The design of artificial nestboxes for the study of secondary hole-nesting birds: a review of methodological inconsistencies and potential biases


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Abstract. The widespread use of artificial nestboxes has led to significant advances in our knowledge of the ecology, behaviour and physiology of cavity nesting birds, especially small passerines. Nestboxes have made it easier to perform routine monitoring and experimental manipulation of eggs or nestlings, and also repeatedly to capture, identify and manipulate the parents. However, when comparing results across study sites the use of nestboxes may also introduce a potentially significant confounding variable in the form of differences in nestbox design amongst studies, such as their physical dimensions, placement height, and the way in which they are constructed and maintained. However, the use of nestboxes may also introduce an unconsidered and potentially significant confounding variable due to differences in nestbox design amongst studies, such as their physical dimensions, placement height, and the way in which they are constructed and maintained. Here we review to what extent the characteristics of artificial nestboxes (e.g. size, shape, construction material, colour) are documented in the ‘methods’ sections of publications involving hole-nesting passerine birds using natural or excavated cavities or artificial nestboxes for reproduction and roosting. Despite explicit previous recommendations that authors describe in detail the characteristics of the nestboxes used, we found that the description of nestbox characteristics in most recent publications remains poor and insufficient. We therefore list the types of descriptive data that should be included in the methods sections of relevant manuscripts and justify this by discussing how variation in nestbox characteristics can affect or confound conclusions from nestbox studies. We also propose several recommendations to improve the reliability and usefulness of research based on long-term studies of any secondary hole-nesting species using artificial nestboxes for breeding or roosting.

Key words: methods, nestboxes, nest sites, passerines, secondary cavity-nesting birds, field experiments, tit, flycatcher, Ficedula, Parus, Cyanistes

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Habitat and landscape characteristics affecting the occurrence of Ural Owls Strix uralensis in an agroforestry mosaic

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Abstract. Ural Owls inhabit mainly the large boreal forests of Eurasia. An isolated subspecies (S. u. macroura) occurs in the mountain beech forests of central Europe. Populations from the Carpathians seem to be expanding, and in recent decades, these owls (breeding and non-breeding) have also been found in the agroforestry landscape of the Central European Foothills and Uplands. The aim of our study was to analyse the influence of agroforestry landscape characteristics and the age of forest patches on the presence of breeding and non-breeding Ural Owls. The research was conducted in the Polish Carpathian foothills during 1996–2007. Breeding Ural Owls need at least 100 ha of forest situated far from human habitation, and at least part of such a forest should be over 60 years old. The forests inhabited by the Ural Owl were also frequently surrounded by other patches of forest connected by wooded corridors. Non-breeding Ural Owls did not exhibit any preference for some of the examined habitat characters. Hence, young owls probably have large dispersal abilities and spread randomly in the search for new territories. A positive dependence between the occurrence of non-breeding owls and distances from breeding territories shows that non-breeding birds can remain for some time in the vicinity of territories occupied by adult Ural Owls.

Key words: Ural Owl, forest, fragmentation, Carpathians, foothills

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INTRODUCTION

The distribution of organisms depends on the availability of habitats preferred by particular species. Some of the most important factors influencing species distributions are fragmentation and isolation of environment patches (e.g. van Dorp & Opham 1987, Hinsley et al. 1995, Rochelle et al. 1999, Zanette 2000, Tvorek 2004). The influence of habitat fragmentation and isolation on different aspects of biology and ecology was studied for many species, especially those inhabiting forest patches (e.g. Cieślak 1994, Haila et al. 1994, Mason 2001, Mazgajski & Rejt 2006).

In current climatic conditions, temperate zone forests should naturally cover most terrestrial areas (Olson et al. 2001), as was the case in the near past, so many species have adapted to large and non-isolated woodland (Pullin 2002). Recently, anthropogenic transformation of the environment has led to forest fragmentation and isolation. Some areas, particularly with a diverse terrain morphology (highlands, foothills), are characterized by a mosaic landscape structure — many medium-sized and small forests are connected by tree belts creating corridors along fields and river valleys. In consequence, species inhabit a network of scattered patches of preferred habitat. Ecological corridors may be used by species for migration and feeding (e.g. Todd & Cowie 1990, Suhonen 1993). The distribution of birds strictly dependent on larger forests (at least during the breeding season) may be limited by factors connected with (i) structure and/or forest age, (ii) patch size and level of forest fragmentation, (iii) isolation of woodland and (iv) pressure from raptors and competitors (e.g. Saunders et al. 1991, Hinsley et al. 1995, Newton 1998).

