Nestling food of European hole-nesting passerines: do we know enough to test the adaptive hypotheses on breeding seasons?

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Abstract. Hole-nesting passerines constitute a ‘model’ group for which importance of synchronisation between food availability — mainly caterpillars — and appearance of nestlings is commonly postulated. Is there an adequate set of data allowing one to prove this relationship? The recent climate change could lead to a mis-match between food peaks and nestlings’ appearance. Do the data exist that show that the birds have switched to other food sources? We analyse data on nestling food of eleven European hole-nesting passerines (158 papers). The diet of some species is hardly known (< 100 broods observed), there are large gaps in geographical coverage (70% of data from five countries — Germany, Russia, Slovakia/Czech Republic, Poland and Great Britain) and most of studies do not meet the minimum requirement of representativeness (three seasons, ≥ 20 broods/season), which limits their external validity. The majority of investigations were done decades ago, in different conditions and most probably they cannot be treated as representative for the current situation. There is no study in which the past (before warming) and current nestling diet in the same local population have been compared, so, direct empirical support for the ‘mismatch’ idea is rather weak. Knowledge of nestling diet and its variation is far from adequate and new, properly designed, studies are needed.

Key words: timing of breeding, caterpillar peak, climate change, Great Tit Parus major, Blue Tit Cyanistes caeruleus, Coal Tit Periparus ater, Crested Tit Lophophanes cristatus, Marsh Tit Poecile palustris, Willow Tit Poecile montanus, Redstart Phoenicurus phoenicurus, Pied Flycatcher Ficedula hypoleuca, Collared Flycatcher Ficedula albicollis, European Starling Sturnus vulgaris, Eurasian Nuthatch Sitta europaea

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INTRODUCTION

As early as sixty years ago Lack (1950) postulated that ‘the breeding season of each species of bird is adapted by natural selection to coincide with the season of the year when there is abundant food for its young and suggested that ‘the breeding season of tits is adapted to the caterpillar season’. Though several authors (Perrins 1965, 1970, Daan et al. 1988, Drent 2006) indicated that the availability of food for egg-producing females could be more critical, the original proposals of Lack have been regularly repeated in papers on the timing of breeding in passerines (e.g. Immelmann 1971, Zandt et al. 1990, Visser & Lambrechts 1999, Tremblay et al. 2005, Both & Visser 2005). To test the Lack’s adaptive hypothesis one has to study the composition of the nestling food in order to determine whether folivorous caterpillars are indeed an important food source for tit nestlings. Only after proving that some food type (e.g. caterpillars) plays an essential role in rearing young, it is justifiable to look for possible adjustments of the species’ breeding season to temporal variation in the availability of this food resource, to find out whether and to what extent synchronisation with its accessibility is critical for successful reproduction. However, do we know enough on nestling diet to test the adaptive hypotheses on the breeding seasons of hole-nesting passerines?

Varying spring temperatures are the most important factor influencing short-term variation both in the commencement of egg-laying by birds (e.g. Perrins 1973, 1991, Schmidt 1984, McCleery & Perrins 1998, Visser et al. 2006, Wesołowski & Cholewa 2009), and in the budburst timing of deciduous trees (review in Chmielewski & Rötzer 2001, Wesołowski & Rowiński 2006), the latter
Home range and habitat use by Aquatic Warblers *Acrocephalus paludicola* on their wintering grounds in Northwestern Senegal

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**Abstract.** The Aquatic Warbler *Acrocephalus paludicola* was once a common breeding bird in mesotrophic fen mires all over Central and Western Europe. In the last century large parts of its habitat have been destroyed by wetland drainage and agricultural intensification. Besides protecting the remaining breeding habitats, it is of great importance to preserve suitable migration stopover habitats and wintering grounds to avert the extinction of the species.

We determined home-range size and the use of vegetation associations of Aquatic Warblers on the wintering grounds in a flooded plain north of the Djoudj National Park in Senegal. Individual birds (11) were caught in mist nets and equipped with radio transmitters. Locations were assessed by radiotelemetry and a compositional analysis was conducted to determine which vegetation types were preferred within home ranges.

