.40	7.41	6.00	29.00	10
	clutch size	9.70	1.25	7.00	11.00	10
	♀ wing length	73.60	2.59	69.00	77.00	10
	♂ wing length	76.44	1.81	74.0	79.00	9
1989	first egg	15.52	3.46	10.00	26.00	21
	clutch size	8.10	1.26	5.00	10.00	21
	egg length	18.09	0.73	16.70	19.10	21
	egg breadth	13.50	0.45	12.60	14.30	21
	egg volume	1.58	0.14	1.30	1.85	21
	♀ wing length	74.31	1.14	72.0	76.00	16
	♂ wing length	77.08	1.61	75.0	80.00	13
1990	clutch size	7.93	1.03	6.00	10.00	15
	egg length	17.93	0.58	16.80	18.90	15
	egg breadth	13.49	0.26	13.20	14.00	15
	egg volume	1.57	0.09	1.43	1.74	15
	♀ wing length	74.30	2.16	71.0	79.00	10
	♂ wing length	78.00	0.0	78.0	78.00	1
Average over four years						
	first egg	14.19	5.32	6.0	29.00	31
	clutch size	8.74	1.42	5.0	11.00	61
	egg length	18.02	0.59	16.7	19.10	51
	egg breadth	13.53	0.35	12.6	14.30	51
	egg volume	1.58	0.11	1.30	1.85	51
	♀ wing length	74.23	1.95	69.0	79.00	44
	♂ wing length	76.87	1.66	74.0	80.00	23

Discussion

The laying date of the Great Tit was earlier in the alder wood than in the oak forests *(Török* and *Csörgő, 1988).* Several data from the literature also show later breeding in many European countries *(Berndt et al. 1983, Dhondt*

