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Research note

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EGG DIMENSIONS OF THE GREAT TIT (*PARUS MAJOR* L.) IN CROATIA

The purpose of this study is to submit, (for the first time), data on characteristics of Great Tit eggs in Croatia and the relation of egg dimensions with selected reproductive variables.

In birds, egg size (volume or/and weight) varies with female age (e.g. Desrochers and Magrath 1993), clutch size (e.g. Batt and Prince 1979) laying date (e.g. Bancroft 1984), position in the laying order (e.g. Haftorn 1986), female body weight (e.g. Nager and Zandt 1994), and other factors. Egg size in species varies within and between clutches, within and between years (e.g. Flint and Sedinger 1992). Large eggs have been shown to give rise to large nestlings which survive better than smaller nestlings from smaller eggs, or achieve higher fledgling weight (e.g. Schifferli 1973, Hegyi 1996). Being hatched from a large egg could be potentially beneficial for a chick; from the viewpoint of the laying female, however, weak investment into egg size might conflict with her own energetic demands and willingness to produce more offspring (Horak *et al*. 1995).

This study took place in the rural area (Hrvatsko Zagorje), in north-western Croatia (45°58'–46°10'N, 15°50'–16°08'E). The study period lasted from March to April 1999. Only the first clutch was analysed. On an area (614 ha) of deciduous wood 90 nest-boxes were used. The nest-boxes were of a standard type, the diameter of the entrance hole being 32 mm. All nest-boxes had a sliding top so that the nesting could be monitored. The nest-boxes were situated 3–4 m above ground and an average distance of 30–40 m apart. The dominant two tree species were oak (*Quercus robur*) and hornbeam (*Carpinus betulus*), and the other ones (low proportion) were: common maple (*Acer campestre*), ash (*Fraxinus angustifolia*) and common elm (*Ulmus minor*). Nests were visited regularly during the breeding season to determine the exact date of laying. The maximum wing length (in flattened and straightened state) to the nearest half mm of breeding females was measured (Svensson 1975), and the birds were weighed 2–3 days upon laying the last egg. Egg volume was calculated from the equation: $EV = 0.51 \times L \times B^2$, where L is egg length and B is egg breadth (Hoyt 1979). The egg shape index (ES) was calculated using the formula $ES = L/B$, where L is the length and B the breadth of the egg (Schönwetter 1979). The mean values of first clutches were only analysed.

During the research period, 8–13 eggs in 52 layings were recorded (Table 1). The mean clutch size was 10.87, egg length – 17.44 mm, egg breadth – 13.31 mm, egg volume – 1576 mm^3 and egg shape index – 1.31. The between clutch CV (coefficient of variation) was 3.5% for length, 2.3% for breadth, 6.3% for volume and 3.1% for egg shape index. The mean female wing length was 72.91 mm (CV = 1.7%), and mean female body weight 20.78 g (CV = 5.7%). As shown in Table 2, the dominant number of eggs per nest was 10–11 (50%), 12–13 eggs was found in 38% of all nests and 8–9 eggs in 12%.

There was no statistically significant correlation between clutch size and the dimensions of eggs, as well as between egg dimensions and reproductive variables. Only a marginally significant negative correlation has been found between the index of the egg shape and clutch size ($r = -0.25$; $P = 0.08$; $n = 52$). Therefore, the possible trend is that clutches with a greater number of eggs would be more spherical. The special attention has been drawn to the relation of egg size and clutch size. The combination of clutch size and egg size determines the total energetic investment in clutch formation by a laying female. According to Lack (1967) species producing relatively large eggs must compensate by laying fewer eggs. The theory of optimal clutches predicts an inverse relationship between clutch size and the size of egg (Smith and Fretwell 1974, Brockelman 1975). This idea of a trade-off between egg size and clutch size has an important role in theoretical life-history models. However, empirical studies generally have not supported such an hypothesized trade-off (e.g. Hepp *et al.* 1987, Järvinen and Pryl 1989, Dolenec 2001). Accordingly, we also have not found a significant correlation between clutch size and egg size ($P > 0.05$). There is no significant correlation between female body weight and clutch size as well ($P > 0.05$). So we can conclude that the results of our research do not support predictions based on the theory of optimal clutch/egg size.

Table 1. Breeding characteristics of the Great Tit females. Only first clutches are included (n = 52)

Variable	Mean	SD	Range
Female weight (g)	20.78	1.19	19.0–23.5
Wing length (mm)	72.91	1.20	70.5–75.0
Clutch size	10.87	1.22	8–13
First laying date	6th April	3.34	29th March–16th April
Egg length (mm)	17.44	0.61	15.93–18.95
Egg breadth (mm)	13.31	0.31	12.55–13.99
Egg volume (mm^3)	1576	99.63	1355–1842
Egg shape index	1.31	0.04	1.18–1.44

Table 2. Egg dimensions of the Great Tit different clutch size classes. Only first clutches are included (n = 52)

Clutch size		Egg length (mm)		Egg breadth (mm)		Egg volume (mm^3)		Egg shape index	
	%	Mean	SD	Mean	SD	Mean	SD	Mean	SD
8–9	12	17.66	0.54	13.27	0.37	1589	133.16	1.33	0.02
10–11	50	17.41	0.54	13.25	0.26	1571	86.48	1.31	0.04
12–13	38	17.39	0.65	13.40	0.32	1595	101.84	1.30	0.06

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