Among birds, diurnal raptors (Accipitres) and owls (Strigidae) are proper representatives of
Habitat and landscape characteristics affecting the occurrence of Ural Owls *Strix uralensis* in an agroforestry mosaic

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Among birds, diurnal raptors (Accipitres) and owls (Strigidae) are proper representatives of
Analysing large-scale temporal variability in passerine nest survival using sparse data: a case study on Red-backed Shrike *Lanius collurio*

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Abstract. Availability of nest survival estimates over large spatial and temporal scales is necessary for the complex modelling of population dynamics. However, there may be no standardized nest monitoring schemes, as a primary source of data, for many species, locations or years. Although other potential datasets often do exist, their applicability for analysing large-scale temporal patterns in nest survival is not well established. We used an alternative dataset of ringing records of 3,091 nests of the Red-backed Shrike *Lanius collurio*, representing five time series (6 to 42 years) from different sites within the Czech Republic, to analyse long-term variability in nest survival. We modelled trends in daily nest survival rates (DSR) over the years, either assuming a constant DSR, or accounting for unequal nest search efforts during the breeding season by assuming that DSR varies as a function of nest age and seasonal date. We found that even sparse nesting data may produce realistic estimates of nest survival. DSR varied greatly among sites, from 0.975 to 0.984, corresponding to a nest success from 48% to 62%. Both modelling approaches yielded almost identical estimates of DSR trends over the years. In this study, nest survival has either declined at all three agricultural sites or remained stable at one suburban site since the late 1980s. We conclude that sparse datasets with unequal searching effort during the nesting cycle and/or nesting season can be used to estimate long-term trends in nest survival, but this approach is warranted only if the analyses, based on different assumptions, yield consistent estimates.

Key words: Logistic exposure model, nest survival, Red-backed Shrike, *Lanius collurio*, ringing data, spatio-temporal variability, trends

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INTRODUCTION

Nesting mortality affects many aspects of avian reproduction and various measures of nest mortality/survival are often considered as potential predictors of avian life histories and population dynamics (reviews in Lima 2009, Martin & Briske 2009). Such analyses are contingent upon availability of usable nest survival data. These are usually obtained from standardized monitoring schemes such as the nest record scheme (e.g. Koskimies & Väisänen 1991, Wesołowski & Czapulak 1993, Crick et al. 2003). Given the absence of such schemes in many areas and time periods, it is often difficult to analyse large-scale temporal variability in nest survival, while generalization of site-specific estimates is hardly feasible.

Yet, alternative sources of potentially useful nest survival data sometimes exist, such as personal nest records of volunteer bird ringers. As these data are not systematically collected for nest survival analysis, the number of nest visits is often low, while nest-visit intervals are long and the searching effort is unequal during the nesting cycle and season. All these facts make the application of the simple Mayfield method (Mayfield 1975, Jehle et al. 2004) or even the apparent
Intraspecific variation in the wing shape and genetic differentiation of Reed Warblers *Acrocephalus scirpaceus* in Croatia

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**Abstract.** Wing shape plays a major role in determining the aerodynamics and performance of avian flight. Intraspecific variation in wing shape reflects different migratory strategies or distances between breeding and wintering areas. Differences in the wing morphology and genotypes between coastal and inland breeding populations of the Reed Warbler in Croatia were studied. A total of 105 adult birds were measured, while blood samples were taken from 59 individuals. The results showed that the two geographically close populations of Reed Warblers differ in wing morphology, with birds from the inland population having more pointed and more slotted wings than those from the coastal population. There was a slight but significant difference in microsatellite allele frequencies between the two populations (FST = 0.015), suggesting that gene flow between the two populations is partly restricted. The differences in wing morphology imply that the two populations use different migratory routes and/or winter in different areas. Consequently, this migratory pattern may have influenced the contemporary genetic differentiation of the two populations.