Similar to their behaviour on the breeding grounds, the Aquatic Warblers showed no territorial behaviour in their winter quarters. They used home ranges that averaged 4 ha in size, which they shared with conspecifics and other warblers. The home ranges overlapped 54% on average, with a maximum of 90% in an area used by four individuals. The vegetation structure of the wintering habitat is similar to breeding grounds and stopover sites of the species. Preferential vegetation had 80% to 100% cover and consisted of 60 to 90 cm high stands of *Oryza longistaminata*, *Scirpus maritimus* or *Eleocharis mutata*. Most birds stayed more often near the edge of open water, probably for foraging. A constant inundation seems essential, because Aquatic Warblers never occurred in desiccated parts of the study site.

**Key words:** *Acrocephalus paludicola*, Djoudj National Park, radio telemetry, transsaharan migrant, vegetation structure

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**INTRODUCTION**

The Aquatic Warbler is the only globally threatened passerine bird species in continental Europe. It is classified as vulnerable at the global level (BirdLife International 2008). The world population is estimated at 10,500–14,200 singing males (Flade & Lachmann 2008). As a habitat specialist the Aquatic Warbler breeds in mesotrophic or slightly eutrophic open fen mires as well as similarly structured marshy biotopes. In the 20th century these habitats have been destroyed by large scale wetland drainage and agricultural intensification. Today the Aquatic Warbler occurs in less than 40 regular breeding sites in only six countries (Tanneberger et al. 2009). The species has an extraordinary promiscuous mating system varying between polyandry and polygyny (Schulze-Hagen et al. 1999). Only the females provide parental care for the offspring and males do not occupy territories. At breeding sites, home ranges of individual birds can be up to 8 ha in size and are used by several birds (Schaefer et al. 2000).

The Aquatic Warbler is an insectivore. It forages near to ground in the cover of dense vegetation (Leisler 1975). The main prey species are among spiders Arachnida, dragonflies Odonata, beetles Coleoptera and caterpillars of butterflies Lepidoptera (Schulze-Hagen et al. 1989). Both in breeding grounds (Wawrzyniak & Sohns 1977) and at migration stopover sites (Kerbiriou et al. 2010) relatively large prey is preferred.

The currently most important wintering site of the species is the Djoudj National Park area in the Northwest of Senegal in Africa south of the Sahara in the western Sahel zone. Here the bird inhabits...
Ranging behaviour of non-breeding Eurasian Griffon Vultures *Gyps fulvus*: a GPS-telemetry study

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Abstract. Little is known about the spatial ecology and ranging behaviour of vultures in Europe. In this paper we used GPS satellite telemetry to assess home-ranges of eight non-breeding Eurasian Griffon Vultures in Spain, trying to answer the main questions on when (i.e. the time of the day), how far (i.e. hourly and daily distances) and where vultures range (i.e. home-range size). Results indicated that vultures ranged extensively mainly in areas where traditional stock-raising practices and pasturing were still common, also including some vulture restaurants, which were visited occasionally. Eurasian Griffon Vultures concentrated their hourly and daily movements in the middle of the day, when the availability of thermal updrafts was higher, favouring foraging activities. The overall foraging range, calculated as Minimum Convex Polygon (MCP) (7419 km²), or as 95% and 50% kernel contours (4078 km² and 489 km², respectively), was higher than those reported in previous studies. The precise knowledge of the ranging behaviour and spatial parameters is particularly important for the conservation of scavenger species inhabiting human-dominated areas where human activities may jeopardize vulture populations in the long term.

Key words: conservation, daily activity, home-range, satellite-tracking, Spain, spatial ecology

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INTRODUCTION

To date, Spain holds more than 95% of the European population of the Eurasian Griffon Vulture *Gyps fulvus*, and still maintains one of the healthiest populations of the scavenger guild all over the world (Ferguson-Lees & Christie 2001, Del Moral 2009). The Eurasian Griffon Vulture population has experienced an overall increase in the Spanish stronghold, where it has increased from 2283 to 25541 breeding pairs between the first censuses carried out in late 70s until present (Del Moral 2009). The species is globally and regionally catalogued as “Least Concern” (Del Moral 2009, BirdLife International 2011). Habitat loss, rural abandonment, intensification of farming practices, and rising of non-natural mortality caused by poisoning (Gangoso et al. 2009), pollutant ingestion (Hernández & Margalida 2008, Lemus et al. 2008) and collision with wind-farms (Tellería 2009, Martínez-Abraín et al. 2012), are the main threats to vulture populations (García-Ripollés & López-López 2011).