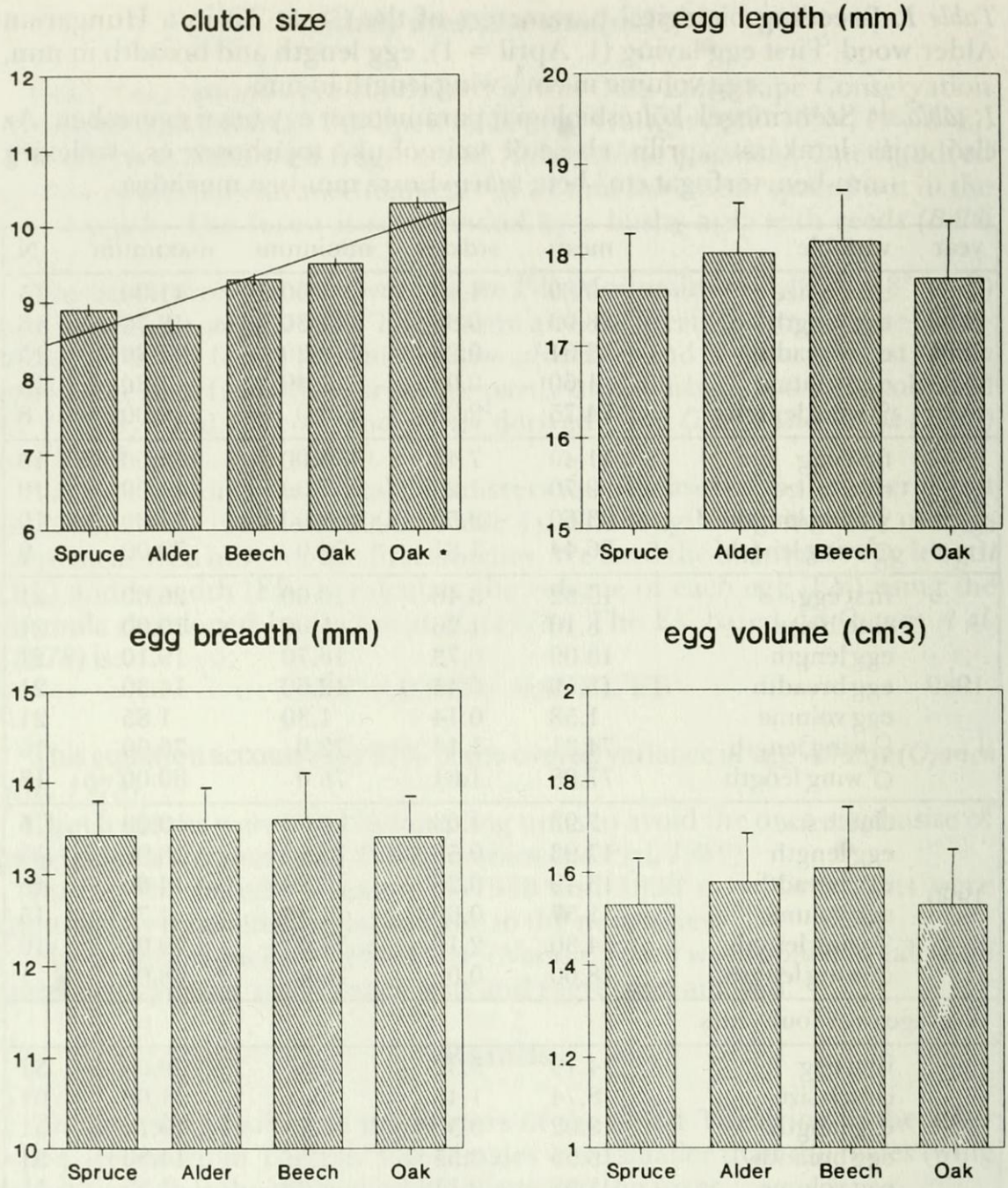

Fig. 1. Clutch size and egg dimensions of the Great Tit in different habitats. The number of clutches measured for egg sizes were 8, 51, 15 and 26 in the spruce, alder, beech and oak habitats, respectively. The sources for clutch size data in the spruce, beech and oak were Török and Csörgő (1988), and in the oak(*) habitat Tóth et al. (1989). These data are based on a long-term survey in the Buda Hills, in the same geographical area

1. ábra. Széncinegék fészekalj- és tojásméretei különböző élőhelyeken. A vizsgált fészkek száma 8, 51, 15 és 26 volt a lucos, égeres, bükkös és tölgyes élőhelyeken. A (*) jelölt élőhely adatainak forrása Tóth et al. (1988), mely vizsgálat a Budai-hegyekben készült

Table 2. Comparison of egg dimensions between the four different habitats by t-test. One-tailed significances are given. (*: $p<0,05$)
2. táblázat. A négy vizsgált élőhelyen mért tojásméretek összevetése t-próbával (*: $p<0,05$).

	Df	length	breadth	volume
Alder–Oak	75	1,859*	1,541	1,730*
Alder–Beech	64	–0,762	–0,517	–0,900
Alder–Spruce	57	1,801*	0,850	1,332
Oak–Beech	39	1,969*	1,500	1,970*
Oak–Spruce	32	0,464	0,138	0,174
Beech–Spruce	21	2,161*	0,979	1,664

et al. 1990, Perrins 1965). However, in the study years (1988 and 1989) the winter weather was extremely mild *(Báldi* and *Csörgő, 1991),* which may allow an earlier start to breeding.

Several authors *(Isenmann, 1987, Lemel, 1989)* argued that the clutch size of Great Tits is predominantly linked to habitat quality, as in the Pied Flycather *(Ficedula hypoleuca) (Järvinen, 1989)* or in the Marsh Tit *(Parus palustris) (Nilsson, 1991). Nilsson* found that female Marsh Tits provisioned with additional food responded to it by laying one egg more than control females. However, *Orell* and *Ojanen, (1983)* found that the clutch size was irrespective of habitat in the Great Tit in Finland. *Järvinen, (1993)* found significant differences in reproductive traits of adjacent Pied Flycather populations.

