

Occupation and breeding parameters in the Great Tit *Parus major* and the Italian Sparrow *Passer italiae* in nest-boxes of different size

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Abstract

This study examined the preference for nest-boxes of two different dimensions (14x14x22 cm, hole diameter 3.7 cm, 'normal'; 25x25x35 cm, hole diameter 6 cm, 'large') for three breeding seasons in the Great Tit and the Italian Sparrow together with specific reproductive parameters. Sparrows showed a significant preference for normal boxes while tits seemed not to discriminate between large and normal boxes although in the large ones the breeding success was impaired by higher predation rates. For both species no differences between the two kinds of boxes

were found for date of laying. As regards clutch size, data suggest that in large boxes tits laid larger clutches.

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Introduction

In hole-nesting birds the selection of nest site is based on several characteristics such as risk of predation (Bellrose et al. 1964, Nilsson 1984, Blancher & Robertson 1985), degree of moisture in the cavity (Slagsvold & Lifjeld 1988), parasite infestation (e.g. Moss & Camin 1970, Møller 1989, Opplinger et al. 1994), presence of old nest material (Thompson & Neill 1991, Olsson & Allander 1995), and size of the cavity (e.g. Löhrl 1973, van Balen 1984, Gustafsson & Nilsson 1985, Slagsvold 1989).

As regards the latter feature, most of the previous studies have analysed the relationship between the size of nest-boxes and clutch size in small hole-nesting passerines by using the bottom area as independent variable (e.g. Grakzyc 1967, Löhrl 1973, Karlsson & Nilsson 1977, van Balen 1984, Gustafsson & Nilsson 1985). Data were collected in boxes with floors ranging from 25 cm² (Ludescher 1973) up to 314 cm² (Löhrl 1973), boxes of 100–120 cm² being considered normal. Almost all the publications included the Great Tit among the species studied; this species was shown to have a preference for larger cavities (>150 cm², Löhrl 1977, van Balen 1984, Gustafsson & Nilsson 1985), but differences

in dates of laying were observed only in one study (van Balen 1984). Clutch size was found to be adjusted to the available cavity space, the so-called "area effect", and this plasticity, whose mechanisms are unknown, was found at different degrees in many other species (e.g. Karlsson & Nilsson 1977, van Balen 1984, Gustafsson & Nilsson 1985). As regards breeding success, results are sometimes contradictory. For example, the risk of an hyperthermic state, which might result in increased mortality of the nestlings, has been demonstrated in broods reared in very small (36 cm²) boxes (van Balen 1984). Gustafsson & Nilsson (1985) also found a reduced breeding success in flycatchers (*Ficedula spp.*) nesting in smaller (57–87 cm²) boxes. However, in Great Tit Löhrl (1973) found no differences between small (64 cm²) and large (314 cm²) boxes.

No data about box size preference are available neither for the Italian Sparrow, nor for the House Sparrow *Passer domesticus*, the latter being considered a more determinate layer in comparison with tits (Anderson 1989).

The present study was aimed at investigating the preference for two kinds of artificial nesting cavities with very different bottom area and entrance hole diameter in the Great Tit and the Italian Sparrow

Table 1. Occupation percentages of the two kinds of nest-boxes in Italian Sparrow and Great Tit in the three study areas.

Procent beläggning i de två holkyperna för italiensk sparv och talgoxe i de tre undersökningsområdena.

	Italian Sparrow <i>italiensk sparv</i>					Great tit <i>talgoxe</i>				
	normal <i>normala</i>	n	large <i>stora</i>	n	P	normal <i>normala</i>	n	large <i>stora</i>	n	P
Burano	55.6	54	6.7	15	0.01	28.4	74	44.4	18	0.30
Orbetello	24.7	77	9.5	21	0.25	10.3	97	16.7	24	0.90
Macchiagrande	55.6	54	64.3	14	0.80	51.4	114	31.2	18	0.20
All areas <i>Alla</i>	42.7	185	24.0	50	0.05	31.2	285	29.3	60	0.90

Data reported refer to three breeding seasons; n is the number of nest boxes available

Rapporterade data avser tre häckningssäsonger; n är antalet tillgängliga holkar

together with specific reproductive parameters (date of laying, clutch size, and breeding success).

