

Cavity-nesting black rats in distinct Corsican oak habitats and their potential impact on breeding Paridae

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Abstract. Black rats and avian cavity-nesters share the same nest boxes in different oak habitat types on Corsica. The proportion of boxes occupied by cavity-nesting rats did not differ between broad-leaf deciduous and evergreen oak woodland, but was higher in boxes with a larger entrance hole. Competition between black rat and avian hole-nesters on Corsica may be stronger in great tits than in blue tits.

Key words: *Rattus rattus*, competition, Corsica

Introduction

Different forms of interference or exploitation competition between avian species can have reproductive consequences at ecological or evolutionary time scales (Dhondt 1977, Dhondt & Eijckerman 1981, Doutrelant et al. 2000), and can vary spatially in relation to habitat characteristics (e.g. Rodriguez et al. 2007). Across-taxa interactions, including mammals attacking bird nests, can also be implicated in the expression of avian reproductive traits (e.g. Julliard et al. 1997, Fontaine & Martin 2006 and references therein). Whether mammalian hole-nesters have an important impact on avian reproduction, and whether this impact varies with habitat characteristics or species life-histories, remain largely unexplored issues (e.g. Juškaitis 1995, Koppmann-Rumpf et al. 2003, Sarà et al. 2005, Wesolowski & Tomialojć 2005, Juškaitis 2006).

In the Mediterranean region, blue (*Cyanistes caeruleus*) and great tits (*Parus major*) breed in habitat dominated by broad-leaf deciduous downy oak (*Quercus humilis*) and in habitat dominated by evergreen holm oak (*Q. ilex*). The two oak habitat types often differ in timing and amount of food available for breeding tits, which has consequences for the expression of life-history traits and reproductive success (Blondel et al. 2006, Lambrechts et al. 2008). Here we explore whether these two oak habitats also differ in the level of competition between mammalian and avian hole-nesters, with the assumption that this type of competition could be another environmental factor reflecting avian breeding habitat quality. Wild black rat (*Rattus rattus*) (e.g. Magnanou et al. 2006) and other mammalian cavity nesters (e.g. *Apodemus sylvaticus*, *Glis glis*) can exploit nest boxes that were erected for breeding Mediterranean great and blue tits (unpublished data). We examine and discuss the potential consequences of cavity-nesting black rats for tits breeding in Downy and Holm oak habitat on the island of Corsica.

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Material and Methods

Concrete avian nest boxes occupied by breeding blue and great tits and/or cavity-nesting mammals were visited following the basic protocols of the long-term monitoring program established in the Mediterranean region since 1976 (e.g. B l o n d e l & I s e n m a n n 1979, B l o n d e l et al. 2006). We present here data from broad-leaf deciduous and evergreen study plots situated in one valley (Muro) in Corsica (see L a m b r e c h t s et al. 2004 for details). Black rats with nest, and mammalian nests not occupied by a live animal during the nest box visit, were identified by 16 different observers between 2000 and 2004 (4.4 ± 1.5 observers per season). Mammalian nests consisted of tree leaves partly or completely filling the nest boxes. Because cavity-nesting mammals other than black rat were never observed during the study period in our study sites, we assume here that all mammal nests that did not contain a life individual were constructed by this species.

Small nest-box entrance holes can exclude some species from breeding. Our study focused on plots where half of the boxes had an entrance hole of 26 mm accessible for blue tits (D h o n d t & E i j c k e r m a n 1981). The other half of the boxes had an entrance hole of 32 mm, allowing larger mammals and great tits to occupy these boxes.

In the study period 2000–2004, plots were checked at least once a week from prior to nesting till the tit chicks leave the nest. Although nest boxes were cleaned after each breeding season, some boxes contained late tit nests that were still occupied after the monitoring period. Nest boxes containing old tit nests (i.e. from a former breeding season) were not considered in analyses. To increase sample sizes, data from sub-plots belonging to the same oak habitat type were lumped. We tested whether the percentage of avian nest boxes with mammal nests or live mammals differ between the two oak habitat types (downy versus holm) and the two nest box types (small versus large entrance hole) using general linear mixed models (GLMMIX with binomial error and logit link function, Type 3) (SAS V9.1, Windows). As the same nest boxes were monitored repeatedly each year of the study, this factor was included as a random term in the model. No observer biases in relation to oak habitat type or nest box type were noticed. The statistically non-significant interaction terms between oak habitat type and nest box type are not presented.