**Key words:** Reed Warbler, *Acrocephalus scirpaceus*, wing morphology, migration, microsatellites, genetic diversity

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**INTRODUCTION**

Wing shape plays a major role in determining the aerodynamics and performance of avian flight. Two conflicting constraints have decisive effect on the wing structure: the need for energy-efficient flight and maneuverability. Long, pointed wings cause less drag and permit faster flight, while short, broad wings allow better maneuverability in dense vegetation (Videler 2005). Wing shape is thus largely determined by a trade-off of opposing selection pressures derived from everyday flight requirements, resulting from habitat use, foraging, or predator evasion and, on the other hand, by the demands of annual migration. Comparative studies on different bird genera revealed correlations between migratory behavior and wing shape among species (Winkler & Leisler 1992, Lockwood et al. 1998), and demonstrated that migrants have more pointed wings (Marchetti et al. 1995, Mönkkönen 1995, Kaboli et al. 2007). Variations of wing shape in different songbirds reflect different migratory strategies or distances between breeding and wintering areas also at the intraspecific level. Northern populations have often longer and more pointed wings, while those of southern populations are more rounded (Pérez-Tris & Tellería 2001, Fiedler 2005, Arizaga et al. 2006). This variation is more pronounced in short-distance migrant species, but was recorded also in some long-distance migrants, such as the Reed Warbler *Acrocephalus scirpaceus* (Peiró 2003).

Long-distance migrants annually cover immense distances and their high movement potential enables them to exploit seasonally abundant resources in their breeding grounds and retreat to the non-breeding grounds to escape the harsh conditions of the boreal winter (Greenberg & Marra 2005). The regular journeys undertaken
Inter-specific egg recognition among two diving ducks species, Common Pochard *Aythya ferina* and Tufted Duck *Aythya fuligula*

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Abstract. According to the majority of studies, brood parasitism may have significant negative effects on the reproductive success of an incubating female. The ability to discriminate a parasitic egg in a nest could decrease breeding costs. We tested this ability in two species of diving ducks — Common Pochard and Tufted Duck — by adding experimental parasitic eggs of Mallard *Anas platyrhynchos*. Individual reactions were compared with control nests, where no parasitic egg(s) were added. We looked for three different reactions to the parasitic egg(s): (1) abandonment of the clutch, (2) ejection of the eggs from the nest and (3) acceptance of the eggs. In total, experiments with 15 Common Pochard and 24 Tufted Duck nests were carried out. The parasitic egg(s) (as well the brooding bird’s own) were ejected from a nest only sporadically, the most common reaction being to accept the eggs. Abandonment of the clutch proved to be the only negative reaction to parasitic egg(s), a reaction that occurred significantly more often in Tufted Duck clutches. The ability to identify parasitic eggs does not always need to be a profitable antiparasitic strategy. This strategy could lead to the abandonment of the clutch and could diminish the nest success of the host female.

Key words: inter-specific brood parasitism, *Aythya ferina*, *Aythya fuligula*, diving ducks, waterfowl, breeding strategy

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INTRODUCTION


Brood parasitism is classified as conspecific when the female lays egg in the nest of the same species, or inter-specific when the female lays egg in the nest of another species. The form of brood parasitism could be facultative or obligatory. In the case of facultative form of brood parasitism female lays parasitic egg/s and at the same time has her own nest. Obligatory brood parasite lays egg/s just in the nest of other birds. The only one known obligate parasite in precocial species is the South American Black-headed Duck *Heteronetta atricapilla* (Payne 1977, Davies 2000).

Of all bird families waterfowl show the highest frequency of conspecific brood parasitism (Lyon & Eadie 1991, Kear 2005). Inter-specific brood parasitism seems to be an accidental consequence of conspecific breeding parasitism and occurs in all waterfowl groups and in all geographic regions (Yom–Tov 1980, Rohwer & Freeman 1989, Geffen & Yom-Tov 2001, Kear 2005).