The large boxes we used were very discernible and the hole entrance was very large (see below). Predictions were that i) both tits and sparrows prefer normal boxes because of higher predation risks in larger ones; ii) tits breeding in larger boxes lay larger clutches because of the area effect; iii) sparrows breeding in larger boxes do not increase clutch size because their potential to adjust it is low; iv) for both species breeding success is impaired in larger boxes.

Materials and methods

Field data were collected during three breeding seasons (1990–1992) in three woodland areas dominated by Mediterranean vegetation along the Thyrranian coast of Central Italy, namely Orbetello, Burano and Macchiagrande. Great Tits and Italian Sparrows are resident in these areas, and this gives the opportunity to inspect potential nest sites long before onset of breeding. In these study years sparrows started laying between 25 April and 5 May being often triple-brooded (pers. obs.) and tits between 1 April and 10 April being often double-brooded (Bellavita & Sorace 1994). Sparrows were usually breeding only in the outer parts of the woods. Potential competitors for nest sites were rats *Rattus rattus*, the Hoopoe *Upupa epops* and the Blue Tit *Parus caeruleus*, both bird species having very low population density (pers. obs.). Potential predators were the Four-line Snake *Elaphe quatorlineata*, the

Aesculapian Snake *Elaphe longissima*, the Western Whip Snake *Coluber viridiflavus*, rats (*Rattus sp.*) and the Weasel *Mustela nivalis*.

In January 1990, 62 'normal' (14x14x22 cm, hole diameter 3.7 cm, bottom area 196 cm²) and 20 'large' (25x25x35 cm, hole diameter 6 cm, bottom area 625 cm²) nest-boxes were attached to trees 3 m above the ground and spaced 50 m. The large boxes were regularly scattered among the normal ones.

For sparrows, only boxes in the outer parts of the wood were considered available. In case of tits, which are known to prefer a clean cavity (Perrins 1979), after the first brood fledged, boxes with rests of a successful nest were considered not available for other females.

From 1 April up to 7 July in Burano and Macchiagrande nest-boxes were checked weekly, in Orbetello they were checked every 15 days. The parameters considered were percentages of occupation, date of laying, clutch size, predation rate, and breeding success. Nest-boxes were considered occupied when at least one egg was found inside. Dates of laying were recorded assuming that in both species the female lays one egg per day (Kluijver 1951, Lack 1955, Summers-Smith 1963). Because of the influence of the date of laying on clutch size (Kluijver 1951, Lack 1955), comparisons between large and normal boxes were performed considering only clutches laid during corresponding periods in the three years. Predation rate was the percentage of clutches and/or broods that failed because of predation. For each brood breeding success was calculated

Table 2. Date of laying (mean), clutch size (mean) and breeding success (mean %) in Italian Sparrow and Great Tit for the two kinds of nest-boxes.

Läggingsdatum (medel), kullstorlek (medel) och häckningsframgång (medel %) för italiensk sparv och talgoxe i de två holkyperna.