Traditionally, Spanish farmers have dumped organic remains of dead cattle in the so-called “vulture restaurants” or “supplementary feeding stations”. Vulture restaurants are broadly distributed all over inner Spain, mainly close to traditional livestock areas, and are commonly located in remote regions (García-Ripollés et al. 2004, review in Donázar et al. 2009). Although there are geographic variations in the management procedures, vulture restaurants normally work all over the year (at least in the study area) and the contribution of carrion is continued, varying usually from weekly to fortnightly. However, since the outbreak of the neurodegenerative disease in cattle, Bovine Spongiform Encephalopathy (BSE), mandatory regulations of the European Union led to the temporary closure of existing vulture restaurants in order to avoid the likely risk of transmission to humans (the Creutzfeldt-Jakob disease). Consequently, owing to this temporal food shortage, the populations of scavengers seem to have been affected, with survival and breeding success being reduced.
How many Aquatic Warblers *Acrocephalus paludicola* stop over in France during the autumn migration?

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**Abstract.** The autumn world population of the endangered Aquatic Warbler *Acrocephalus paludicola* probably numbers between 23,000 and 69,000 individuals, including 5,000 to 44,000 first-year individuals, depending on variation in breeding success and post-fledging survival. After breeding, the species migrates as early as August along a westerly route along French coast to reach its African wintering grounds. In 2009, French ringers have carried out targeted mist-netting to enhance the capture of the species, using tape luring in suitable habitats. Overall, 874 different individuals were captured in France in that year. In 2010 similar ringing effort allowed the capture of 646 different individuals. From this ringing information, we propose a simple method to estimate the number of individuals which stopped in France each year during the autumn migration, considering all birds or first-years only. Splitting the country in two parts (northern and southern), the method uses the total number of captures and the number of southern recaptures of birds first ringed in the north. Overall, we estimated that between 24,000 and 30,000 individuals — most of them in their first calendar year — stop in France each year during the fall migration. These estimates suggest that probably all first-year Aquatic Warblers migrate by this western flyway and stop in France to refuel, while adults may partly use a different flyway or may stop in France, but for shorter times or at fewer sites. The proposed figures highlight the importance of maintaining suitable refuelling habitats for the species all along coastal France.

**Key words:** *Acrocephalus paludicola*, capture effort, recaptures, refuel, ringing, stopover

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**INTRODUCTION**

The Aquatic Warbler *Acrocephalus paludicola* is the most threatened European migratory songbird (BirdLife International 2010). Its population has declined dramatically over the last decades, largely because of the drainage of its wetland breeding habitats. Most Aquatic Warblers use a western migration route in autumn (Dyrcz 1992), with large numbers visiting French coastal marshes mainly in August, where many important stopover sites have been identified (Julliard et al. 2006). In 2009, French ringers were invited to follow a standardized protocol dedicated to maximize captures of the species, using tape luring in suitable habitats. Classical extensive warbler ring-
Differences between the predictors of abundance, trend and distribution as three measures of avian population change

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Abstract. Changes in bird populations can be described as simple changes in abundance or density of individuals or, in larger areas, as changes of distribution or population indices. Although these measures describe different aspects of population change, they are often used interchangeably when discussing the relationships between various predictors of bird population changes found in different studies. This hampers a meaningful comparison of results, because it is unclear which differences between studies are biologically relevant and which are just methodological artifacts, caused by the different nature of measures used to quantify population changes. We compared predictors of the three measures of population changes: (i) change in abundance, (ii) change in magnitude of population trend and (iii) change in distribution, using data collected in a single region, the Czech Republic, and over similar time periods. We also aimed to identify significant drivers of population changes of Czech birds, using a large set of predictor variables and virtually all species regularly breeding in the region. No significant predictors were common across the three measures of population change tested. Abundance increased mostly in forest birds, while the change in magnitude of population trend was positive in species with a higher level of legal protection and in r-selected species. Species extending their distribution include wetland birds, above-ground nesters and north European species. Although individual measures of population changes are positively correlated, their predictors are different. This limits possibilities of simple comparisons, but also offers a better insight into forces shaping bird population changes in time and space.