Variation in the rate of brood parasitism among species may be explained with differences in the costs and benefits of parasitism for the parasitic female (Sorenson 1992). Parasitism can have significantly negative or in some cases positive effects on the reproductive success of the incubating female. Negative effects include desertion, egg displacement and breakage or reduction of the host clutch (Weller 1959, Andersson & Eriksson 1982, Kear 2005) or it could decrease the survival of ducklings in larger broods. An enlarged clutch requires more energy for incubation in waterfowl (Erikstad & Tveraa 1995, Kilpi & Lindström 1997, Hanssen et al. 2003) and can have other costs. Brood rearing reduces future potential reproduction in ducks (Milonoff et al. 2004, Hanssen et al. 2005). Another negative effect of nest parasitism
Nest-site selection by Abbott’s Babblers *Malacocincla abbotti* in northeastern Thailand

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**Abstract.** Identifying nesting microhabitat variables associated with nest site choice is important for understanding bird-habitat relationships. We studied nest-site selection at two spatial scales along with structural vegetation variables associated with nesting success of the Abbott’s Babbler in north-eastern Thailand. Seventy-nine nests were found during the study. Ninety percent of the nests were placed in rattans (*Daemonorops* sp. or *Calamus* sp.). The vegetation and vegetation structure around nest sites (0.01 ha circular plots) were compared with those in areas surrounding the nest-site (4 x 0.01 ha circles), defined as a nest patch, and with randomly selected non-use sites. Nest sites had a significantly higher percentage of foliage cover and a greater cover and abundance of rattans, suggesting that Abbott’s Babbler sites its nests in areas with a large number of potential nest sites. There were no clear vegetational differences associated with successful versus failed nests, probably reflecting the diversity of local predators and their search patterns.

**Key words:** Abbott’s Babbler, *Malacocincla abbotti*, nest-site selection, nest success, breeding, Thailand

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**INTRODUCTION**

Identifying habitat or nesting microhabitat variables associated with nest site choice is important for understanding bird-habitat relationships (Martin 1988, Boulton et al. 2003). Nest predation is the major cause of reproductive failure for small birds, highlighting the importance of examining adaptations employed to reduce nest predation (Martin 1996, Jones & Robertson 2001). Selection of a suitable nesting site may determine failure or success of the breeding attempt. Many birds hide their nests or build them in inaccessible sites (Filliater et al. 1994, Flaspohler 1994) or within plant species where they have higher levels of concealment (Robinson et al. 2000a, Stutchbury & Morton 2001, Vigallon & Marzluff 2005). In some species the probability of nest predation varies with the species of plant that supports the nest and the location of the nest inside the plant (Martin & Roper 1988, Wilson & Cooper 1998, Farnsworth & Simons 1999). Presumably plant structure influences a predator’s ability to spot a nest and adult activity at the nest and, therefore, the extent to which vegetation obscures both nest structure and adult activity is expected to significantly affect nesting success. Thus, these patterns of habitat use are assumed to be the result of the process of natural selection (Martin 1988, Clark & Shutler 1999) because nest-site selection may have a direct influence on individual fitness.

The purpose of our study was to describe the characteristics of nesting microhabitat variables that influence the probability of the site to be used for nesting by a tropical passerine and whether there is any relationship between characteristics of the nest microhabitat and nesting success. We predicted, given the relatively high nest predation rates observed in tropical as compared with temperate passerines (Stutchbury & Morton 2001), that nests would be placed in denser vegetation and that successful nests would be more concealed and surrounded by more potential nest sites than those that fail (Martin 1993, Liebezeit & George 2002). These hypotheses were tested using the Abbott’s Babbler.
Reproduction parameters of the Great Bittern *Botaurus stellaris* in the fish ponds of eastern Poland