	Italian Sparrow <i>italiensk sparv</i>							Great tit <i>talgoxe</i>						
	normal <i>normala</i>	n	s.e.	large <i>stora</i>	n	s.e.	P	normal <i>normala</i>	n	s.e.	large <i>stora</i>	n	s.e.	P
Date of laying <i>Läggingsdatum</i>	45.0	61	0.9	45.3	9	2.2	0.90	13.4	39	1.6	14.0	14	2.5	0.85
Clutch size <i>Kullstorlek</i>	5.1	21	0.2	5.5	11	0.3	0.20	7.0	17	0.4	7.9	14	0.5	0.20
Breeding success <i>Häckningsframgång</i>	57.7	63	5.4	45.9	10	13	0.45	67.5	81	4.3	36.1	17	10.3	0.01

Data reported refer to three breeding seasons and three study areas

Rapporterade data avser tre häckningssäsonger och tre områden

s.e. = standard error

Day 1 = 1 April *Dag 1 = 1 april*

ed as number of nestlings/number of laid eggs x 100. At Orbetello, because of larger intervals between inspections, it was not possible to evaluate breeding success in 42% of the broods.

Data on percent of occupation and predation rate were analysed by χ^2 test. Data on reproductive parameters were analysed by Student t-test; because of the non-normal distribution, data on breeding success were arcsin transformed and data on clutch size square root transformed prior to the parametric analysis (Fowler & Cohen 1984).

Results

Overall sparrows showed a significant preference for normal boxes. However, in Macchiagrande there were small differences in the occupation of the two kind of boxes (Table 1). Tits did not discriminate between large and normal boxes (Table 1).

No significant differences for date of laying were observed in any of the species (Table 2). As regards clutch size, tits laid on average more eggs in large boxes; however, this trend did not reach statistical significance (Table 2). Breeding success in large boxes was significantly lower than in normal ones for tits but not for sparrows (Table 2). This was, as expected, due to a higher predation rate, at least in tits (33.3% vs. 6%; $\chi^2_1 = 7.99$, $p < 0.01$). For sparrows total predation rate was higher in large boxes (30% vs. 17%), although data collected were too scarce to allow statistical analysis. In tits predation rate for both kinds of boxes was higher in Burano when

compared with all others areas (24.1% vs. 6.2%; $\chi^2_1 = 4.0$; $p < 0.05$).

Discussion

Our results show that only sparrows discriminated between the two kinds of nest-boxes and preferred the normal ones. In this species, the potential to increase the clutch size is low (Anderson 1977, Murphy 1978, Pinowska 1979, Anderson 1989), and the opportunity to lay a higher number of eggs in larger cavities is reduced. Among the species studied only in the Starling *Sturnus vulgaris* the size of the bottom area had no effect on clutch size (e.g. Moed & Dawson 1979, Karlsson & Nilsson 1977). Interspecific differences have been attributed to the size of the species, that could affect the amount of energy lost from the brood filling the nest cavity (Karlsson & Nilsson 1977); in our study the response of the heavier species (Italian Sparrow) to an unusually large nest site seemed to be weaker.

On the other hand tits, for which the potential to increase clutch size is higher, showed no discrimination in spite of an impaired breeding success in large boxes. However, in this species the possibility to lay a larger clutch is limited, since in the Mediterranean area clutch size is generally lower than in other European populations (Blondel et al. 1987, Isenmann 1987, Bellavita & Sorace 1994). It is likely that this feature could have partially buffered the area effect. Differences between areas are more difficult to interpret; however, we note that in Burano

where the highest predation rates were recorded, tits showed preference for the normal boxes. It must be pointed out that other factors such as age, intraspecific competition, and nesting site availability can play important roles in the choice of the nesting cavity (Nilsson 1984, Barba & Gil Delgado 1990, Cramp & Perrins 1993), and can affect the individual choice of nest site.

As regards the temperature to which the offspring can be exposed van Balen (1984) reported that a large brood (>8 young) of Great Tit in a small cavity (36 cm²) could run the risk of hyperthermia over a threshold value of 20 °C. This temperature is easily reached and exceeded in the Mediterranean area and this element should be considered with more attention as a selective factor for nest size choice. However, at least in tits, females nesting in large cavities may completely cover the bottom with moss and other isolating materials thus assuring a good thermic stability.

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References

Anderson, T. 1977. Reproductive responses of sparrows to a super-abundant food supply. *Condor* 79: 205–208.