Key words: abundance, distribution, population trend, population changes, land-use change

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INTRODUCTION

Biodiversity dynamics could be evaluated based on a wide array of measures (Magurran & McGill 2011), pertaining to species assemblages, individual species or genes. On the level of individual species, the majority of studies addressing dynamics of species in space and time, focus on analyses of long-term population changes. Such temporal changes in bird populations are best described as simple changes in abundance or density of individuals, but these are often quite difficult to quantify over larger areas. Therefore, other measures are frequently used as proxies for the population change, including changes in species distribution (or occupancy) or changes in various population indices (Böhning-Gaese & Bauer 1996, Lemoine et al. 2007, Kerbiriou et al. 2009, Koleček et al. 2010). One can also look at indices measuring the amount of population change over time to quantify the rate of population change (trend) and its temporal variation, i.e. dynamics of population change (Van Strien et al. 2001, Gregory et al. 2009). In summary, for a given time period, bird population changes are being characterized as change in (i) abundance, (ii) magnitude of population trend or (iii) distribution. These measures have been frequently used in the studies aiming to found the trait-based predictors of bird population changes (e.g. Donald et al. 2001, 2007, Sanderson et al. 2006, Lemoine et al. 2007, Bauer et al. 2008, Reif et al. 2008a, Kerbiriou et al. 2009, Van Turnhout et al. 2010).

Although they describe different aspects of population change, these measures are often used interchangeably when discussing various
Nest-sites used by Stock Doves *Columba oenas*: what determines their occupancy?

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Abstract. Nest-site preferences of the Stock Dove *Columba oenas* population breeding in holes excavated by the Black Woodpecker *Dryocopus martius* in three sites in western Poland was examined. During the surveys, 176 different trees with 326 holes of Black Woodpeckers were found and investigated. Habitat data at nest locations were characterized on a fine microhabitat scale — hole tree. We used individual selection indices and canonical variate analysis to describe nest-site preferences. Both analyses provided similar results. Nest-site selection of the Stock Dove was consistently associated with live beeches *Fagus sylvatica* with more than one hole. These features were clearly associated with diameter at breast height. Moreover, holes situated higher in tree trunk were preferred. Dead trees, mostly Scots Pines *Pinus sylvestris*, were avoided by the Stock Dove. We suggest that positive selection for smooth-barked beech trees with a number of holes, as well as holes situated higher might reduce the risk of predation by arboreal predators, e.g. the Pine Marten *Martes martes*. The positive selection for live trees, and clear avoidance of the dead ones, may reduce the cost of incubation and thermoregulation. Moreover, the live beech trees have long life expectancy compared to other tree species. Our results provide evidence that large alive beech trees with the number of holes excavated by Black Woodpeckers are necessary for maintaining breeding population of the Stock Dove.

Key words: Stock Dove, nest-site selection, woodpecker-made holes, Black Woodpecker, keystone species

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INTRODUCTION

Nest-holes excavated by woodpeckers are frequently used by secondary hole nesting species (Martin et al. 2004, Remm et al. 2006, Wesołowski 2007). Black Woodpecker *Dryocopus martius* is the largest European woodpecker species which creates holes large enough for several large and medium size secondary users, e.g. Stock Dove *Columba oenas*, Tengmalm’s Owl *Aegolius funereus*, Goldeneye *Bucephala clangula* and Pine Marten *Martes martes* (Lang & Rost 1990, Johnsson et al. 1993, Lange 1993, Zalewski 1997, Meyer & Meyer 2001, Christensen 2004). In Central Europe, the Black Woodpecker played a unique role in conservation of the Stock Dove which seems to be completely dependent upon its old holes as breeding sites (Lange 1993, Meyer & Meyer 2001, Kosiński et al. 2010).