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Abstract. Reproduction of the Great Bittern *Botaurus stellaris* was studied in fishponds in eastern Poland from 2003 to 2009. Study areas were surveyed from March to early July, and the booming period of the Great Bittern was from March to July, varying between 58 to 108 days. The start of booming activity was linked to climatic factors. We visited 143 active nests in the study population, with the majority of females starting to lay eggs at the end of April to the beginning of May. The mean clutch size was 4.8 ± 0.8 (n = 109, range 1–6). There was no significant difference in clutch size between years or within years as the season progressed. Hatching success was high 92% (n = 78 broods). For all years of the study the breeding success (measured as a proportion of successful broods to all broods) was 51% (n = 120). The mean number of fledglings (15-days old chicks) per breeding female was 1.5 (SD ± 1.7, n = 116) and the mean number of fledglings per successful female was 3.0 (SD ± 1.2, n = 58). The main mortality factor for eggs and nestlings was mammalian predation. The high breeding parameters obtained for this population were probably due to extensive fish management and the good and stable food resources in the fishponds surveyed. Long-term monitoring and study of the population structure and breeding parameters of the Great Bittern in relation to known environmental factors are an essential tool for the conservation and management plans for this threatened species.

Key words: Great Bittern, *Botaurus stellaris*, breeding biology, fishponds, clutch size, predation

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INTRODUCTION

The Great Bittern *Botaurus stellaris* is a little known, solitary and secretive reedbed heron. This species differs in many aspects of ecology from other herons Ardeidae (Voisin 1991, Kushlan & Hafner 2000, Puglisi et al. 2003). The Great Bittern has a polygynous mating system and one to five nests of different females can be found within one male’s booming range (Gauckler & Kraus 1965, Puglisi & Bretagnolle 2005). Females do not receive any help from males in the care of the young (Cramp & Simmons 1977, Adamo et al. 2004, White et al. 2006, but see Klejdus 2007). Males have a long seasonal period of booming (vocalising) activity which apparently serves as an advertising call for territorial defence and mate attraction (Cramp & Simmons 1977, Gilbert et al. 2005b). Great Bitterns are generally reported to nest on wet vegetation stands with rich food resources such as fish, crustaceans, amphibians and insects (Gilbert et al. 2005a, Poulin et al. 2005, Poulin et al. 2007, Polak et al. 2008).

This species has recently attracted attention because of dramatic population declines throughout its range (Bibby & Lunn 1982, Tucker & Heath 1994, White et al. 2006). Great Bittern breeding populations have not yet recovered to the pre-decline level and this species still has high protection status (category 3 SPEC) in Europe (BirdLife International 2004). In Western Europe the main threat for Great Bittern is the progressive reduction of habitat availability due to the destruction or deterioration of wetlands (Voisin 1991, Kushlan & Hafner 2000, Puglisi et al. 2005). By contrast, in Eastern Europe, where large reedbeds and good Great Bittern populations remain, the over-exploitation of commercial reedbeds and the inappropriate, or changing management of fishponds are the key issues (White et al. 2006). Fishpond complexes are an important habitat for Great Bitterns in this part of Europe. Great Bittern is
Contrasting effects of climatic and habitat changes on birds with northern range limits in central Europe as revealed by an analysis of breeding bird distribution in the Czech Republic

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Abstract. The results of spatial modelling based on various climatic change scenarios predict shifts in the geographical ranges of species. Theoretically, a species can spread into new areas if the local habitat composition meets its ecological requirements. Therefore, habitat change in an unfavourable direction should inhibit climatically induced range shifts in some species. We tested this prediction using data on breeding bird distribution in the Czech Republic, a small central European country. We selected 28 species whose northern range limits are in central Europe and compared their distribution in the Czech Republic between 1985–1989 and 2001–2003. From these species, we identified 10 affected by habitat changes, such as a loss in environmental heterogeneity or agricultural intensification, using a local literature survey. As a group, the 28 species did not show any significant changes in their breeding distribution. However, those species affected by habitat change significantly restricted their distribution, whereas the remaining species not affected by habitat change increased their distribution. We suggest that the increasing occupancy of species not affected by habitat change could be caused by climate change. However, climate cannot overshadow the negative impacts of land-use changes on the distribution of species affected by habitat change. Therefore, such species could be seriously threatened: they might not be able to track their climatic optima if future climate change proceeds in tandem with the destruction of their habitats.