Anderson T. 1989. Determinate vs. indeterminate laying in the House Sparrow. *Auk* 106: 730–732.

Balen, J. H. van 1984. The relationship between nest-box size, occupation and breeding parameters of the Great Tit *Parus major* and some other hole-nesting species. *Ardea* 72: 163–175.

Barba, E. & Gil-Delgado, J. A. 1990. Competition for nest-boxes among four vertebrate species: an experimental study in Orange Groves. *Hol. Ecol.* 13: 183–186.

Bellavita, M. & Sorace, A. 1994. Clutch size of Great Tit *Parus major* and Blue Tit *Parus caeruleus* in some areas of Central Italy. *Avocetta* 18: 1–8.

Bellrose, F. C., Johnson, K. L. & Meyers, T. U. 1964. Relative value of natural cavities and nesting houses for Wood Ducks. *J. Wildl. Manag.* 28: 661–676.

Blancher, P. J. & Robertson, R. J. 1985. Site consistence in kingbird breeding performance: implication for site fidelity. *J. Anim. Ecol.* 54: 1017–1027.

Blondel, J., Clamens, P., Cramm, P., Gaubert, H. & Isenmann, P. 1987. Population studies on tits in the mediterranean region. *Ardea* 75: 21–34.

Fowler, J. & Cohen, L. 1984. *Statistics for Ornithologists*. B.T.O. Guide n. 22.

Graczyk, R. 1967. The fecundity of tits (Paridae) in dependence upon size of nesting box. *Ornithologia Stosowana* 2: 41–47.

Gustafsson, L. & Nilsson, S. G. 1985. Clutch size and breeding success of Pied and Collared flycatchers *Ficedula* spp. in nest-boxes of different sizes. *Ibis* 127: 380–385.

Isenmann, P. 1987. Geographical variation in clutch-size: the example of the Blue Tit (*Parus caeruleus*) in the Mediterranean area. *Vogelwarte* 34: 93–99.

Karlsson, J. & Nilsson, S. G. 1977. The influence of nest-box area on clutch size in some hole-nesting passerines. *Ibis* 119: 207–211.

Kluijver, H. V. 1951. The population ecology of Great Tit (*Parus major*). *Ardea* 39: 1–135.

Lack, D. 1955. British tits (*Parus* spp.) in nesting boxes. *Ardea* 43: 50–84.

Löhr, H. 1973. Einfluss der Brutraumfläche auf die Gelegenheitsgröße der Kohlmeise (*Parus major*). *J. Orn.* 114: 339–347.

Löhr, H. 1977. Nistökologische und ethologische Anpassungserscheinungen bei Höhlenbrütern. *Vogelwarte* 29, Sonderheft: 92–101.

Ludescher, F. B. 1973. Sumpfmehse (*Parus palustris*) und Weidenmehse (*Parus montanus*) als sympatrische Zwillingarten. *J. Orn.* 114: 3–56.

Møller, A. P. 1989. Parasites, predators and nest boxes: facts and artefacts in nest-box studies of birds. *Oikos* 56: 421–423.

Moed, A. & Dawson, D.G. 1979. Breeding of Starlings (*Sturnus vulgaris*) in nest boxes of various types. *New Zealand J. Zool.* 6: 613–618.

Moss, W. W. & Camin, J. H. 1970. Nest parasitism, productivity, and clutch size in Purple Martins. *Science* 168: 1000–1003.

Murphy, E. C. 1978. Seasonal variation in reproductive output of House Sparrows: the determination of clutch size. *Ecology* 59: 1189–1199.

Nilsson, S. G. 1984. The evolution of nest site selection among hole-nesting birds: the importance of nest predation and nest competition. *Ornis Scand.* 15: 167–175.

Olsson, K. & Allander, K. 1995. Do fleas, and/or old nest material, influence nest-site preference in hole-nesting passerines? *Ethology* 101: 160–170.