The choice of a good quality nest-site is of vital importance for the probability of survival and reproduction and may be affected by many factors operating on different spatial scales (Johnson 1980, Block & Brennan 1993). Apart from different characteristics of the nest-sites affecting reproductive success at the microhabitat scale, the height of the nest-site above ground, smoothness of the bark and tree condition seems to be of primary importance in defining nest quality in hole-nesting birds. These specific, recognizable features of the environment may act as proximal cues to elicit a settling response from an individual bird (Block & Brennan 1993). Although, a dimension of the hole, its age and presence of old nest material
Faecal analysis as a method of nestling diet determination in insectivorous birds: a case study in Blue Tits *Cyanistes caeruleus* and Great Tits *Parus major*

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Abstract. Insectivorous birds have very diversified diet, but particular species usually show some specialisation, which leads to a varying level of dependence on special prey. Their reproductive cycles are dependent on the availability of appropriate arthropods; in the case of Blue Tits *Cyanistes caeruleus* and Great Tits *Parus major* reproduction is usually coordinated with the availability of caterpillars as the key food for nestlings. Therefore a picture of nestling diet, with some estimates of the actual frequency of caterpillars and alternative prey, is an important component of explanations of aspects of Tit life-histories. As in most cases a rough assessment of diet composition and relative proportions of prey items is satisfactory, we suggest that faecal analysis is a feasible method to get such a picture. Droppings may be collected to examine the diet of individual nestlings grouped in broods, at a particular age stage or at many stages reflecting development. The most time-consuming part of this method includes segregation and identification of prey remains in the laboratory. We draw attention to the procedures and the most diagnostically useful features of arthropod prey of Tits. Especially, we provide clues to identification of the remains of different arthropods. As an example, clypeus proved to be the most valuable structure to identify caterpillars, while chelicerae were the most diagnostically significant in Arachnids. Exemplary results on diet spectrum for the Blue Tit and Great Tit are also presented. Faecal analysis is fast and effortless at the sampling stage, with almost all effort being postponed to the stage of laboratory work.

Key words: *Cyanistes*, *Parus*, nestlings, food, arthropods, droppings, method, diet

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INTRODUCTION

Given the great diversity of herbivorous insects, food composition of insectivorous birds could also be expected to be very diversified (Morse 1971). Yet, usually particular species of insectivorous birds are specialised in exploiting a narrow spectrum of potential food base (Lack 1971, Cholewa & Wesolowski 2011), with the Blue Tit *Cyanistes caeruleus* and Great Tit *Parus major* being mostly tree canopy caterpillar exploiters during the nestling and post-fledging phases of their breeding period (Blondel et al. 1991, Perrins 1991, Bańbura et al. 1994, Naef-Daenzer & Keller 1999). The nestling phase is timed to occur at the time when energetic bottle-necks of breeding are relaxed by peak abundance of caterpillars (Nilsson 1994). The specialisation of Blue Tits and Great Tits in exploiting caterpillars undergoes natural selection (Perrins 1991, Van Noordwijk et al. 1995), which evidently results in distinct ecological and behavioural adaptations (Blondel et al. 1991, Bańbura et al. 1994, 1999, Nour et al. 1998, Garcia-Navas & Sanz 2010). However, it is also clear that some special nutritional demands of nestlings must be fulfilled by providing non-caterpillar prey, such as spiders or snail shells, which together with caterpillars constitute a balanced diet (Perrins 1979, Blondel et al. 1991). Too low supply of caterpillars, resulting from inter- and intra-seasonal variation in the trophic base, results in lower reproductive success (Perrins 1991, Blondel et al. 1991, Van Noordwijk et al. 1995).
Effects of land use on nocturnal birds in a Mediterranean agricultural landscape

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Abstract. Knowledge on the effects of land use on community composition and species abundance is crucial for designing realistic conservation strategies, particularly in highly dynamic systems such as Mediterranean agricultural mosaics that are subjected to intensive cultivation. We investigated these effects on the nocturnal bird species occurring in the study area (Stone Curlew Burhinus oedicnemus, Red-necked Nightjar Caprimulgus ruficollis, Barn Owl Tyto alba, Eurasian Scops Owl Otus scops, Little Owl Athene noctua, Tawny Owl Strix aluco, Long-eared Owl Asio otus, Short-eared Owl Asio flammeus and Eagle Owl Bubo bubo) across an agricultural-natural habitat mosaic in Central Spain for three consecutive years. Shares of vineyards, scrubland, herbaceous cropland, water bodies, and roads significantly affected the composition of the nocturnal bird community. Herbaceous cropland and olive groves, which covered 50% of the study area, proved to be neutral for all species. Remnant patches of natural and semi-natural scrubland (around 10% of the study area) and water bodies (only 1.5% of the study area) showed a positive effect on Eagle Owls, Eurasian Scops Owls, Long-eared Owls, and Red-necked Nightjars. Vineyard (35% of the study area) had a negative influence on Eagle Owls, Long-eared Owls, and Eurasian Scops Owls. Our results indicate, first, that the relative extent of land use types was apparently not related with the presence of nocturnal bird species and, second, that natural scrublands and water bodies are key habitats for assuring the persistence of nocturnal birds in agricultural Mediterranean landscapes. Current land planning focused toward land use intensification will likely increase the areas of habitats that are neutral or have adverse effects on nocturnal birds.