Key words: breeding distribution, atlas mapping, habitat change, global warming, range shift, birds

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INTRODUCTION

The abundance of birds generally decreases from the centre of their ranges towards the margins (Brown et al. 1995, McGill 2003), and the spatial distribution becomes patchier along this gradient (Blackburn et al. 1999). As abundance and isolation are among the most important predictors of population persistence (Lande 1993, Hanski 1999), populations near range margins are more prone to extinction compared to populations in other areas of their ranges (Thomas et al. 2008). It is thus not surprising that from a conservation perspective, species with distributional limits in a given country are common subjects of local conservation interests (Voršík et al. 2008). Conservation activities are consequently targeted to preclude a species’ extinction within a given country, i.e. to preclude a shift of their range boundaries in an unfavourable direction (Mac Donald & Service 2006). For such an effort to succeed, it is necessary to elucidate factors that are limiting the species’ ranges and drivers that are causing range shifts.

Many studies have described factors contributing to the emergence of distributional limits of geographic ranges for bird species (see Gaston 2003, for review). The most important include physical constraints (e.g. high mountain ranges or continental boundaries), biotic interactions with other species (e.g. parasites or competitors) and changes in habitat composition and landcover (Gross & Price 2000, Fuller et al. 2007). One of the most widely debated external factors limiting species geographic ranges is climate (Gaston 2003,
Delayed plumage maturation correlates with testosterone levels in Black Redstart *Phoenicurus ochruros* males

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Abstract. Black Redstart males usually have female-like (olive-brown) feathers during their first breeding season. This subadult coloration contrasts sharply with the grey and black feathers of the adults. To examine the proximate mechanisms of this phenomenon, known as delayed plumage maturation, we assessed levels of testosterone in circulating blood of subadult and adult males captured in Prague, Czech Republic. Analysis of 23 blood samples (performed by radioimmunoassay) collected during the molt, i.e., at the time of plumage development, revealed significantly higher testosterone levels in males molting to the adult color than in those molting to the subadult one. This may suggest a certain role played by testosterone in the regulation of delayed plumage maturation. However, there were no marked differences between males of different coloration and/or age during the breeding season. Analysis of 46 blood samples collected outside the molting period confirmed the seasonal testosterone pattern (spring peak and winter minimum) typical of most temperate passerines.

Key words: testosterone, delayed plumage maturation, Black Redstart, *Phoenicurus ochruros*

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INTRODUCTION

The plumage coloration plays a significant role in female mate choice (Sundberg & Dixon 1996, Greene et al. 2000). As a rule, brightly colored males are the preferred ones. Nevertheless, coloration of sexually mature yearling males is regularly dull or even female-like in numerous bird species including some turdids (Escalona-Segura & Peterson 1997). This phenomenon known as delayed plumage maturation (DPM) causes an obvious paradox concerning sexual selection. Regardless to their dull plumage, yearlings are as comparably attractive for females and successful in breeding and acquiring the territories, as are the adult males with fully colored feathers (Flood 1984, Nicolai 1994, Schwarzová & Exnerová 2004).

It was hypothesized that dull subadult coloration is favored by natural selection as its bearers are less likely and/or less severely attacked by their adult rivals (Selander 1965, Rohwer et al. 1980, 1983, Lyon & Montgomerie 1986). A contrasting explanation of DPM is proposed by the hypothesis suggesting that subadults reduce their overall investment in the first breeding event and therefore they lower energetic investment to the development of bright plumage during their preceding molt (Studd & Robertson 1985, Procter-Gray 1991).

Testosterone is an important steroid hormone affecting primarily timing and magnitude of the reproductive functions and associated morphological and behavioral traits (Gill 1990, Schwabl & Kriner 1991, Absil et al. 2003). Only high quality males are able to cope with elevated testosterone level that is supposed to suppress immune response according to immunocompetence handicap hypothesis (Folstad & Karter 1992, Roberts et al. 2004). Consequently, testosterone related traits are frequent subjects of mate choice and related reproductive decisions (Ligon et al. 1990, Enstrom et al. 1997, Foerster & Kempenaers 2005). Yearling
Responses of Reed Warblers *Acrocephalus scirpaceus* to non-mimetic eggs of different sizes in a nest parasitism experiment