Ekman and *Johansson–Allende, (1990)* studied the trade-off between the number and size of eggs in tit species. They found that the relative investment in the size of eggs was negatively related to clutch size. They also pointed out that the variation between clutches in three tit species may rather reflect the quality of the habitat *(Ekman* and *Johansson–Allende, 1990).*

Egg sizes of hole nesters seems to be greater in Northern-Europe than in Central – or Southern-Europe *(Järvinen, 1989, Järvinen and Väisänen 1983, Järvinen and Pryl, 1989,* but see *Soler and Soler, 1992).* Egg sizes are usually greater at high altitudes *(Hamann et al. 1989).* In our study the geographical variations in breeding phenology of the Great Tit was neglected, because study plots were in near geographical proximity. The altitudinal differences influence mainly the starting of the breeding *(Gil-Delgado et al. 1992, Török* and *Csörgő, 1988),* therefore did not affect clutch or egg sizes directly.

Variation in breeding biological has an adaptive basis (but see *Dhondt et al. 1990).* We assumed that the female tries to maximize her reproductive effort (Fig. 2). To achieve this goal the female should 'predict' her future investment *(Coleman* and *Gross, 1991).* The female can adjust three main factors to maximize success, namely the clutch size, egg size and the quality of eggs and/or offsprings. The female should reduce all the three factors in bad quality habitat, because of the environmental constraints. In good

habitat the female should increase both quality and clutch size, and decrease her investment through the reduction of eggs' size. Egg size reduction did not handicap the quality of offspring, because egg size did not correlate with fledgling quality *(Schifferli, 1973)*. In intermediate habitat the female is able to produce good quality fledglings, but the egg size needs to be increased, to balance poor conditions. This may negatively influence the clutch size.

low RS alacsony RS	intermediate RS közepes RS	high RS magas RS
few small fledgings (15d) kevés, kicsi 15 napos fióka	not many big fledgings (15d) kevés, nagy 15 napos fióka	many big fledgings (15d) sok, nagy 15 napos fióka
few small nestlings kevés, kicsi fióka	not many big nestlings kevés, nagy fióka	many small nestlings sok, nagy fióka
few small eggs kevés, kicsi tojás	not many big eggs kevés, nagy tojás	many small eggs sok, nagy tojás
poor (spruce) rossz (fenyő)	intermediate (beech, alder) közepes (éger, bükk)	good (oak) jó (tölgy)
	h a b i t a t s é l ő h e l y e k	

Fig. 2. The proposed explanation on differences in reproductive success (RS) of the Great Tit between habitats of different quality. See text for further explanations
2. ábra. A tapasztalt fészekalj és tojásméret változatosságot magyarázó hipotézis (RS: szaporodási siker)

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Élőhelyek hatás a széncinegék *(Parus maior)* fészekalj- és tojásméreteire

Báldi András és dr. Csörgő Tibor

Az ócsai tájvédelmi körzet egyik égeresében vizsgáltuk a széncinegék költésbiológiáját 1986–1990 között. A kapott eredményeket összevetettük a Pilisből származó adatokkal lucos, bükkös, és tölgyes élőhelyekről.

A költés kezdete korábban volt az égeresben, mint a többi élőhelyen, ami részben a tengerszint feletti magasság hatásával, részben a vizsgálatokat megelőző telek enyhe voltával magyarázható.

Az odúköltő énekesmadarak költésbiológiájára döntő hatása van az élőhelynek. Az általunk megfigyelt fészekalj- és tojásméret változatosságot az alábbi gondolatmenettel lehet magyarázni. Az egyedek szaporodási sikerességüket igyekeznek maximalizálni, a ráfordítások minimalizálása mellett. Jó minőségű élőhelyen (pl. tölgyesben) sok kisméretű tojást rakhat a tojó, abból a kirepülés idejére súlyos, azaz jó túlélő képességű utódok lesznek. Jó táplálékellátottságú területen ugyanis a tojás mérete és a kirepülő fiókák súlya között nincs korreláció. Közepes élőhelyen (pl. bükkösben vagy égeresben) a kedvezőtlenebb táplálékkínálat miatt csak a nagy tojásból, eleve nagyobb fiókák lesznek, jó túlélő képességűek. Ezért a tojó nagyobb tojásokat rak, amiből kevesebbet képes előállítani. A széncinegék számára másodlagos élőhelynek számító lucosban a környezeti feltételek csak kevés és kisméretű tojás létrehozását biztosítják.