Key words: agricultural intensification, agricultural landscape, farmland, population conservation, owl, nightjar, Stone Curlew

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INTRODUCTION

The type of land use strongly affects bird community composition and species abundance (Coppedge et al. 2001, Benton et al. 2002, Webb et al. 2007). This effect might be particularly important in agricultural landscapes, as they are often heterogeneous and dynamically managed as a consequence of the farming practices (Meeus et al. 1990, Llausas et al. 2009). Land planners and conservation practitioners need guidance on effective ways to reconcile retention or enhancement of biodiversity in farming systems while maintaining economic productivity (Haslem & Bennett 2008, Rey Benayas et al. 2008). This may be challenging in landscapes subjected to rapid agricultural intensification, which has been repeatedly shown to be a major cause of species decline (Benton et al. 2003, Fox 2004, Wretenberg et al. 2007, Firbank et al. 2008). Mediterranean climates can make this challenge more difficult as a consequence of their characteristic extreme events (severe droughts and heat waves) which may affect habitat suitability for species (Saether et al. 2004, Giorgi & Lionello 2008).

Most of the species addressed in this study are regionally threatened or representing declining populations (BirdLife International 2004).
Fidelity to roost sites and diet composition of wintering male urban Common Kestrels *Falco tinnunculus*

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**Abstract.** During harsh winters, partially migratory raptors face making a decision whether leave their breeding sites or not. However, decision to leave brings advantages for maintaining own body condition, but also disadvantages for further reproduction. We studied individual variability in fidelity to roost sites during two winters. The kestrel males in České Budějovice (Southern Bohemia) roost near their breeding sites for most of the winter. Individuals occupy the same roost site continuously, unless they temporarily leave the city. We collected pellets at the males' roost sites from November to April in 1996/1997 and 1997/1998. We analysed the factors that affect males' presence (proportion of days with snow cover — PSC, snow depth and mean temperature). There were fewer absences, overall, in 1997/1998 than in 1996/1997, probably due to milder weather conditions, and better prey availability. Individuals responded differently to periods of snow cover; some males left the city but others remained. Males that remained had a higher proportion of non-vole prey (birds, insectivors and insects) in their diet compared to those that left. Moreover, the proportion of birds in diet was positively correlated with PSC in males that stayed at roost sites during the period with snow cover. We suggested that males able to feed on birds during snow cover could remain in the city in harsh winters, and this would give them an advantage during competition for breeding sites in the following spring.

**Key words:** diet composition, *Falco tinnunculus*, Kestrel, winter roost fidelity, urbanization

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**INTRODUCTION**

Mortality of wintering raptors largely depends on weather conditions and prey availability (Kostrzewa 1988). When the main prey becomes less available, raptors obviously exploit alternative ones (Village 1981, Angelstam et al. 1984, Korpimäki 1988, Jędrzejewski et al. 1994, Reif et al. 2001, Sánchez et al. 2009). When a snow cover occurs, vole eating specialists like Common Buzzard *Buteo buteo*, Common Kestrel *Falco tinnunculus* and Harriers *Circus* sp. shift to more available prey, such as carrion or birds (Kostrzewa & Kostrzewa 1991) or change their hunting techniques (Schipper et al. 1975). In partial migrants, some individuals leave the area and seek for a more suitable environment. However, a decision to leave breeding area is connected with disadvantages during following spring. For example, resident Common Kestrels in Scotland gained their mates earlier than migratory individuals (Village 1985). Similar results were obtained in Merlins *Falco columbarius* from Saskatchewan. On the other hand, non-migratory Merlins trapped in following summer were lighter than migratory ones (Warkentin et al. 1990).

