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BLUE TITS *CYANISTES CAERULEUS* AND GREAT TITS *PARUS MAJOR* AS URBAN HABITAT BREEDERS

ABSTRACT

The Great Tit *Parus major* and the Blue Tit *Cyanistes caeruleus* are the only Western Palearctic Parids that maintain numerous urban populations as well as forest populations. Because of their evolutionary history both these species are best adapted to different types of deciduous and mixed forests. Ecological conditions in cities are different from those dominating in forests, especially in such aspects as: habitat fragmentation, tree species composition, microclimate, human activity, predators and food conditions. The tits breeding in cities start laying eggs earlier in the season, lay smaller clutches and fledge fewer fledglings of lower quality. Yet urban populations are often relatively stable in numbers. This may result from the fact that survival of winter is higher in cities due to increased availability of food and milder weather.

Key words: *Parus*, *Cyanistes*, urbanization, breeding, trophic conditions, mortality

INTRODUCTION

The Blue Tit and the Great Tit are the only parid species in the Western Palearctic that regularly use urban green spaces and even single trees amongst blocks of apartments as their breeding habitat. At the same time, they are abundant nesters in different types of forests. Both the Blue Tit and the Great Tit evolved as forest species, adapted to conditions of deciduous and mixed forests (Perrins 1979, Cramp and Perrins 1993, Gosler 1993). Although phylogenetic lineages of the genera *Parus* and *Cyanistes* diverged several million years ago and the species *Parus major* and *Cyanistes caeruleus* themselves exist for less than one million years (Packert et al. 2007, Illera et al. 2011, Tietze and Borthakur 2012), it is evident that current ecological adaptations of both these species, like other forest birds, evolved under selection pressures occurring in forest habitats of the Western Palearctic after the Pleistocene glaciations (Blondel and Mourer-Chauvire 1998, Yalden and Albarella 2009). Blue Tits and Great Tits survived the last glaciation in the Iberian and Balkan refugia, but also in Corsica. From those refugia they colonized continental Europe following subsequent stages of post-glacial forest development (Kvist et al. 1999, 2004).

Urban habitats suitable for breeding tits constitute a much more recent phenomenon. Although towns are known from ancient times and the human population of the city of Rome was as large as 1 million people in the 2nd century of the present era, the number of people dwelling in cities has grown gradually, only in 2010 did the urban human population outnumber the non-urban population (Liszewski 2012). Because of defensive fortifications, European towns have long been very compact and almost devoid of trees, parks first appearing in 18th and 19th centuries (Ostrowski 2001). Subsequently, older towns expanded and new towns were designed with the deliberate creation or inclusion of tree-covered areas for public or restricted use (Ostrowski 2001). This resulted in the creation of urban habitats suitable for more versatile forest bird species.

Although both the Blue Tit and Great Tit are strictly insectivorous during the breeding season, they become opportunistically omnivorous and even granivorous during winter when most foraging is performed outside of forest habitats, increasingly in human settlements (Perrins 1979, Cramp and Perrins 1993, Gosler 1993). It is probable that they were non-breeding-season visitors originally rather than breeders in towns and in human settlements, and that they started to opportunistically nest there as long as adequate tree-covered patches were available. The ecological flexibility and opportunism of Great and Blue Tits suggests that they did not undergo a gradual process of city colonization, like the Wood Pigeon *Columba palumbus* (Tomiałojć 1976) or the Blackbird *Turdus merula* (Evans et al. 2010).

ECOLOGICAL CONDITIONS FOR URBAN BLUE AND GREAT TITS

There are essentially two main conditions for the two tits to breed: (i) availability of holes to construct nests and (ii) availability of herbivorous insects for nestlings. Tree cavities are the most typical nest location, but in some forests nesting in burrows, rock crevices or spaces between fallen tree logs has been observed (Wesołowski 1989, Perrins 1979, Gosler 1993, *pers obs*). The most important nestling food is caterpillars with some admixture of other arthropods (Perrins 1979, 1991, Cholewa and Wesołowski 2011), but even in this respect both the species are flexible and opportunistically exploit other abundant prey, for instance stick insects in Mediterranean forests or aphids in central Poland (Bańbura et al. 1994, 1995, own unpublished obsertvations). Such plasticity seems a good basis for competition-dependent rearrangements of behavioural reactions that are useful, perhaps necessary, for living in human-modified habitats.

Urban habitats differ from primeval woodland conditions, with a tentative list of major contrasts in ecological factors important for tit lifecycle being shown in Table 1. The habitat contrast includes tree species composition and the form of tree cover. Tree species present in cities are usually not a random sample from original forest characteristic for the area in question; they are often deliberately chosen for their utility

features and attractiveness. In addition, they undergo special care treatments and are arranged in lines or patches enhancing fragmentation. This results in changes in insect assemblages associated with them, usually a reduction in numbers and diversity of original assemblages (Robinson 2005). This would include caterpillars which are the key food of nestling tits. As a result of urban tree care practices, the number of potential nesting cavities is also reduced. On the other hand, city parks and even street trees are often supplied with nest-boxes, which creates nesting sites that are readily accepted by Blue and Great Tits. Because of tree cover fragmentation, sunshine often operates directly on the nest-boxes, probably enhancing the effects of relatively benign urban microclimate (Bezzel 1985, Moller 2009, Moller and Ibanez-Alamo 2012). In addition to all these human influences, the city environment is also characterized by pedestrian traffic as well as chemical pollution and noise, produced mostly by heavy vehicle traffic and industry (Bezzel 1985, Moller 2009).