Oppliger, A., Richner, M. & Christe, D. 1994. Effect of an ectoparasite on laying date, nest site choice, desertion and hatching success in the Great Tit. *Behav. Ecol.* 5: 130–134.

Perrins, C.M. 1979. *British Tits*. Collins. London.

Pinowska, B. 1979. The effect of energy and building resources of females on the production of House Sparrow *Passer domesticus* L. populations. *Ecol. Pol.* 27: 363–393.

Slagsvold, T. 1989. Experiments on clutch size and nest size in passerine birds. *Oecologia* 80: 297–302.

Slagsvold, T. & Lifjeld, J. T. 1988. Pied Flycatcher *Ficedula hypoleuca* prefer dry nest cavities. *Fauna Norvegica Ser. Cinclus* 11: 67–70.

Summers-Smith, J.D.: 1963. *The House Sparrow*. Collins. London.

Thompson, C.F. & Neill, A.J. 1991. House wrens do not prefer clean nest boxes. *Anim. Behav.* 42: 1022–1024.

Sammanfattning

Beläggning och häckningsparametrar för talgoxe Parus major och italiensk sparv Passer italiae i holkar av olika storlek

Bland hålhäckande fåglar påverkas valet av boplatser av flera faktorer såsom predationsrisk, fuktighet i bohålan, parasitförekomst, gammalt bomaterial och hållighetens storlek. Flera studier, de flesta på småfåglar, särskilt talgoxe, har gjorts av holkar med bottenyta från 25 till 314 cm². Hos flera arter har man påvisat att holkstorleken har effekt på kullstorleken och för talgoxe att den föredrar holkar som har en bottenyta större än 150 cm². Uppgifter om holkstorlekens inverkan på kullstorleken saknas för såväl gråsparv som italiensk sparv.

Denna studie syftar till att studera holkvalet för talgoxe och italiensk sparv för holkar med mycket olika bottenyta och håldiameter samt att studera datum för äggläggning, kullstorlek och häckningsframgång i de olika holkarna. Undersökningen utfördes 1990–1992 i tre områden med medelhavsvegetation i centrala Italien. Både talgoxe och italiensk sparv är stannfåglar året om i dessa områden, där talgoxen ofta lägger två och sparven tre kullar.

De två holktyper som användes var ”normala” (bottenyta 196 cm², håldiameter 3,7 cm; 62 stycken) respektive ”stora” (bottenyta 625 cm², håldiameter 6

cm; 20 stycken). De sattes upp i januari 1990, 3 m högt och 50 m från varandra, med de stora holkarna jämt spridda bland de normala. Holkarna kontrollerades veckovis i två och var femtonde dag i ett av områdena mellan 1 april och 7 juli.

Vi fann att sparvarna föredrog normala holkar framför stora i två av områdena, medan inga skillnader noterades för talgoxe. Det fanns ingen skillnad i läggningsdatum mellan normala och stora holkar för någon av arterna. Det fanns en tendens till större kullar i de större holkarna, men skillnaderna var inte signifikanta. Häckningsframgången var däremot lägre i de större holkarna för talgoxe medan det bara var en obetydlig skillnad för italiensk sparv. Skillnaden berodde på högre predation i de större holkarna. För talgoxe var predationen 33% i de stora mot 7% i de små holkarna, medan skillnaden var mindre 30% mot 17% för sparvarna, och den senare skillnaden var inte signifikant.

Att vi inte fick något svar på kullstorleken med ökad holkstorlek för italiensk sparv var väntat eftersom det är känt att arten liksom den närbesläktade gråsparven har ringa förmåga att modifiera antalet lagda ägg. För talgoxe hade vi däremot väntat en effekt av holkstorleken. Att denna uteblev kan bero på att talgoxen i Medelhavsområdet har mindre kullstorlek än i andra europeiska populationer, vilket kan ha buffrat yteffekten.