Results and Discussion

Black rats or their nests were observed during the first nest-box visits of the season, between 7 February and 5 April depending on the year of study (Table 1). Because of human intervention, the overlap between the black rat nesting season and the tit breeding season was low in our study system. Despite our efforts to remove all mammalian nest material from the avian nest boxes to

Table 1. The percentage of avian nest boxes with a mammal nest for habitat dominated by broad-leaf deciduous downy oak or evergreen holm oak, covering all nest box visits during a year. Percentages given for boxes with large and small entrance holes (see Methods). For boxes visited by mammals more than once during a season, only the first observation of the year was considered. Between parentheses is the number of nest boxes, cumulating the data from five study years.

Habitat type	Nest box type	% occupied
Holm oak	Small hole (265)	8.7
	Large hole (251)	21.1
Downy oak	Small hole (329)	7.3
	Large hole (325)	23.4

protect tits against competitors or parasites, 18.5% of the boxes that contained mammalian nest material prior to the start of the tit breeding season were visited by black rats more than once during the same season. We observed during five occasions, black rats building a nest on top of an unfinished tit nest between 28 March and the first of May, depending on the study year. Because cavity-nesting black rats fill up nest holes with tree leaves, and great and blue tits do not remove these nests, we assume that cavities occupied by black rats become unavailable for breeding blue and great tits (cf. J u š k a i t i s 1995 for other cavity-nesting mammals). In addition, black rats can have an important impact on avian breeding success on some islands in the Mediterranean region (e.g. I g u a l et al. 2006). We found dead tits in black rat nests twice early in the season without knowing whether the tits were present before mammalian nests were built. We also reported several cases of nest predation in our study system which could also be attributed to nest predators (e.g. weasel) other than black rat (L a m b r e c h t s et al. 2004). We therefore do not reject the hypothesis that the occupation rate of avian nest boxes by black rats could be an important additional factor influencing breeding habitat quality in Mediterranean Paridae. However, oak habitat type did not have a significant effect on the proportion of avian nest boxes occupied by mammals. The percentage of boxes containing a mammal nest prior to the tit breeding season did not differ significantly between the two oak habitat types ($F_{1,12}=0.06$, $p=0.81$). The same result was found for the percentage of boxes containing live rats during the monitoring period, which did not differ between deciduous and evergreen oak forest ($F_{1,12}=0.36$, $p=0.56$). The significant oak habitat type effect on tit breeding success previously observed in this Corsican landscape could therefore most probably not be attributed to spatial variation in the level of competition or predation between black rats and avian cavity nesters in different oak habitats (see also L a m b r e c h t s et al. 2004).

The impact of mammals on birds is determined by their encounter probability, which may differ between avian cavity nesting species because of several reasons (K o p p m a n - R u m p f et al. 2003, J u š k a i t i s 2006). Interestingly, the percentage of boxes containing a mammal nest prior to the tit breeding season was significantly higher for the boxes with the large entrance hole than for the boxes with the small entrance hole ($F_{1,12}=58.48$, $p<0.0001$). A similar result was found for the percentage of boxes occupied by one or more live black rats during the monitoring period (nest box type effect: $F_{1,12}=15.94$, $p=0.0018$). Both black rats and tits enter in nest boxes with an entrance hole of 32 mm, whereas only blue tits can easily enter in nest boxes with an entrance hole of 26 mm (see above). Rats occasionally increase the size of the entrance hole allowing both mammals and great tits to occupy these boxes. Encounter probabilities may therefore be influenced by the relative difference in avian and mammalian body size relative to the size of the cavity entrance hole. It also indicates that especially the larger great tits are more exposed to activities of mammalian hole-nesters in this study system, and that blue tits might avoid direct or indirect interactions with these mammals by occupying cavities with small entrance holes. These hypotheses could be tested in the future in study systems where black rats are not removed from avian nest boxes.

A c k n o w l e d g e m e n t s

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