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**Abstract.** Host rejection of parasitic eggs is the most important defence against avian brood parasitism. Here, we examined the influence of egg size differences between host and parasite eggs on egg rejection behaviour in a population of Reed Warblers *Acrocephalus scirpaceus* parasitized by Common Cuckoos *Cuculus canorus*. To this end, we experimentally parasitized host clutches using real Chinese Quail *Coturnix chinensis* and conspecific eggs. Both egg types were painted immaculate blue. The Chinese Quail eggs differed from host eggs in both size and colour, while the conspecific eggs differed only in colour. There were no differences in the rate of rejection rate of the two types of experimental eggs. However, Chinese Quail eggs were rejected primarily by nest desertion, whereas conspecific eggs were mostly ejected. Moreover, clutches with Chinese Quail eggs were deserted significantly sooner in comparison with the ejection of conspecific eggs. Therefore, egg size differences apparently affect the mode and speed but not the rate of egg rejection in this host population.

**Key words:** brood parasitism, Cuckoo, Reed Warbler, rejection behaviour, parasitic egg, egg size

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**INTRODUCTION**

Brood parasitism most often reduces host fitness dramatically. Therefore, there should be a strong selection pressure for evolving defences to minimize host reproductive costs (Rothstein 1990). In hosts of avian brood parasites, the most common defence adaptation is recognition and rejection of parasitic eggs (Rothstein 1975a, Davies & Brooke 1989, Moksnes et al. 1990), and several host species of the Common Cuckoo (hereafter Cuckoo) *Cuculus canorus* have evolved a fine-tuned rejection behaviour, where most individuals reject foreign eggs from their nests as long as they can be distinguished from their own eggs (e.g. Honza et al. 2004, Stokke et al. 2004, 2005, Antonov et al. 2006b). Therefore, rejection behaviour in these hosts is apparently more or less fixed with minor influence of conditional stimuli or age differences (Røskaft et al. 2002, Stokke et al. 2004, 2005). In contrast, other host species exhibit a pronounced variation in rejection behaviour both within and among populations, in which some individuals reject foreign eggs while others accept them even in cases where the parasitic egg apparently should be easily distinguished from host eggs (Stokke et al. 2005). One such host species is the Reed Warbler *Acrocephalus scirpaceus*, which ranks among the most commonly used hosts of the Cuckoo in Europe (Moksnes & Røskaft 1995). Previous studies have found a significant spatial and temporal variation in Reed Warbler egg rejection rate and level of parasitism (Davies & Brooke 1988, Davies et al. 1996, Brooke et al. 1998, Stokke et al. 1999, 2007a, 2008, Lindholm & Thomas 2000, Sklepowicz & Halupka 2009), and host individuals
Factors affecting habitat selection by breeding Lesser Spotted Eagles *Aquila pomarina* in northeastern Poland

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Abstract. We tested a hypothesis on the influence of prey distribution on habitat selection by the Lesser Spotted Eagle *Aquila pomarina* in north-eastern Poland during the breeding season. We analysed the habitat composition in schematic territories around the nests of 116 breeding pairs of eagles (in a radius of 3 km) and related them to randomly selected sites. Next, we compared the habitat requirements of potential prey species with the proportion of different prey categories found in the eagle’s diet. We demonstrated that, in contrast to random sites, eagle nests were located closer to the forest edges. The habitat composition of schematic territories of eagles was different from the random sites owing to the lower proportion of forest and higher proportion of meadows and agricultural land. The feeding habits of Lesser Spotted Eagles were opportunistic, and the diet was composed mainly of rodents (voles), insectivorous mammals (hedgehogs and moles), small birds, and amphibians. Small prey species (body mass below 50 g) and species indicating preferences for open habitats dominated in the diet of eagles (69% and 74% of prey captured respectively). Prey species inhabiting grasslands were hunted more frequently than species preferring agricultural areas. Moreover, eagle pairs nesting deep in the forest interior captured relatively more larger-sized species, whereas the proportion of small prey in the eagle’s diet increased as the distance of nest from forest edge decreased. We hypothesize that eagles have to breed closer to the forest edge to minimize energy expenditure and time associated with prey capture and delivery to the nest.