The Common Kestrel is almost entirely migratory in northeast Europe. The northern limit of its winter distribution follows the line of the permanent winter snow cover (Village 1990). Populations breeding in Central Europe are partially migratory (Cramp 1987). Long-term data from the Czech Ringing Centre show that juveniles are migratory and leave their natal territories during late summer (Riegert 2008). Adult kestrels may or may not be migratory, with no apparent pattern. In agreement with results from other European countries, they usually stay at their breeding territories for a longer period than juveniles (Village 1990).

Among raptors, the Common Kestrel has settled in urban areas most successfully. Winter
Plumage bacterial load is related to species, sex, biometrics and fledging success in co-occurring cavity-breeding passerines

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Abstract. Plumage bacteria might influence the trade-off between parental and self-preening efforts in birds, therefore affecting breeding success. However, too little is known about natural variation patterns in plumage bacterial communities for these hypotheses to be thoroughly assessed. We studied the density and phylotypic richness of plumage bacterial assemblages in wild breeding populations of Pied Flycatchers *Ficedula hypoleuca* and Great Tits *Parus major* in the same area and breeding season, using flow cytometry and ribosomal intergenic spacer analysis (RISA). The density of plumage bacteria was higher in Tits than in Flycatchers, providing evidence that bacterial microflora differs even between co-occurring hosts that share habitat, nest site and foraging preferences. It is concurrent with the finding that migratory birds might have lower bacterial loads than sedentary birds. In both species bacterial loads were higher in females than in males, which along with two earlier studies, indicates the generality of this sex pattern. A negative correlation between parental body mass and the richness of feather-degrading bacterial phylotypes was found in Pied Flycatchers. In Great Tits, higher bacterial densities in the plumage of parent birds were associated with the production of fewer fledglings. However, the causality of these associations remains to be tested experimentally.

Key words: microbe-host interactions, feather-degrading bacteria, cavity nesters, Great Tit, Pied Flycatcher

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INTRODUCTION

Wild animals are colonized by a diverse community of bacteria and fungi (reviewed in Clayton 1999). As the impact of microorganisms on their hosts — both mutualistic and parasitic — can be high (Hackstein & Van Alen 1996, Nuttall 1997), a clear understanding of microbe-host interactions is crucial for explaining behavioral and reproductive variation in host populations. Recent evidence suggests that plumage bacteria play a role in shaping the life histories of wild birds (Clayton & Moore 1997, Muza et al. 2000, Burtt 2009, Gunderson et al. 2009, Peralta-Sanchez et al. 2010). For example, certain bacteria that live in bird plumages are capable of degrading feather keratin (Sangali & Brandelli 2000, Lucas et al. 2003b, Riffel et al. 2003, Shawkey et al. 2003) and plumage deterioration may result in decreased thermal insulation (Brush 1965, Booth et al. 1993), aerodynamic efficiency (Swaddle et al. 1996) or coloration-based communication (Shawkey et al. 2007, 2009). In the long-term, excessive bacterial load might reduce reproductive success either via changes in parental condition (Burtt & Ichida 1999, Muza et al. 2000, Gunderson et al. 2009), through the trade-off between reproductive effort and self-preening (Burtt & Ichida 1999, Merilä & Hemborg 2000, Muza et al. 2000) or because of hampered social communication and mate choice (Shawkey et al. 2009).

Relatively few studies have examined the factors shaping bacterial assemblages on avian plumage (see Muza et al. 2000, Shawkey et al. 2003, Burtt & Ichida 2004, Cristol et al. 2005, Lucas et al. 2005, Saranathan & Burtt 2007, Saag et al. 2011). For example, it has been noted that different bird species may host different bacterial communities in their plumage (Burtt & Ichida 1999, Muza et al. 2000, Whitaker et al. 2005, Shawkey et
Deteriorating weather conditions predict the use of suboptimal stopover sites by Aquatic Warblers *Acrocephalus paludicola*