Table 1. Comparison of major features of forest and urban habitats of Blue Tits and Great Tits

Feature	Forest	Urban green space
Tree species	Typical of geographic area	Selected for visual attractiveness and special utility; often exotic
Structure of tree cover	Large-scale continuous with some natural gaps	Highly fragmented, even only single trees
Climatic factors	More severe	Milder
Human influence	Negligible	Very important
Predatory animals	All kinds, including nest predators, abundant	Domestic cats and corvids
Food resources during breeding (caterpillars)	Rich but variable between years	Poorer, variable
Food resources during non-breeding time (including winter)	Poorer, sometimes very difficult to find	Richer
Nest holes	Numerous holes of variable types	Fewer natural holes, numerous nest-boxes and other artificial cavities

Urban habitats differ markedly form forests with respect to predatory mammals and birds. Except human vandalism, depredation of Tit nests seems uncommon, even in large parks, while it happens frequently in forests (Wesołowski 2007). Predation on inexperienced fledglings just after leaving nests is probably more important in cities, as it is performed by domestic cats and corvids that are often very common and numerous there (Luniak 2004, Moller and Ibanez-Alamo 2012). This is also a period of increased risk for young Tits in forests (Perrins 1979). A relatively high risk of predation on Tits in forests all year round is combined with more severe weather conditions and lower availability of food during winter than in urban habitats. While breeding time food, especially caterpillars, is usually less abundant in city trees and bushes than in forests (Marciniak et al. 2007), during winter cities provide Tits with richer food resources,

ranging from frequent supplying deliberate feeding stations to various by-products of human activity (Robb et al. 2008).

BLUE TIT AND GREAT TIT POPULATIONS IN CITIES

Because of the fragmentation of urban tree cover it is often difficult to assess Tit population density, but it seems that at least in parks and residential areas it tends to be higher than in forests in the same regions (Tomiałojć and Profus 1977, Schmidt and Steinbach 1983, Hedblom and Soderstrom 2012, *pers obs*). The fact that urban conditions are more favourable to wintering birds than forest conditions is likely to result in a reduced tendency to migrate and disperse (Luniak 2004). Data on migrations, dispersion, isolation and connections between urban and forest populations of Tits are scarce and those concerning Great Tits are not consistent but suggest that urban park populations are self-sustaining, with some interchange with forest being possible (Schmidt and Steinbach 1983, Schmidt 1988, Bjorklund et al. 2010). A strict correlation between density of urban park and forest Great Tits and lack of such a correlation in Blue Tits in Łódź (*pers. obs.*) suggest that the population systems of both these species may work in a different way. This possibility needs further studies.

Although it is well known that Great Tits and Blue Tits may breed in a great array of strange places in cities, including street lamps, fence pillars, building wall cracks, post boxes and so on, almost no reliable scientific data are available on the resulting reproductive success. In a suburban area of Warsaw, fence pillars constructed of vertical metal pipes provided nesting space for almost 80% of breeding great tits and 12.5% of blue tits (Lesiński 2000). The average number of fledgling great tits found by Lesiński (2000) for pillar-located nests was lower than for nest-boxes (5.6 and 7.9, respectively).

The data on tit reproduction that were published for city habitats concern mostly nest-box populations breeding in city parks or gardens in residential areas (Perrins 1965, Cowie and Hinsley 1987, Luniak et al 1992, Solonen 2001, Marciniak et al. 2007, Hedblom and Soderstrom 2012). A meta-analysis of bird productivity in urban habitats shows some consistent patterns of variation in Blue Tits and Great Tits (Chamberlain et al 2009). In comparison with forest habitats, urban populations of both species start breeding earlier in spring, lay fewer eggs per clutch and produce fewer fledglings of lower quality. Physiological condition of urban tit nestlings was shown to be lower in comparison with forest nestlings (Nadolski et al. 2006, Bańbura et al. 2007). These effects are most probably a consequence of poorer trophic conditions of city parks as compared to forests (Marciniak et al. 2007). This is consistent with the well-established idea that the optimal breeding habitat of Blue Tits and Great Tits is the deciduous forest (Perrins 1965, 1979), the habitat to which both these species are adapted, as discussed above.

Yet, Great Tits and Blue Tits seem to be rather successful city birds (Bezzel 1985). Large broods of the Tits are a life-history trait typical of species characterized by high

and unpredictable mortality (Stearns 1992). High population fluctuations recorded in the Tits have been suggested to be dependent on the survival in the non-breeding season (Perrins 1965, Orell 1989). Because of the high availability of food, lower predation and milder climatic conditions in cities, urban Blue Tits and Great Tits may survive better than in forests. Horak and Lebreton (1998) found such an effect in Great Tits in Estonia. The same is most probably true of Blue Tits. This suggests that mortality and productivity may be less variable in urban park populations of tits, which can potentially make their populations more stable than in forests.

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