Key words: prey size, central place foraging, nest site, diet composition, agricultural land, forest, meadows, Białowieża Primeval Forest

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INTRODUCTION

Two main natural factors limit the number of breeding raptors: availability of nest-sites and prey abundance (Newton 1979). Both factors are related to habitat structure and quality. Most publications describe only habitat components affecting territory and nest site selection in birds of prey (Morris et al. 1981, Jędrzejewski et al. 1988, Sieg & Becker 1990, Bakaloudis et al. 2001, Langgemach et al. 2001, Brambilla et al. 2006). Only recently there has been growing awareness of the need to study influence of prey distribution and availability on habitat choice by predators (Ward & Gutiérrez 1998, Ontiveros & Pleguezuelos 2000, Rodriguez-Estrella 2000, Aschwanden et al. 2005, Katsner et al. 2006). Factors affecting the breeding territory choice are often related to the nest safety, but they are more important for passerine birds and species inhabiting open landscapes (Regehr et al. 1998, Rauter et al. 2002, Velando & Márquez 2002, Davis 2005). On the other hand, food resources are crucial for successful rearing of the offspring (Newton 1979, Rosenberg et al. 2003, Gil-Sánchez et al. 2004). If breeding territories of raptors are distributed randomly, then they will tend to optimize their effort related to prey delivery to the nest (Carlson 1983, Krebs & Avery 1985). Birds of prey can also locate their territories in the proximity of potential food resources, in order to minimize energy demands related to travelling between nesting site and hunting grounds (Sodhi 1992).
Does nest box location and orientation affect occupation rate and breeding success of Barn Owls *Tyto alba* in a semi-arid environment?

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Abstract. To date, nest orientation and location in hole-nesting birds have been studied mainly in temperate regions and in diurnal cavity breeders. Here we studied the effect of exposure, orientation, and habitat on nest box occupation and breeding success of Barn Owls in a semi-arid environment. The occupation of nest boxes varied with exposure and orientation. A higher percentage of occupation and more Barn Owl nestlings per breeding attempt were found in nest boxes located in the shade than in the sun, and in those facing east/north rather than other directions. The temperature in the nest boxes varied, being lowest in those located in the shade and in those facing east. Nest boxes located in crop fields fledged more young per breeding attempt than those located in date plantations. We suggest that the higher nest box occupation and number of nestlings fledged was probably due to the lower temperatures in those boxes, an important factor in a hot/arid environment, although alternative explanations are also considered.

Key words: Barn Owl, *Tyto alba*, nest box, orientation, exposure, semi-arid, occupation, nestlings, breeding success

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Birds may select their nest sites in specific locations and orientations that maximize their chances to breed successfully. For example, east-facing nest cavities are warmed in the morning, north-facing ones receive the least amount of sunlight, and south-facing ones receive the most (Raphael 1985, Dhondt & Philips 2001, Wiebe 2001). Directional preference and avoidance of particular nest sites has been reported mainly in temperate regions (e.g. McEllin 1979, Raphael 1985, Toland & Elder 1987, Plesnik 1991, Charter et al. 2007, Goodenough et al. 2008b) and to a lesser extent in arid regions (Austin 1974, 1976), where birds optimize sun exposure (Korol & Hutto 1984, Balgooyen 1990, Hooge et al. 1999, Ardia et al. 2006), thereby lowering incubation costs (Hartman 1988, Yom-Tov & Wright 1993). Furthermore, offspring quality may also differ in nests according to orientation (Goodenough et al. 2008a).

In addition to nest orientation, exposure to shade versus sunlight may be important in semi-arid environments, with nests receiving direct sunlight reaching higher temperatures (Hartman & Oring 2003, Burton 2007). Secondary cavity breeders are restricted by the nest site selection of primary cavity breeders, thus hindering studies of orientation and location of such secondary cavity nesters using natural cavities. Nest boxes provide an alternative for studying occupation and breeding success.

Barn Owls *Tyto alba* are cosmopolitan secondary cavity breeders that breed in a wide variety of natural cavities, such as holes in trees, caves and man-made structures (Taylor 1994, Meyrom et al. 2008), but also in nest boxes (Taylor 1994), making them an attractive species for study in a semi-arid environment. Furthermore, most studies have dealt with the effect of temperature on nest