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Abstract. The Aquatic Warbler *Acrocephalus paludicola* is a globally threatened songbird and its decline is related to habitat loss. Accordingly, most studies dealing with the stopover ecology of this species have been chiefly focused on the habitat use and the availability of suitable habitats along its route of migration. In contrast, much less attention has been paid to other environmental causes potentially explaining the use of stopover sites. Our aim here was to investigate whether the Aquatic Warbler at an apparently suboptimal stopover site with small area of suitable habitats stops over only or during adverse weather conditions. We used data obtained at a suboptimal (Jaizubia marshland, northern Iberia) and another optimal (Villefranque, southwestern France) stopover sites during the autumn migration over four seasons (2007–2010). The Aquatic Warbler tended to stop over at Jaizubia in days with rain, a fact that was not so evident at Villefranque, supporting the hypothesis that they used the suboptimal site only, or mostly, when adverse weather conditions forced them to land. In contrast, the optimal habitat was used independently of weather conditions. To properly identify key stopover localities for the Aquatic Warbler, we should consider the potential influence of adverse weather in occurrence of individuals, especially in small areas without preferred habitat.

Key words: migration, stopovers, tailwind, weather, rain, western Pyrenees

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The Aquatic Warbler *Acrocephalus paludicola* is a globally threatened songbird, with a population size probably less than 14,000 individuals (BirdLife 2004). It breeds across western Palearctic between 47° and 59° N, east of 22° E, and its wintering areas are found in central-western Africa, mainly in Senegal (Schaffer et al. 2006, Walther et al. 2007). The Aquatic Warbler migrates through western Europe and Africa, where the known stopover sites seem to lie in northwestern France (Julliard et al. 2006). Some other relevant stopover sites also exist in Iberia (Atienza et al. 2001, Jubete 2001).

The species decline is chiefly caused by habitat loss, especially through its western distributional range (Kloskowski & Krogulec 1999, Kozulin & Flade 1999, Kozulin et al. 2004, Tanneberger et al. 2008). Accordingly, many studies have dealt with the habitat use and the restoration of suitable breeding habitats (e.g., Tanneberger et al. 2006, 2009). In contrast, little is known about other factors determining its presence along migration route (but see Jubete et al. 2006).

Migratory performance is strongly determined by weather; in particular, migration mostly takes place in days without rain and with tail wind (i.e., wind assistance) (reviewed in Newton 2008). Thus, adverse weather could strongly influence landfall of migrants at given stopover sites. Such an effect should be expected to be much more pronounced in suboptimal stopover sites, where migrants would land only in case of “emergency”.

Our aim was to investigate whether at an apparently suboptimal stopover site with a very small area of suitable habitats, Aquatic Warblers tend to stop over only or mostly during adverse
Energetic and special-nutrient demands of parental birds and their offspring accumulate especially severely during the nestling phase of the breeding period (O’Connor 1984, Martin 1987, Perrins 1991). This generates a natural selection pressure on breeding at the time of the best availability of food (Lack 1954), but with some plasticity because there is a lot of variation in food abundance among habitats and years (Perrins 1991, Blondel et al. 1991, Banbura et al. 1994, Marciniak et al. 2007). At least in some years and some habitats, perhaps most years and habitats, the trophic base during the breeding season of small insectivorous passerines, like tits (Parus, Cyanistes and so on), is suboptimal (Perrins 1979). In view of life-history theory, under the influence of limited resources, different physiological functions are traded-off and the resources should be allocated first of all into the most basic functions, enabling nestlings to survive to fledging and, then, to sexual maturity and reproduction (Metcalf & Monaghan 2001, Brzeż & Konarzewski 2007). Body condition and health status of nestlings are critically important for their future prospects (e.g. Perrins 1979, Tinbergen & Boerlijst 1990, Tilgar et al. 2010).

Yet, producing healthy offspring of good physiological condition, being dependent on resource availability and rearing environment (Hörak et al. 1999, Ilmonen et al. 2003, Arriero 2009), is also traded-off with the own maintenance of parents (Karell et al. 2009). Experiments are necessary to disentangle the complicated relationships between ecological factors and physiological traits. There are different ways to manipulate components of nestling rearing environment, such as brood size manipulation (Hörak et al. 1999, Ilmonen 2003, Banbura et al. 2008) or food supply manipulation (De Neve et al. 2007, Karell et al. 2009, Brommer et al. 2011). The latter some-